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Abstract

Caring has its most obvious effects when it is actually required. Yet the effects of care are likely to extend to other periods of the life course. People may anticipate the need to provide informal care, either as part of their fertility decisions, or in response to deteriorating health of loved-ones. Similarly, a reason given for high savings rates among the elderly is the desire to self-insure against the costs associated with adverse health shocks, including the need for (expensive) formal care. Furthermore, both informal care and incapacity demanding care can have effects that persist well after the actual episodes of care are past, for example, due to labour market scarring and/or depleted savings. This study uses current best-practice methods of economic analysis to explore these phenomena, focussing on the channels of employment and savings.

Keywords: Social care, childcare, aging, projections, life cycle
JEL codes: J11, J13, D15

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1 Introduction

Giving and receiving care are defining features of life. They shape who we are, and can profoundly affect diverse aspects that bear on life quality, including the two key margins of economic decision making: labour/leisure and consumption/saving. The demographic transition toward older populations that is now taking place throughout OECD countries will profoundly alter the demand and supply of care. This study uses current best-practice methods of economic analysis to consider the likely implications of contemporary population aging in the UK for care, and associated employment and savings decisions.

At the turn of the 20th century, approximately 5% of the UK population was aged 65 or over, and less than 2 in every thousand was aged 85 or over. Since then, the proportion of the population aged 65 or over has increased by almost 4 times (to 19%) in 2022, and by more than 10 times (to 2.5%) for the population aged 85 or over. Furthermore, the trend toward an older population is projected to continue into the next century, with the proportion of people aged 65 and over projected to exceed 30% in the early 2100s, and those aged 85 and over projected to account for almost 1 in 10 people in the UK.[1]

The trend toward older populations has been driven primarily by increases in longevity, reinforced by declining fertility. Life expectancy at birth in the UK increased from 66.2 (70.9) years for men (women) born in 1950 to 79.0 (82.7) years in 2012.[2] Similar increases in life expectancy have been observed in North America, and slightly higher increases in other Western European countries. Furthermore, although increases in life expectancy in the UK plateaued during the decade to 2023, official projections anticipate a return to growth of approximately 0.1 year of life for each consecutive cohort born between 2024 and 2070.[3]

At the same time, fertility rates in the UK fell precipitously from just under 2.93 children per woman in 1964 to 1.69 in 1977, and have since displayed a moderate downward trend to 1.57 in 2022.[4] The rates since 1977 have been well below replacement (2.1), which exaggerates population aging. Furthermore, the persistence of recent shifts in fertility has come as some surprise to social planners. The Office for National Statistics (ONS) projected that the UK total fertility rate in 2040 would be 1.89 when projections were made in 2014, falling to 1.84 in the 2016 projections, 1.78 in the 2018 projections, and 1.57 in 2020 projections.[5]

The shifts in longevity, fertility, and population aging outlined above have wide-ranging implications for social planning. In this context, considerable attention has focused on the implications for care arrangements. OECD (2022), for example, projects that public spending

[1] ONS population estimates and principal population projections available in 2023. See Appendix B.2, Figure

[2] Period life expectancies evaluated on year specific data reported by the United Nations, Population Division, Department of Economic and Social Affairs, World Population Prospects 2024.

[3] ONS, Expectation of life, 2020 principal population projections, UK, period life expectancies.

[4] World Bank, World Development Indicators, SP.DYN.TFRT.IN

[5] See Figure B.1 of Appendix B.

on long-term care across the 27 EU countries will increase from 1.7% of GDP in 2019 to 2.8% in 2070. Projected increases to 2070 vary widely by country, from near zero in Greece, Latvia and Bulgaria, up to 2.7% in the Netherlands and 3.4% in Denmark.

Similar projections to those discussed above have been reported for the UK. The Office for Budget Responsibility, for example, reports in the most recent *Fiscal Risks and Sustainability Report* that adult social care spending is projected to rise from 1.5% of GDP in 2028/29 to 2.4% by 2073/74 (OBR, 2024). This increase is attributed to "a combination of demographic pressures and real-terms unit cost growth". See also Charlesworth *et al.* (2018) and Rocks *et al.* (2021).

The modelling work underling the projections outlined above is often thinly documented. In the case of UK projections, for example, much of the underlying modelling work has been conducted using models developed at the Personal Social Services Research Unit (PSSRU). The most recent publicly available description of a PSSRU model used to generate social care projections is Wittenberg *et al.* (2006), which may now be out of date.[6] Nevertheless, what documentation there is suggests that models typically used to project social care into the future share a common analytical approach.

That approach involves combining existing population projections with statistical descriptions concerning the incidence of care and exogenous assumptions about how care needs will evolve into the future. Key assumptions underlying the OECD (2022) projections, for example, are that "half of the future gains in life expectancy are spent in good health and an income elasticity of health care spending is converging linearly from 1.1 in 2019 to unity in 2070" (p. 210). Modelling assumptions like these help to provide a "statistical projection" of what care needs may be into the future, and have the advantage of connecting in an ostensibly transparent fashion disparate statistical evidence to obtain inferences for tertiary subjects of interest. Although the abstractions associated with such methods are generally transparent, they also risk obscuring important features concerning the influence of caring through the life course.

Specifically, although caring has its most obvious effects when it is actually required, the effects of care are likely to extend to other periods of life. People may anticipate the need to provide informal care, either as part of their fertility decisions, or in response to deteriorating health of loved ones. Similarly, a reason given for high savings rates among the elderly is the desire to self-insure against the needs consequent on adverse health shocks, including the need for (expensive) formal care.[7] Furthermore, both informal care and incapacity demanding care can have effects that persist well after the actual episodes of care have ended due, for example, to labour market scarring and/or depleted savings.

This study uses current best-practice methods of economic analysis to explore the life course effects associated with the demand and supply of care. The life-course perspective

[6] See European Commission (2021) for model approaches underlying the previously cited OECD (2022) projections.

[7] See De Nardi *et al.* (2021).

considered for analysis is designed to account for *ex-ante* effects associated with anticipation of the possibility of future care needs and responsibilities, the influence on individual circumstances while care is needed, as well as *ex-post* effects after care needs have passed.

Analysis is based on projections for the prospective half century derived from a dynamic microsimulation model. The effects of care are explored by comparing the central projections against projections generated under alternative sets of assumptions concerning agent behaviour. Comparisons of interest include the effects on employment and savings of alternative sources of demand and supply of care through the life-course, and across the income and wealth distributions. All materials used for the study are fully-open source, and a step-by-step walkthrough to replicate reported results is provided in Appendix E.

The remainder of the study is organised as follows. Section 2 discusses the statistical background for the study, focussing on the influence of alternative forms of care on the life course. The approach taken to model care is described in Section 3 and results are reported in Section 4. A summary and directions for further research are provided in Section 5.

2 Statistical Background

The current study focusses on two forms of care: childcare and social care. Childcare refers to provision of care for dependent children, and includes formal care provided by creche, nursery, or childminder services, and informal care provided by parents, family, or others. Social care refers to the provision of personal care, social work, protection, or social support services to people in need or at risk, including older people with needs arising from illness, disability, or poverty.

2.1 Childcare

Figure 2.1 displays the incidence rates of respondents to the Family Resources Survey (FRS) – an annual household survey which collects information on a representative sample of private households in the United Kingdom – who reported paying for childcare. Statistics are distinguished by survey year, employment status and age of children, during the period for which data are available.[8] The figure indicates no strong trends for the reported series, with 2020 being an outlier due to the COVID-19 pandemic.

The two panels of Figure 2.1 show that incidence rates of formal childcare vary inversely with child age and positively with employment status of adult members. Panel A of the figure reports that approximately 60 per cent of benefit units with all adult members in full-time work and with children under 5 years of age[9] pay for childcare. This incidence falls to approximately 40 per cent for benefit units with children aged between 5 and 9 years, and 20

[8] Similar statistics calculated using data from the Living Cost and Food Survey (LCF) are reported in Appendix B.1.

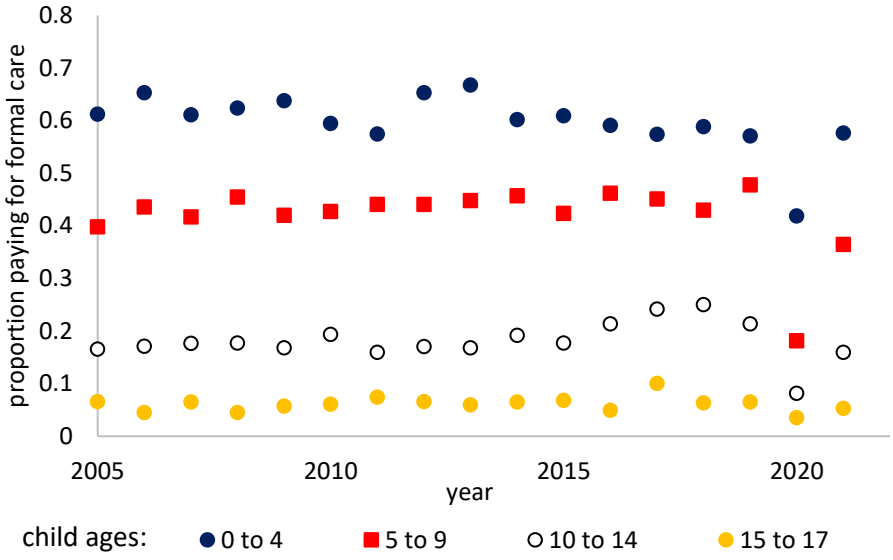
[9] School typically starts in the UK in September following a child's fourth birthday.

percent for children aged 10 to 14 years. Similarly, comparing Panels A and B of the figure indicates that the proportion of benefit units with children under 5 years of age that pay for childcare falls from 60 to just over 40 per cent when at least one adult is not full-time employed.

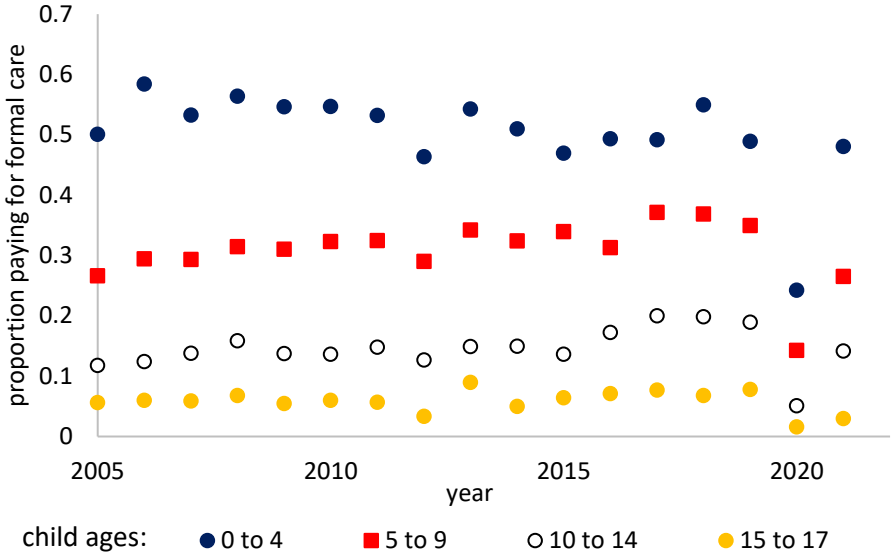
Figure 2.2 provides further detail concerning the variation of incidence of formal childcare costs by child age and parental employment status. This figure indicates the incidence of childcare peaks for children aged two years, at 70% for benefit units in which all adults are full-time employed. The incidence of formal childcare is slightly lower for benefit units in which all adults are employed but at least one does not work full-time, and sharply lower for benefit units with at least one adult is not employed.

Summary statistics for the scale of childcare costs, where costs are incurred, closely mirror the incidence statistics discussed above (see Appendix B.1). Specifically, benefit units with children aged 0 to 4 years and where all adults work full-time report paying the highest childcare costs on average, equal to £42.87 per week (2015 prices, equal to 9% of average weekly earnings).[10] This decrease to £23.44 per week for benefit units with children aged 5 to 9 years, and £8.27 for those with children aged 10 to 14 years. Similarly, smaller childcare costs are reported by benefit units where at least one adult report not working full-time: those with children aged 0 to 4 report average childcare costs of £23.80 per week, and those with children aged 5 to 9 report average costs of £12.06 per week.

[10] Statistics evaluated on FRS data reported between 2005 and 2019. Average total pay was £484 per week in October 2015; see Office for National Statistics.



Panel A: All adults full-time employed



Panel B: All adults employed, but not full-time

Figure 2.1: Incidence of childcare costs among benefit units reported by the Family Resources Survey (2005-2021), by year, child age, and adult employment status

Source: Authors' calculations on data from the Family Resources Survey.
Notes: Weighted averages across population subgroups. Population subgroups mutually exclusive by year and adult employment status, but not by child age, so that a benefit unit with multiple children of different age groups will contribute to averages in multiple statistics reported in the figure.

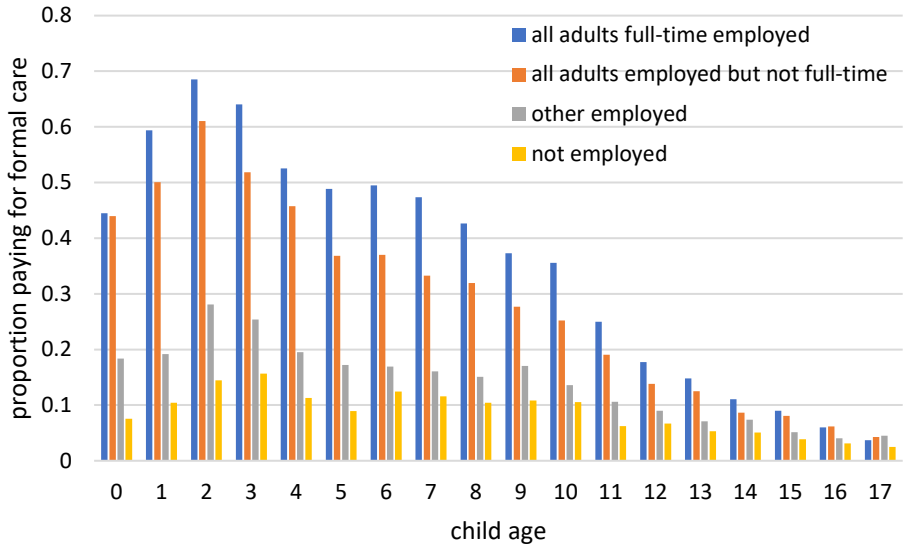


Figure 2.2: Incidence of formal childcare by child age and adult employment status; pooled data reported by the Family Resources Survey 2010-2019

Source: Authors' calculations on pooled data reported at annual intervals by the Family Resources Survey.
Notes: See Figure 2.1.

2.2 Social Care

2.2.1 Receipt of social care

Summary statistics describing receipt of social care are reported in Table 2.1. Data describing receipt of social care are predominantly reported for individuals late in life (see Appendix A for details). The FRS is conspicuous in this regard, as it provides some information concerning receipt of social care for all adult survey respondents.

The top panel of Table 2.1 indicates that the incidence of social care for individuals aged 16 to 64 is broadly stable by age, at approximately 3% of the weighted samples. This social care is primarily provided informally, with 90% of care recipients under age 65 receiving some informal care, and those exclusively in receipt of formal care within the same age band comprising 0.3% of the population.

Further analysis of the related data (not reported in Table 2.1) reveals that approximately four-fifths (79%) of the population under age 65 and in receipt of social care services also report being long-term sick or disabled, while just over one third (36%) of those described as long-term sick or disabled also report receiving social care. Hence, while long-term sick or disabled are more prevalent than those in receipt of social care in the population under age 65, there is substantial cross-over between the two groups.

Data reported in the bottom half of Table 2.1 indicate that the incidence of social care for people aged 65 and over is very similar between two other UK surveys – the Health Survey for England (HSE) and the UK Household Longitudinal Study (UKHLS), a.k.a. Understanding Society – both of which tend to exceed the incidence of social care reported

by the FRS. The relative disparities between statistics reported by the FRS on the one hand the HSE/UKHLS on the other reflect the respective survey questionnaires. As discussed in Appendix A, the UKHLS and HSE both elicit similar information concerning social care in relation to a list of explicit "activities of daily living"; the current analysis considers social care in relation to all activities considered by each of these surveys. In contrast, the FRS is "deliberately vague" concerning the activities for which social care is provided.

A conspicuous feature of the rates of receipt of social care reported in Table 2.1 for the three surveys is the increasing incidence of formal care with age. The incidence of formal care is reported by both the HSE and UKHLS to increase from approximately 2% of the survey population aged 65 to 69, up to approximately 15% of the survey population aged 85 and over. Furthermore, the HSE and UKHLS statistics reported in Table 2.1 indicate that the proportion of the population receiving all their social care via formal providers (difference between the first two columns) increases from 1% among those aged 65 to 69, to 6% of the population aged 85 and over.

An interesting feature of the hours data reported in the right-most two columns of Table 2.1 is that they indicate a negative relationship between the rates of receipt of social care by survey, and the quantity of social care received. Hence, the UKHLS data describe the highest incidence of social care receipt and the lowest average hours of care among those in receipt, while the reverse is true for the FRS. This is consistent with the interpretation that the UKHLS tends to report a sample of social care recipients that includes more marginal cases.

The average hours of social care described by each of the three surveys for the population aged 65 and over are broadly stable by age. It is notable that averages for formal care hours (among those with some receipt of formal care) are appreciably lower than for informal care, with the largest differences reported by the FRS and the smallest by the UKHLS.

Table 2.1: Incidence of social care receipt in the week preceding the survey by age and survey data source

	proportion receiving care				hours/week		
age	all	informal	formal	both	informal	formal	all
Family Resources Survey (FRS)							
16-19	0.019	0.017	0.005	0.003	80.82	14.96	76.98
20-24	0.024	0.022	0.006	0.004	84.00	20.10	81.87
25-29	0.014	0.013	0.004	0.003	67.74	23.68	66.32
30-34	0.013	0.011	0.003	0.002	73.44	26.88	71.78
35-39	0.016	0.014	0.003	0.002	67.64	22.50	64.72
40-44	0.021	0.018	0.005	0.002	65.59	20.87	60.75
45-49	0.026	0.022	0.006	0.003	57.98	22.67	55.58
50-54	0.029	0.026	0.005	0.002	55.49	16.32	52.89
55-59	0.036	0.031	0.008	0.003	56.90	21.01	53.58
60-64	0.042	0.039	0.008	0.005	60.09	20.14	58.87
65-69	0.048	0.043	0.011	0.006	58.08	16.35	55.47
70-74	0.058	0.051	0.013	0.006	57.83	12.95	53.61
75-79	0.091	0.076	0.031	0.015	63.26	11.24	56.17
80+	0.199	0.156	0.087	0.044	58.14	15.54	52.36
Health Survey for England (HSE)							
65-69	0.108	0.101	0.017	0.010	29.59	15.25	29.96
70-74	0.118	0.106	0.025	0.012	25.15	7.47	24.04
75-79	0.187	0.164	0.047	0.024	26.57	9.85	25.74
80+	0.359	0.300	0.144	0.085	20.70	7.12	20.16
UK Household Longitudinal Study (UKHLS)							
65-69	0.117	0.107	0.026	0.016	20.30	12.62	21.37
70-74	0.161	0.146	0.037	0.022	17.19	11.09	18.12
75-79	0.222	0.200	0.066	0.043	19.56	7.43	19.75
80+	0.407	0.343	0.169	0.105	18.21	10.35	19.62

Source: Authors' calculations on pooled data reported by the FRS at annual intervals 2015/16 to 2019/20 and 2021/22; by the HSE at annual intervals 2015/16 to 2019/20; and waves "g", "i", and "k" of the UKHLS.

Notes: The HSE and UKHLS only report social care for the sample aged 65 and over. Table reports weighted averages. Averages for "hours/week" of care evaluated only on non-zero observations. Measures of social care evaluated using the HSE and UKHLS aggregate all activities of daily living reported by each survey.

Table 2.2 provides some indication of the extent to which social care received compares with potential demand for care reflecting the reported ability of individuals to perform selected activities. This table indicates that the proportion of individuals who reported that they required some help with any activity (top row) substantially exceeds the proportion who reported that they received some help at any time during the last month.[11] The difference between these two statistics by age band is approximately stable, varying between 5 and 6 percentage points.

Closer inspection of the data indicated that 82% of those who reported not being able to manage with at least two activities also reported receiving help in the week preceding the survey. This compares with 63% of those who reported being unable to manage with at least one activity. These features broadly reflect terms set out by the Care Act 2014, which states that an individual is eligible to social care support if they cannot achieve two or more activities listed by the Act.

Table 2.3 displays the distribution of care receivers by the number and type of care givers, highlighting the role played by informal care in the UK. This table indicates that more than two-thirds (67.6%) of care recipients reported receiving only informal care. Furthermore, among people who received some formal care just under two thirds (62%) also receive some informal care assistance.

[11] The UKHLS only asks about help received from survey respondents that indicate some difficulty with queried activities, so that it is not possible to evaluate the extent to which help is received by people who do not indicate any difficulties achieving the queried activities.

Table 2.2: Ability to perform reported activities and rates of help received by age band, UKHLS pooled data 2015-2020

	65-69	70-74	75-79	80+
limitations managing activities				
need help with at least 1	0.232	0.314	0.405	0.606
need help with at least 2	0.115	0.154	0.223	0.412
cannot manage at least 1	0.129	0.170	0.220	0.376
cannot manage at least 2	0.049	0.061	0.082	0.201
help received				
last month	0.183	0.259	0.347	0.551
last week	0.117	0.161	0.222	0.407

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of the UKHLS.
Notes: Table reports weighted averages by population age group. Limitations managing activities identified by survey responses that include options "on my own", "only with help", and "not at all". "Need help" identified as either "with help" or "not at all". "Cannot manage" identified as "not at all". All activities of daily living, including instrumental activities, considered.

Table 2.3: Number of social care givers of individuals aged 65 and over reporting some receipt of care, distinguishing formal and informal providers

number of informal carers	number of formal carers 0	1	2+	total
0		0.100	0.023	0.123
1	0.546	0.130	0.020	0.696
2	0.099	0.029	0.009	0.137
3+	0.030	0.010	0.003	0.044
total	0.676	0.269	0.055	1.000

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of the UKHLS.
Notes: Table reports weighted averages.

Table 2.4 describes the relationship between the person receiving care and their informal care providers. The top row of this table indicates that "partners" predominate among informal care providers of people aged 65 and over, followed by daughters; sons and "others" are less frequent. The bottom panel of Table 2.4 indicates the relative prevalence of multiple care providers. The first column of these statistics indicates that, among those people who receive some informal care from their partner 9.9% also receive care from a daughter, 5.9% from a son, and 4.4% from other people. These statistics, together with those reported in Table 2.3, indicate substantial heterogeneity in the range of informal care providers reported by the UKHLS.

The UKHLS includes a series of questions to identify the costs of formal social care services. The most useful information concerning costs of social care for the current analysis are costs before allowance for any state subsidies. This detail is difficult to extract from the UKHLS, due to the focus of the survey on out-of-pocket costs and population heterogeneity concerning organisation of formal care provisions and associated means-tests. The current analysis side-steps these complications by imputing the costs of formal social care from the hours of care received that are reported by the UKHLS (see Table 2.1) and hourly wage rates for social care workers reported by the Annual Survey of Hours and Earnings (ASHE).

Data concerning hourly wage rates of social care workers described by the ASHE are reported in Table 2.5. This table indicates that the mean hourly wage rate of social care workers grew consistently in nominal terms during the period between 2015 and 2022, by an average annualised rate of 4.4 per cent. This compares with 2.9 per cent growth over the same period reported for the consumer price index, and 3.5 per cent for economy-wide average hourly earnings.[12] During the same period there is some evidence of a compression in hourly wage rates among social care workers. Whereas the ratio of the mean to median hourly wage rates reported in Table 2.5 are approximately stable (1.08), the 90:10 ratio falls consistently during the reported period, from 1.84 in 2015 to 1.62 in 2022.

Table 2.4: Distribution of informal social care providers and incidence of shared care by relationship with person in receipt of care

	receives care from			
	partner	daughter	son	other
share	0.459	0.271	0.162	0.187
proportion also receiving care from				
partner	1.000	0.168	0.168	0.109
daughter	0.099	1.000	0.336	0.293
son	0.059	0.201	1.000	0.182
other	0.044	0.202	0.210	1.000

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of the UKHLS.
Notes: Table reports weighted averages. "share" reports the proportion of people in receipt of informal care receiving at least some care from the respective relation. The sum of all "shares" exceed 1.0 due to the incidence of multiple informal carers. Lower panel reports the incidence of carers by relationship to person in receipt of care, given that at least one person with the relationship defined at the top of the column also provides care.

[12] CPI reported by ONS Table 20a, variable D7BT, annual average all items. Hourly earnings growth reported by the Office for Budget Responsibility (OBR) March 2023 Economic and fiscal outlook, supplementary economy tables, Table 1.6.

Table 2.5: Summary statistics for the distribution of hourly wage rates of care workers by survey year (£ per hour, market prices)

			percentiles				
year	median	mean	10	30	60	70	90
2011	7.83	8.52	6.05	6.87	8.45	9.17	11.92
2012	7.92	8.57	6.21	7.00	8.51	9.21	11.97
2013	7.91	8.58	6.30	7.00	8.50	9.22	12.02
2014	8.00	8.58	6.41	7.12	8.55	9.23	11.95
2015	8.18	8.79	6.63	7.29	8.73	9.44	12.21
2016	8.50	9.20	7.20	7.70	9.02	9.76	12.50
2017	8.84	9.54	7.50	8.06	9.36	10.04	12.87
2018	9.15	9.93	7.83	8.37	9.70	10.37	13.35
2019	9.50	10.36	8.21	8.75	10.03	10.81	13.83
2020	10.02	10.84	8.72	9.25	10.66	11.34	14.26
2021	10.24	11.08	8.97	9.50	10.81	11.53	14.56
2022	11.02	11.92	9.61	10.23	11.59	12.39	15.54

Source: ONS dataset "Earnings and hours worked, care workers", Table 26.5a.
Notes: Reports gross hourly pay for all employee jobs in United Kingdom, focussing on "care workers, home carers and senior care workers". Provisional data reported for 2022.

2.2.2 Provision of social care

This section focusses on the characteristics of people who provide informal social care; characteristics of formal sector providers are beyond the scope of the study. Table 2.6 reports statistics describing the incidence and intensity of informal social care, distinguished by 5-year age bands, gender, health and education status.

The statistics reported in Table 2.6 indicate that women typically play a more prominent role in provision of informal social care than men. This is especially true during the working lifetime, with some evidence that the gender gap closes (and possibly even reverses) into old age. Averaging over the entire adult population, 19% of women reported providing some informal social care, relative to 15% of men.[13] Similarly, female carers reported spending 24 hours per week on average, relative to 20 hours for male carers.

The age profiles for the incidence and hours of informal care are (surprisingly) smooth and non-linear (figures that clarify these profiles are reported in Appendix B.2). In the case of incidence, the proportion of people providing care rises steadily from low levels when young, to peak around retirement age, before falling away again into older ages. This profile is more discrete for women, with a distinct peak at 30% among women aged 55-59, whereas for men the profile describes a smoother curve peaking around 20% at age 60-69.

[13] Aldridge and Hughes (2016) report that 12% of women and 8% of men were carers based on UK data reported by the FRS for 2013/14. They also report that the FRS understated the incidence of carers relative to census data.

In the case of hours of care, the age statistics describe a bimodal distribution, peaking for both men and women in their late 30s early 40s, and then again late into the life course.[14]

Statistics reported in the middle panel of Table 2.6 indicate that informal care activity tends to vary inversely with self-reported health status, so that those in the poorest health provide the most hours. This potentially surprising result can be attributed to correlations between self-reported health and the health, and financial means, of an individual's social network. It may also reflect more tenuous connections with the labour market among individuals with poor health, who consequently have fewer competing demands for their time.

Statistics reported in the bottom panel of Table 2.6 indicate that both the incidence and intensity of informal social care decline appreciably with highest education qualification, with similar shifts identified for both men and women.

[14] Note that the population averages for hours per week reported here are heavily skewed, comprising many individuals who provide very few hours and a minority who provide a lot of hours. We return to discuss the distribution of care hours below.

Table 2.6: Incidence and hours of informal social care provided by age band, self-reported health status, gender, and education status

	men		women	
	share	hours	share	hours
		age		
16-19	0.070	8.2	0.095	11.5
20-24	0.076	12.4	0.101	18.6
25-29	0.093	17.2	0.111	26.3
30-34	0.089	18.9	0.142	31.5
35-39	0.118	21.8	0.157	31.0
40-44	0.116	22.1	0.193	29.2
45-49	0.156	18.9	0.222	23.4
50-54	0.191	17.4	0.274	20.1
55-59	0.201	15.5	0.301	19.6
60-64	0.213	18.5	0.265	18.9
65-69	0.209	18.0	0.229	21.9
70-74	0.174	25.8	0.196	29.3
75-79	0.176	33.2	0.178	34.7
80+	0.164	35.7	0.109	34.2
		self-reported health status		
excellent	0.101	16.1	0.153	15.6
very good	0.136	15.9	0.173	18.0
good	0.153	18.3	0.200	23.9
fair	0.188	27.1	0.230	30.6
poor	0.183	33.0	0.211	38.6
		highest education qualification		
higher	0.120	13.0	0.161	16.3
middle	0.156	19.2	0.202	22.6
lower	0.171	30.1	0.203	35.0
all	0.147	20.2	0.190	24.1

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Table reports weighted averages. Incidence of informal social care reported as population "share" as a fraction of the respective population subgroup. Averages reported for "hours" per week of informal social care evaluated only on non-zero observations. "Higher" education is degree qualification or above, "middle" is from GCSE qualification, and "low" is all educational classifications below GCSE.

Table 2.7 displays statistics that describe the number and relationships of the people that informal carers reported providing care to. The top panel of the table indicates that over three-quarters (79%) of informal carers provided care to a single individual, with approximately 5% of informal carers supporting 3 or more people. The bottom panel of the table indicates that informal care is most commonly provided to parents, followed by partners, and then other family members. These statistics emphasize the importance of family relationships underlying informal care provisions.[15] Nevertheless, a sizeable minority – approximately 17% – of informal carers reported that they provided care to non-family members.

