Is extending eligibility for Adult Social Care better than investing more in existing users in England?

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Appendix A

Table A1 – Data sources.

Variable	Original unit	Unit of analysis	Source of data	Link	Date of last access
Care-related quality of life, gender, age, ethnicity, language, type of social care support, help with questionnaire, questionnaire version, private and informal care received	Individual	Individual	NHS Digital: Personal Social Services Adult Social Care Survey	https://digital.nhs.uk/data-and-information/publications/statistical/personal-social-services-adult-social-care-survey	01/02/2022
Activities of daily living in the past two years	Individual	Local authority			
Informal unpaid carer characteristics	Individual	Local authority	NHS Digital: Personal Social Services Survey of Adult Carers in England	https://digital.nhs.uk/data-and-information/publications/statistical/personal-social-services-survey-of-adult-carers	01/02/2022
Public adult social care expenditure, adult social care activity volumes	Local authority	Local authority	NHS Digital: Adult Social Care Activity and Finance Report	https://digital.nhs.uk/data-and-information/publications/statistical/adult-social-care-activity-and-finance-report	01/02/2022
Vision impairment	Local authority	Local authority	NHS Digital: Registered Blind and Partially Sighted People	https://digital.nhs.uk/data-and-information/publications/statistical/registered-blind-and-partially-sighted-people	01/02/2022
Hearing impairment	Local authority	Local authority	NHS Digital: People registered as deaf or hard of hearing	https://digital.nhs.uk/data-and-information/publications/statistical/people-registered-as-deaf-or-hard-of-hearing/people-registered-as-deaf-or-hard-of-hearing-england-year-ending-31-march-2010	01/02/2022
Dementia	Local authority	Local authority	NHS Digital: Recorded Dementia Diagnoses	https://digital.nhs.uk/data-and-information/publications/statistical/recorded-dementia-diagnoses	01/02/2022
Population characteristics across local authorities	LSOA	Local authority	2011 Census	https://census.ukdataservice.ac.uk/get-data/aggregate-data	01/02/2022
Income deprivation, disability deprivation, education deprivation	LSOA	Local authority	Ministry of Housing, Communities & Local Government website	https://opendatacommunities.org/resource?uri=http%3A%2F%2Fopendatacommunities.org%2Fdef%2Fconcept%2Ffolders%2Forganisations%2Fdepartment-for-communities-and-local-government	01/02/2022
Council tax base	Local authority	Local authority	Government website: council taxbase statistics	https://www.gov.uk/government/collections/council-taxbase-statistics	26/02/2021
Business rate tax base	Local authority	Local authority	Government website: non-domestic rating - stock of properties collection	https://www.gov.uk/government/collections/non-domestic-rating-stock-of-properties-collection	26/02/2021
Area cost adjustment index	Local authority	Local authority	National archive	https://webarchive.nationalarchives.gov.uk/20140505105851/http:/www.local.communities.gov.uk/finance/1314/CalcFFs.pdf	26/02/2021

Table A2 – Key first-stage results in all financial years.

Instrument	2017/18				2018/19				2019/20			
	Longo et al. (2021)	New model (2)			Longo et al. (2021)	New model (2)			Longo et al. (2021)	New model (2)		
	Public adult social care expenditure per user	Public adult social care expenditure per user	Public adult social care expenditure per user squared	Proportion of eligible users	Public adult social care expenditure per user	Public adult social care expenditure per user	Public adult social care expenditure per user squared	Proportion of eligible users	Public adult social care expenditure per user	Public adult social care expenditure per user	Public adult social care expenditure per user squared	Proportion of eligible users
Council tax base per user	0.718***	1.459***	-13.646***	-0.204***	0.730***	1.319***	-10.155***	-0.171***	0.624***	1.344***	-10.926***	-0.159***
Council tax base per user squared		-0.014***	0.234***	0.002***		-0.011***	0.179***	0.002***		-0.012***	0.191***	0.002***
County		1.312	-26.963***	-0.034		0.814	-21.042***	-0.033		1.651***	-1.418	-0.013
Metropolitan district		0.798	-5.722	-0.145***		0.754	-4.450	-0.164***		2.504***	12.826***	-0.140***
Unitary authority		2.486***	-16.491*	-0.044		2.245***	-5.990	-0.026		3.303***	9.701**	-0.006
Observations	52,602	52,602	52,602	52,602	55,570	55,570	55,570	55,570	50,441	50,441	50,441	50,441
First-stage Kleibergen-Paap rk Wald F statistic	434.3		15.8		398.6		10.9		408.9		7.4	
First-stage Sanderson-Windmeijer F statistic	434.3	26.4	31.7	27.1	398.6	18.8	22.7	18.6	408.9	13.6	11.1	13.1

Longo et al. (2021)=regression (1) as proposed by Longo et al. (2021), New model (2)=regression (2) in this study.
The results on control variables are not reported. All regressions are weighted using the survey weight. Standard errors are clustered within LAs and strata.
*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.10

Appendix B

B1. Unobserved eligibility level as a source of bias

Longo, et al. [1] discusses the potential sources of bias for the estimated marginal effect of ASC expenditure per user on CRQoL. One of these potential sources is, if unobserved, the level of eligible users across LAs. This is because the higher the eligibility levels, the more users receive ASC and, therefore, for a given budget, the lower the public ASC expenditure or intensity of care for each user. In addition, higher eligibility levels reduce users' uncertainty on future care costs and, therefore, are expected to have a positive impact on users' CRQoL. If unobserved, the effect of a marginal increase in public ASC expenditure on CRQoL will capture the beneficial effect on CRQoL of greater intensity of care and the detrimental effect on CRQoL of lower eligibility levels. Hence, unobserved variability in eligibility levels is likely to bias the marginal effect of ASC expenditure per user on CRQoL downwardly.