Table 2.8 describes distributions of hours of care provided by informal carers of working age, alongside associated statistics describing employment arrangements. The data in the left-most column indicate that almost two-thirds of informal carers (64%) report spending under 10 hours per week providing care, with a sizeable minority (7%) spending 80 hours or more per week. Approximately one in every four carers report spending 20 or more hours per week; this subgroup has been associated with poverty rates that are approximately twice those of the population more generally.[16] A key reason for this is that most of those who provide long hours of care provide care to someone in their household, compounding associated limitations to labour market activity (e.g. Aldridge and Hughes, 2016).

The remaining statistics reported in Table 2.8 clearly indicate the impact that caring activities can have on employment arrangements. The proportion of informal carers (of working age) reported to be in work declines from 87% for those providing 0-4 hours of care per week, to 35% among those reporting 80+ hours of care per week. This last statistic is perhaps surprising in how large it is – that someone who spends 80+ hours providing social care has any time left over to work at all – and may allude to the constrained circumstances that accompany provision of informal care (see also Aldridge and Hughes, 2016).

Furthermore, the proportion of informal carers defined as unemployed (and looking for work) tends to increase with hours of informal care provided, with evidence of a decline for those providing the most time in care. Approximately 92% of all informal carers are described as either employed, unemployed, or that their care activities make it impossible for them to work. Interestingly, this is irrespective of the hours of care provided, with a clear shift of incidence out of the labour market as hours of care increase. The incidence of informal carers reporting that their care activities have a limited impact on their employment makes up most of the residual (7%), rising from 2% of carers providing under 5 hours of care per week to 21% for those providing 80+ hours of care per week.

[15] Similar statistics reported by Aldridge and Hughes (2016).

[16] See Aldridge and Hughes (2016).

Table 2.7: Number of people cared for and relationships with informal care providers

	men	women	all
number cared for			
1	0.788	0.760	0.771
2	0.161	0.183	0.174
3	0.030	0.036	0.034
4+	0.021	0.021	0.021
relationship between carer and person receiving care			
partner	0.253	0.175	0.207
parent	0.433	0.449	0.442
child	0.083	0.128	0.109
sibling	0.018	0.011	0.014
grand child	0.007	0.005	0.006
grand parent	0.045	0.054	0.050
other family	0.093	0.119	0.108
other	0.163	0.173	0.169

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Table reports weighted averages. Table reports population fractions of those who provide some informal social care. Relationships reported from the perspective of the carer.

Table 2.8: Distribution of care hours among informal carers and impact on employment

care hours	share	employed	unemp	impossible	limited	no effect
0-4	0.415	0.865	0.046	0.010	0.017	0.224
5-9	0.223	0.835	0.062	0.018	0.032	0.335
10-19	0.115	0.796	0.086	0.032	0.079	0.397
20-39	0.062	0.672	0.103	0.116	0.176	0.508
40-79	0.112	0.476	0.151	0.278	0.217	0.563
80+	0.073	0.346	0.099	0.503	0.214	0.646
all	1.000	0.757	0.073	0.087	0.074	0.355

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS. Sample limited to informal carers between ages 20 and 59 who are not retired or long-term sick or disabled.
Notes: Table reports weighted averages. "Employed" includes both employees and the self-employed. "Unemp" refers to unemployment. "Impossible" reports the incidence of survey respondents indicating that they are "unable to work at all" due to the informal care that they provide. "Limited" reports the incidence of respondents indicating that they are "unable to do as much paid work as they might", and "no effect" reports incidence of respondents indicating that informal care has no impact on their work arrangements or those reporting that they are engaged in "family or home care".

3 Modelling Care

The statistical analysis reported in Section 2 informed the methods used to generate projections for care that are the focus of the current analysis. These methods were implemented in SimPaths, an open-source dynamic microsimulation model parameterised to data observed for the UK. The model assumed for this study is freely available for download from Github at: https://github.com/centreformicrosimulation/WELLCARE/releases/tag/life-course-care. A walk-through to facilitate replication of reported results is also provided in Appendix E.

This section starts with a brief overview of the SimPaths model, before providing a detailed description of the methods used to simulate childcare and social care. The methods used to project forward-looking behaviour are then described.

3.1 Overview of SimPaths[17]

SimPaths is a fully open-source structural dynamic microsimulation model of the life-course, coded in Java using the JAS-mine simulation libraries (Richiardi and Richardson, 2017).[18] Individuals in the model are organised in benefit units (for fiscal purposes), and benefit units are organised in households. The model projects data for all simulated individuals at yearly intervals, which reflects the yearly frequency of the survey data used to parameterise the model.

The current analysis is based on a variant of SimPaths that is composed of ten modules: (i) Ageing, (ii) Education, (iii) Health, (iv) Family composition, (v) Social care, (vi) Investment income, (vii) Labour income, (viii) Disposable income, (ix) Consumption, and (x) Statistical display. Each module is composed of one or more processes; for example, the ageing module contains ageing, mortality, child maturation, and population alignment processes. The empirical specifications assumed for dynamic processes include extensive cross-module interaction of simulated characteristics (state variables).

The simulated modules and processes are organised in SimPaths as displayed in Figure 3.1. In each simulated year, agents are first subject to an ageing process, followed by population alignment. The alignment process adjusts the simulated population to match official population projections distinguished by gender, age, and geographic region, which ensures that simulated output remains representative of UK population projections.

The education module simulates transitions into and out of student status. Students are assumed not to work and therefore do not enter the labour supply module. Individuals who leave education have their level of education re-evaluated and can become employed.

The health module projects an individual's health status, comprising a self-rated general health metric based on a five-point scale (poor, fair, good, very good, excellent), and an

[17] For a detailed description of the SimPaths model, see Bronka *et al*. (2023).

[18] The version of the model used for this study is freely available for public download from: https://github.com/centreformicrosimulation/SimPaths/releases/tag/2024.06.12.

identifier to distinguish people affected by long-term sickness or disability. People who are long-term sick or disabled cannot work and may require social care.

The family composition module is the principal source of interactions between simulated agents in the model. The module projects the formation and dissolution of cohabiting relationships and fertility. Where a relationship forms, then spouses are selected from within the simulated population via a matching process that is designed to reflect correlations between partners' characteristics observed in survey data.

Females in couples can give birth to a (single) child in each simulated year, as determined by a process that depends on a range of characteristics including age and presence of children of different ages in the household. The existence of dependent children is associated with childcare responsibilities that are simulated as described in Section 3.2.

The social care module projects provision and receipt of social care activities. Social care in the model refers to assistance provided to people who are in need of help due to poor health or advanced age. The module is designed to distinguish between formal and informal social care, and the social relationships associated with informal care. The social care module accounts for the time cost incurred by care providers with respect to informal care, and the financial cost incurred by care receivers with respect to formal care and is described in Section 3.3.

The investment income module projects income based on accrued asset values and exogenously projected rates of return.

The labour income module begins by projecting potential (hourly) wage rates for each simulated adult. Employment status is then projected, given the potential wage rates, as described in Section 3.4. Finally, (gross) labour income is determined by multiplying hours worked by the respective wage rate.

The disposable income model evaluates the income available to each benefit unit for financing consumption. This module imputes disposable income using a matching procedure to a reference database derived from the tax-benefit model UKMOD, as described in van de Ven *et al*. (2022).

Given disposable income and household demographics, the consumption module projects measures of benefit unit expenditure, as described in Section 3.4. Wealth is then projected through time as a simple accounting identity.

At the end of each simulated year, SimPaths generates a series of year specific summary statistics. All of these statistics are saved for post-simulation analysis, with a subset of results also reported graphically as the simulation proceeds.

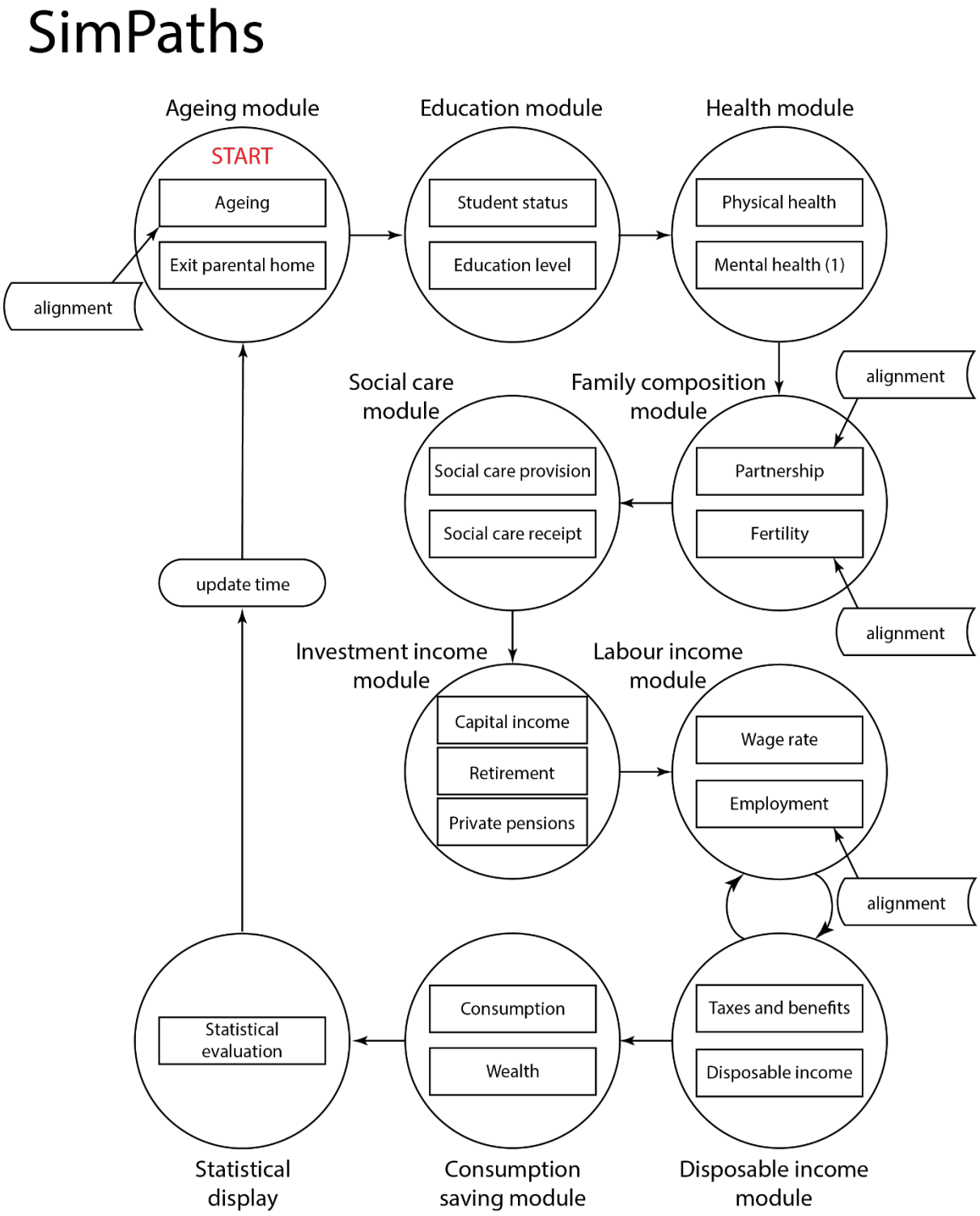


Figure 3.1: Module configuration of the SimPaths microsimulation model

3.2 Simulating childcare

Childcare conceptually covers a wide range of alternative circumstances. Demand for childcare can vary by age and special needs of dependent children, place of abode and schooling provisions, and by features that are difficult to observe such as a child's emotional maturity. Similarly, supply of childcare can vary, among a variety of features, by the proximity and strength of social ties in the case of informal care, by the prevalence of childcare providers in the case of formal care, and by ancillary parental time commitments. Capturing this diversity represents a significant modelling challenge.

The current study is primarily concerned with exploring the balance between the financial implications of formal childcare and the time-use implications of informal childcare (the two main economic margins of decision making). The starting point for projecting these trade-offs is the assumption that children under the assumed age of maturity (18) require some care. Projections for the number and age of dependent children in a benefit unit are consequently taken to imply some demand for childcare. The challenge is then to project the scale of financial and/or time costs associated with the (assumed) demand for childcare.

3.2.1 Modelling formal childcare costs

A double-hurdle regression specification is used to describe the costs of formal childcare. First, a probit function is used to describe the incidence of formal childcare costs for each benefit unit as a function of a set of explanatory variables that includes the number and age of dependent children, the relationship status and employment of adult members, whether any adult in the benefit unit is higher educated, region, and year. Secondly, given the incidence of formal childcare, a (log) linear least-squares regression equation is used to describe the scale of childcare costs where these are incurred.

Both regression models referred to above were estimated on Family Resources Survey (FRS) data and results are reported in Appendix C.1. As discussed in Appendix A, use of FRS data implies a higher prevalence of childcare costs than would be obtained using the Living Costs and Food Survey (LCF), with broadly similar costs projected where these are incurred.[19] Use of the FRS rather than the LCF for estimation reflects the view that the FRS likely provides a more comprehensive description for the incidence of childcare use in the UK.

Coefficient estimates for the incidence of formal childcare costs (Table C.1) reflect the strong associations with child age that are discussed in Section 2.1, peaking at ages 2 and 3, and declining precipitously from age 10. Unsurprisingly, the incidence of formal childcare is also strongly associated with employment, with estimated coefficients for full-time and part-time employment of single adults corresponding approximately to those of couples in which

[19] The FRS and LCF are the principal microdata sources for household incomes and expenditure in the UK; see Appendix A for further details.

at least one adult is full-time employed. Graduate education is also positively associated with formal childcare, possibly reflecting an associated income effect.

Estimated parameters for the scale of formal childcare costs where these costs are incurred (Table C.2) reinforce the relationships for incidence. There is weak evidence for sample selection, with the estimated correlation between the residuals of the selection and value equations (rho) equal to 0.022, and significant at the 90% (but not the 95%) confidence interval.[20]

As with incidence, costs show a strong relationship with child age, peaking for young children (aged 1 and 2), and dropping to insignificant at 95% confidence interval by age 7. The estimated coefficients also display strong positive correlations with employment status, with coefficients for singles being larger than those for couples.

Influence of public transfers

SimPaths imputes tax and benefit payments from a database derived from a static tax-benefit calculator (UKMOD), following the approach described by van de Ven *et al*. (2023). This approach involves identifying an appropriate "donor" from a reference database derived from the tax-benefit calculator to use as a template for imputing transfer payments for each simulated context in which such payments are required. Donor selection is made via matching methods. The matching algorithm starts with coarsened exact matching over a selected set of features that include the number and age of benefit unit members, the incidence of formal childcare costs, employment and disability status of adult members, and income quintiles. Having identified a broad group of candidate donors, the matching algorithm uses nearest neighbour matching with respect to Mahalanobis distances evaluated for original (pre-tax and benefit / private) income and childcare costs.

3.2.2 Distinguishing formal from informal childcare

SimPaths projects employment as a trade-off between adult leisure time and disposable income available for expenditure. The description of formal childcare costs described above affects this trade-off, by associating increased parental employment with an expectation of higher (non-discretionary) childcare costs, and therefore lower disposable income. This alters the time-use/disposable income trade-off to discourage employment by parents in favour of (implicit) informal childcare.

Consider, for example, the employment decisions of a single mother with a 2-year-old child. When any individual makes an employment decision in SimPaths, the decision to work involves a trade-off between lower leisure time and higher disposable income. In the case of the single mother, the decision to work is associated with an anticipated formal childcare cost. This cost will detract from the increase in disposable income that working would otherwise deliver, thereby swaying the decision against working. Where the mother responds to this trade-off by choosing not to work, then their increased leisure can be

[20] Implying higher likelihood of incidence associated with higher childcare values.

interpreted as provision of informal childcare. Where the mother chooses to work regardless, then the associated formal childcare cost is projected as described in Section 3.2.1.

3.3 Simulating social care

Receipt of social care is simulated differently for individuals aged under 65, with a more detailed process adopted for older people reflecting the more extensive data available for parameterisation. All empirical specifications considered for projecting social care are reported in Appendix C.2. The current analysis focusses exclusively on home based social care, ignoring transitions into residential care. Residential care was not considered due to the limited data available for empirical analysis.[21] In 2022, the ONS UK Health Accounts indicate that the value of health care expenditure on providers of home healthcare services was £14.2 billion (2022 prices, 0.57% of GDP), relative to £34.1 billion (1.36% of GDP) on providers of residential long-term care facilities.[22]

3.3.1 Need and receipt of social care for population aged under 65

All individuals under age 65 who are identified as long-term sick and disabled are assumed to have a need for social care. Furthermore, any individual in need of social care is assumed to be unable to work, so that long-term sick and disabled are omitted from employment. These assumptions reflect the adoption of an employment status identifier (FRS variable *empstati*) for the empirical specification of disability, and the high incidence of social care receipt reported among people with a disability as discussed in Section 2.2.1.

Receipt of social care among individuals under age 65 focusses exclusively on informal social care. At the time an individual under age 65 is projected to enter a disabled state, a probit equation (Table C.3) is used to identify whether the individual receives informal social care. In the absence of longitudinal data to parameterise persistence, this projection is assumed to continue for as long as the person remains ill or disabled. If an individual under age 65 is identified as receiving social care, then care is assumed to be provided by a single person, with the time of care described by a linear equation (Table C.4). The (informal) carer is identified deterministically, using a hierarchical approach falling first to a spouse under age 75 (if one exists), then to parents under age 75, and finally to "other" adults aged between 25 and 74 years.

3.3.2 Need and receipt of social care for population aged 65 and over

Social care provisions for individuals aged 65 and over are projected using the following process:

[21] Transitions into formal care were included as a question in the forerunner to the UKHLS (British Household Panel Survey), but were discontinued due to very low response numbers.

[22] ONS Reference tables accompanying the 2022 UK Health Accounts and 2023 provisional estimates, Table 4a.

1. The incidence of needing care is modelled following probabilities described by a probit equation (Table C.5).
2. The incidence of receipt of care is also modelled as a probit equation (Table C.6).
3. If in receipt of care (from 2), a multinomial logit equation (Table C.7) is used to determine if the individual receives: i) only informal care; ii) formal and informal care; or iii) only formal care.
4. If in receipt of informal care (from 3), a multi-level model is used to distinguish between alternative providers of informal care. The first level (Table C.8) considers whether a partner provides informal care, for individuals with partners and in receipt of some informal care. For individuals who receive social care from their partner, the second level uses a multinomial logit (Table C.9) to consider whether they also receive care from a daughter, a son, or someone else (other). For individuals in receipt of informal care who do not have a partner caring for them, another multinomial logit (Table C.10) considers six alternatives that allow for up to two carers from "daughter", "son", and "other".
5. For each carer (from 3 and 4), a log linear equation (Tables C.11 to C.15) is used to project number of hours of care provided.
6. Hours of formal care are converted into a cost, based on the year-specific mean hourly wages for all social care workers, as reported in Table 2.5.[23]

Discussion of regression estimates

The probit equations describing need and receipt of social care for individuals aged 65 and over were estimated in a similar fashion, using pooled data reported by waves "g", "i" and "k" of the UKHLS. Individuals were identified as "needing care" if they reported requiring help with at least two of the activities of daily living (ADL) or instrumental activities of daily living (IADL) reported by the survey. The focus on ADLs to identify "need of care" is common in the associated literature (e.g. Albuquerque, 2022), and the focus on two ADLs reflects observations discussed in Section 2.2.1 (especially Table 2.2) and associated terms set out by the Care Act 2014. Similarly, individuals were identified as "receiving care" if they reported receiving some assistance with at least one ADL or IADL in the week preceding the survey.

The same set of explanatory variables are considered for the probit equations governing need and receipt of social care discussed above. These variables include gender, education status, relationship status, self-reported health status, age, and geographic region. Each regression also included a one-year lag of the dependent variable (imputed as discussed in

[23] Where the simulated year lies outside the time-series reported in the table, the series is extended assuming a (geometric) growth rate of 3.1% per annum. This growth rate is the average reported between 2011 and 2022 in Table 3.5, and is greater than the rate assumed for inflation of 2.6% per annum.

Appendix A.5.1). This set of covariates corresponds to pre-determined variables for social care in the schedule used by SimPaths to project data for any given year.

Coefficient estimates reported in Tables C.5 (need for care) and C.6 (receipt of care) share close similarities, alluding to the close correspondence between reported need for and receipt of social care. The incidence of social care tends to be lower for men than for women, after controlling for the remaining set of covariates. Caution should be exercised in interpreting this result, which may reflect under-reporting of gender biases in informal care among partner couples later in life. It is nevertheless consistent with estimates reported elsewhere in the literature (e.g. Albuquerque, 2022).

Rates of social care tend to be inversely proportional to education level, which is also consistent with findings generally reported in the associated literature. Although self-reported health status is included in the set of covariates, this result may reflect a higher incidence of physically demanding work history among lower educated survey respondents. This interpretation is also consistent with the inverse relationship identified between rates of social care and self-reported health.

Unsurprisingly, the estimated coefficients describe significant persistence for rates of social care, which rise appreciably with age. The estimates also indicate a positive relation between social care of having a partner, which reflect the predominant role of partners in provision of informal care as discussed in Section 2.2. While the coefficients that allow for regional variation are mixed, they tend to suggest higher rates of social care in London (the reference group), relative to the remainder of the UK.

The simulation reported in Section 4 uses a Monte Carlo approach to project need of care, based on probabilities described by the probit model reported in Table C.5. A similar approach is used to project receipt of care based on probabilities described by Table C.6. Importantly, projections for need and receipt of care are based on the same random draw from a uniform [0,1] distribution. This implies that, where the probability of needing care (Table C.5) exceeds the probability of receiving care (Table C.6), then care will only be simulated where it is needed. Hence, in the current context unmet care needs reflect the degree to which probabilities describing needs for care exceed those of receiving care.

Table C.7 reports multinomial regression coefficients for the split between informal and formal social care for the population aged 65 and over in receipt of some care. The covariates included in this equation were selected after noting that coefficient estimates were insignificant for gender, self-reported health, and age under 85. The coefficient estimates reported in Table C.7 indicate that individuals receiving social care via the formal market tend to be higher educated, without a partner, or at an advanced age.

Table C.8 indicates that, for individuals aged 65 and over, who receive some social care and have a partner, men are more likely than women to receive informal care from their partner. This is notable, as estimates reported in Tables C.5 and C.6 indicate that men are generally less likely to report receiving care. Table C.8 also highlights the persistence of care arrangements, and that care from partners is less prevalent toward the end of the life course.

Tables C.9 and C.10 report multinomial logit regression estimates for the set of informal carers where an individual is identified as receiving some informal care. In this case, covariates are limited to the lagged dependent variable (and a constant) to facilitate reflection of persistence in caring arrangements, subject to the limited data available for estimation.

Tables C.11 to C.15 report linear regression estimates for hours of care received, distinguished by type of provider. Inspection of these tables indicates that the most precise estimates were evaluated for informal care hours provided by partners, for which the largest survey sample is available. The estimated statistics for care provided by partners indicate that hours of care tend to be higher for men, who are lower educated, in poor health, and who also have daughters that care for them. Other regression estimates reveal substantial uncertainty concerning coefficient estimates, with the positive relationship between hours of care and poor health being a notable exception.

Influence of public transfers

Public transfers to support social care spending are not reflected by UKMOD and cannot therefore be accommodated using the imputation method based on data derived from that model. SimPaths was consequently extended to reflect public subsidies for social care costs using a functional add-on to transfer payments imputed using database methods. Specifically, total transfer payments are projected by first imputing transfer payments based on UKMOD data, and then projecting social care payments for relevant benefit units using a tailored function. This is facilitated by the fact that social care related public transfers are exogenous to the wider public transfers system in the UK.

3.3.3 Simulating provision of social care

The model is adapted to project provision of social care by informal sector providers; the characteristics of formal sector providers of social care are beyond the scope of this study. The approach adopted for simulating receipt of social care described above identifies the incidence and hours of informal social care that individuals are projected to receive. In the case of people aged 65 and over, it also identifies the relationship between those in receipt of informal social care and their informal care providers, and the persistence of those care relationships. These details consequently provide much of the information necessary to simulate provision of informal social care, in addition to the receipt of care.

Nevertheless, the input data considered for SimPaths – with the notable exception of partners – omit social links that are implied to exist between informal social care providers and those receiving care. Specifically, links between adult children and their parents, and the wider social networks that often supply informal social care services are not recorded by the input data. The method that is used to project informal provision of social care is designed to accommodate limitations of the available survey data in a way that broadly reflects projection of social care receipt.

Specifically, the model distinguishes between four population subgroups with respect to provision of informal social care: (i) no provision; (ii) provision only to a partner; (iii) provision to a partner and someone else; and (iv) provision but only to non-partners. For people who are identified as supplying informal care to their partner via the process described in Section 3.3, a probit equation (Table C.16) is used to distinguish between alternatives (ii) and (iii). Similarly, for the remainder of the population, another probit equation (Table C.17) is used to distinguish between alternatives (i) and (iv). A log linear equation (Table C.20) is then used to project number of hours of care provided, given the classification of who care is provided to.

3.4 Simulating forward-looking behaviour

The current study explores the influence of social care through the life-course, distinguishing between:

- *anticipation effects* when individuals foresee potential future periods of social care;
- *impact effects* when social care is provided or received; and
- *scarring effects* after periods of social care have passed.

Analysis focuses on the two main margins of economic decision making: labour/leisure and consumption/savings choices. Our interest in anticipation effects of social care motivates the adoption of a forward-looking framework to simulate decisions.

Labour supply and discretionary consumption decisions are simulated as though they are made to maximise expected lifetime utility subject to forward-looking (rational) expectations. The unit of analysis is the benefit unit, and incentives are translated into behaviour via an assumed intertemporal utility function. A nested constant elasticity of substitution (CES) utility function was adopted for analysis, as described by equation (2).

$$U_{i,t} = \frac{1}{1-\gamma}\left\{u\left(\hat{c}_{i,t}, l_{i,t}\right)^{1-\gamma} + E_{i,t}\left[\sum_{j=t+1}^{\infty} \delta^{j-t}\left(\varphi_{i,j} u\left(\hat{c}_{i,j}, l_{i,j}\right)^{1-\gamma} + \left(1-\varphi_{i,j}\right) Z\left(w_{i,j}\right)^{1-\gamma}\right)\right]\right\} \quad (2)$$

$$u\left(\hat{c}_{i,t}, l_{i,t}\right) = \left[{\hat{c}_{i,t}}^{1-1/\varepsilon} + \alpha^{1/\varepsilon} {l_{i,t}}^{1-1/\varepsilon}\right]^{\frac{1}{1-1/\varepsilon}} \quad (3)$$

$$Z\left(w_{i,j}\right) = \zeta_0\left[w_{i,j}^{+}\right]^{\zeta_1} \quad (4)$$

where subscripts i denote benefit units and t time. $u\left(\hat{c}_{i,t}, l_{i,t}\right)$ represents within period utility derived from equivalised discretionary consumption ($\hat{c}$) and time spent in leisure (l). $Z(w)$ represents the warm-glow model of bequests, derived from non-negative net wealth at death (w^{+}). E is the expectations operator and φ the probability of survival of the benefit unit reference person, which varies by gender, age and year. γ is the coefficient of relative risk aversion, ε the elasticity of substitution between equivalised consumption and leisure, α the utility price of leisure, and δ the constant exponential discount factor.

Each adult is considered to have three labour supply alternatives, corresponding to full-time, part-time and non-employment. Labour supply and discretionary consumption are projected as though they maximise the assumed utility function, subject to a hard constraint on net wealth and assumed agent expectations. Expectations are "substantively rational" in

the sense that uncertainty is characterised by the random draws that underly dynamic projection of modelled characteristics.

No analytical solution exists to the decision problem described above. Furthermore, application of the decision problem in a way that captures real-world circumstances invalidate adoption of computational short-cuts.[24] Numerical solution methods were consequently adopted, following standard practice in the dynamic programming literature (see e.g. van de Ven, 2017).

The model proceeds in two discrete steps. The first step involves solution of the lifetime decision problem for any potential combination of agent specific characteristics, with solutions stored in a look-up table. The second step uses the look-up table as the basis for projecting labour supply and discretionary consumption. Technical details of the numerical solution method are provided in Appendix D.

3.4.1 Specification of preference parameters

The utility function parameters described above were adjusted to match model projections for 2019 to selected statistics estimated from UKHLS survey data. Use of UKHLS data to parameterise preferences is consistent with the data used to estimate most of the other model parameters, as discussed in Bronka *et al*. (2023). Use of data for a single population cross-section to parameterise the preference parameters of the model follows van de Ven (2017). Data for 2019 were considered, as this is the first year from which projections are made, so that most agent characteristics (model state variables) are based on survey data.

The value of γ (the coefficient of relative risk aversion) was exogenously set to 2.0, based on meta-analyses reported by Elminejad *et al*. (2022) and Havranek *et al*. (2013). Elminejad *et al*. (2022) explore 1,021 estimates for relative risk aversion from 92 studies. They report that mean risk aversion is equal to 1 in economics and between 2 and 7 in finance contexts. In a similar vein, Havranek *et al*. (2013) analyse 34 studies that report 242 estimates for the intertemporal elasticity of substitution calculated on UK data. The mean of these estimates is 0.487 and the standard deviation is 1.09. In our case, adoption of CES intertemporal preferences implies that the intertemporal elasticity of substitution is (approximately) equal to the inverse of relative risk aversion, suggesting a value for γ in the region of 2.0.[25]

Given the assumed value for γ, α (utility price of leisure) was adjusted to match the model to the proportion of people aged 18 to 74 who were reported by the UKHLS to be not employed in 2019.

Following van de Ven (2017), ε (elasticity of substitution between equivalised consumption and leisure) was adjusted to match the model to distributional variation

[24] For example, two-stage budgeting is invalidated by assuming that labour decisions in any period affect potential wages in subsequent periods. Similarly, homotheticity of the preference relation is invalidated by assuming that labour is chosen from a discrete set of alternatives.

[25] The inverse relationship between the intertemporal elasticity and relative risk aversion is imperfect due, for example, to the influence of discrete labour supply alternatives.

observed for the ratio between equivalised consumption and leisure. Specifically, the preference relation described by equation (2) implies that, as ε increases, so too does the ratio of equivalised consumption to leisure of high income people (graduates) relative to lower income people (non-graduates).

δ (constant exponential discount factor) and ζ_0 (warm glow model for bequests) were adjusted to reflect the ratio of average equivalised expenditure by benefit units with heads aged 55 to 74, relative to benefit units with heads aged 18 to 54.[26]

The above parameters were manually adjusted until the disparity between statistics evaluated from simulated and survey data for each of the moments noted above were reduced to less than one percentage point. Specifically, the following parameters were identified for analysis:

$\gamma = 2.0$ $\alpha = 1.26$ $\varepsilon = 0.34$ $\delta = 0.98$ $\zeta_0 = 17$ $\zeta_1 = 0.4$

With these preference parameters, the model projects:

- 37.45% people aged 18 to 74 not in employment, compared with 38.08% described by survey data
- the ratio of equivalised consumption to leisure of graduates 1.3541 times that of non-graduates, compared with 1.3614 described by survey data
- average equivalised consumption among people aged 18 to 54 equal to 0.7972 times that of people aged 55 to 74, compared with 0.7896 described by survey data.

Further analysis revealed that the assumed preference parameters implied a population average intertemporal elasticity of substitution of consumption equal to 0.3501, which lies well within the range of estimates reported by Havranek *et al*. (2013). This is consistent with the motivation underlying the assumed value for γ. Similarly, the population average (Marshallian) labour supply elasticity implied by the parameterised model was evaluated at 0.1789. This property of the model is also in common with estimates reported in the associated empirical literature, which are typically between -0.12 and +0.28.[27]

3.5 Limitations of the modelling approach

The approach used to simulate provision and receipt of care that is outlined above is highly stylised reflecting the practical constraints to which the study was subject. One key aspect of caring that is not taken into account is the **relationships between individuals beyond a person's immediate benefit unit** that are important in provisions of informal care.

[26] As the UKHLS does not report comprehensive measures of household expenditure, these statistics were evaluated using data reported by the Living Costs and Food (LCF) survey from 2019. Use of the ratio of consumption, rather than consumption in levels was done to accommodate any fundamental differences in financial flows described by the LCF and UKHLS.

[27] Based on estimates reported in the review by Keane (2011) and the meta-analysis of Bargain and Peichl (2016); see Appendix A.6.

Accommodating inter-benefit unit relationships is complicated by the sparse data that exist for model parameterisation. Allowing for such relationships in a coherent fashion also represents a significant computational burden.

The current analysis consequently omits inter-benefit unit relationships when projecting the incidence of receiving and providing care. Compared to the practical reality, this stylisation will tend to increase the forecasting errors underlying agent expectations. This will tend to dampen behavioural variation across the population, with simulated behaviour representing a weighted mean between those with relatively high and low probabilities of providing/receiving care.

A further consequence of omitting inter-benefit unit relationships from the model is that it complicates use of projections for exploring potential evolution of the gap represented by those who need but do not receive social care. In this regard, the current analysis takes a "conservative" approach designed to dampen the projected size of the care gap by projecting recipients of social care in a way that is biassed toward those projected to need care.[28] This approach also reflects the survey design of the UKHLS data that are the primary basis for parameterising the model (see discussion in Section 2.2.1). Hence, discussion of the "care gap" is limited, in keeping with the primary focus of the analysis.

The **sample of social care is restricted** due to limitations of the survey data available for analysis. Consideration of social care amongst people under age 65 is based on "labour market" measures of long-term sickness and disability, who are all considered to be in need of and receive informal social care. Although a more comprehensive account of social care is included for analysis among people aged 65 and over, analysis nevertheless omits consideration of people in residential care. Hence, analysis focuses on a subset of social care only. Particular concern relates to the omission of residential care, where substantial social care costs can accrue, and which was omitted only because of the sparse data available for analysis. Nevertheless, it is noteworthy that the importance of residential care in the UK has declined in recent years following a public drive toward in-home care.[29]

One additional feature of the considered modelling approach is that it is **designed to focus on the economic trade-offs in relation to provision and receipt of child and social care**. A key aspect of this modelling strategy is to exogenously impose "risks" of care provision and receipt in a way that abstracts from some of the decision problems that people actually face. For example, although informal social carers may often be able to choose not to provide care, the modelling approach outlined above implicitly assumes that carer responsibilities are unavoidable once they are exogenously allocated. Similarly, whereas a parent may find the provision of childcare more pleasurable than working in paid

[28] This is achieved by using a single random draw to evaluate need and receipt of care. This ensures that any individual who receives social care will also need care so long as the probability of care need exceeds the probability of care receipt.

[29] Banks *et al.* (2023) report that 60% of recipients of public social care currently receive care at home.

employment, the current analysis the decision to provide informal childcare to an economic trade-off between time-use and (disposable) income.

4 Results

This section reports summary statistics evaluated for simulated data projected under alternative scenarios, distinguished by assumptions concerning the influence of childcare and social care. The alternative scenarios all project forward from the same starting population comprised of 1,000,000 individuals. Differences between scenarios are designed to be limited to two key margins. First, alternative aspects of care may be taken into consideration when evaluating descriptions for employment and savings decisions. Second, dynamics of care may be included when projecting the evolving circumstances of people through time. These two margins are distinct in the sense that application of one does not depend on application of the other. It is possible, for example to simulate employment and consumption decisions that take into consideration the possibility of care effects without actually projecting evolution of care, or vice versa. Comparisons between alternative simulation scenarios help to clarify factors underlying simulated projections.

Discussion begins in Section 4.1 by reporting projections generated under our "base scenario", where care is assumed to consume the time of (informal) care providers, and consume wealth of (formal) care recipients. Labour and expenditure decisions are assumed to take these costs into account. Section 4.2 explores the factors underlying observations reported in Section 4.1 by comparing projections based on alternative simulation scenarios.

4.1 Projections for care during the prospective half century

The model upon which this analysis is based (SimPaths) includes migration flows to align the simulated population to the principal population projections published by the Office for National Statistics.[30] These projections imply that the UK population will grow by just over 11 million, from 66.7 million in 2019 to 78.0 million by 2070. This population growth underlies the simulated aggregates that are reported below.

4.1.1 Childcare

Headline statistics for formal childcare provisions projected under the base scenario are displayed in Figure 2.1. This figure indicates a slight downward trend in aggregate expenditure on childcare, from £5.5 billion (2024 prices) in 2020 to £5 billion per year by the early 2030s, and thereafter approximately stable to 2070. Over the same period, the

[30] Population estimates reported to mid-2023 and projections from 2024. Full set of data compiled from a range of sources – see "info" sheet of model input file "align_popProjections.xlsx".

proportion of benefit units projected to pay for formal childcare is projected to fall from 5.4 to 2.8 percent.[31]

The trends in formal childcare noted above reflect underlying projections for fertility, which in turn depend on model parameters estimated from UKHLS data and ONS population projections. Declining fertility rates see the projected average number of children per benefit unit fall throughout the simulated period, from 0.40 in 2020 to 0.31 in 2070. Interestingly, the model projections indicate that the decline in fertility will be driven by growth in the share of childless benefit units. The share of benefit units with any children is projected to fall sharply between 2020 and 2035 – from 0.25 to 0.14 – and then to drift further downward to 0.12 by 2070 (Figure F.2 of Appendix F). It is this trend that underlies the falling incidence of benefit units that are projected to pay for childcare noted above.

In contrast, the number of children per benefit unit with children is projected to *increase*, from 1.58 in 2020 to 2.42 in 2036, and remain broadly stable thereafter. This, in conjunction with underlying population growth, works to off-set the declining proportion of benefit units paying for childcare, resulting in broadly stable aggregates for both childcare expenditure and the number of people aged 0 to 17 (about 13.6 million).

It is worth noting that aggregate childcare expenditure is likely to be the more reliable of the two series reported in Figure 2.1. As discussed in Appendix A.5.2, the model projections are aligned with ONS population estimates by age, gender, geographic region, and year. These projections – especially the stability of the number of people aged 0 to 18 – drive the aggregate projections for childcare expenditure displayed in Figure 2.1. In contrast, the projected trend of children increasingly concentrated within a smaller share of benefit units hinges on margins estimated from UKHLS data, which may not be fully representative of the broader UK population (see Appendix A.5.2 for further discussion).

Bearing in mind the above caveat, an interesting feature of the projections for childcare is that, among benefit units with children, the projected rise in the average number of children per benefit unit coincides with a rise in the proportion of benefit units with at least one adult not employed. Specifically, the share of benefit units with children that also has at least one adult not employed is projected to increase from 47 percent in 2020 to 55 percent in 2070 (Figure F.3). This trend reflects increased economies of informal childcare enjoyed by larger families.

[31] 5.4% of benefit units paid childcare costs in pooled Family Resources Survey data reported between 2015 and 2019. The projections reported here reflect those reported by the Greater London Authority; see Appendix F, Figure F.1.

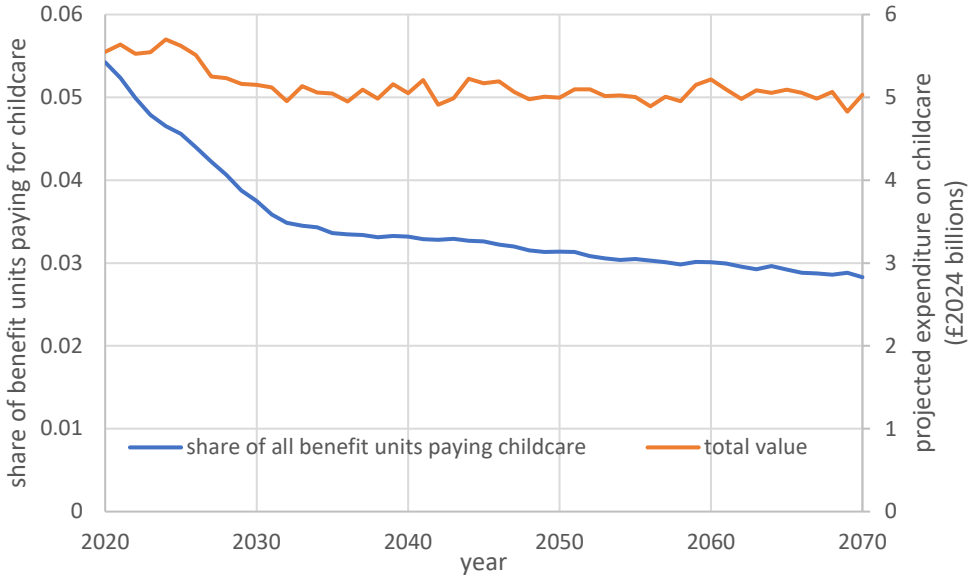


Figure 4.1: Projected childcare costs by simulated year

Source: Authors' calculations on simulated data.
Notes: Simulations generated by SimPaths model including time and financial costs associated with childcare and social care and rational, forward-looking preferences.

4.1.2 Social care need

Figure 4.2 displays projections for the incidence of need of social care distinguished by age band and simulation year. Panel A of the figure indicates that the absolute number of people in need of social care is projected to rise from 4.8 million in the early 2020s, to 9.7 million by 2070. This increase is projected predominantly for people aged 80 and over, among whom an additional 2.5 million are projected to be in need of care by 2070 than in 2020.

The projected increases in the numbers of people needing social care are broadly attributable to population aging. Panel B of Figure 4.2 indicates that the proportions of people by age band projected to need care are broadly stable with the simulated time horizon, equal to approximately 5% for people under age 65, 20% for people aged 65 to 79, and 45% for people aged 80 and over. Within this broad stability, slight upward trends in rates of care need can be seen from 2020 to 2030, followed by gradual downward trends to 2070.

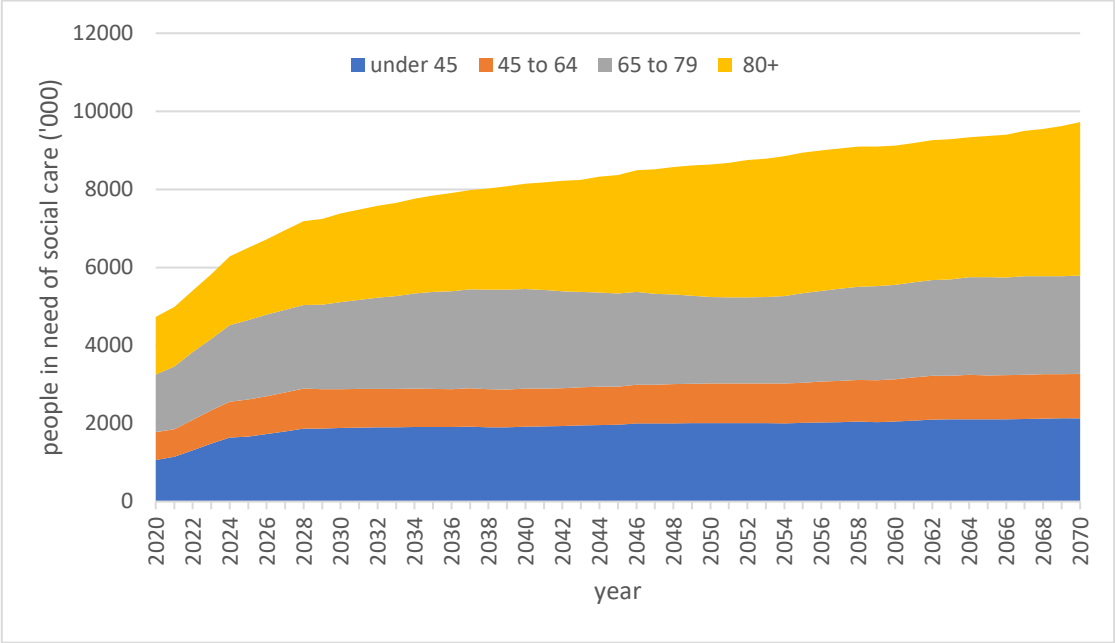
The rise in rates of projected care need early in the simulated time horizon reflect a mis-match between the incidence of care in the population cross-section data from which projections commence and the transition probabilities governing evolution of care need. This aspect of the projections is somewhat reassuring, as the rise in rates of care need are generally muted, suggesting there is a reasonable degree of correspondence between the care needs described by the starting population cross-section, and the estimates underlying associated simulated dynamics.

The gradual decline in rates of care need projected over the longer-term reflect underlying trends in education. Specifically, higher education is associated with lower rates

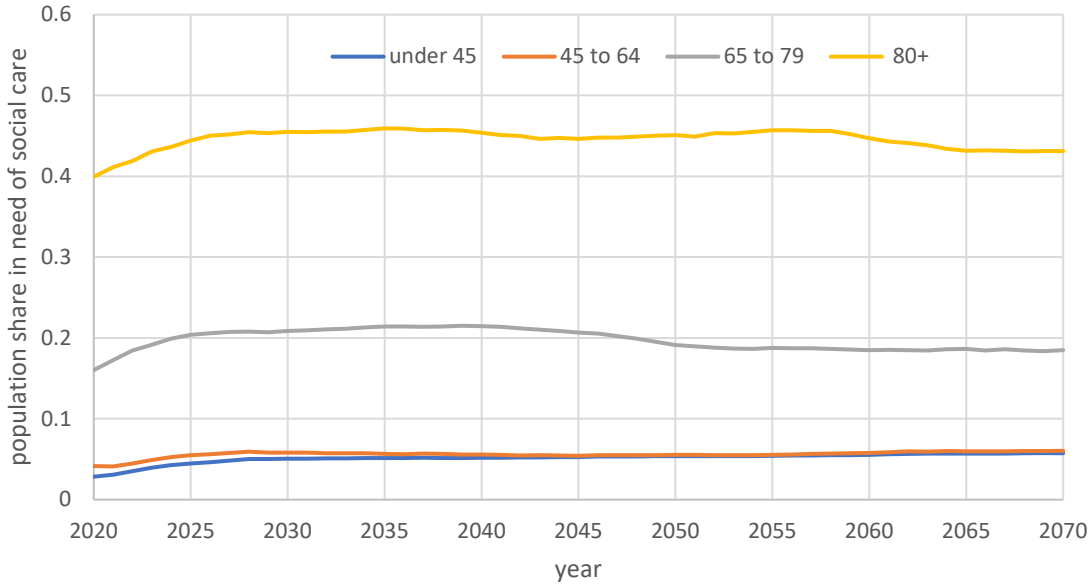
of care need and the projections indicate a pronounced reduction in the proportion of the population with less than GCSE (high school) qualifications. From over half (53%) of all people aged 80 and over in 2020, those without any qualifications are projected to fall to 1 in 20 (5%) by 2070. Over the same period, the proportion of people aged 80 and over with degree level qualifications is projected to rise from 12 to 48%, and those with GCSE qualifications to rise from 38 to 47%. Similar trends are projected for the population aged under 80, although more muted because younger subgroups start in 2020 with appreciably smaller shares of people without qualifications (see Figure F.4).

Although the trends toward higher education in the UK population noted above are clear, it is important to recognise that associated implications for care needs are based on correlations reported in contemporary data. The assumption that contemporary correlations between education and care needs will persist into the future is currently untestable. Given this aspect of uncertainty concerning the simulation assumptions, it is somewhat reassuring that projected rates of care need by age do not exhibit strong temporal trends.

A further point of note is that the influence of shifts in education on care needs are offset in the case of people aged 80 and over by a rise in the average age of the respective population subgroup, which increases from 85.5 in 2020 to 86.6 in 2070. The influence of this simulated trend toward older age is, however, muted due to top-coding at age 85+ in the empirical specifications used to identify care needs. Top-coding of age was assumed for the analysis due to small-sample issues associated with currently available survey data for older people.



Panel A: Numbers of people in need of care



Panel B: Age-specific rates of people in need of care

Figure 4.2: Projected incidence of needing social care by age band and simulated year

Source: Authors' calculations on simulated data.

Notes: See notes to Figure 4.1.

4.1.3 Social care receipt

As discussed in Section 3.3, the model projects hours per week of social care received, distinguished by care provider. In this section, hours of social care received were converted into financial equivalents by interacting with median hourly earnings reported for care workers by the Office for National Statistics (ONS).[32] Figure 4.3 displays headline projections for measures of social care received.

The top panel of Figure 4.3 indicates that the aggregate value of social care received is projected to increase from £40 billion in 2020 (2024 prices), to £180 billion by 2070. These figures are equivalent, respectively, to 1.8% and 3.3% of contemporaneous GDP, as displayed in the bottom panel of the figure. Hence, the model projects that social care will account for an increasing share of the UK economy over the next five decades, reflecting the anticipated aging of the population.

The scale of the projected increase in the value of social care receipt that is reported here is qualitatively similar to projections reported in the contemporary literature, as discussed in the introduction. It is important to note, however, that precise comparisons with the related literature are complicated by differences in subjects of interest. As discussed in Section 3, the current analysis omits residential care, which accounted for 71% of all formal long-term social care expenditure in 2022 (see beginning of Section 3.3). In contrast, the current discussion includes an account for the value of informal social care received, which is often omitted from the contemporary literature (see Banks *et al.*, 2023, for an exception).

Figure 4.3 indicates that informal social care accounts for most of the projected rise in social care burden, increasing from 1.5% of GDP in 2020 to 2.8% in 2070. Partners are projected to be the most important providers of (informal) social care, accounting for 54% of all social care over the simulated time horizon, with the next most import provider being the formal sector, at 13%.

As noted above, the projected emphasis on informal care is partly attributable to the omission of residential care from the analysis. Nevertheless, even grossing up the value of projected formal social care expenditure to account for residential care[33], the value projected for care received informally remains between 1 and 3 times as large as formal care over the simulated time horizon.[34] These figures are consistent with associated statistics reported by Banks *et al*. (2023).

As discussed in Section 3.5, the UKHLS data used to parameterise the model limits identification of care receipt of people aged 65 and over to survey respondents who also

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[32] ONS Earnings and hours worked, care workers: ASHE Table 26 - Gross hourly pay all workers; data for 2023 are provisional. Data for 2020 to 2023 adjusted to 2024 prices via the Consumer Prices Index. Forward projections from 2024 based on data for average nominal earnings growth and price inflation reported by the Office for Budget Responsibility (2024). Mean hourly earnings typically exceed medians by 8 percentage points.

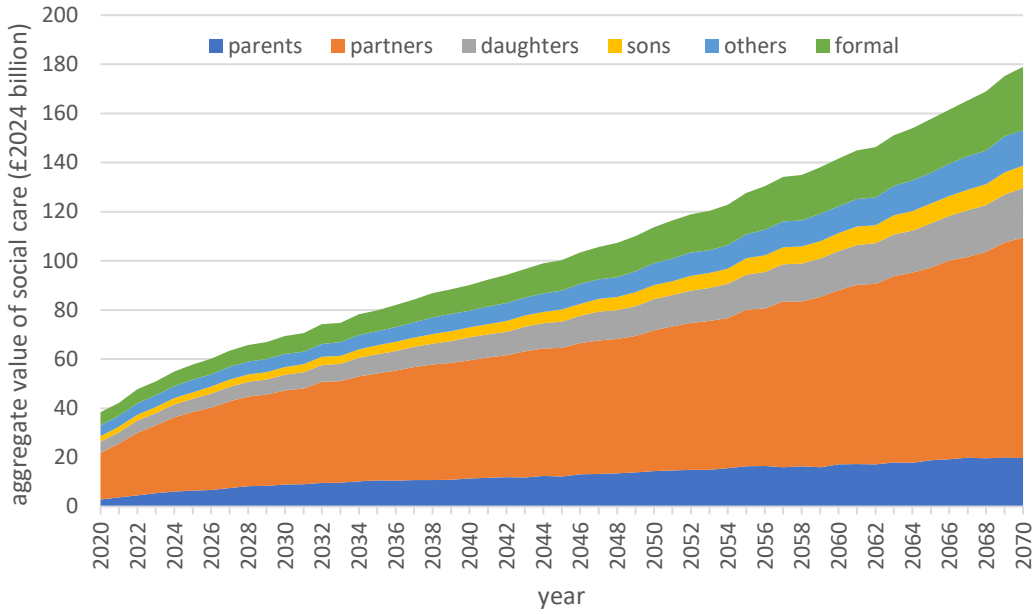
[33] By dividing the value of formal social care by (1.0 – 0.71) = 0.29.

[34] Ratio of projected value of informal to formal social care ranges between 1.7 and 2.6 over the simulated time period, after grossing up formal social care by a factor of 1/0.29.

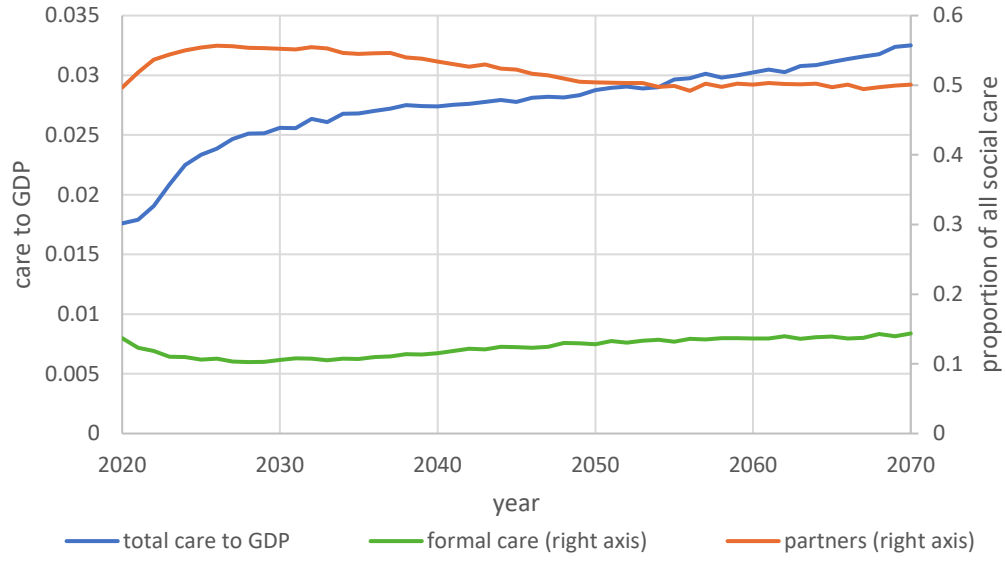
indicated that they experienced some difficulty in managing at least one activity of daily living (including instrumental activities). Care need is identified in Section 4.1.2 based the incidence of survey respondents that reported experiencing difficulty with at least two activities in the UKHLS. There is consequently a close correspondence between projected receipt of social care discussed here and care needs discussed above.

Relative to the care needs by age that are discussed in Section 4.1.2, rates of care receipt by age are broadly stable over the simulated horizon, averaging 15% for people aged under 45, 30% for people age 45 to 64, 94% for people aged 65 to 79, and 98% for people aged 80 and over (see Figure F.6). The step-difference projected for people under age 65 reflects the incidence of care receipt among long-term sick and disabled reported by the Family Resources Survey, in contrast to broader account of social care that is provided by UKHLS data, as discussed in Section 2.2.1.

Hours of care received per care recipient are also broadly stable within age bands across the simulated time horizon. Care recipients aged under 45 are projected to receive an average of 57.5 hours of care per week, 49.8 hours per week when aged 45 to 64, 16.1 hours per week aged 65 to 79, and 14.9 hours per week when aged 85 and over. This intertemporal stability concerning care received reflects the underlying simulation approach, which projects forward through time based on observations drawn from contemporary survey data. It is important to bear in mind that the simulation approach omits temporal trends in care receipt due to limitations of the data available for parameterisation.



Panel A: Aggregate value of social care received



Panel B: Ratios of value of social care received

Figure 4.3: Projected value of social care received, by provider and simulated year

Source: Authors' calculations on simulated data. Median wages of social care workers reported by ONS dataset "Earnings and hours worked, care workers", Table 26.5a. Gross Domestic Product (GDP) figures for the UK reported by ONS, variable YBHA. Real growth of GDP derived from baseline long-term projections reported by the Office for Budget Responsibility (OBR), 16 May 2024. Inflation figures based on Consumer Price Indices (CPI) reported by the OBR. OBR projections run from 2022/23 to 2073/74.

Notes: See notes to Figure 4.1. Social care projected as hours per week converted to monetary values assuming the median hourly wage rates of social care workers. All values discounted to 2022 prices based on CPI.

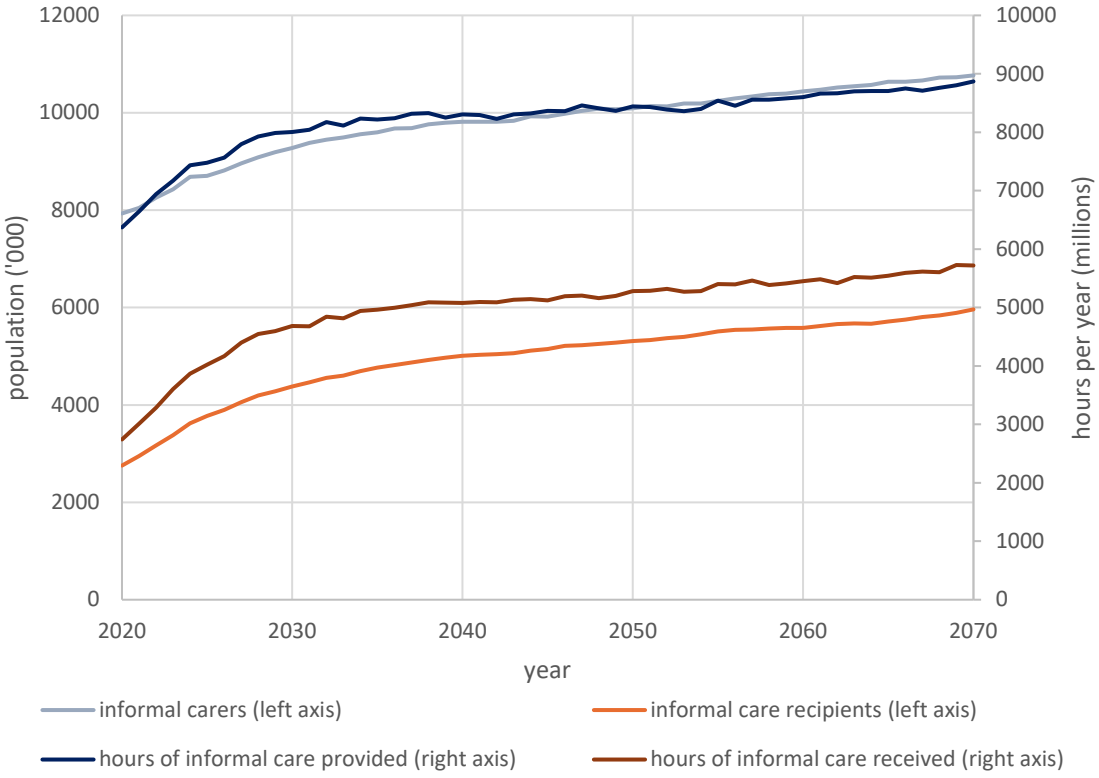
4.1.4 Informal social care provision

Figure 4.4 contrasts projections for receipt and provision of informal social care. The two panels indicate that both the incidence and scale of informal social care provision projected by the model substantially exceed those of social care receipt. This disparity may be explained by a range of factors.

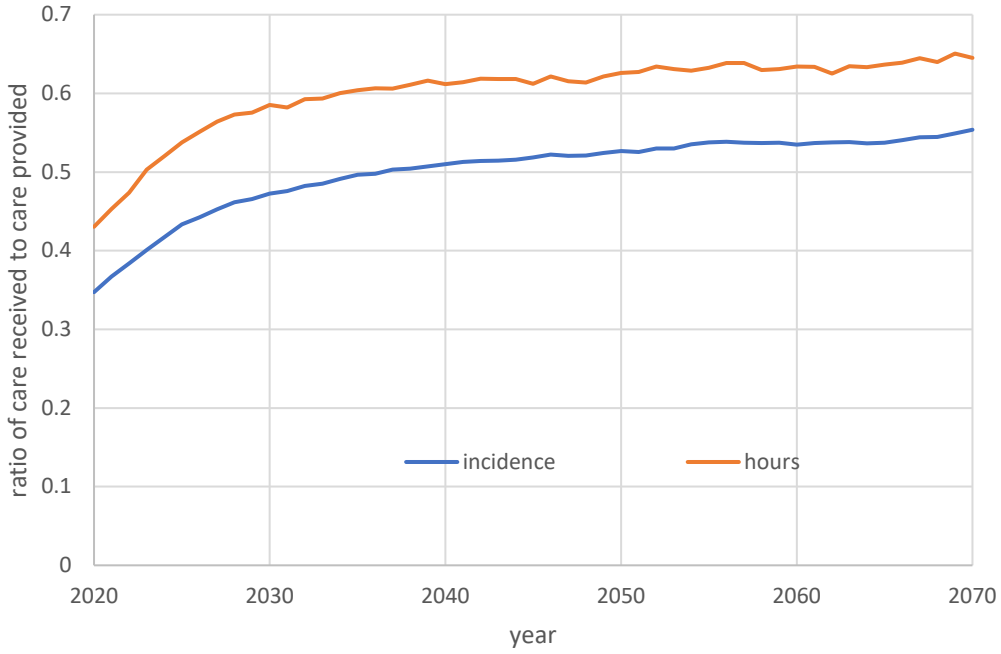
The UKHLS survey statistics that are used to parameterise informal social care provision focus on help to someone "who is sick, disabled or elderly", but do not refer to specific activity limitations that help may be provided for. The associated survey questions query "how many hours do you spend each week" in providing care, but do not clarify if a respondent should include time spent outside of the actual provision of assistance, for example, while in transit or in the company of someone between assistance activities. The UKHLS questionnaires do not permit assistance to people under age 45 to be distinguished to those aged 45 and over. Beyond basic definitional variation, biases in survey responses may also be involved. It is possible, for example, that there is a tendency among carers to overstate their provision of care and for care recipients to similarly understate their receipt of care.

Figure 4.4 indicates similar time profiles of informal social care provision and receipt between 2020 and 2070. A notable feature of these profiles is that the ratio of care receipt to care provision, measured with respect to both incidence and hours, tends to increase with time. This feature is made clear in Panel B of Figure 4.4, where the ratios for incidence and hours are both seen to increase from around 0.4 in 2020 to around 0.6 in 2070.

Bearing in mind the range of potential drivers for the difference in measures of informal care provision and receipt discussed above, the fact that measures of receipt are found to rise relative to those for provision suggest a tightening in the "market" for informal social care. This aspect of the projections suggests that informal social care may become increasingly difficult to source by those in need. To the extent that this is the case, we might expect a shift toward formal care where people have sufficient financial means. We now turn to explore associated implications for behaviour through the life course.



Panel A: Provision and receipt of informal social care



Panel B: Ratios of receipt to provision of informal social care

Figure 4.4: Projected provision and receipt of social care by simulated year

Source: Authors' calculations on simulated data.

Notes: See notes to Figure 4.1.

4.2 Effects of care during the life course

This section begins with an overview of projections for a representative birth cohort, before focussing on selected subjects of interest.

4.2.1 Overview

Table 4.1 reports summary statistics by age group for simulated population cohorts born between 1990 and 1999. These birth cohorts were aged between 20 and 29 in 2019 (first simulated year), and 71 and 80 in 2070 (last simulated year), thereby capturing the full working lifetime and early years of retirement. The table focuses on ages between 29 and 71, ensuring that all ten considered birth cohorts contribute equally to all reported age specific statistics.[35]

Summary statistics are reported for three alternative simulation scenarios. The top panel of the table reports statistics obtained under the "zero costs" scenario. This scenario suppresses time and financial implications of care, both when evaluating labour and expenditure decisions and projecting the population through time.

The middle panel of Table 4.1 reports the difference between statistics evaluated assuming the "ignore costs" scenario and the zero costs scenario. The ignore costs scenario assumes behaviour as identified under the zero costs scenario, but imposes the costs of care as estimated from survey data when projecting the population through time. Hence, under the ignore costs scenario, agents are implicitly assumed to make decisions that systematically ignore the costs associated with care even though these costs are incurred.

The bottom panel of Table 4.1 reports the difference between statistics evaluated assuming the "base" scenario and the ignore costs scenario. The base scenario includes the estimated costs of care both when identifying employment and savings decisions and projecting the population through time – it is the same scenario as used to produce statistics reported in Section 4.1.

Starting with results reported for the zero costs scenario, the top row of Table 4.1 indicates that the projected incidence of disability rises until the 41-50 age band and is broadly stable at 3 to 4% of the simulated cohorts thereafter. This reflects the empirical identification of disability from variables reporting labour market status, upon which the projections are based.

Disability rates govern projected need for care until age 64, after which care needs are projected based on survey respondents' reported abilities to manage selected activities (see Section 3.3). This is the source of the distinct jump in rates of needing care, relative to disability, that is reported to ages 66-71 in the second row of Table 4.1. The jump here reflects

[35] Simulated sample screened to focus on balanced panels comprised of the same observations across simulated scenarios. Results reported here are robust to consideration of alternative sets of birth cohorts.

the underlying survey statistics upon which the simulations are based, as discussed in Section 2.2.1.

The incidence of people providing informal social care is projected to more than double from 8.7% of people aged 29 to 35, to 19.2% of people aged 51 to 55, and to remain approximately stable at higher ages. Note that, although the top panel of Table 4.1 includes rates of disability, care need and care provision, these conditions are not projected to be associated with any (direct) costs in terms of activity limitations, leisure hours, or financial circumstances under the zero costs scenario.[36] They are included here as a reference for interpreting results discussed below.

Employment rates are projected under the zero costs scenario to decline from early in the working lifetime into retirement. At the same time, (disposable) income is projected to rise throughout the simulated lifetime, with investment returns and pensions off-setting lost labour income late in life. Consumption and wealth are also projected to increase into late life, with savings later in life supported by a strong bequest motive.[37] This aspect of the model projection was necessary to capture the ratio of consumption of people aged 18 to 54 to that of people aged 55 to 74 described by contemporary survey data (see Section 3.4.1).

The middle panel of Table 4.1 – headed "ignore costs scenario less zero costs scenario" – reports the effects of adding care costs to the simulation, while holding the descriptions of employment and savings behaviour the same as projected under the zero costs scenario. This comparison helps to identify the "impact" effects that care costs have on simulated life profiles. The middle and bottom panels of the table omit statistics for the incidence of disability, care needs and carer responsibilities, as these do not differ appreciably between the three simulations considered here.

The top row of the middle panel of Table 4.1 indicates that employment rates during the working lifetime tend to fall very slightly under the ignore costs scenario, relative to the zero costs scenario. This shift is driven by the assumption that employment is not possible when an individual is disabled/in need of social care under the ignore costs scenario (which is not imposed by the zero costs scenario). It is notable that the falls in employment rates reported in the middle panel are appreciably lower than the (age specific) incidence of care needs reported in the top panel. This observation indicates that substantial shares of those with care needs do not choose to work under the zero costs scenario, potentially due to low imputed wages.

Annual disposable income is projected to rise very slightly in the middle panel of Table 4.1. One driver of the increase in disposable income is public subsidies off-setting the coincident rise of expenditure on formal care also reported in the middle panel of Table 4.1. Care expenditure is projected to peak early in the reported period reflecting the incidence

[36] Disability state has "indirect" effects on projected wage rates.

[37] Although standard life-cycle theories suggest that savings should fall late in life, observed persistence of saving into old age is well recognised. De Nardi *et al*. (2021), for example, note that retirees save to prepare for uncertain end of life medical expenses and to leave bequests.

formal childcare associated with young children. Formal care costs are then projected to fall for people in their 50s and 60s, before rising into later life as social care needs intensify.[38] Although the average measures of annual care expenditure are not large – under 1.6% of contemporaneous disposable income – note that this masks the true value of care costs incurred by those in need of care as it is averaged over the entire simulated cohort.

The solution to the lifetime decision problem solves for discretionary consumption as a proportion of available liquidity (liquid wealth plus available credit and disposable income net of care expenditure). As available liquidity falls under the "ignore costs" scenario, so too does discretionary consumption. Early in life, the decline in discretionary consumption only partly offsets the decline in disposable income net of care expenditure, so that savings are projected to fall, relative to the zero costs scenario. Later in life, rises in income and declines in consumption more than off-set associated care expenditure, so that the short-fall of wealth projected under the ignore costs scenario is projected to decline.

The lower panel of Table 4.1 – headed "base scenario less ignore costs scenario" – reports the effects of including an allowance for care costs in the specification of forward-looking labour/leisure and consumption/savings decisions. The employment statistics reported in the bottom panel indicate that labour supply is projected to fall in response to the allowance for care costs. This response is driven by informal social carers, who respond to their reduction in available leisure hours by reducing their labour supply – responses that are absent under the ignore costs scenario.

As with the influence of disability, it is notable that the reductions in employment reported in the bottom panel of Table 4.1 understate the respective shares of the population providing care. This indicates that an appreciable share of carers are not projected to alter their employment status as a result of the reduction in leisure time implied by their care responsibilities.

The influence on disposable income of the reduced rates of employment projected under the base scenario are somewhat muted through most of the life course. This reflects the fact that reduced earnings are offset by higher investment returns associated with coincident increases in wealth (discussed below). It is also attributable to a stronger propensity for social carers with the low wages to drop out of employment. Later in life, disposable income is projected to fall (relative to both the ignore costs and zero costs scenarios) as wealth declines and informal social care responsibilities affect a wider segment of the population.

Expenditure on formal care is broadly invariant between the "ignore costs" and "base" scenarios. This is important early in life, as it suggests that the model does not reflect an appreciable shift of parents out of employment in favour of informal childcare. Note, however, that the muted effects of childcare reported here may not apply to younger birth

[38] Comparing the measures of care expenditure under the ignore costs scenario reported in Table 4.1 with those reported for the simulations that omit social care costs (not reported here) reveals that almost all of the care expenditure reported under age 60 is attributable to childcare, and to social care thereafter. Recall that all social care received under age 65 is assumed to be provided informally.

cohorts as associated economies of scale increase (as discussed in Section 4.1.1). Late in life, projections for the costs of (formal) social care are not designed to react to simulated labour and consumption behaviour.

Discretionary consumption is projected to fall more substantially under the base than the ignore costs scenario throughout the reported life course. This behavioural variation is particularly interesting to age 55. During this period, the projected fall in discretionary consumption, relative to the zero costs scenario, exceeds the coincident decline in disposable income, so that savings are projected to increase to the 56-60 age band.

The rise in wealth projected under the base scenario, relative to the ignore costs scenario, can be understood as a precautionary behavioural response to the risk posed by the costs of care. Specifically, people are projected as though they anticipate the possibility of being subject to care costs at some time in the future and set aside provisions against those costs. Most of this precautionary response appears to be attributable to social care, in context of muted behavioural responses to childcare (as noted above). These precautionary balances are projected to be consumed by the 61 to 65 age band, principally due to the lower rates of employment projected under the base scenario through the life course.

Table 4.1: Average differences between simulation scenarios by age band of cohorts born between 1990 and 1999

	29-35	36-40	41-50	51-55	56-60	61-65	66-71
zero costs scenario							
disabled	0.015	0.027	0.032	0.038	0.034	0.034	0.042
need care	0.015	0.027	0.032	0.038	0.034	0.044	0.131
social carers	0.087	0.119	0.146	0.192	0.194	0.198	0.212
employed	0.745	0.743	0.594	0.538	0.484	0.342	0.148
income	51638	59308	65894	73705	79508	84206	91904
care expenditure	0	0	0	0	0	0	0
consumption	42586	41692	43223	44383	44598	44052	42261
wealth	76641	144634	295020	480281	635076	817190	1036115
ignore costs scenario less zero costs scenario							
employed	0.001	-0.003	-0.003	-0.003	-0.002	-0.003	-0.005
income	186	257	265	246	123	258	213
care expenditure	813	948	312	49	14	23	288
consumption	-304	-225	-97	-78	-71	-73	-89
wealth	-1667	-3424	-5161	-4012	-2861	-1380	-1253
base scenario less ignore costs scenario							
employed	-0.007	-0.016	-0.012	-0.009	-0.017	-0.015	-0.015
income	-62	-286	-300	-560	-1140	-1765	-3318
care expenditure	-6	-12	-4	-1	-1	1	5
consumption	-636	-372	-530	-682	-553	-601	-558
wealth	575	3033	5642	6331	6335	2020	-7859

Source: Author's calculations on simulated data.

Notes: "zero costs" scenario imposes no time or financial costs for social care or childcare. "Base" and "ignore costs" scenarios impose the same statistical estimates for (potentially) non-zero time and financial costs of social care and childcare. Both "zero costs" and "base" scenarios project employment and saving behaviour reflecting rational expectations concerning costs of care assumed for the respective simulations. "Ignore costs" scenario projects employment and saving behaviour based on the same processes assumed for the "zero costs" scenario, despite including non-zero costs as projected under the "base" scenario. Top panel reports population average statistics projected under the zero costs scenario. Middle panel reports differences between the ignore costs and zero costs scenarios. Bottom panel reports differences between the base and ignore costs scenarios. "disabled" reports the proportion of the population subgroup affected by long-term illness or disability. "need care" reports the proportion of the population subgroup with social care needs. "social carers" reports the proportion of the population subgroup with social care responsibilities. "employed" reports the proportion of the population subgroup in paid employment. "income" reports annual disposable benefit unit income. "consumption" reports annual benefit unit discretionary consumption. "care expenditure" reports annual benefit unit financial costs of formal care. "wealth" reports net value of benefit unit assets and liabilities. All financial values reported in GBP, 2022 prices. Samples limited to balanced panels of simulated individuals born between 1990 and 1999. Samples also screened to include benefit units comprised of the same sample of simulated individuals across simulated scenarios. All statistics evaluated on simulated data for 9,309 observations.

4.2.2 Influence of child rearing

Discussion in Section 4.2.1 suggests that responses to childcare costs are muted through the life course. This section seeks to clarify this proposition by focussing exclusively on projected responses to childcare. Discussion is framed around statistics evaluated for the cohort of women born between 2001 and 2010 who were projected to have their first child at age 29 and to otherwise be unaffected by long-term illness or disability. These birth cohorts are simulated between ages 18 and 60, so that the respective analysis captures a decade prior to first child birth, and a decade following first child maturity (age 18). The analysis consequently permits consideration of anticipation and scarring effects of child birth.

In common with results reported in Section 4.2.1, the current analysis reports results derived from three simulations. The "zero costs" scenario reported here is identical to that considered in Section 4.2.1, whereas the "ignore childcare costs" and "base childcare" scenarios are similar, respectively, to the ignore costs and base scenarios considered in Section 4.2.1 with the exception that all scenarios considered here omit costs associated with social care.

Particular care was exercised when selecting the sample of simulated observations for analysis, beyond the limits on cohorts, disability, and age of first birth described above. Specifically, analysis considers only women with a full simulated record between ages 18 and 60 in all three simulated scenarios (omitting partial records due to migration or death). Furthermore, the sample was limited to women projected to have the same relationship status at each age, and who were matched to the same men (when married), under all three simulated scenarios. These limitations ensure that the sample of simulated individuals at each age is the same for all three simulated scenarios. This is important, because transitions in relationship status have an important bearing on wealth (as assets between new partnerships are combined, and between dissolving partnerships are divided), which would otherwise complicate the analysis.

Summary statistics for the three simulated scenarios are reported in Table 4.2. The top panel of the table bears close similarities with Table 4.1, differing only due to differences between the considered samples. The bottom two panels of Table 4.2 indicate that simulated responses to childcare costs are subdued, as anticipated in Section 4.2.1. Some interesting variation between simulated scenarios can nevertheless be identified.

The middle panel of Table 4.2 displays anticipated impact effects of formal childcare. Expenditure on childcare rises strongly in the years just after first child birth (ages 29 to 33). It is also projected to rise substantially in second five years following first child birth, driven by births of subsequent children. These expenditures reduce wealth, resulting in lower consumption and increased labour supply (due to associated wealth effects).

The lower panel of Table 4.2 suggests weak precautionary responses underlying increased saving in the years following first child birth (29 to 33). These precautionary responses are displayed by both the women who are the focus of the reported statistics and their respective partners, as the men who marry targeted women are observed to possess

higher wealth at the time of relationship formation under the base childcare scenario than under the ignore costs scenario.

Table 4.2: Average differences between simulation scenarios by age band of cohorts of women born between 2001 and 2010 who were projected to have their first child at age 29

	18-28	29-33	34-38	39-43	44-48	49-60
zero costs scenario						
need care	0.000	0.000	0.000	0.000	0.000	0.000
social carers	0.062	0.099	0.103	0.154	0.154	0.245
employed	0.554	0.626	0.620	0.558	0.543	0.515
income	31520	59133	60363	64173	70867	84140
care expenditure	0	0	0	0	0	0
consumption	25781	43940	45689	45788	45677	46323
wealth	18121	114440	175737	259696	366649	629967
ignore childcare costs scenario less zero costs scenario						
employed	0.000	-0.015	-0.007	0.002	-0.004	0.001
income	0	48	1033	885	302	105
care expenditure	0	2296	2561	745	247	43
consumption	0	-848	-227	-878	-297	-318
wealth	0	-1472	-9995	-9339	-8165	-5856
base childcare scenario less ignore childcare costs scenario						
employed	-0.005	-0.002	-0.018	0.004	-0.004	-0.003
income	-167	126	-261	384	244	606
care expenditure	0	-106	-145	63	-32	-1
consumption	-250	401	-365	195	94	137
wealth	378	3265	1739	3237	3372	8223

Source: Author's calculations on simulated data.
Notes: See Table 4.1. "Base childcare scenario" imposes (non-zero) statistical estimates for time and financial costs of childcare. "Ignore childcare scenario" projects the population using the same processes as the "base childcare scenario", except for behaviour which is projected as described under the "zero costs scenario". Samples limited to balanced panels of women born between 2001 and 2010 who had their first child at age 29 and were unaffected by disability. Samples also screened to include benefit units comprised of the same sample of simulated individuals across simulated scenarios. All statistics evaluated on simulated data for 91 observations.

4.2.3 Precautionary responses to social care

Discussion in Section 4.2.1 notes the role of precautionary behavioural responses underlying projected differences, especially in relation to balances of net wealth. This section evaluates the precautionary behavioural responses associated with social care costs. Results are reported for two simulated scenarios: the "zero costs" scenario as discussed previously, and a "restricted social care costs" scenario.

The restricted social care costs scenario is similar to the base scenario discussed in Section 4.2.1, with two key exceptions that are adapted to the current focus of interest. First, the restricted social care costs scenario omits childcare costs, and in this sense is a

counterpart to the base childcare costs scenario discussed in Section 4.2.2. Secondly, the restricted social care costs scenario is adapted so that simulated individuals are prevented from either needing or providing social care. This second limitation helps to focus on anticipatory behavioural responses to care needs, and is needed because otherwise very few individuals are projected to avoid all costs of social care, either in the form of providing informal care, needing formal care, or sharing a benefit unit with someone else who does.

Summary statistics are reported in Table 4.3. Comparing the top panel of Table 4.3 with Table 4.1 indicates close similarities between the respective samples considered for analysis. The statistics reported in the bottom panel indicate how anticipatory responses to social care costs influence employment and savings decisions through the life course. The top two rows of the bottom panel indicate that precautionary incentives have little bearing on either employment decisions or disposable income. The former of these observations confirms the proposition that the reductions in employment reported in the bottom panel of Table 4.1 reflect responses of informal care providers to their associated reduction in leisure hours.

Table 4.3: Average differences between simulation scenarios by age band of cohorts born between 1990 and 1999 who at no time provided or received social care

	29-35	36-40	41-50	51-55	56-60	61-65	66-71
zero costs scenario							
employed	0.779	0.783	0.633	0.577	0.517	0.360	0.152
income	54288	65079	74149	84094	91230	96495	104723
care expenditure	0	0	0	0	0	0	0
consumption	42558	42270	44953	47035	47496	47369	46308
wealth	89089	182717	377087	616120	812861	1040766	1309494
base scenario less ignore costs scenario							
employed	-0.002	-0.004	-0.002	0.002	-0.003	-0.003	0.001
income	-115	-430	-342	-50	-336	72	289
care expenditure	0	0	0	0	0	0	0
consumption	-228	-236	-489	-640	-488	-429	-319
wealth	688	948	571	1851	5193	5796	9645

Source: Author's calculations on simulated data.

Notes: See Table 4.1. "Restricted social care scenario" projects savings and employment behaviour that takes into account possibility of social care costs but omits those costs from arising in the simulated population. Samples limited to balanced panels of people born between 1991 and 1999 in benefit units with no members affected by disability. Samples also screened to include benefit units comprised of the same sample of simulated individuals across simulated scenarios. All statistics evaluated on simulated data for 4,839 observations.

Key results are reported in the last two rows of Table 4.3. These rows indicate reduced consumption and increased saving throughout the reported age band in response to the risks of exposure to social care costs. Importantly, responses are muted prior to age 50 compared to associated results reported in Table 4.1. This indicates that childcare costs are important early in the simulated lifetime, which is also supported by the associated reported in Table 4.2. Later in life, it is also interesting to note that the precautionary balances reported for ages 66-71 in Table 4.3 are only sufficient to partly offset anticipated social care costs (as indicated by the last row reported in Table 4.1).

4.2.4 Influence of social care

Preceding discussion has highlighted the role of childcare early in adult life, and social care later in life in shaping employment and savings decisions. Section 4.2.3 focusses on anticipatory effects of social care. Here we consider the combination of anticipation, impact, and scarring effects of social care.

Like the preceding discussion in Section 4.2, discussion is framed around comparisons between three simulation scenarios: the "zero costs" scenario described previously, and the "ignore social care costs" and "base social care" scenarios. The last two of these scenarios are similar to related scenarios described in Sections 4.2.1 and 4.2.2, with the distinction that the current analysis omits childcare costs to focus exclusively on social care costs. Associated summary statistics are reported in Table 4.4.

The top panel of Table 4.4 reports summary statistics for the target population of individuals born between 1990 and 1999. As this population is the same as considered in Sections 4.2.1, the reported results are almost identical to those reported in Table 4.1. The slight differences between these two panels are entirely due to differences in the considered samples, which differ due to limitations imposed to obtained balanced panels for analysis.

The middle panel of Table 4.4 presents a number of interesting contrasts for the impact effects of social care, relative to the costs of care more generally as reported in Table 4.1. One of the most obvious of these differences is that care costs are zero prior to age 65 reported in Table 4.4. This is because all social care needs associated with long-term illness or disability projected prior to age 65 are assumed to be met by informal social care in the simulations (see Section 3.3). Hence all costs associated with social care prior to age 65 are assumed to apply in the form of reduced leisure, and the associated bearing on employment decisions.

With no formal social care costs, disposable income does not benefit from associate public subsidies, which works depress disposable income in the middle panel of Table 4.4 between ages 29 and 35, relative to Table 4.1. In contrast, the incidence of carer responsibilities is taken into account by the ignore social costs scenario, so that disposable income is buoyed later in life (from age 41). These higher incomes are, however, treated as unanticipated by the zero costs scenario. The result of lower (formal) social costs and unanticipated income increases sees additional wealth accrued throughout the reported period of life. Later in life, expenditure on formal social care bites, so that similar costs are reported of the 66 to 71 age band in both Table 4.4 and Table 4.1.

Comparing the bottom panel of Table 4.4 with Table 4.1 reveals almost identical effects for employment and disposable income. This observation confirms the view that simulated employment effects are driven by the reduction of labour supply among informal social carers discussed above.

Comparisons between the effects on wealth reported in Table 4.4 with those reported in Table 4.1 suggest the accrual of smaller precautionary in the absence of childcare. This conclusion is, however, fails to account for the fact that lower measures of wealth are projected under the ignore costs than the ignore social care costs scenario. Omitting childcare costs increases projected wealth throughout the reported life course, rising from a surplus of £1700 between ages 29-35, to £4600 between ages 66-71.

Table 4.4: Average differences between simulation scenarios by age band of cohorts born between 1990 and 1999

	29-35	36-40	41-50	51-55	56-60	61-65	66-71
zero costs scenario							
disabled	0.015	0.027	0.032	0.037	0.034	0.034	0.041
need care	0.015	0.027	0.032	0.037	0.034	0.044	0.132
social carers	0.086	0.116	0.144	0.188	0.192	0.198	0.212
employed	0.747	0.745	0.594	0.537	0.485	0.344	0.148
income	51356	59252	66024	73773	79634	84384	92013
care expenditure	0	0	0	0	0	0	0
consumption	42308	41611	43215	44473	44629	44073	42321
wealth	75749	143965	294851	481128	635798	818814	1038838
ignore social care costs scenario less zero costs scenario							
employed	-0.001	-0.004	-0.002	-0.003	-0.003	-0.004	-0.006
income	-2	97	241	347	306	492	442
care expenditure	0	0	0	0	0	24	294
consumption	-18	91	66	60	55	46	30
wealth	-2	274	653	2304	3835	5764	6406
base social care scenario less ignore social care costs scenario							
employed	-0.006	-0.011	-0.014	-0.010	-0.016	-0.013	-0.015
income	-118	-241	-513	-635	-1081	-1682	-3419
care expenditure	0	0	0	0	0	-1	2
consumption	-271	-369	-580	-702	-599	-647	-606
wealth	657	1376	3387	3029	2896	-1049	-10945

Source: Author's calculations on simulated data.

Notes: See Table 4.1. "Base social care scenario" imposes (non-zero) statistical estimates for time and financial costs of social care. "ignore social care costs scenario" projects the population using the same processes as the "base social care scenario", except for behaviour which is projected as described under the "zero costs scenario". Samples limited to balanced panels of simulated individuals born between 1990 and 1999. Samples also screened to include benefit units comprised of the same sample of simulated individuals across simulated scenarios. All statistics evaluated on simulated data for 9,874 observations.

5 Conclusions

Population aging consequent on increased longevity and declining fertility has profound implications for social organisation in many countries during the prospective half century. This study focuses on associated implications for giving and receiving of social and childcare. The current study departs from the related literature in two key respects.

First, the analysis is based on projections derived from a model designed to follow individuals, their evolving families and households through time. Furthermore, the model projects labour/leisure and consumption/savings decisions through time in a way designed to reflect forward-looking expectations that are consistent with the evolving economic context. This permits the analysis to capture anticipation, impact, and scarring effects of giving and receiving care.

Secondly, the analysis is based on fully open-source materials. The model used to conduct the analysis is freely available for download from the internet, without limitation. The input data from which model projections are made are held by the UK Data Service, and are freely available for non-commercial purposes. The study includes a step-by-step walk through to facilitate replication of reported results.[39] This feature of the analysis is designed to encourage scrutiny and experimentation of the study's findings.

Projections reported here imply that total national expenditure on formal childcare will remain broadly level over the next 50 years, equal in value to approximately £5 billion (2024 prices). This aggregate result is the product of countervailing influences. The Office for National Statistics anticipates that population growth will approximately off-set declining fertility, so that the number of people aged under 18 will remain approximately stable, varying between 13.4 and 14.4 million between 2019 and 2070.

At the same time, model projections reported here suggest that children will be increasingly concentrated across benefit units (families), with the number of children per benefit unit with children projected to rise from 1.6 in 2020 to 2.5 in 2070. The increased concentration of children across benefit units is associated with positive economies of scale in informal childcare. This underlies a projected shift toward informal childcare in the model, as the projected share of benefit units with children in which at least one adult is not employed increases from 47% in 2020 to 55% in 2070.

Projections for social care contrast sharply with the stable projections for formal childcare. The pronounced trend in population aging projected for the UK during the prospective half century is projected to see a sharp rise in the incidence of need for social care, from 4.8 million in 2020 to 9.7 million in 2070. Half of this increase is projected to be among people aged 80 and over. Although a pronounced increase in highest education qualification amongst older people tends to weaken the rise in need for social care, associated effects are found to be small.

[39] See Appendix E for full details.

Receipt of social care is projected to follow the rise in social care need noted above. Using the median hourly wage rate of care workers to impute costs for informal social care, the total costs of social care are projected to rise from £40 billion in 2020 to £180 billion by 2070. These figures are equivalent, respectively, to 1.8% and 3.2% of contemporaneous GDP. Informal social care provided by partners is projected to account for over half of all social care throughout the simulated time period, with the formal sector being the next largest provider accounting for 13% of provisions.

The relatively muted role of the formal sector in social care provision projected by the model is in part attributable to omission of residential care from the analysis, which accounted for 71% of all formal long-term social care expenditure in 2022. Nevertheless, aggregate informal care is found to be between 1 to 3 times as large as formal care even after grossing up formal care for the omission of residential care. This finding is consistent with statistics reported elsewhere in the literature. The size of the informal care provision is important, as the analysis suggests a "tightening" in the balance between demand and supply of informal social care. This suggests that there will be a shift in favour of formal social care, to the extent that the formal sector is better placed to respond to the projected tightening than informal care.

Analysis of behavioural alternatives helps to clarify drivers underlying the aggregate projections summarised above. A number of key narratives are identified by the analysis. The "impact effects" of care costs reduce wealth, which in turn tends to depress discretionary consumption.

Accounting for behavioural responses to the impact on leisure of care responsibilities sees employment fall. This reflects both the increased prevalence projected for informal childcare that is noted above, and responses to provision of informal social care. These labour supply responses are associated with reduced earnings, and – all else being equal – would be associated with larger reductions in wealth than the pure "impact effects" outlined above. Yet the model projections suggest that precautionary savings set aside against the risks posed by care more than off-sets the above factors, so that the net impact of care on savings to age 66 is positive when averaged over the population cohorts born between 1990 and 1999.

Taken together the analysis outlined above provides an indication of the pronounced implications that existing projections for population aging have for care arrangements in the UK. The model projections emphasise that informal care arrangements will come under increasing demand side pressure during the prospective five decades, particularly with respect to social care. These pressures will tend to drive up returns to formal care at the same time as informal care demands weigh on labour markets, with associated implications for national productivity. The ability of the economy and of policy to respond to these diverse challenges currently remains unclear.

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Appendix A Data Sources

A.1 Living Costs and Food Survey (LCF)

The LCF was introduced in 2008 when it replaced the Expenditure and Food Survey (EFS), which had been introduced in 2001 following amalgamation of the Family Expenditure Survey (FES, introduced in 1957) and the National Food Survey. The structure of the survey through these three iterations has remained broadly unchanged since 1971, reporting detailed information regarding demographics, income, and expenditure for a sample of approximately 5,500 households in the United Kingdom. The three surveys are consequently referred to collectively throughout this report as the LCF.

The basic unit in the survey is the household, with households being selected at random from the Royal Mail's small users Postcode Address File (PAF) in Great Britain (excluding the Scottish Isles and the Isles of Scilly). The small users PAF is limited to addresses which receive, on average, fewer than 50 items of post per day and which are not flagged with Royal Mail's "organisation code". Northern Ireland is sampled through the Valuations and Lands Agency list. Participation in the LCF is voluntary. The LCF defines a household as: "a group of people living at the same address with common housekeeping that is sharing household expenses such as food and bills, or sharing a living room."

All individuals aged 16 and over in participating households are asked to complete a computer-assisted income questionnaire and to keep a diary of expenditure covering a two-week period, with children aged 7 to 15 also being asked to keep a simplified diary since 1998. Regular expenditure, demographic, and income data are recorded at a household interview, and retrospective information is collected on expenditure of selected large and infrequent purchases. The survey is collected on a continuous basis and reported at annual intervals.

The representative nature of the LCF for the UK population is affected by a number of factors. Firstly, people in institutions — such as retirement homes, the military, or prison — are omitted from the survey. Also, people with no fixed address (the homeless) are not surveyed. Furthermore, the voluntary nature of the survey typically obtains a response rate of those initially approached in the region of 50-60 per cent and has been found in the past to be not uniformly distributed across the population.

A.1.1 Measurement of childcare

The LCF reports weekly equivalent expenditures on childcare derived from the household questionnaire.[40] Prior to 1992, however, the costs of childcare were not reported by the LCF separately from other domestic help, including housekeeping, gardening, etc.

[40] From 2001, variables cc4121 (nursery, creche, playschools) and cc4122 (childcare payments), and prior to 2001 variables d080102t and d080103t.

A.2 Family Resources Survey (FRS)

The FRS was introduced by the Department for Work and Pensions (DWP) in October 1992, in response to the perceived limitations of the Living Costs and Food Survey (LCF) and the General Lifestyle Survey for analysing household incomes in the UK. The FRS reports detailed information regarding household demographics and income for a cross-section of households in the United Kingdom. Although the FRS omits detail concerning household expenditure that is reported by the LCF, it includes finer detail concerning income sources, for samples that are typically more than three times those reported by the LCF.

Like the LCF, the FRS sample is drawn from the Royal Mail's small users Postcode Address File (PAF) in Great Britain. The sampling frame used by the FRS for Northern Ireland is the NISRA Address Register (NAR). The NAR is primarily based on the Land and Property Services (LPS) Pointer database, the most comprehensive and authoritative address database in Northern Ireland, with approximately 745,000 address records available for selection.

The current study reports results from pooled data reported at annual intervals from 2015/16 to 2019/20 and for 2021/22. The 2019/20 data are from interviews conducted between April 2019 and March 2020. Interviews were suspended in mid-March 2020 in line with the national lockdown. At this point, nearly a full year's worth of FRS interviews had already taken place and there is no material impact of COVID-19 upon these results, with the overall response rate for 2019/20 being 49%. Data reported by the FRS for 2020/21 are omitted from the study due to concerns regarding representativeness of the sample due to the effects of the COVID-19 pandemic.

A.2.1 Measurement of childcare

Information regarding childcare costs have been solicited from all parents responding to the FRS since 2003/04. Prior to that year, questions regarding childcare were only asked if one of the adults responsible for children reported being in paid work (or if it was noted that childcare was paid for on a regular basis for the 2001/02 and 2002/03 surveys). Furthermore, analysis by Brewer and Shaw (2004) indicated that the FRS tends to understate the incidence of low cost (or free) forms of childcare. The FRS was consequently altered substantially in 2005, with the revised survey structure focussing on childcare costs actually incurred by parents or guardians in the 7 days preceding the survey, rather than averages distinguishing "term time" and holiday care.

A.2.2 Measurement of social care

FRS respondents are asked if they receive care from anyone. This includes both professional help – paid-for care from the local authority, health professionals or domestic staff – but it also includes informal care. This is any care where their carer is not doing it as a paid job; it can be for many, or only a few hours a week, and can take several different forms. The

survey is intentionally not prescriptive about what counts as care; it could, for example, include going shopping for someone, or helping them with paperwork.[41]

Where respondents are receiving care at least once a week, they are further asked about the nature and frequency of that care. No information is collected concerning the cost of formal care services received or how those services are paid for.

FRS respondents are also asked if they provide care to someone else, on an informal basis. That person could be living with them, in their household, or they could live somewhere else (outside the household).

A.3 Health Survey for England (HSE)

The HSE reports data at annual intervals, with the current study pooling data from 2015 to 2019. The 2019 wave is the most recent that is currently available and was administered to 9,612 addresses selected at random in 534 postcode sectors, over twelve months from January to December 2019. Field work was completed in March 2020. Where an address was found to have multiple dwelling units, one dwelling unit was selected at random. Where there were multiple households at a dwelling unit, one household was selected at random. Adults and children were interviewed at households identified at the selected addresses. Up to four children in each household were selected to take part at random; up to two aged 2 to 12 and up to two aged 13 to 15. Survey response rate in 2019 was 60%, comprising a total of 8,205 adults aged 16 and over and 2,095 children aged 0-15.

A.3.1 Measurement of social care

The HSE includes a Social Care questions module administered to all respondents aged 65 and over. The HSE social care module is very similar to that administered by the UKHLS (described below), and consequently serves as a useful benchmark for comparison.

A.4 Annual Survey of Hours and Earnings (ASHE)

ASHE reports data for a 1% sample of employee jobs recorded by the tax authority collected during the third week of April each year. Data are collected from employers, providing information about the levels, distribution and make-up of earnings and paid hours worked for employees in all industries and occupations. The ASHE tables contain estimates of earnings for employees by sex and full-time or part-time status. Further breakdowns include by region, occupation, industry, age group and public or private sector.

[41] A "showcard" is used, which lists a range of activities, including assisted mobility, personal care, administrative tasks, housework, and other general social support.

A.5 UK Household Longitudinal Survey (Understanding Society, UKHLS)

The UKHLS is a longitudinal household panel study. The Study started in 2009 and follows on from the British Household Panel Study which ran from 1991-2008. Taken together the two studies currently provide researchers with data on households in the UK spanning 30 years.

The General Population Sample (GPS) is comprised of a clustered and stratified, probability sample of approximately 24,000 households living in Great Britain in 2009-10, augmented by a simple random sample of approximately 2,000 households living in Northern Ireland in 2009 (selected with twice the selection probability as the Great Britain part). All household members of the households selected at the first wave and their descendants constitute the core sample and are followed wherever they move within the UK to see how things have changed over time and over their life course. Sample members are interviewed at approximately annual intervals as long as they continue to live in the UK and can be located, contacted and agree to participate.[42] The survey achieved a response rate of 57% in wave 1. Wave 11 (the last for which the social care module is reported – see below) was collected in fieldwork conducted between January 2019 and May 2021, and reported a response rate of 87%.

Although field work for wave 11 was affected by COVID-19 restrictions from March 2020, the overall response rate for the wave compares favourably with 82% achieved for wave 10 (unaffected by COVID-19). All results reported here were consequently calculated including data for 2020, subject to associated checks for robustness.

A.5.1 Measurement of social care

The UKHLS includes two principal modules that describe social care for adults.[43] A "caring module" has been asked in all survey waves, which reports information about informal caring activities provided by survey respondents to "sick, disabled, or elderly" people. Waves 7 (2015 and 2016), 9 (2017 and 2018) and 11 (2019 and 2020) also include a "social care module" that reports metrics describing the receipt of social care services for survey respondents aged 65 and over.

Caring module

The caring module administered by the UKHLS elicits information about the incidence and hours of informal care provision, including information about who care is provided to.

Social care module

[42] The English Longitudinal Study of Aging (ELSA) is another panel survey that reports measures of social care. Unlike the UKHLS, however, ELSA reports data at biannual (intervals and only for a sample resident in England.

[43] A separate module also asks questions about care for children.

The social care module administered by the UKHLS elicits information about the following types of tasks for which assistance is needed and/or received:

- getting in and out of bed
- washing your face and hands
- cutting toenails
- having a bath or a shower, including getting in and out of the bath or shower
- dressing or undressing, including putting on shoes and socks
- using the toilet
- eating, including cutting up food
- taking the right amount medicine at the right times
- getting around the house
- getting up and down stairs
- walking down the road
- shopping for food including getting to the shops, choosing the items, carrying the items home and then unpacking and putting the items away
- doing routine housework or laundry
- doing paperwork or paying bills

The first ten activities listed above (to "up and down stairs") are categorised as "activities of daily living" by the survey (ADL). Basic or physical ADLs are commonly recognised as skills required to manage basic physical needs. The remainder of the activities (from "walking down the road") are categorised as "instrumental activities of daily living" (IADL). IADLs are generally considered to include more complex activities than basic ADLs, related to the ability to live independently in the community.

The survey asks each responded if they "manage" the tasks listed above on their own and what extent of difficulty they encounter if doing so. It also asks "In the last month, who has helped you with" each of the tasks listed above, distinguishing between a detailed list of formal and informal providers.[44] Furthermore, respondents are asked "in the last week, how many hours have" each of the care providers given their assistance and a range of details concerning costs incurred.

In principle, the UKHLS can track transitions into residential care. In practice, the incidence of such transitions is very rare and has been omitted for the most recent waves of the survey.[45] In contrast, the British Household Panel Survey (BHPS, the forerunner of the UKHLS) reported information concerning transitions into institutions in all waves. In this case, the proportion of the survey population identified as transitioning into an institution –

[44] Informal providers distinguished by the survey: partner, son, daughter, grandchild, sibling, niece or nephew, parent, other family, friend, neighbour. Formal providers: home care worker, intermediate care staff, occupational therapist, voluntary, sheltered housing, cleaner, council handyman.

[45] The same issue affects the English Longitudinal Study of Aging (ELSA), a related panel data source reporting health dynamics of the English population aged 50 and over.

including prisons and residential care – was typically less approximately 0.05 percentage points.

Addressing data observed at two-year intervals

The regression estimates used to parameterise the simulation procedure described above were estimated on UKHLS data reported for the social care module in waves "g", "i" and "k". Lagged dependent variables appear in some of the functions used to project social care receipt, which helps to accommodate persistence in care arrangements. The fact that the UKHLS only provides social care data for every other year, however, raises procedural complications given the annual periodicity of the SimPaths model.[46]

Interpolation methods were used to impute data in year *t+1* for any individual with social care data reported in years *t* and *t+2*, and these data were used to estimate transition equations underlying the simulation. Where a social care statistic was observed to be the same in years *t* and *t+2*, then the same value was assumed to apply in year *t+1*. Alternatively, where a social care statistic was observed to vary from years *t* to *t+2*, then the observation was replicated, with each replication assigned half the respective survey weight. One of these replicated observations was assigned the value observed in year *t* for year *t+1*, while the other was assigned the value observed in year *t+2*.

The former of these imputation assumptions (no-change where values are the same in years *t* and *t+2*) will dampen projected volatility of simulated social care receipt, to the extent that it fails to capture (unobserved) variation. The latter assumption (replication where values are different in years *t* and *t+2*) will dampen (unobserved) temporal biases of social care transitions, including biases associated with age.

A.5.2 Population representativeness

Many challenges associated with obtaining a representative description of the underlying population of interest are exaggerated for panel surveys like the UKHLS, relative to purely cross-sectional surveys. One particular focus of concern is how to adapt survey weights in a way that accounts for panel attrition and associated population distortion. An appreciation for this issue may be obtained from Figure A.1, which reports the UK population age distribution for three years described by alternative data sources.[47]

Statistics reported for 2011 show a close correspondence between the age distribution described by (cross-sectionally weighted) UKHLS data and the ONS population estimates. This was two years after introduction of the UKHLS, which included a new population sample designed to reflect the UK population cross-section.

Ten years later, the statistics reported for 2021 (the most recently available wave at the time of writing) indicate appreciable differences between the age distributions described by

[46] For example, a probit equation governing receipt of care that includes as a regressor receipt of care with a two-year lag would treat a person who first received care in the preceding year identically to one who did not receive care. This could result in undesirable oscillations in projected care states.

[47] The FRS covers Great Britain only (omits Northern Ireland).

ONS population estimates and the (weighted) UKHLS data. Relative to the ONS estimates, the UKHLS data tend to understate people under 10 years of age and between ages 25 and 40 (peak child-rearing ages), and overstate people aged 50 and over. In contrast, the FRS (a large cross-sectional survey, see Appendix A.2) display a close correspondence with the ONS population estimates. Finally, data for 2019 (Panel B of Figure A.1) suggest that the differences between the ONS population estimates and UKHLS weighted data have been widening with time.

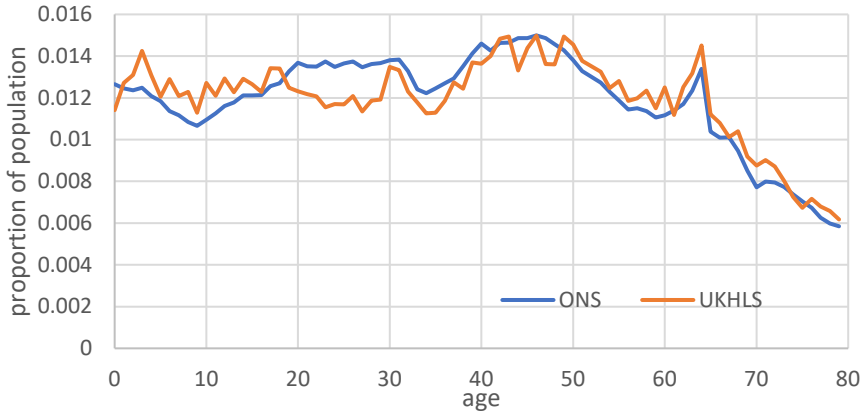
Strategies to address non-representativeness of UKHLS

The disparities between ONS population estimates and UKHLS data discussed above are clearly important for the current study. Understatement of children risks missing the incidence of childcare, while overstatement of the elderly risks over-stating needs for social care. The modelling framework considered for this study employs three methods to mitigate these risks.

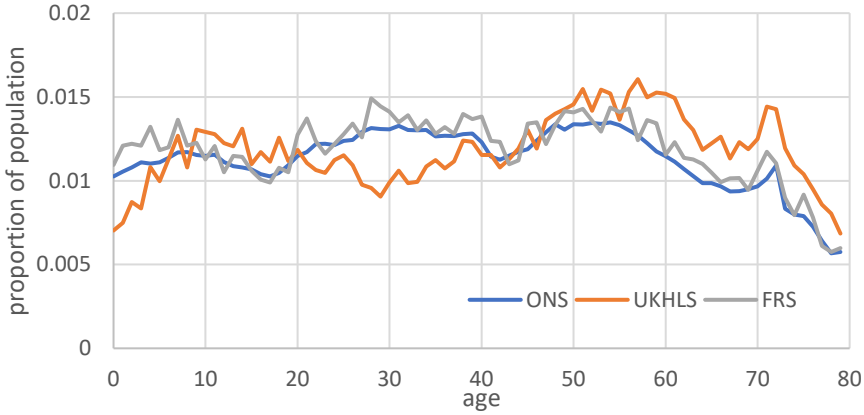
First, a re-sampling routine is used to ensure that the **starting data for analysis** match to ONS population estimates distinguished by single year of age (0 to 100), gender (male/female), and Government Office Region (12 geographic regions). Briefly, the routine involves taking the cross-sectionally weighted data described by the UKHLS for 2019 and randomly sampling households from these data with replacement until the targets described by the ONS population estimates are satisfied. The efficacy of this routine is supported by stratifying the UKHLS population between households with and without children. Child targets are matched first, followed by adult targets.[48]

Second, alignment methods are used to adjust the probit functions governing **fertility and cohabitation** to match model projections to year-specific population targets reported by the ONS. Specifically, the probit functions governing fertility and cohabitation were estimated on UKHLS data, and so may be affected by the same population biases as discussed above. Furthermore, these functions are centrally important to both childcare and social care. Hence, the intercepts of the respective probit functions were adjusted to match population averages for (period) fertility and the incidence of cohabitation.

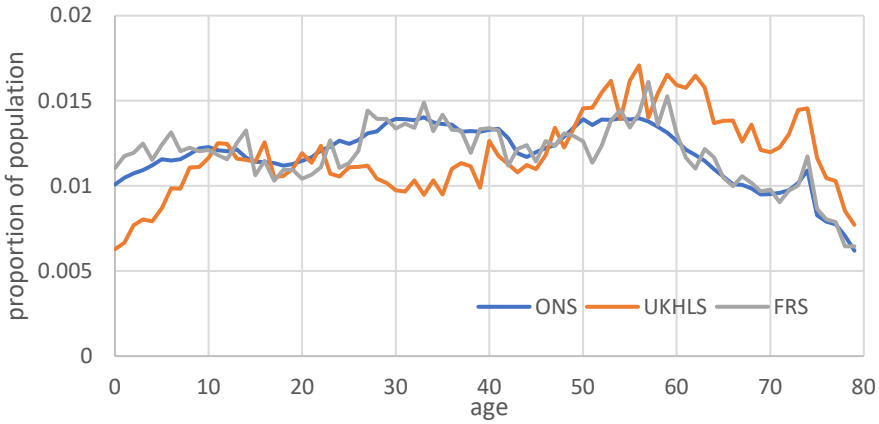
[48] This is important because all households with children include adults, so that matching child targets is only possible if there is adequate flexibility over the number of age specific adults.



Panel A: 2011



Panel B: 2019



Panel C: 2021

Figure A.1: Population distribution by age, year and data source

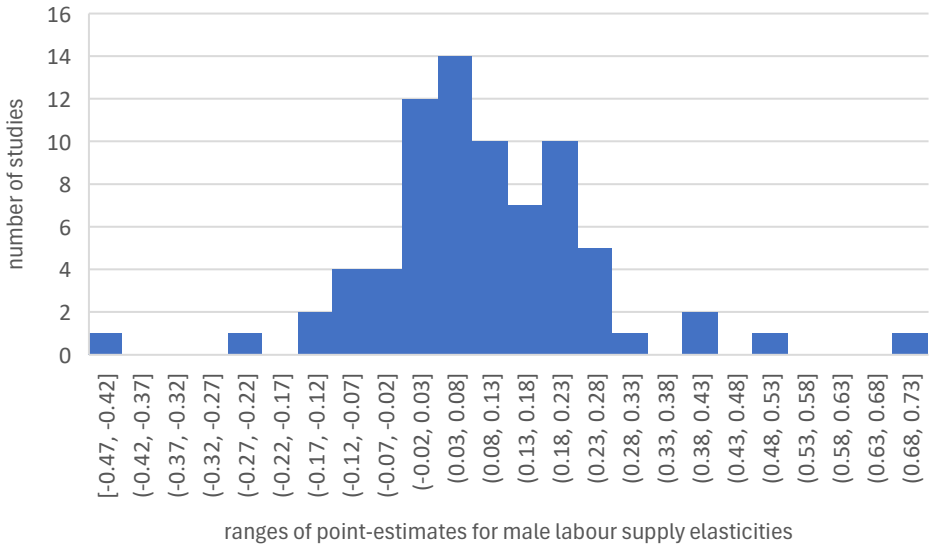
Source: Office for National Statistics (ONS) mid-year population estimates published June 2021. Family Resources Survey (FRS), 2019 and 2021 waves (series starts 1993). UK Household Longitudinal Survey (UKHLS). FRS and UKHLS series (cross-sectionally) weighted.

Third, **population projections in each simulated year** were aligned to ONS projections distinguishing the same age, gender and region subgroups as targeted for the input data.[49] Briefly, the population alignment routine is structured around the youngest member of each benefit unit. Starting with people aged 0, benefit units are moved between geographic regions to match to ONS population targets, for so long as there exist some regions that are deficient and others that exceed their respective targets. These transitions are considered to represent implicit internal migration. Any residual deficiency is met by cloning existing simulated benefit units, implicitly reflecting international immigration. Any residual excess is met by randomly selecting benefit units for remove, implicitly reflecting international emigration.

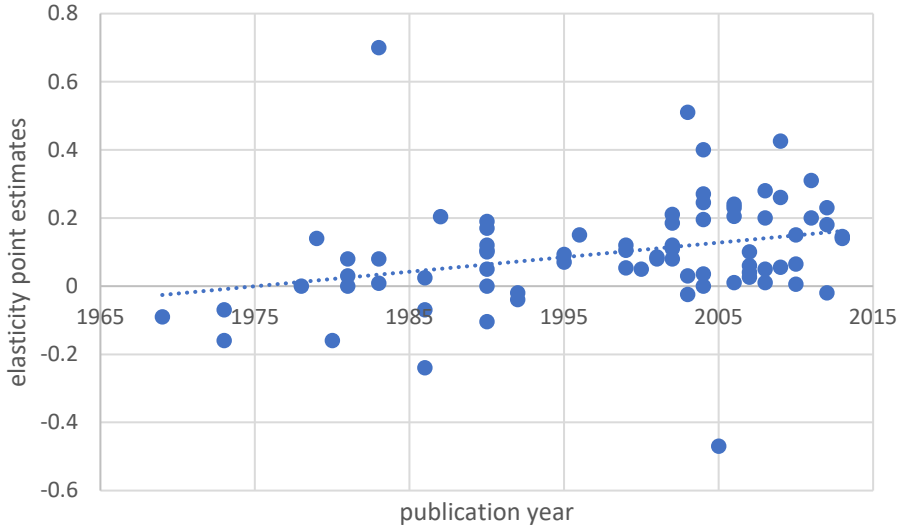
A.6 Econometric estimates for the elasticity of labour supply

An appreciation for the diversity of reported estimates of labour supply elasticities may be obtained from Figure A.1, which displays estimates reported for men in the studies surveyed by Keane (2011) and the meta-analysis of Bargain and Peichl (2016). The top panel of the figure indicates that estimates reported in the literature tend to cluster between -0.12 and 0.28, with a mildly positive mode between 0.03 and 0.08.

[49] To clarify, population estimates and projections reported by the ONS were obtained for single year of age between 0 and 100, for males and females, and for the 12 UK Government Office Regions, for each year between 2019 and 2070.



Panel A: Histogram of estimates



Panel B: Estimates by publication year

Figure A.1: Estimates of male (Marshallian) labour supply wage elasticities

Source: Authors' compilation of estimates reported for Marshall elasticities in Table 6 of Keane (2011), and for male wage elasticities with respect to employed hours in Tables 1 to 3 of Bargain and Peichl (2016).

Appendix B Statistical Background

B.1 Childcare

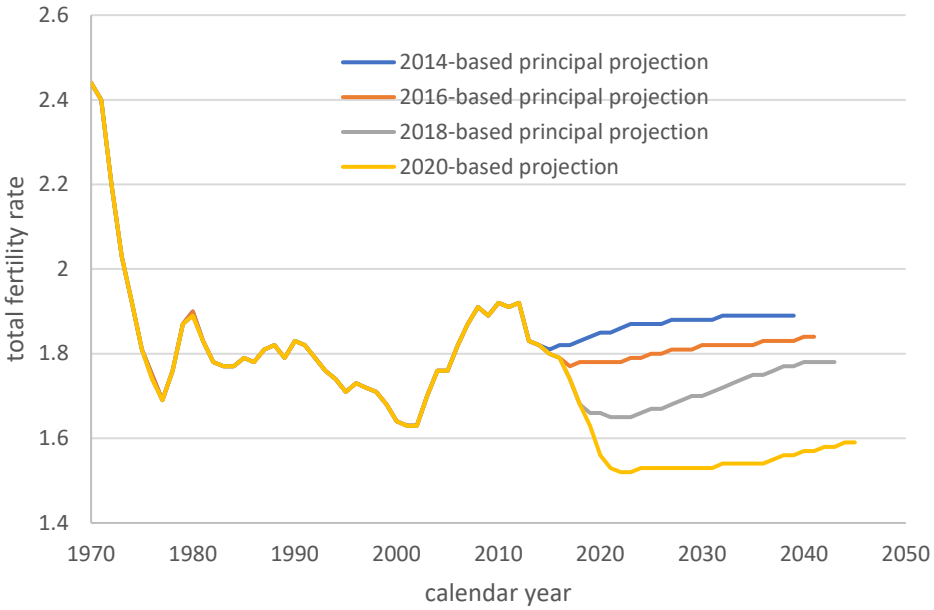


Figure B.1: Office for National Statistics fertility assumptions underlying successive series of principal population projections

Source: ONS National population projections, fertility assumptions: 2020-based interim, Figure 2.

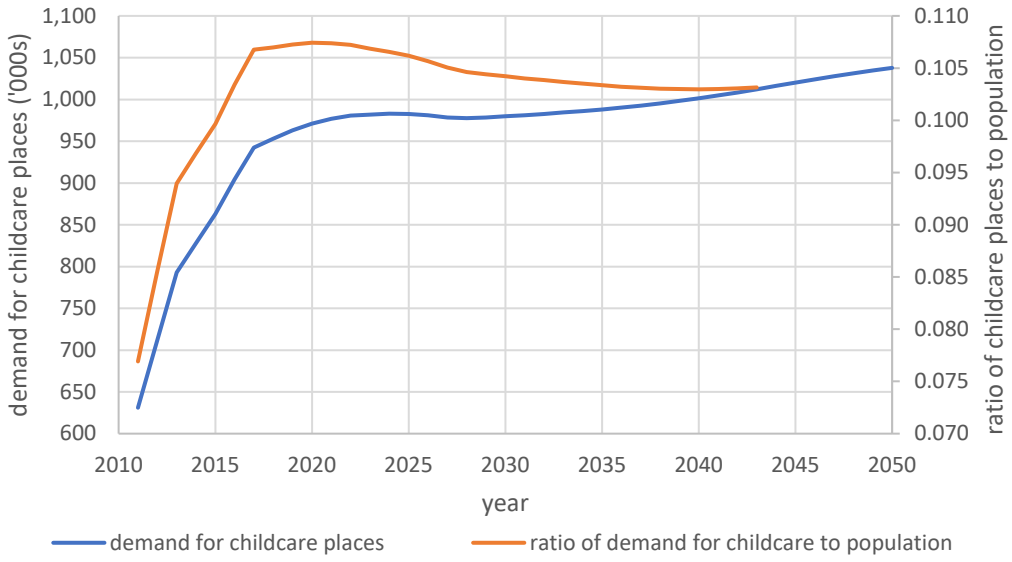
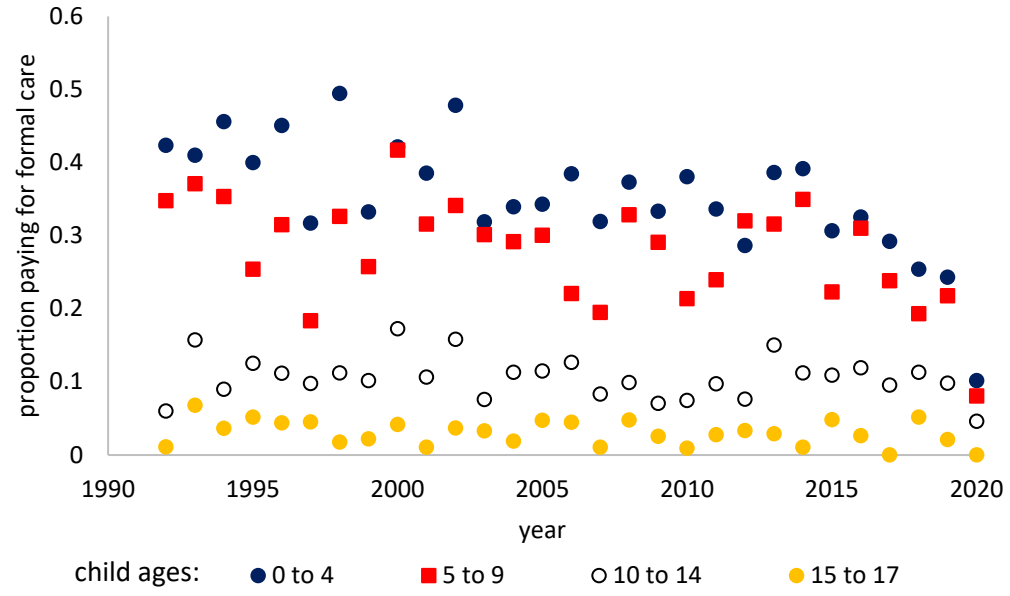
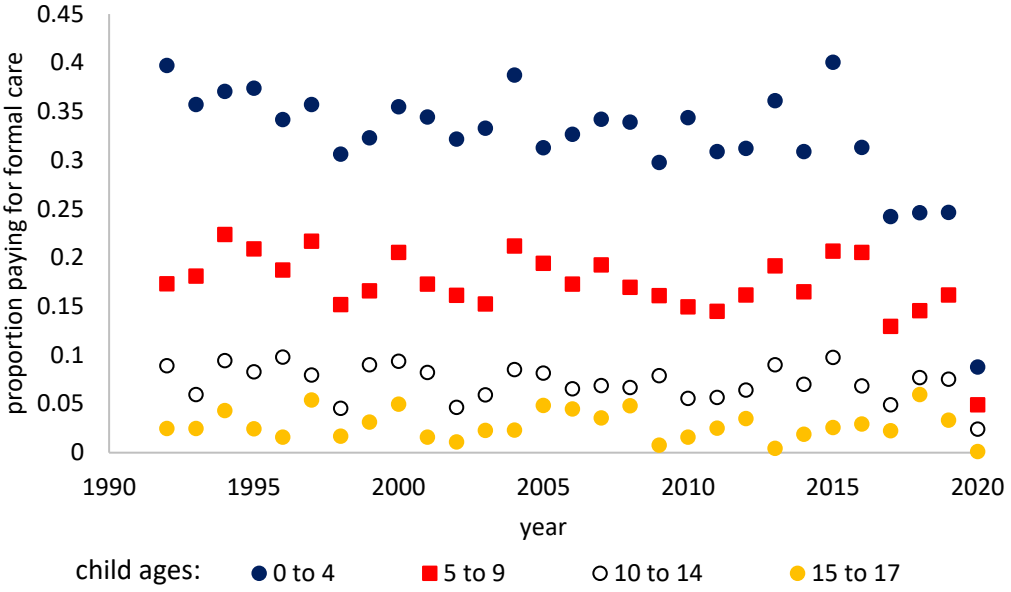


Figure B.2: Projections for total demand for childcare places in London 2011-2050

Source: Greater London Authority Childcare demand projections for London by age band, last updated August 2021. Population estimates for London for 2011-2017 derived from ONS population estimates for regions in England and Wales by sex and age, Table 4: Population estimates for Government Office Regions (GOR). Population projections from 2018 derived from ONS 2018-based subnational population projections, Table 2: Local authorities and higher administrative areas within England (persons).



Panel A: All adults full-time employed



Panel B: All adults employed, but not full-time

Figure B.1: Incidence of childcare costs among benefit units reported by the Living Costs and Food Survey (1992-2020), by year, child age, and adult employment status

Source: Authors' calculations on data from the Living Cost and Food Survey (and forerunner surveys).
Notes: See Figure 2.1.

Comparing Figure B.1 with Figure 2.1 indicates some noticeable differences between statistics reported by the FRS and LCF. First, the LCF statistics describe greater year-on-year volatility than the FRS statistics. This feature is attributable to the smaller sample sizes reported by the LCF. Second, the FRS statistics indicate substantially higher prevalence of formal childcare than do the LCF statistics. Focussing on benefit units with children aged 0

to 4, for example, the FRS indicates that approximately 60% of benefit units in which all adults are full-time employed pay for childcare, compared with 35% in data reported by the LCF. This latter point may be attributed to differences in the nature of the questions elicited by each survey: whereas the LCF collects childcare costs incidentally as part of the diary of expenditures of each survey respondent, the FRS elicits childcare via a targeted survey module.

In contrast to the incidence statistics discussed above, there is no clear bias between the values of average childcare expenditure reported by the LCF and FRS; see Figures B.3 and B.4 below.

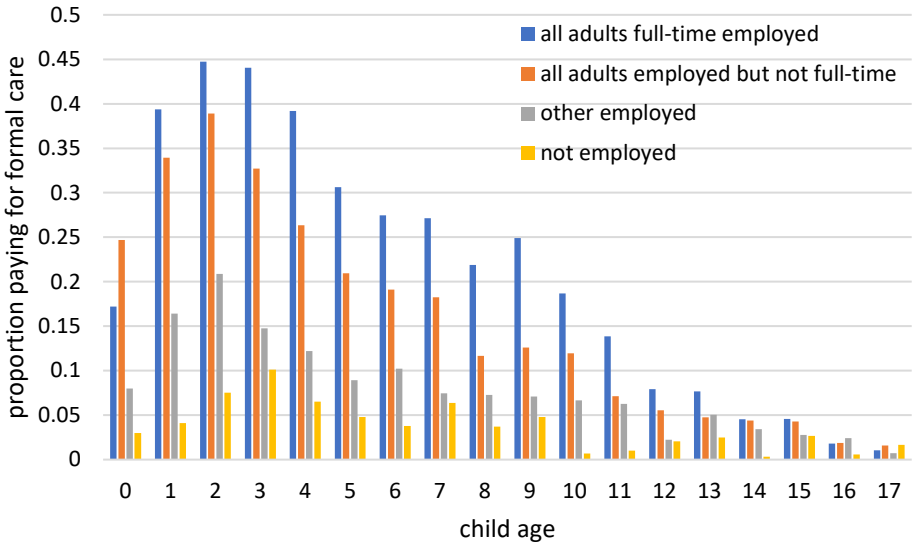
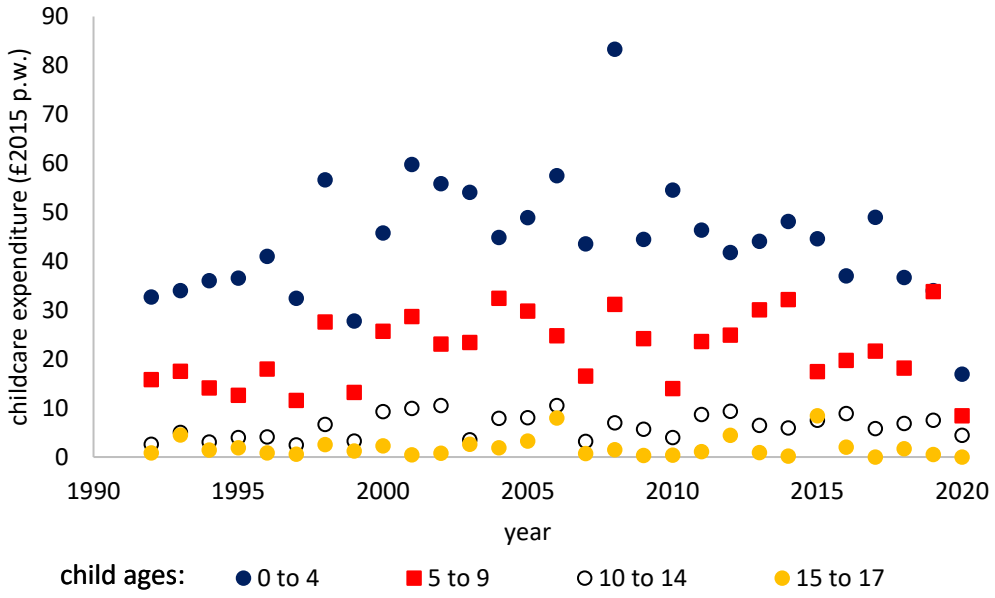
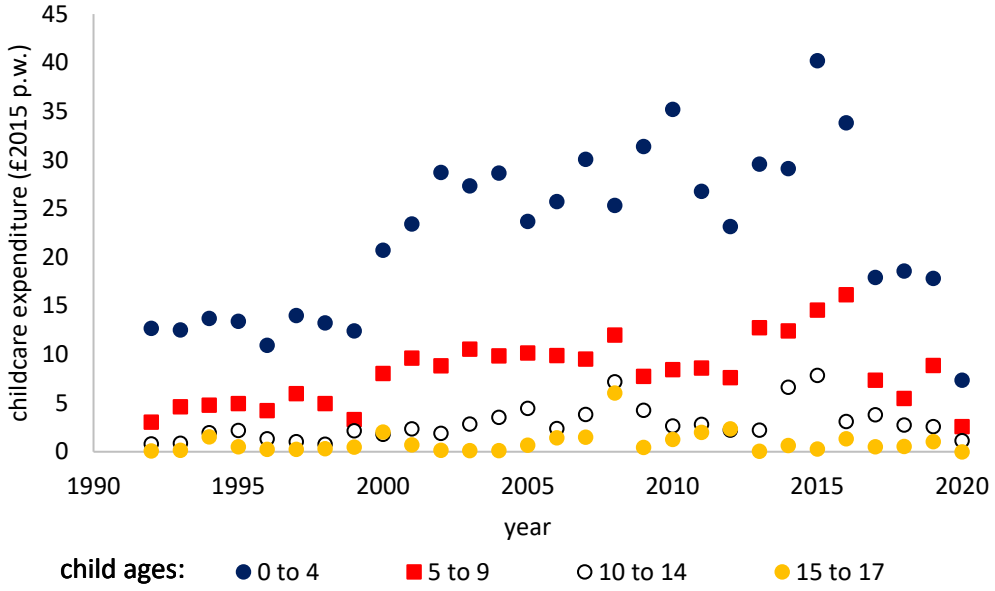


Figure B.2: Incidence of formal childcare by child age and adult employment status; pooled data reported by the Living Costs and Food Survey, 2010-2019

Source: Authors' calculations on pooled data reported at annual intervals by the Living Costs and Food Survey.
Notes: See Figure 2.1.



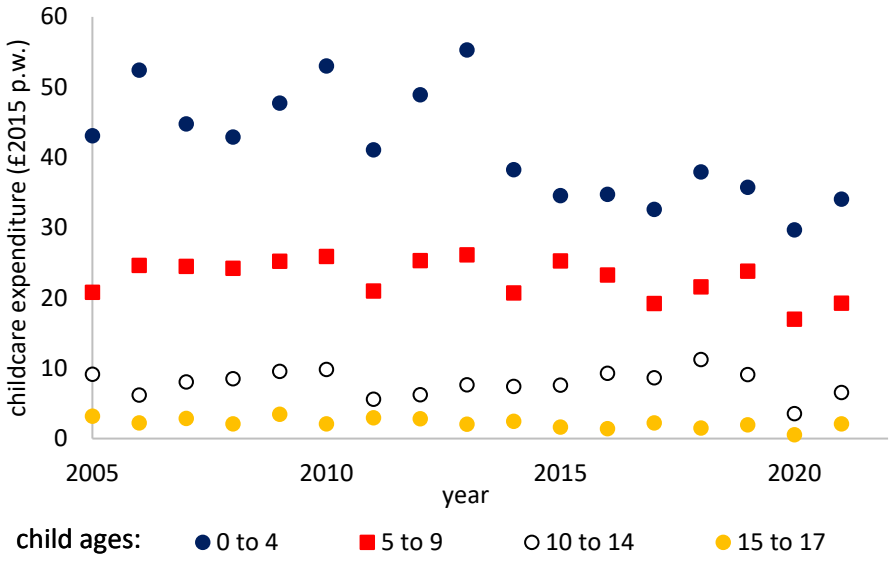
Panel A: All adults full-time employed



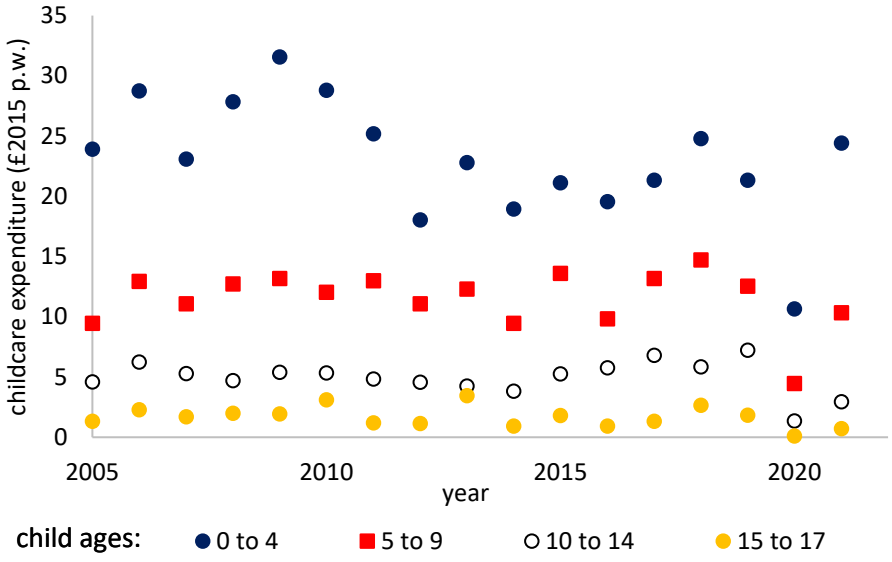
Panel B: All adults employed, but not full-time

Figure B.3: Average childcare costs of benefit units with formal childcare by year, child age, and adult employment status: Living Costs and Food Survey (1992-2020)

Source: Authors' calculations on data from the Living Cost and Food Survey (and forerunner surveys).
Notes: See Figure 2.1.



Panel A: All adults full-time employed



Panel B: All adults employed, but not full-time

Figure B.4: Average childcare costs of benefit units with formal childcare by year, child age, and adult employment status: Family Resources Survey (2005-2021)

Source: Authors' calculations on data from the Family Resources Survey.
Notes: See Figure 2.1.

B.2 Social care

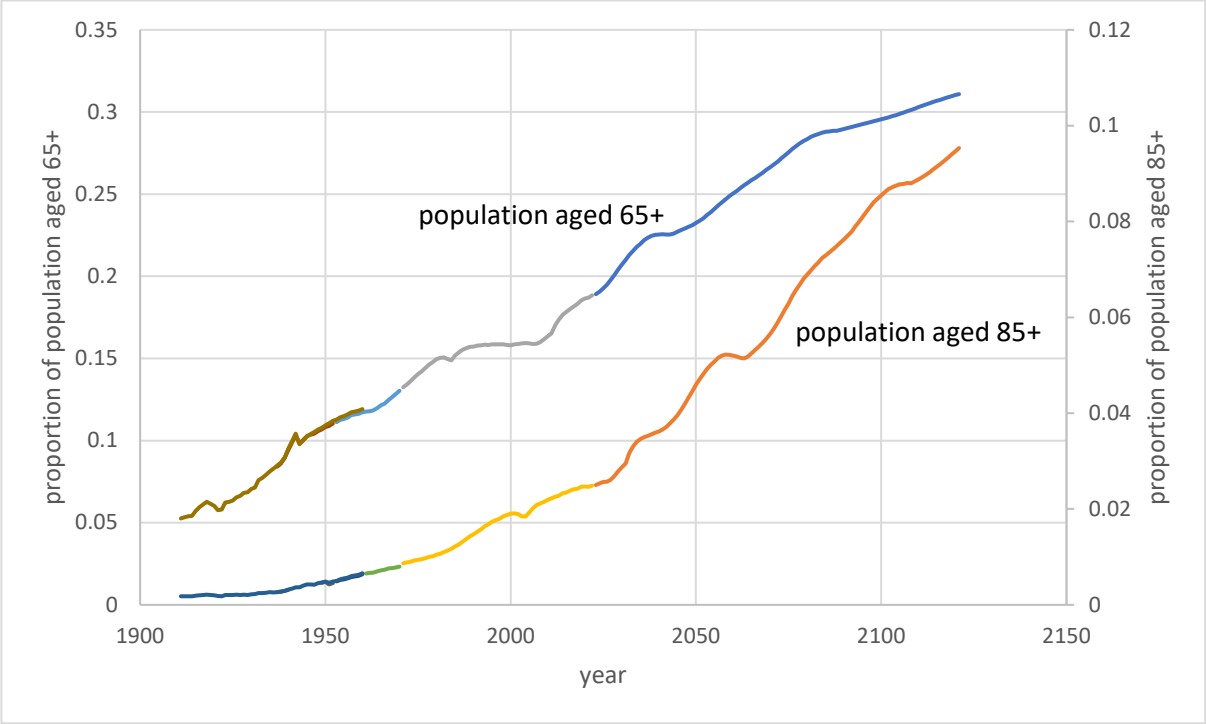
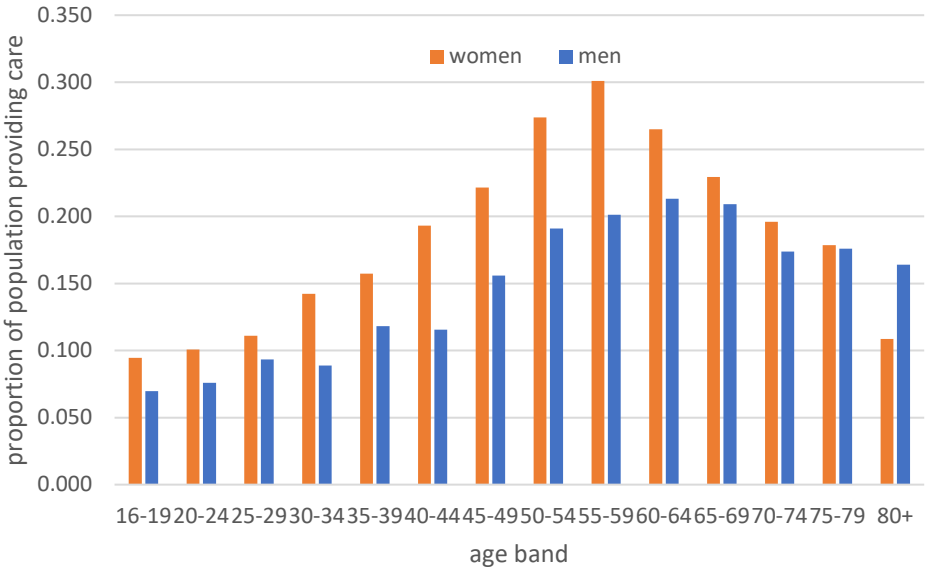
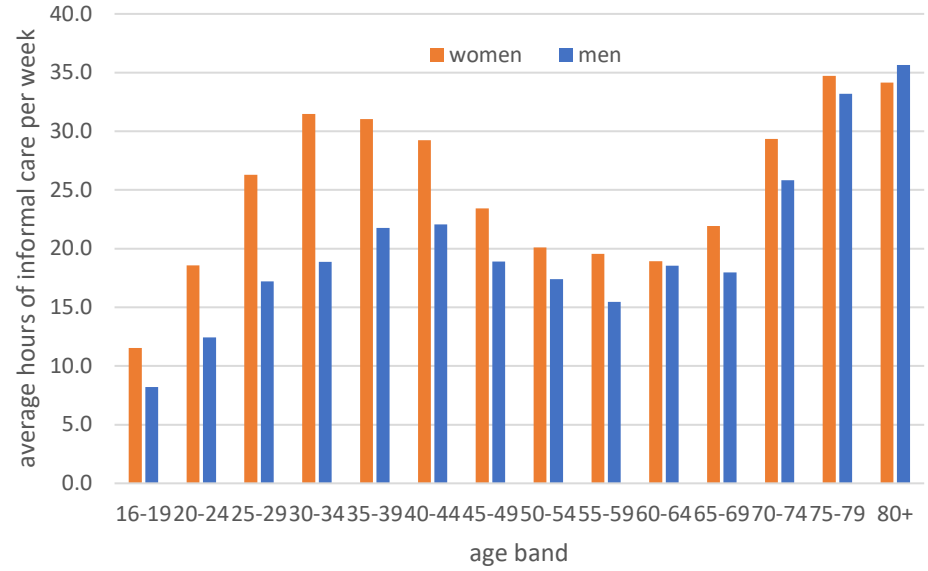


Figure B.5: Population shares by age band and data source

Source: ONS population estimates to 2022, and principal population projections from 2023.
Notes: Population estimates from 1911 to 1960 for Great Britain (excluding Northern Ireland). Estimates from 1953 to 1970 combine separate estimates for Great Britain and Northern Ireland. Estimates from 1961 to 1970 for Great Britain top-coded at age 84.



Panel A: Population shares of individuals providing informal social care



Panel B: Average hours of informal social care by those providing some care

Figure B.5: Incidence and hours of informal social care by age and gender

Source and Notes: See Table 2.6

Appendix C Regression Statistics

C.1 Childcare

Table C.1: Probit regression estimates describing the incidence of formal childcare costs

	Coef.	s.e.	p>z		Coef.	s.e.	p>z
Children by age				Children by age			
0	-0.067	0.0283	0.018	8	0.134	0.0234	0.000
1	0.367	0.0233	0.000	9	0.142	0.0233	0.000
2	0.682	0.0228	0.000	10	0.084	0.0253	0.001
3	0.533	0.0221	0.000	11	-0.194	0.0257	0.000
4	0.254	0.0218	0.000	12	-0.396	0.0281	0.000
5	0.081	0.0221	0.000	13	-0.500	0.0296	0.000
6	0.144	0.0222	0.000	14	-0.600	0.0326	0.000
7	0.133	0.0228	0.000				
Adults by employment (ref = single adult not employed)							
couple, 2 full-time					0.965	0.0322	0.000
couple, 1 full-time, 1 part-time					0.724	0.0317	0.000
couple, 2 part-time					0.434	0.0720	0.000
couple, 1 full-time, 1 not employed					0.108	0.0343	0.002
couple, 1 part-time, 1 not employed					-0.026	0.0613	0.671
couple, 2 not employed					-0.140	0.0571	0.014
single, full-time					0.971	0.0416	0.000
single, part-time					0.783	0.0367	0.000
Graduate educated					0.450	0.0158	0.000
Region (Ref = London)							
North East					-0.073	0.0452	0.107
North West					0.006	0.0319	0.839
Yorkshire and the Humber					0.028	0.0347	0.425
East Midlands					-0.002	0.0360	0.964
West Midlands					-0.049	0.0347	0.156
East of England					0.025	0.0339	0.460
South East					0.099	0.0309	0.001
South West					0.066	0.0353	0.061
Wales					-0.219	0.0439	0.000
Scotland					-0.049	0.0305	0.111
Northern Ireland					-0.040	0.0327	0.217
Constant					-1.590	0.0413	0.000
Number of observations					48833		
Proportion positive					0.2735		
Pseudo R2					0.1632		

Source: Authors' calculations on pooled data reported by FRS, 2010 to 2019.
Notes: Sample limited to benefit units with children aged 0 to 14. Weighted estimates with robust standard errors reported.

Table C.2: Linear regression estimates for log childcare costs, controlling for sample selection

	Coef.	s.e.	p>z		Coef.	s.e.	p>z
Children by age				Children by age			
0	-0.072	0.0591	0.224	8	-0.044	0.0631	0.490
1	0.718	0.0485	0.000	9	0.039	0.0585	0.505
2	0.741	0.0421	0.000	10	0.114	0.0611	0.063
3	0.458	0.0453	0.000	11	0.059	0.0645	0.359
4	0.262	0.0474	0.000	12	-0.245	0.0802	0.002
5	0.212	0.0450	0.000	13	-0.121	0.0769	0.115
6	0.165	0.0465	0.000	14	-0.166	0.0939	0.077
7	0.076	0.0463	0.102				
Adults by employment (ref = single adult not employed)							
couple, 2 full-time					1.334	0.0902	0.000
couple, 1 full-time, 1 part-time					0.895	0.0935	0.000
couple, 2 part-time					0.748	0.1592	0.000
couple, 1 full-time, 1 not employed					0.288	0.0974	0.003
couple, 1 part-time, 1 not employed					0.094	0.2578	0.716
couple, 2 not employed					-0.101	0.1717	0.557
single, full-time					1.577	0.1038	0.000
single, part-time					1.267	0.0964	0.000
Graduate educated					0.389	0.0352	0.000
Region (Ref = London)							
North East					-0.395	0.0958	0.000
North West					-0.226	0.0760	0.003
Yorkshire and the Humber					-0.531	0.0823	0.000
East Midlands					-0.329	0.0822	0.000
West Midlands					-0.348	0.0820	0.000
East of England					-0.567	0.0818	0.000
South East					-0.353	0.0756	0.000
South West					-0.521	0.0824	0.000
Wales					-0.430	0.1079	0.000
Scotland					-0.396	0.0751	0.000
Northern Ireland					-0.207	0.0793	0.009
Constant					1.461	0.1217	0.000
Number of observations					48833		
rho					0.0219	0.0131	
sigma					1.5283	0.0200	

Source: Authors' calculations on pooled data reported by FRS, 2010 to 2019.
Notes: Estimation controls for sample selection using a Heckman correction. Selection equation estimates reported in Table A.1. Sample limited to benefit units with children aged 0 to 14. Weighted estimates with robust standard errors reported. "rho" defines estimated correlation between residuals of selection and target equation. "sigma" defines estimated standard error of target equation.

C.2 Social care

Table C.3: Probit regression estimates for receipt of informal social care services among people aged 16 to 64 with a long-term illness or disability.

	Coef.	s.e.	p>z
Education Level (Ref = High)			
Medium	0.0018	0.0009	0.036
Low	-0.0231	0.0013	0.000
Gender (Ref = Women)			
Men	0.0937	0.0008	0.000
under age 25	0.3368	0.0013	0.000
Region (Ref = London)			
North East	0.2579	0.0022	0.000
North West	0.2259	0.0017	0.000
Yorkshire and the Humber	0.1577	0.0019	0.000
East Midlands	0.2917	0.0020	0.000
West Midlands	0.1143	0.0019	0.000
East of England	0.1945	0.0020	0.000
South East	0.1999	0.0019	0.000
South West	0.2308	0.0019	0.000
Wales	-0.0191	0.0021	0.000
Scotland	0.1728	0.0018	0.000
Northern Ireland	0.2750	0.0024	0.000
Constant	-0.7291	0.0015	0.000
Number of obs	7248		
Pseudo R2	0.0098		

Source: Authors' calculations on pooled data reported by FRS at annual intervals between 2015/16 and 2019/20, and 2021/22.
Notes: Sample limited to individuals between age 16 and 64 with a long-term illness or disability. Robust standard errors reported. Long term illness or disability identified as code 9 of variable empstati.

Table C.4: Linear least squares regression estimates for hours of informal care per week received by people aged 16 to 64 years, with a long-term illness or disability, and in receipt of some informal social care

	Coef.	s.e.	p>z
Education Level (Ref = High)			
Medium	0.064	0.0014	0.000
Low	0.077	0.0020	0.000
Gender (Ref = Women)			
Men	-0.039	0.0013	0.000
Age (Ref = under age 25)			
25 to 39	-0.308	0.0022	0.000
40+	-0.568	0.0018	0.000
Region (Ref = London)			
North East	-0.008	0.0032	0.010
North West	0.046	0.0027	0.000
Yorkshire and the Humber	0.066	0.0030	0.000
East Midlands	-0.202	0.0031	0.000
West Midlands	0.022	0.0030	0.000
East of England	-0.148	0.0032	0.000
South East	-0.154	0.0030	0.000
South West	-0.251	0.0031	0.000
Wales	-0.033	0.0033	0.000
Scotland	-0.001	0.0029	0.724
Northern Ireland	-0.086	0.0035	0.000
Constant	4.213	0.0028	0.000
Number of obs	2265		
RMSE	1.1671		
R-squared	0.0359		

Source: Authors' calculations on pooled data reported by FRS at annual intervals between 2015/16 and 2019/20, and 2021/22.
Notes: Sample limited to individuals between age 16 and 64 with a long-term illness or disability. Robust standard errors reported. Long term illness or disability identified as code 9 of variable empstati.

Table C.5: Probit regression estimates for "in need of care" for people aged 65+

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.040	0.0293	0.173
Education Level (Ref = High)			
Medium	0.074	0.0402	0.064
Low	0.180	0.0420	0.000
partner	0.216	0.0324	0.000
need care (lag)	2.429	0.0342	0.000
Self-rated health (Ref = Excellent)			
Very good	0.082	0.0818	0.313
Good	0.395	0.0786	0.000
Fair	0.836	0.0796	0.000
Poor	1.404	0.0903	0.000
Age group (Ref = 65-66)			
67-68	-0.322	0.0580	0.000
69-70	-0.241	0.0554	0.000
71-72	-0.177	0.0538	0.001
73-74	-0.084	0.0563	0.134
75-76	-0.036	0.0593	0.543
77-78	0.032	0.0621	0.603
79-80	0.082	0.0662	0.215
81-82	0.061	0.0681	0.374
83-84	0.194	0.0683	0.005
85+	0.532	0.0647	0.000
Region (Ref = London)			
North East	0.076	0.0945	0.423
North West	0.064	0.0759	0.400
Yorkshire and the Humber	0.086	0.0795	0.281
East Midlands	0.190	0.0806	0.019
West Midlands	0.183	0.0788	0.020
East of England	0.152	0.0759	0.046
South East	0.149	0.0731	0.042
South West	0.123	0.0751	0.100
Wales	0.198	0.0782	0.011
Scotland	0.150	0.0762	0.050
Northern Ireland	0.354	0.0773	0.000
Constant	-2.441	0.1091	0.000
Number of observations	20464		
Proportion positive	0.2906		
Pseudo R2	0.5683		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and over without missing variables. Weighted estimates with robust standard errors. "Need care" defined as requiring assistance with at least two activities of daily living reported by the UKHLS (including instrumental activities). "lag" defined as preceding year.

Table C.6: Probit regression estimates for receipt of social care for people aged 65+

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.100	0.0284	0.000
Education Level (Ref = High)			
Medium	0.026	0.0387	0.497
Low	0.082	0.0407	0.045
partner	0.201	0.0312	0.000
receive care (lag)	2.296	0.0323	0.000
Self-rated health (Ref = Excellent)			
Very good	0.124	0.1012	0.219
Good	0.498	0.0988	0.000
Fair	0.916	0.0995	0.000
Poor	1.423	0.1071	0.000
Age group (Ref = 65-66)			
67-68	-0.250	0.0564	0.000
69-70	-0.121	0.0539	0.024
71-72	-0.128	0.0528	0.016
73-74	-0.070	0.0549	0.202
75-76	-0.030	0.0591	0.611
77-78	0.059	0.0610	0.335
79-80	0.141	0.0628	0.025
81-82	0.205	0.0660	0.002
83-84	0.289	0.0657	0.000
85+	0.542	0.0631	0.000
Region (Ref = London)			
North East	0.041	0.0920	0.659
North West	0.022	0.0737	0.768
Yorkshire and the Humber	0.030	0.0769	0.699
East Midlands	0.037	0.0789	0.643
West Midlands	0.123	0.0753	0.103
East of England	0.074	0.0733	0.315
South East	-0.001	0.0725	0.989
South West	0.048	0.0729	0.506
Wales	0.177	0.0769	0.021
Scotland	0.134	0.0742	0.071
Northern Ireland	0.268	0.0764	0.000
Constant	-2.376	0.1227	0.000
Number of observations	21723		
Proportion positive	0.2116		
Pseudo R2	0.5372		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and over without missing variables. Weighted regression with robust standard errors reported. "Receive care" defined as reported receipt of help with at least one of the activities of daily living reported by the UKHLS in the week preceding the survey. "lag" refers to preceding year.

Table C.7: Multinomial logit regression estimates for formal and informal social care of population aged 65 and over in receipt of some care (reference group: only informal care)

	Coef.	s.e.	p>z	Coef.	s.e.	p>z
	formal and informal care			*only formal care*		
Population share	0.2057			0.1227		
Education Level (Ref = High)						
Medium	-0.292	0.1570	0.063	-0.387	0.1950	0.047
Low	-0.416	0.1533	0.007	-1.145	0.1938	0.000
partner	-0.576	0.1050	0.000	-1.687	0.1460	0.000
care market (lag, ref = none)						
informal only	-1.244	0.1160	0.000	-2.543	0.2109	0.000
formal and informal	2.987	0.1364	0.000	0.777	0.2076	0.000
only formal	1.607	0.2781	0.000	4.191	0.2431	0.000
aged 85 and over	0.258	0.1295	0.046	-0.006	0.1761	0.974
Region (Ref = London)						
North East	-0.020	0.3503	0.955	-1.156	0.5184	0.026
North West	0.021	0.2964	0.944	-0.197	0.3457	0.569
Yorkshire and the Humber	0.456	0.2991	0.128	-0.118	0.3707	0.750
East Midlands	0.081	0.3118	0.796	0.345	0.3586	0.336
West Midlands	0.124	0.3065	0.686	0.044	0.3583	0.901
East of England	0.769	0.2929	0.009	0.359	0.3368	0.286
South East	0.493	0.2940	0.093	0.094	0.3353	0.779
South West	0.445	0.2892	0.124	0.143	0.3363	0.671
Wales	0.093	0.2918	0.751	-0.272	0.3481	0.434
Scotland	0.321	0.2875	0.264	-0.310	0.3440	0.368
Northern Ireland	0.534	0.2881	0.064	0.017	0.3273	0.960
Constant	-1.128	0.2862	0.000	-0.267	0.3131	0.394
Number of observations	5726					
Share of “only informal care”	0.6716					
Pseudo R2	0.4481					

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and over receiving social care without missing variables. Weighted regression with robust standard errors reported. "lag" refers to preceding year.

Table C.8: Probit regression estimates describing incidence of partners providing social care for people aged 65 and over receiving care and with a partner

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	0.254	0.0864	0.003
care from partner (lag)	1.446	0.0971	0.000
formal care received	-0.301	0.1025	0.003
aged 85 and over	-0.548	0.1142	0.000
Region (Ref = London)			
North East	0.190	0.3080	0.538
North West	-0.047	0.2286	0.837
Yorkshire and the Humber	-0.154	0.2354	0.514
East Midlands	-0.106	0.2416	0.661
West Midlands	-0.303	0.2281	0.184
East of England	-0.043	0.2497	0.862
South East	0.235	0.2435	0.334
South West	0.121	0.2535	0.633
Wales	-0.251	0.2330	0.282
Scotland	0.108	0.2485	0.665
Northern Ireland	-0.329	0.2318	0.156
Constant	0.825	0.2017	0.000
Number of observations	3176		
Proportion positive	0.9186		
Pseudo R2	0.2505		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.

Notes: Sample limited to individuals aged 65 and over receiving social care, with a partner, and without missing variables. Weighted estimates with robust standard errors reported. Explanatory variables describe characteristics of person in receipt of care. "lag" is defined as preceding year.

Table C.9: Multinomial logit regression estimates for receipt of supplementary care for population aged 65 and over who receive care from their partner (reference group: none)

	Coef.	s.e.	p>z
Daughter			
Population share		0.1048	
Supplementary carer (lag, ref = none)			
Daughter	5.253	0.2482	0.000
Son	2.345	0.6135	0.000
Other	2.479	0.6058	0.000
Care from partner (lag)	1.087	0.7086	0.125
Constant	-4.752	0.7263	0.000
Son			
Population share		0.0406	
Supplementary carer (lag, ref = none)			
Daughter	2.305	0.5646	0.000
Son	5.988	0.3731	0.000
Other	3.424	0.6542	0.000
Care from partner (lag)	1.419	0.8477	0.094
Constant	-5.889	0.8788	0.000
Other			
Population share		0.0238	
Supplementary carer (lag, ref = none)			
Daughter	1.332	1.0583	0.208
Son	2.999	0.7267	0.000
Other	6.108	0.4798	0.000
Care from partner (lag)	16.038	0.5285	0.000
Constant	-20.810	0.6080	0.000
Number of observations	1998		
Share of "none"	0.8309		
Pseudo R2	0.5285		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and over receiving social care from their partner and without missing variables. Regression considers four alternatives for supplementary carers: none (reference), daughter, son, and other. Weighted regression with robust standard errors reported. "lag" defined as preceding year.

Table C.10: Multinomial logit regression estimates for informal carer(s) for population aged 65 and over who receive care but not from a partner (reference group: daughter only)

	Coef.	s.e.	p>z	Coef.	s.e.	p>z
	Daughter and son			*Daughter and other*		
Population share	0.0822			0.0924		
Carer(s) (lag, ref: none)						
Daughter only	-2.279	0.3566	0.000	-1.701	0.3164	0.000
Daughter and son	3.415	0.3473	0.000	-2.708	1.0562	0.010
Daughter and other	-0.955	0.6524	0.143	3.162	0.3449	0.000
Son only	2.537	0.5140	0.000	-0.147	0.6953	0.833
Son and other	2.944	1.4254	0.039	1.149	1.4277	0.421
Other only	-0.285	1.0008	0.776	0.757	0.6439	0.240
Constant	-1.533	0.1756	0.000	-1.586	0.1931	0.000
	Son only			*Son and other*		
Population share	0.1640			0.0513		
Carer(s) (lag, ref: none)						
Daughter only	-4.261	0.5518	0.000	-2.628	0.6440	0.000
Daughter and son	-0.152	0.4764	0.750	0.488	0.8075	0.545
Daughter and other	-3.164	1.0421	0.002	-1.710	1.0677	0.109
Son only	4.475	0.4313	0.000	2.982	0.5800	0.000
Son and other	4.226	1.0790	0.000	7.554	1.0474	0.000
Other only	0.400	0.5718	0.484	1.446	0.7086	0.041
Constant	-0.784	0.1372	0.000	-2.216	0.2696	0.000
	Other only					
Population share	0.2492					
Carer(s) (lag, ref: none)						
Daughter only	-4.145	0.4039	0.000			
Daughter and son	-1.396	0.7752	0.072			
Daughter and other	-1.607	0.6581	0.015			
Son only	-0.606	0.7058	0.391			
Son and other	1.213	1.3403	0.365			
Other only	3.771	0.4380	0.000			
Constant	-0.264	0.1181	0.025			
Number of observations	2232					
Share of "daughter only"	0.3609					
Pseudo R2	0.5311					

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and receiving social care but not from a partner and without missing variables. Regression considers six possible alternatives: none daughter only (reference), daughter and son, daughter and other, son only, son and other, and other only. Weighted estimates with robust standard errors reported. "lag" refers to preceding year.

Table C.11: Linear least squares regression estimates for log hours of informal care per week provided by partner to people aged 65 and over

	Coef.	s.e.	p>z
Gender (ref = Women)			
Men	0.144	0.070	0.041
Education Level (ref = High)			
Medium	0.056	0.109	0.606
Low	0.288	0.109	0.009
Supplementary carer (ref = none)			
Daughter	0.355	0.127	0.005
Son	0.280	0.153	0.067
Other	0.522	0.161	0.001
Formal market	0.264	0.096	0.006
Self-rated health poor	0.659	0.085	0.000
Region (Ref = London)			
North East	0.314	0.254	0.217
North West	0.024	0.193	0.901
Yorkshire and the Humber	0.131	0.200	0.513
East Midlands	-0.053	0.198	0.791
West Midlands	-0.267	0.194	0.168
East of England	-0.014	0.187	0.940
South East	-0.128	0.197	0.516
South West	-0.177	0.189	0.348
Wales	-0.012	0.187	0.950
Scotland	-0.090	0.191	0.637
Northern Ireland	-0.026	0.199	0.897
Constant	1.641	0.189	0.000
Number of obs	1626		
RMSE	1.2093		
R-squared	0.1179		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and receiving social care from a partner and without missing variables. Robust standard errors reported. Explanatory variables describe characteristics of person in receipt of care.

Table C.12: Linear least squares regression estimates for log hours of informal care per week provided by daughter to people aged 65 and over

	Coef.	s.e.	p>z
Gender (ref = Women)			
Men	-0.053	0.088	0.549
Education Level (ref = High)			
Medium	-0.236	0.193	0.224
Low	-0.198	0.186	0.286
Supplementary carer (ref = none)			
Partner	-0.282	0.095	0.003
Son	-0.002	0.094	0.985
Other	-0.124	0.089	0.166
Formal market	0.176	0.091	0.055
Self-rated health poor	0.305	0.091	0.001
Region (Ref = London)			
North East	-0.389	0.233	0.094
North West	0.012	0.225	0.959
Yorkshire and the Humber	-0.075	0.243	0.759
East Midlands	-0.204	0.219	0.353
West Midlands	0.013	0.199	0.948
East of England	-0.361	0.201	0.073
South East	-0.329	0.202	0.104
South West	-0.084	0.209	0.688
Wales	0.061	0.206	0.766
Scotland	-0.057	0.202	0.777
Northern Ireland	0.023	0.203	0.909
Constant	1.982	0.234	0.000
Number of obs	894		
RMSE	0.9889		
R-squared	0.0570		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and receiving social care from a partner and without missing variables. Explanatory variables describe characteristics of person in receipt of care. Robust standard errors reported.

Table C.13: Linear least squares regression estimates for log hours of informal care per week provided by son to people aged 65 and over

	Coef.	s.e.	p>z
Gender (ref = Women)			
Men	-0.039	0.109	0.723
Education Level (ref = High)			
Medium	-0.293	0.244	0.232
Low	-0.080	0.228	0.727
Supplementary carer (ref = none)			
Partner	-0.255	0.124	0.039
Daughter	-0.070	0.097	0.470
Other	-0.145	0.098	0.141
Formal market	-0.045	0.110	0.681
Self-rated health poor	0.340	0.116	0.004
Region (Ref = London)			
North East	0.245	0.453	0.589
North West	0.031	0.207	0.882
Yorkshire and the Humber	-0.017	0.220	0.937
East Midlands	-0.056	0.257	0.828
West Midlands	-0.146	0.205	0.476
East of England	-0.255	0.210	0.225
South East	-0.291	0.192	0.130
South West	-0.230	0.226	0.309
Wales	-0.207	0.211	0.327
Scotland	0.177	0.254	0.487
Northern Ireland	0.191	0.203	0.349
Constant	1.892	0.283	0.000
Number of obs	547		
RMSE	0.9513		
R-squared	0.0760		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and receiving social care from a partner and without missing variables. Explanatory variables describe characteristics of person in receipt of care. Robust standard errors reported.

Table C.14: Linear least squares regression estimates for log hours of informal care per week provided by others to people aged 65 and over

	Coef.	s.e.	p>z
Gender (ref = Women)			
Men	0.076	0.086	0.378
Education Level (ref = High)			
Medium	0.072	0.147	0.626
Low	0.239	0.147	0.105
Supplementary carer (ref = none)			
Partner	-0.186	0.093	0.047
Daughter	0.006	0.086	0.944
Son	-0.088	0.098	0.366
Formal market	0.113	0.094	0.234
Self-rated health poor	0.285	0.089	0.001
Region (Ref = London)			
North East	-0.604	0.310	0.052
North West	-0.717	0.281	0.011
Yorkshire and the Humber	-0.536	0.279	0.056
East Midlands	-0.418	0.300	0.164
West Midlands	-0.572	0.293	0.051
East of England	-0.859	0.295	0.004
South East	-0.642	0.281	0.023
South West	-0.536	0.313	0.087
Wales	-0.401	0.277	0.149
Scotland	-0.276	0.285	0.334
Northern Ireland	-0.432	0.296	0.145
Constant	1.760	0.261	0.000
Number of obs	585		
RMSE	0.8472		
R-squared	0.0934		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.

Notes: Sample limited to individuals aged 65 and receiving social care from a partner and without missing variables. Explanatory variables describe characteristics of person in receipt of care. Robust standard errors reported.

Table C.15: Linear least squares regression estimates for log hours of formal care per week provided to people aged 65 and over

	Coef.	s.e.	p>z
Gender (ref = Women)			
Men	0.234	0.078	0.003
Education Level (ref = High)			
Medium	-0.015	0.108	0.890
Low	0.183	0.109	0.093
Informal carer	0.196	0.071	0.005
Self-rated health poor	0.306	0.087	0.000
Region (Ref = London)			
North East	0.016	0.272	0.954
North West	-0.010	0.199	0.961
Yorkshire and the Humber	-0.141	0.211	0.504
East Midlands	0.168	0.224	0.453
West Midlands	0.048	0.210	0.820
East of England	-0.062	0.199	0.754
South East	-0.159	0.190	0.402
South West	-0.044	0.194	0.822
Wales	-0.240	0.187	0.199
Scotland	-0.009	0.190	0.964
Northern Ireland	0.094	0.189	0.617
Constant	1.293	0.179	0.000
Number of obs	1026		
RMSE	0.9433		
R-squared	0.0681		

Source: Authors' calculations on pooled data reported by waves "g", "i", and "k" of UKHLS.
Notes: Sample limited to individuals aged 65 and receiving social care from a partner and without missing variables. Robust standard errors reported.

Table C.16: Probit regression estimates for the incidence of providing informal care to non-partners among people aged 18 and over who supply informal care to their partners

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.100	0.0463	0.031
Education Level (Ref = High)			
Medium	0.006	0.0641	0.922
Low	-0.118	0.0715	0.100
care for partner (lag, Ref = no care)			
care only for partner	-0.135	0.0566	0.017
care for partner and non-partner	1.236	0.0688	0.000
care only for non-partner	1.253	0.0897	0.000
Self-rated health (Ref = Excellent)			
Very good	0.001	0.1030	0.995
Good	-0.005	0.0991	0.956
Fair	-0.033	0.1009	0.746
Poor	-0.007	0.1146	0.953
Age group (Ref = 18-19)			
20-24	0.472	0.4815	0.327
25-29	0.344	0.2273	0.130
30-34	0.592	0.1996	0.003
35-39	0.781	0.1789	0.000
40-44	0.641	0.1701	0.000
45-49	0.775	0.1502	0.000
50-54	0.741	0.1434	0.000
55-59	0.590	0.1422	0.000
60-64	0.436	0.1384	0.002
65-69	0.275	0.1370	0.045
70-74	0.181	0.1346	0.180
75-59	0.164	0.1402	0.243
80-84	-0.031	0.1475	0.832
85+		(omitted)	
Constant	-1.373	0.1868	0.000
Number of observations	6355		
Proportion positive	0.2057		
Pseudo R2	0.2115		

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Sample limited to individuals aged 18 and over with partners to whom they provide informal care and without missing variables. Weighted estimates with robust standard errors. "lag" defined as preceding year. Regional dummy variables generally not significant, and omitted from table for brevity (available from authors upon request).

Table C.17: Probit estimates for the incidence of providing informal care to non-partners among people aged 18 and over who do not supply informal care to a partner

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.139	0.0112	0.000
Education Level (Ref = High)			
Medium	0.099	0.0128	0.000
Low	0.007	0.0181	0.714
Care for partner (lag, Ref = no care)			
care only for partner	0.259	0.0561	0.000
care for partner and non-partner	1.514	0.0744	0.000
care only for non-partner	1.806	0.0119	0.000
Self-rated health (Ref = Excellent)			
Very good	0.043	0.0193	0.024
Good	0.063	0.0195	0.001
Fair	0.082	0.0223	0.000
Poor	-0.007	0.0293	0.815
Partner	-0.107	0.0123	0.000
Age group (Ref = 18-19)			
20-24	0.106	0.0476	0.026
25-29	0.173	0.0482	0.000
30-34	0.216	0.0475	0.000
35-39	0.320	0.0459	0.000
40-44	0.342	0.0447	0.000
45-49	0.434	0.0437	0.000
50-54	0.534	0.0433	0.000
55-59	0.526	0.0431	0.000
60-64	0.483	0.0437	0.000
65-69	0.395	0.0439	0.000
70-74	0.255	0.0448	0.000
75-59	0.106	0.0482	0.028
80-84	0.005	0.0537	0.927
85+	-0.188	0.0639	0.003
Constant	-1.902	0.0473	0.000
Number of observations	167458		
Proportion positive	0.1355		
Pseudo R2	0.3021		

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Sample limited to individuals aged 18 and over who do not provide informal care to a partner and without missing variables. Weighted estimates with robust standard errors. "lag" defined as preceding year. Regional dummy variables generally not significant, and omitted from table for brevity (available from authors upon request).

Table C.18: Probit regression estimates for the incidence of providing informal care among people aged 18 and over who do not have a partner

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.093	0.0193	0.000
Education Level (Ref = High)			
Medium	0.109	0.0233	0.000
Low	0.025	0.0308	0.421
Care for partner (lag, Ref = no care)			
care only for partner	0.400	0.1061	0.000
care for partner and non-partner	1.198	0.1898	0.000
care only for non-partner	1.778	0.0202	0.000
Self-rated health (Ref = Excellent)			
Very good	-0.008	0.0333	0.807
Good	0.038	0.0333	0.260
Fair	0.076	0.0369	0.040
Poor	-0.012	0.0442	0.788
Age group (Ref = 18-19)			
20-24	0.110	0.0483	0.023
25-29	0.191	0.0537	0.000
30-34	0.261	0.0581	0.000
35-39	0.351	0.0578	0.000
40-44	0.423	0.0556	0.000
45-49	0.472	0.0517	0.000
50-54	0.499	0.0503	0.000
55-59	0.446	0.0491	0.000
60-64	0.453	0.0510	0.000
65-69	0.361	0.0515	0.000
70-74	0.291	0.0522	0.000
75-59	0.156	0.0563	0.005
80-84	0.025	0.0609	0.681
85+	-0.160	0.0689	0.021
Constant	-1.922	0.0581	0.000
Number of observations	61235		
Proportion positive	0.1353		
Pseudo R2	0.2956		

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Sample limited to individuals aged 18 and over who do not have a partner and without missing variables.

Table C.19: Multinomial logit regression estimates for the incidence of providing informal care among people aged 18 and over with a partner

	only care for partner (4.9%)			care for partner and other (1.3%)			only care for other (13.0%)		
	Coef.	s.e.	p>z	Coef.	s.e.	p>z	Coef.	s.e.	p>z
Gender (Ref = Women)									
Men	-0.028	0.046	0.550	-0.194	0.075	0.010	-0.336	0.026	0.000
Education Level (Ref = High)									
Medium	0.366	0.057	0.000	0.410	0.096	0.000	0.157	0.029	0.000
Low	0.632	0.069	0.000	0.415	0.118	0.000	-0.059	0.042	0.160
Care for partner (lag, Ref = no care)									
care only for partner	4.707	0.055	0.000	4.601	0.110	0.000	0.317	0.133	0.018
care for partner and non-partner	4.549	0.120	0.000	6.771	0.134	0.000	2.742	0.129	0.000
care only for non-partner	0.404	0.099	0.000	2.561	0.113	0.000	3.198	0.026	0.000
Self-rated health (Ref = Excellent)									
Very good	0.045	0.094	0.632	0.094	0.157	0.550	0.155	0.045	0.001
Good	0.191	0.092	0.038	0.218	0.152	0.152	0.157	0.045	0.001
Fair	0.522	0.099	0.000	0.611	0.159	0.000	0.140	0.052	0.007
Poor	0.606	0.122	0.000	0.722	0.190	0.000	-0.026	0.075	0.732
Age group (Ref = under 35)									
35-44	0.069	0.123	0.574	0.292	0.213	0.171	0.296	0.055	0.000
45-54	0.251	0.116	0.030	0.572	0.192	0.003	0.626	0.052	0.000
55-64	0.651	0.112	0.000	0.554	0.192	0.004	0.701	0.052	0.000
65+	1.203	0.108	0.000	0.472	0.191	0.013	0.199	0.053	0.000
Constant	-5.068	0.162	0.000	-6.623	0.257	0.000	-3.274	0.076	0.000

Source: Authors' calculations on pooled data reported between 2015 and 2020 by waves "f" to "l" of the UKHLS.
Notes: Sample limited to individuals aged 18 and over who have a partner and without missing variables comprising 112,579 observations. Pseudo R2 equals 0.3560. Reference group is people not providing social care. Population shares reported in brackets. Weighted estimates with robust standard errors. "lag" defined as preceding year. Regional dummy variables generally not significant, and omitted from table for brevity.

Table C.20: Linear least squares regression estimates for log hours of informal care per week provided by people aged 18 and over

	Coef.	s.e.	p>z
Gender (Ref = Women)			
Men	-0.260	0.0179	0.000
Education Level (Ref = High)			
Medium	0.250	0.0208	0.000
Low	0.523	0.0285	0.000
Self-rated health (Ref = Excellent)			
Very good	0.011	0.0328	0.739
Good	0.172	0.0331	0.000
Fair	0.329	0.0367	0.000
Poor	0.553	0.0477	0.000
Social care provided (Ref = care only for partner)			
care for partner and non-partner	-0.205	0.0502	0.000
care only for non-partner	-1.272	0.0278	0.000
Partner	-0.234	0.0219	0.000
Age group (Ref = 18-19)			
20-24	0.165	0.0913	0.070
25-29	0.279	0.0936	0.003
30-34	0.526	0.0926	0.000
35-39	0.597	0.0888	0.000
40-44	0.564	0.0864	0.000
45-49	0.309	0.0837	0.000
50-54	0.223	0.0818	0.006
55-59	0.196	0.0811	0.016
60-64	0.152	0.0812	0.062
65-69	0.065	0.0820	0.427
70-74	0.068	0.0833	0.414
75-59	0.071	0.0874	0.415
80-84	0.068	0.0946	0.474
85+	-0.072	0.1086	0.506
Constant	2.704	0.0933	0.000
Number of observations	31490		
RSME	1.2789		
R2	0.1783		

Source: Authors' calculations on pooled data reported by waves "f" to "l" of UKHLS.

Notes: Sample limited to individuals aged 18 and over supplying some social care and without missing variables. See table A.17 for further details.

Appendix D Dynamic programming methods

Projections based on the Dynamic Programming (DP) approach proceed in two discrete stages. In the first stage, the model evaluates a look-up table that describes utility maximising decisions for all feasible simulated combinations of individual specific circumstances (the model state-space). In the second stage, starting from data for a reference population cross-section, the model projects panel data at discrete intervals over the simulated time-horizon. These panel data are generated using statistical descriptions for the intertemporal evolution of individual specific characteristics and the behavioural descriptions evaluated in the first stage. Importantly, the utility maximising decisions evaluated in the first stage are based on the same statistical descriptions for intertemporal evolution as are used in the second stage of the projection. It is this feature that makes the projected decisions 'rational'.

Solution of the lifetime decision problem – the 'first stage' of the simulation noted above – is evaluated by a dedicated Java package in SimPaths: simpaths.model.decisions. This appendix provides technical detail of that program package.

Figure C.1 displays a schematic of the decisions package, which proceeds as follows:

1) The user chooses to implement intertemporal optimising (IO) decisions via the SimPaths GUI (Graphical User Interface).
    a) SimPaths routes work to the simpaths.model.decisions package
2) ManagerPopulateGrids
    a) This class is responsible for creating and populating the look-up table used to simulate IO decisions – this table is referred to as "the grids".
3) ManagerFileGrids
    a) Reads and writes data for the grids to and from the file system
4) ManagerSolveGrids
    a) This class is responsible for managing evaluation of the IO solutions and storing these in the grids.
    b) The solution proceeds via a series of concentric loops.
        i) In the inner-most loop,
            (1) the state combination is defined by object: States currentStates
            (2) expectations are defined by object: Expectations expectations
    c) ManagerSolveState
        i) This class manages numerical optimisation of all control variables for a given combination of state characteristics, as supplied by ManagerSolveGrids.

(1) Search over discrete control variables (labour options) is conducted via an outer set of loops in the ManagerSolveState class.
(2) Search over continuous control variables (consumption) is passed to a dedicated UtilityMaximisation object.

d) UtilityMaximisation
   i) This class defines:
      (1) the function to optimise
         (a) Defined as the CESUtility object by default
      (2) upper bounds for the control variables
      (3) lower bounds for the control variables
      (4) a set of control variables to start the numerical search
   ii) The optimisation problem is then passed to a generic Minimiser object for evaluation.

e) Minimiser
   i) Is instantiated with the factors defined by the UtilityMaximisation class
   ii) Runs numerical optimisation routines via a call to the minimise() method
   iii) Minimiser.minimise()
      (1) Passes the optimisation problem to:
         (a) the brent() method if optimising over a single continuous control
            (i) e.g. consumption only
         (b) the powell() method if optimising over 2 or more continuous controls
            (i) e.g. consumption and portfolio allocation

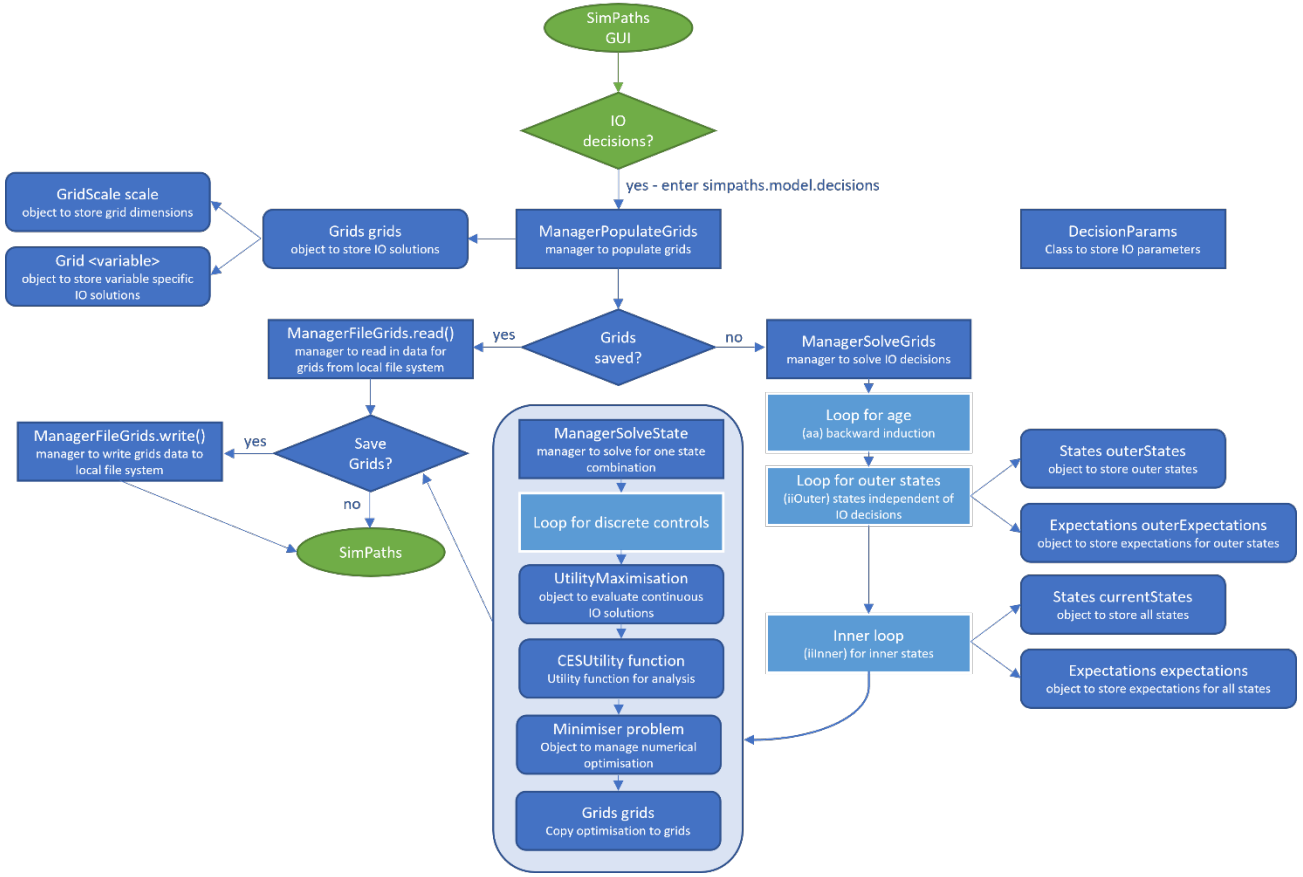
f) CESUtility
   i) Is accessed by Minimiser via the IEvaluation interface, to facilitate testing of alternative utility specifications.
   ii) The CESUtility object is instantiated with Expectations and Grid objects supplied by the UtilityMaximisation class
      (1) The Expectations object describes expectations reflecting all but the decisions described by the continuous controls over which the Minimiser object conducts its search.
      (2) The Grid object records valueFunction solutions obtained via preceding age-specific loops evaluated by the ManagerSolveGrids class.
   iii) Calls to the CESUtility.evaluate(double[] args) method returns a (real number) variable describing (minus) the expected lifetime utility associated with the set of continuous control variables listed in the “args” array.

(1) This result is generated by combining within-period utility, with expected utility, via an intertemporal CES function.
    (a) The within-period measure of utility is a simple CES function of consumption and leisure time associated with the prevailing combination of control variables (consumption and employment)
    (b) Expected utility is evaluated by:
        (i) identifying the set of expected states in the immediately succeeding period associated with the prevailing set of control variables (based on the Expectations object)
        (ii) identifying the value function outcome associated with each set of expected states, via a call to the Grid.interpolateAll(States) method for the valueFunction attribute.
        (iii) aggregating up the measures of the value function, by weighting each by its associated probability

iv) Calls to the Grid.interpolateAll(States states, boolean solution_call) method return a (real number) variable, by interpolating over the respective Grid object.
    (1) The interpolation begins by identifying a grid slice for all continuous states associated with the combination of discrete states described by the "states" object supplied to the method.
        (a) The (Boolean) "solutionCall" variable is used to determine whether the birth year state is considered to be a discrete or continuous state for the interpolation routine.
    (2) Interpolation over the set of continuous states described by the "states" object supplied to the interpolateAll method is evaluated by the interpolateContinuous method.
        (a) The interpolateContinuous method implements a linear spline interpolation

Evaluation of solutions to the dynamic programming problem are organised by a series of "manager" classes, which are described at further length below.

Figure C.1: Flow chart of Java package to evaluate solutions to dynamic programming problem



Green elements are parts of SimPaths not involved in solution of lifetime decision problem. Manager methods in dark blue rectangles with square corners – these provide logic to organise the computations. Objects are denoted by dark blue rectangles with rounded corners. Light blue rectangles denote computational loops.

D.1 ManagerPopulateGrids

ManagerPopulateGrids is the highest-level manager class in the decisions package, providing the entry and exit point of the package. ManagerPopulateGrids instantiates the "grids" object that stores solutions to the lifetime decision problem. The manager then organises for the "grids" object to be populated, either by delegating solution of the lifetime decision problem to the ManagerSolveGrids Class, or delegating reading from the file system to the ManagerFileGrids class. Finally, ManagerPopulateGrids organises for the populated grids object to be saved to the file system, via another reference to ManagerFileGrids.

D.2 ManagerSolveGrids

ManagerSolveGrids is called by ManagerPopulateGrids if new solutions to the IO problem are required. ManagerSolveGrids organises solutions to the IO problem using four concentric loops.

The first loop (aa) proceeds backward from the last potential age in life, to the first age at which an individual is considered to enter the model as a responsible adult of a benefit unit. This backward iterating loop allows the solution to proceed via backward induction.

All state characteristics other than age are divided into two groups, considered in either an "inner" or "outer" loop. Outer loop characteristics are treated in the first loop following age (iiOuter). These characteristics are predominantly comprised of discrete variables that are exogenous to IO decisions (control variables). Consideration of these variables in a separate loop is useful because it allows their state combinations and associated expectations to be evaluated once and re-used for all of the state combinations considered within the inner set of loops.

The "inner" states are iterated over by a parallel loop (IntStream.parallel) to make use of multi-core processing. Inner states are grouped into chunks helps to economise the computational overhead associated with creation and destruction of worker threads.

Combinations of states are recorded by ManagerSolveGrids in objects of the States class. State combinations identified in the outer grid are stored in the object outerStates, and these are used to initialise state combinations identified in the inner loops: States currentStates. A similar approach is used to manage state expectations, via objects of the Expectations class.

D.3 ManagerSolveState

A solution needs to be obtained for utility maximising decisions at each grid ordinate visited via the loop structure of ManagerSolveGrids. This solution is obtained for an assumed utility function, and expectations consistent with the intertemporal dynamics used to project states (individual characteristics) through time.

The code starts from a prevailing set of individual specific characteristics, as supplied by the ManagerSolveGrids class. Each potential discrete decision (control variable, e.g. labour alternative) is considered in turn. For each discrete decision, numerical methods are used to optimise expected lifetime utility with respect to the set of continuous decision variables (e.g. consumption). A preferred set of decision variables is then identified as that with the highest overall measure of expected lifetime utility.

Expected lifetime utility is evaluated in two components. The first and most straight-forward is (current) within-period utility, which is evaluated as a CES function of current period consumption and leisure (the corollary of employment). The second component is expected utility for all periods following the current period. Expected lifetime utility at age A+1, from age A, is evaluated as a weighted sum of a discrete set of alternative possibilities calculated previously by the solution routine. This is made possible by the following features of the solution method:

- Starting with the maximum potential age, and iteratively solving backwards through time.
- Assumption of a von Neumann Morgenstern utility function.
- Use of the Gaussian quadrature to approximate summation over continuous normal distributions via a discrete set of weights and abscissae.
- Use of linear interpolation for approximating off-grid solutions (Keys, 1981).

The numerical optimisation method is based on value function calls rather than first order conditions as the value function is not guaranteed to be smooth or concave, and the computational overhead associated with evaluating first order conditions can outweigh advantages of zero-search algorithms. Brent's method is used to search over a single (continuous) dimension, and Powell's method to search over multiple dimensions (see Press et al., 2007).

D.3.1 Dimensionality of the grids object

Key features assumed for each of the states considered for analysis are listed here.

- *Scale* describes the scale used to describe the respective state in the decision grids.
- *Loop* indicates the loop structure (inner/outer) used to represent the characteristic when solving the IO problem

- *Endogenous* indicates whether or not evolution of the respective state is permitted to depend upon IO decisions (control variables)
- *Uncertain* indicates whether or not the respective state is considered to evolve stochastically when solving the IO problem
- *Dynamics* summarises the intertemporal dynamics assumed to solve the IO problem.

The order of the list reflects the assumed grid structure, as set out in the Grids class.

- Net wealth
    - Scale: Continuous, adjusted logarithmic
    - Loop: inner
    - Endogenous: yes
    - Uncertain: no
    - Dynamics: Follows an accounting identity, where wealth in next period is equal to wealth in current period plus disposable income less consumption.
- Wage potential
    - Scale: Continuous, adjusted logarithmic
    - Loop: inner
    - Endogenous: yes
    - Uncertain: yes
    - Dynamics: Based on estimated latent wage equation.
- Private pension
    - Scale: Continuous, adjusted logarithmic
    - Loop: inner
    - Endogenous: yes
    - Uncertain: no
    - Dynamics: Assumed fraction of net wealth converted to a fixed life annuity upon retirement.
- Birth cohorts (year of birth)
    - Scale: Discrete for IO solutions, continuous for projections
    - Loop: outer
    - Endogenous: no
    - Uncertain: no
    - Dynamics: none
- Low wage offer principal earner
    - Scale: Discrete
    - Loop: outer
    - Endogenous: yes

    - Uncertain: yes
    - Dynamics: Based on an estimated probit regression
- Retirement status
    - Scale: Discrete, distinguishing between those in and out of retirement
    - Loop: outer
    - Endogenous: yes
    - Uncertain: no
    - Dynamics: Entry to retirement is non-reversible, and occurs in the first period of non-employment beyond a "minimum age of retirement"
- Health status
    - Scale: Discrete self-reported health status variable
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on an ordered probit regression equation
- Disability status
    - Scale: Discrete, distinguishing those affected by disability
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on an estimated probit regression
- Social care receipt
    - Scale: Discrete, distinguishing whether care needed and source of care received
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on an estimated probit and multi-nomial logit regression equations
- Social care provision
    - Scale: Discrete, distinguishing who care provided to
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on an estimated probit and multi-nomial logit regression equations

- Region
    - Scale: Discrete
    - Loop: outer
    - Endogenous: no
    - Uncertain: no (ignored)
    - Dynamics: none (ignored)
- Student status
    - Scale: Discrete
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on an estimated probit regression
- Education attainment
    - Scale: Discrete
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Education assigned at transition from student status and otherwise remains invariant.
- Number and age of dependent children
    - Scale: Discrete number of 'birth ages', with discrete number of children permitted per birth age
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Scaled to reflect fertility probabilities described by estimated probit regressions
- Cohabitation status
    - Scale: Discrete, distinguishing single/couple
    - Loop: outer
    - Endogenous: no
    - Uncertain: yes
    - Dynamics: Based on estimated probit regressions
- Gender
    - Scale: Discrete, distinguishing male/female
    - Loop: outer

    - Endogenous: no
    - Uncertain: no
    - Dynamics: none
- Age
    - Discrete: Annual increments
    - Loop: first (before both outer loop, which is before inner loop)
    - Endogenous: no
    - Uncertain: no
    - Dynamics: age next period equals age this period + 1

D.4 ManagerFileGrids

There are a wide range of methods available for reading and writing data to disk available in Java. Some of the available approaches are legacy methods that have been superseded by newer ones. Nevertheless, there is no single method that is most efficient to apply in all contexts, which complicates design. In the current context, we seek the quickest method for reading and writing large double formatted arrays. For our use case, two methods currently stand out:

- BufferedOutputStream with byte arrays
- FileChannel with direct byte buffer

Of these two methods, FileChannel was selected for the ManagerFileGrids class.

Appendix E Walk-through of Analysis

This appendix provides a step-by-step walk through to facilitate replication of projections that are the focus of this study. Directions concerning the SimPaths model can be found on the Github wiki at: https://github.com/centreformicrosimulation/SimPaths/wiki. Directions concerning UKMOD can be found at: https://www.microsimulation.ac.uk/ukmod. All analysis was conducted on personal workstations using Windows operating systems. Any further queries concerning the analysis should be directed to the authors.

1. Download the SimPaths model from the public Github repository at: https://github.com/centreformicrosimulation/SimPaths/releases/tag/2024.09.28
2. Download survey data sources used for model input. The survey data sources were obtained from the UK data service at https://ukdataservice.ac.uk
    a. Understanding Society survey, Serial Number 6614.
    b. Wealth and Assets Survey, Serial Number 7215.
3. Compile the model input data:
    a. Using the Stata statistical program, open file found in the SimPaths directory: `input\InitialPopulations\compile\00_master.do`
    b. Amend working directories as necessary.
    c. Run the Stata file.
4. Compile the input data used to impute taxes and benefits:
    a. Obtain UKMOD, version B2024.14 from the public Github repository at https://github.com/centreformicrosimulation/UKMOD-PUBLIC
    b. Request UKMOD input dataset "UK_2019_b1" via the on-line application form at: https://www.microsimulation.ac.uk/ukmod/access
    c. Run UKMOD for system years 2011 to 2027, using the input data from (4b)
    d. Copy and paste output data from (4c) to SimPaths directory: `input\EUROMODoutput\database1`
    e. Copy and paste output data from (4c) again, this time to SimPaths directory: `input\EUROMODoutput`
5. Create model input database:
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "create database.yml"
    c. Run SimPathsMultiRun
6. Extend the tax database:
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`

b. Change the name of configFile at line 53 to "sc analysis0.yml"
c. Open SimPaths file: `src\main\java\simpaths\model\taxes\database\DatabaseExtension.java`
d. Change the file directory at line 31 to UKMOD's input folder
e. Run SimPathsMultiRun
f. When simulation is complete navigate to UKMOD's input folder
g. Rename "UK_2019_b1.txt" to "UK_2019_b1 – database1.txt"
h. Rename "UK_2019_b1 – augmented.txt" to "UK_2019_b1.txt"
i. Copy "UK_2019_b1.txt" and rename as "UK_2019_b1 – database2.txt"
j. Run UKMOD for system years 2011 to 2027, using the input data from (5h)
k. Copy and paste output data from (5j) to SimPaths directory: `input\EUROMODoutput\database2`
l. Copy and paste output data from (5j) to SimPaths directory: `input\EUROMODoutput`
m. Run SimPathsStart
n. Select option "Load new input data for tax and benefit systems" and click "next"
o. Exit when "Start-up Options" are complete

7. Replicate calibration statistics
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "sc calibration.yml"
    c. Run SimPathsMultiRun
8. Evaluate intertemporal elasticity of substitution for
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "intertemporal elasticity.yml"
    c. Run SimPathsMultiRun
    d. Open Stata analysis file: `analysis\intertemporal elasticities.do`
    e. Change the "moddir" to indicate the output directory from (8c)
    f. Run the Stata do file
9. Evaluate labour supply elasticity
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "labour supply elasticity.yml"
    c. Run SimPathsMultiRun

    d. Open Stata analysis file: `analysis\labour supply elasticities.do`
    e. Change the "moddir" to indicate the output directory from (9c)
    f. Run the Stata do file
10. Run social care analysis for the simulated base scenario.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "sc analysis1.yml"
    c. Run SimPathsMultiRun
11. Evaluate summary statistics reported in Section 4.1.
    a. Open Stata analysis file: `analysis\care analysis1.do`
    b. Change the "moddir" to indicate the output directory from (10c).
    c. Run the Stata do file.
        i. Note: Results are reported piecemeal to the Stata working environment and were copied and pasted to the Excel file "projections.xlsx"
12. Run social care analysis for the simulated base scenario, omitting population alignment.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "sc analysis1b.yml"
    c. Run SimPathsMultiRun
13. Run social care analysis for the "zero costs scenario".
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "sc analysis2.yml"
    c. Run SimPathsMultiRun
14. Run social care analysis for the "ignore costs scenario".
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to "sc analysis3.yml"
    c. Run SimPathsMultiRun
15. Evaluate summary statistics reported in Section 4.2.1.
    a. Open Stata analysis file: `analysis\care analysis2.do`
    b. Change the "basedir", "zerocostdir", and "naivedir" to indicate the output directories from (12c), (13c), and (14c) respectively.
    c. Run the Stata do file.
    d. Note: results are reported in Excel file "lifecourse.xlsx"

16. Run social care analysis for the “base childcare scenario”.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to “sc analysis4.yml”
    c. Run SimPathsMultiRun
17. Run social care analysis for the “ignore childcare costs scenario”.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to “sc analysis4b.yml”
    c. Run SimPathsMultiRun
18. Evaluate summary statistics reported in Section 4.2.2.
    a. Open Stata analysis file: `analysis\care analysis3.do`
    b. Change the “costsdir”, “zerocostdir”, and “naivedir” to indicate the output directories from (16c), (13c), and (17c) respectively.
    c. Run the Stata do file.
    d. Note: results are reported in Excel file “childcare.xlsx”
19. Run social care analysis for the “base social care scenario”.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to “sc analysis5.yml”
    c. Run SimPathsMultiRun
20. Run social care analysis for the “ignore social care costs scenario”.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to “sc analysis5b.yml”
    c. Run SimPathsMultiRun
21. Run social care analysis for the “restricted social care costs scenario”.
    a. Open SimPaths file: `src\main\java\simpaths\experiment\SimPathsMultiRun.java`
    b. Change the name of configFile at line 53 to “sc analysis5c.yml”
    c. Run SimPathsMultiRun
22. Evaluate summary statistics reported in Section 4.2.3.
    a. Open Stata analysis file: `analysis\care analysis4.do`
    b. Change the “costsdir”, “zerocostdir to indicate the output directories from (21c) and (13c).
    c. Run the Stata do file.

d. Note: results are reported in Excel file “social care.xlsx”, “precaution” worksheet.

23. Evaluate summary statistics reported in Section 4.2.4.
    a. Open Stata analysis file: `analysis\care analysis5.do`
    b. Change the “costsdir”, “zerocostdir”, and “naivedir” to indicate the output directories from (19c), (13c), and (20c) respectively.
    c. Run the Stata do file.
    d. Note: results are reported in Excel file “social care.xlsx”, “lifecourse 1990-99” worksheet.

Appendix F Supplementary Analytical Statistics

F.1 Projections for care during the prospective half-century

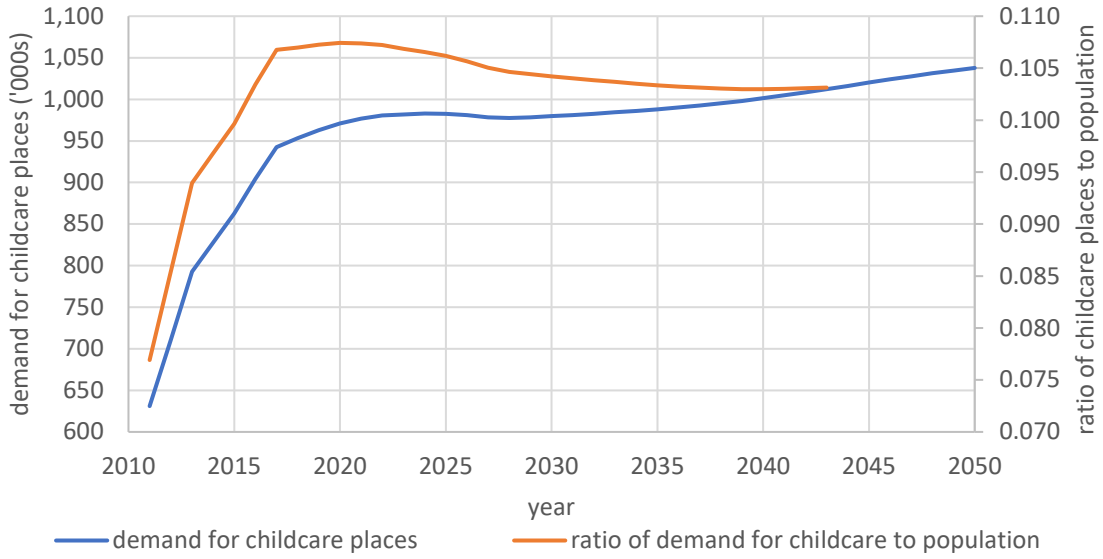


Figure F.1: Projected demand for formal childcare in London

Source: Childcare demand projections for London by age band produced by Greater London Authority, last updated Aug 2021 ONS Population estimates for regions in England and Wales, 2011 to 2017, 2018-based subnational population projections.

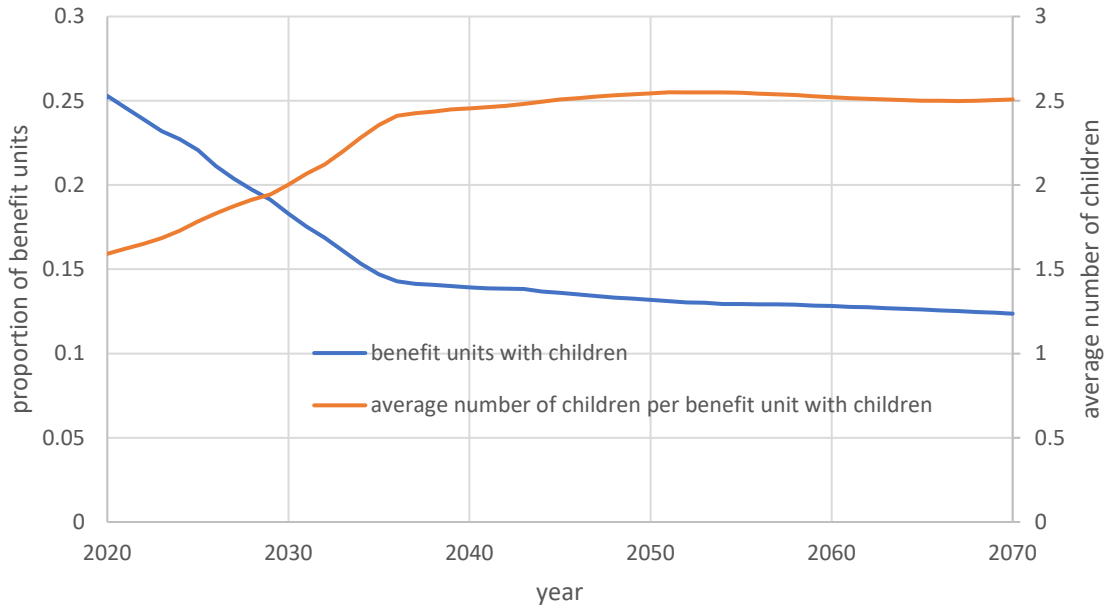


Figure F.2: Projected proportion of benefit units with dependent children and number of children per benefit unit with children

Source: Authors' calculations on simulated data, see notes to Figure 4.1.

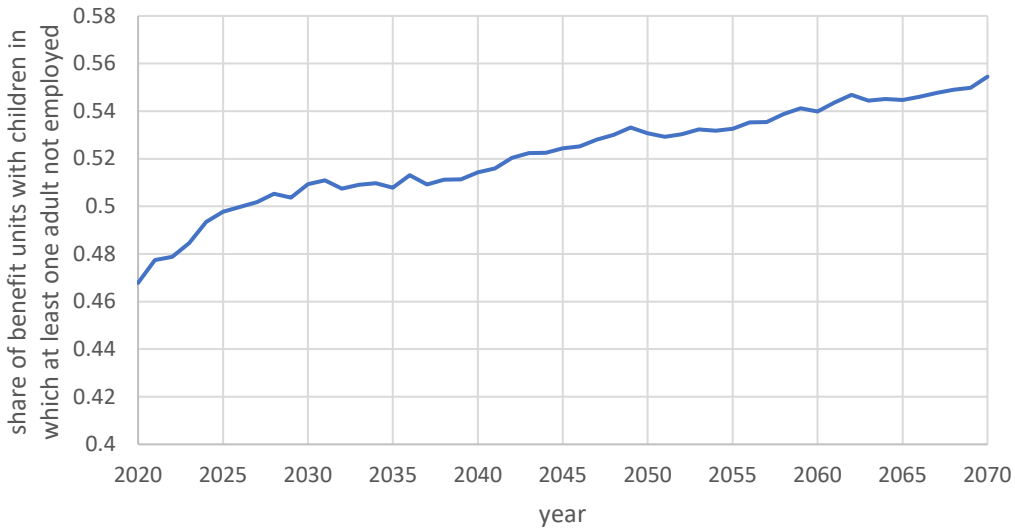
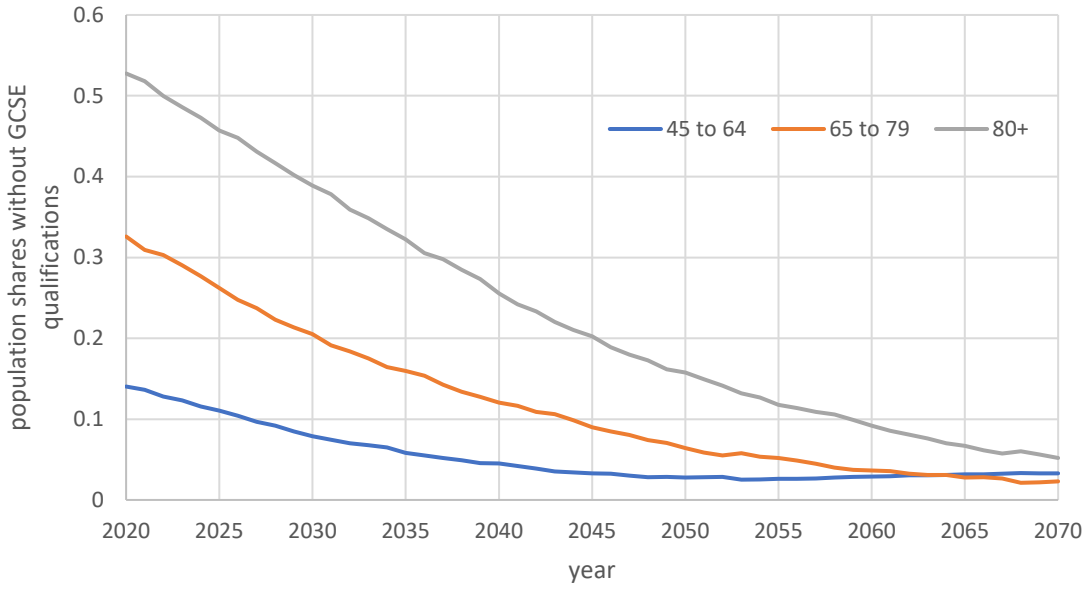
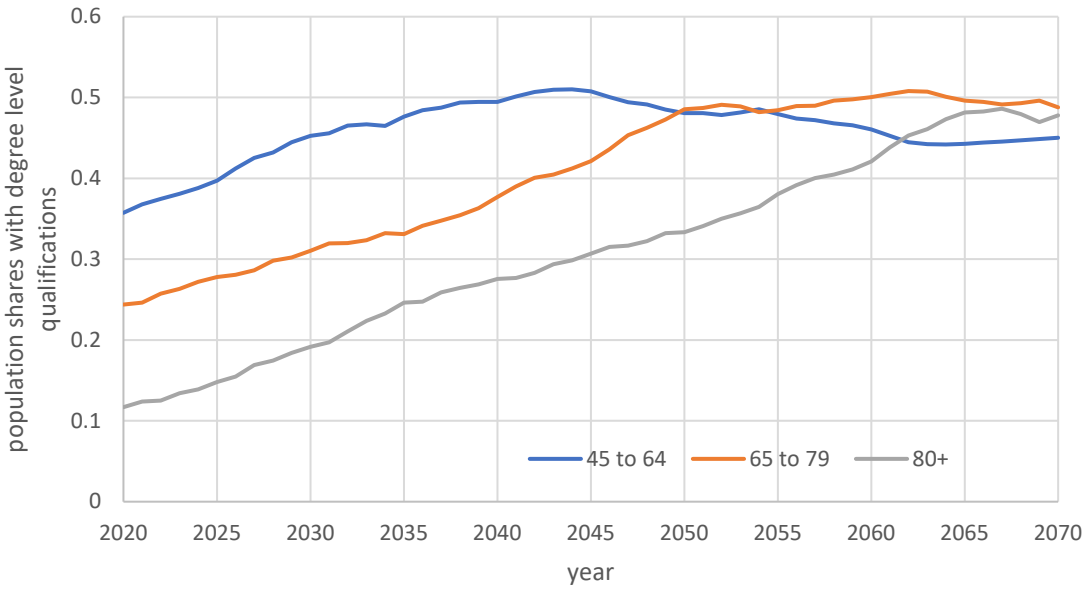


Figure F.3: Projected proportion of benefit units with dependent children that have at lease one adult member that is not employed

Source: Authors' calculations on simulated data, see notes to Figure 4.1.



Panel A: Population shares with less than GCSE (high school) qualifications



Panel B: Population shares with degree level qualifications

Figure F.4: Educational qualifications of projected population by age group and simulation year

Source: Authors' calculations on simulated data, see notes to Figure 4.1.

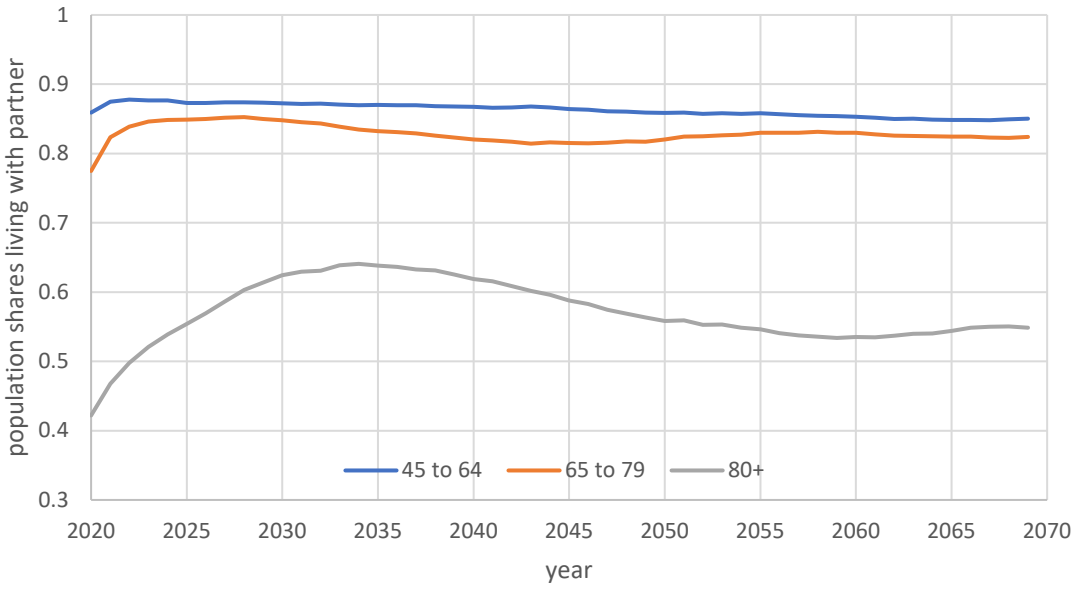
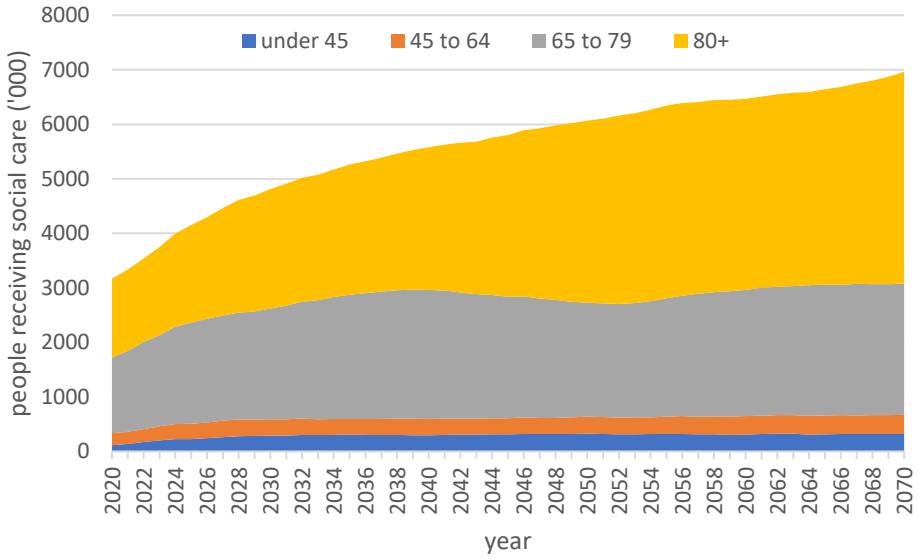
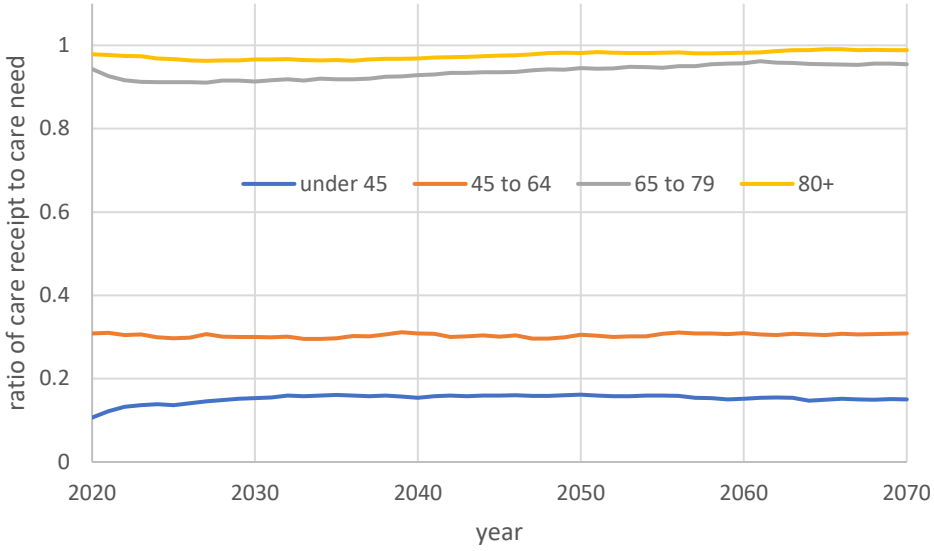


Figure F.5: Population shares living with partner by age group and simulation year

Source: Authors' calculations on simulated data, see notes to Figure 4.1.



Panel A: Numbers of people in receipt of care



Panel B: Age-specific ratios of care receipt to care need

Figure F.6: Projected incidence of receipt of social care, by age band and simulated year

Source: Authors' calculations on simulated data.

Notes: See notes to Figure 4.1.

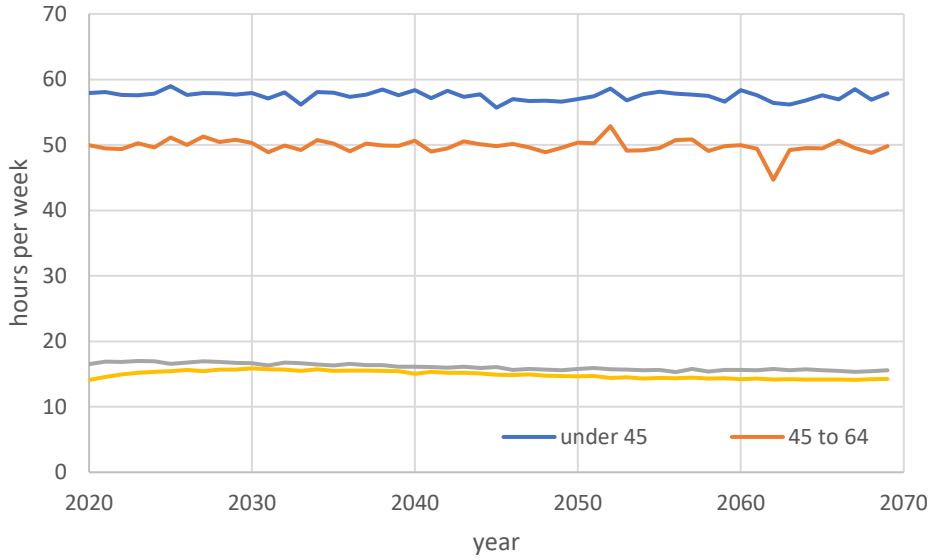


Figure F.7: Projected average hours of social care received by care recipients, by age band and simulated year

Source: Authors' calculations on simulated data, see notes to Figure 4.1.