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Appendix C

C1. Selection of the control variables in the new model

The new regression (2) proposed in this study includes a subset of the control variables in regression (1), which replicates the study by Longo, et al. [1]. Table C1 provides the list of the control variables used in the two analyses. Longo, et al. [1] includes several user-level and LA-level control variables. This is because the exogeneity argument on the instrument, the council tax base per user, is valid conditionally on the socio-economic status of the LAs. Therefore, the inclusion of several control variables aims to fully capture the socio-economic status of each LA.

Regression (2) requires the same assumption of conditional exogeneity of the instruments used by Longo, et al. [1] to produce an unbiased estimate of the effect of ASC expenditure per user. However, in addition to ASC expenditure per user, it includes two further endogenous variables: ASC expenditure per user squared and the proportion of eligible users. These three endogenous variables are expected to be highly correlated. This high correlation is likely to inflate the estimated variance of the parameters of interest, i.e. the parameters on ASC expenditure per user and its square, making the estimates less precise. This is called the issue of multicollinearity.[2, p. 83] To measure the magnitude of the potential multicolinearity we use the variance inflation factor (VIF). The VIF indicates the extent an explanatory variable can be explained by the other explanatory variables in the model. For example, if the VIF of a variable is greater than 10 then the R-squared from regressing that variable on the other covariates is greater than 90%. The bottom of Table C2 shows that, in the model proposed by Longo, et al. [1], the VIF on ASC expenditure per user is relatively low varying between 5.3 in 2017/18 and 9.1 in 2019/20. If the same control variables used by Longo, et al. [1] are included in regression (2), however, the multicolinearity issue becomes more substantial as the VIF on ASC expenditure per user is well above 70 in all financial years. A substantially higher VIF implies that the variance of the key estimated parameters of interest are inflated and, therefore, their interpretation becomes unclear.

To reduce this issue, we restrict the set of control variables used by Longo, et al. [1] to the subset indicated in Table C1. We argue that this subset of control variables accounts for socio-economic characteristics across LAs such that the required assumption of conditional exogeneity on the instruments still holds true. This is because we include all user-level variables as well as all the LA-level variables used to distribute central funding across LAs, as these are expected to properly reflect need and socio-economic status.[1] In addition, we retain most of the variables capturing carer characteristics. As shown in the bottom of Table C2, this variable selection leads to a substantial reduction of the VIF on ASC expenditure per user in the new regression (2). The VIF now varies between 18.4 in 2017/18 and 26.4 in 2019/20. Finally, in line with our assumption, the over-identification test suggests that the instruments are still likely to be exogenous conditional on the

[1] The central government distributes grants across LAs using the ASC relative needs formula. This formula includes a constant amount per capita across LAs and top-ups to account for needs through age, socio-economic deprivation, and rurality. It adjusts also for labour costs.

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chosen subset of control variables.

Table C1 – Selection of the control variables.

	Control variable	Level	Longo et al. (2021)	New model (2)
Eligibility	Outer London borough	LA	Yes	No
	County	LA	Yes	No
	Metropolitan district	LA	Yes	No
	Unitary authority	LA	Yes	No
	Proportion of eligible users	LA	No	Yes
user needs	Female user	Ind	Yes	Yes
	User aged 65 or older	Ind	Yes	Yes
	User of non-white ethnicity	Ind	Yes	Yes
	User who did not state ethnicity	Ind	Yes	Yes
	User whose questionnaire was in non-English European languages	Ind	Yes	Yes
	User whose questionnaire was in South Asian languages	Ind	Yes	Yes
	User whose questionnaire was in Middle Eastern languages	Ind	Yes	Yes
	User who received sensory support	Ind	Yes	Yes
	User who received support with memory and cognition	Ind	Yes	Yes
	User who received learning disability support	Ind	Yes	Yes
	User who received mental health support	Ind	Yes	Yes
	User who received social support	Ind	Yes	Yes
	User who did not receive help with questionnaire	Ind	Yes	Yes
	User whose questionnaire was read by someone else	Ind	Yes	Yes
	User whose questionnaire was translated by someone else	Ind	Yes	Yes
	User whose questionnaire was only filled in by someone else	Ind	Yes	Yes
	User whose questionnaire was talked through with someone else	Ind	Yes	Yes
	User whose questionnaire was answered without asking by someone else	Ind	Yes	Yes
	User who received an easy-read questionnaire	Ind	Yes	Yes
	Users who cannot manage personal hygiene by themselves in past year	LA	Yes	No
	Users who cannot manage continence by themselves in past year	LA	Yes	No
	Users who cannot dress by themselves in past year	LA	Yes	No
	Users who cannot feed by themselves in past year	LA	Yes	No
	Users who cannot ambulate by themselves in past year	LA	Yes	No
	Users who cannot manage personal hygiene by themselves in past two years	LA	Yes	No
	Users who cannot manage continence by themselves in past two years	LA	Yes	No
	Users who cannot dress by themselves in past two years	LA	Yes	No
	Users who cannot feed by themselves in past two years	LA	Yes	No
	Users who cannot ambulate by themselves in past two years	LA	Yes	No
	People who are sight impaired	LA	Yes	No
	People who are hearing impaired 2010	LA	Yes	No
	People who are sight and hearing impaired	LA	Yes	No
	People aged 65 or older with dementia	LA	Yes	No
	People whose disability limits daily activities a little	LA	Yes	No
	People whose disability limits daily activities a lot	LA	Yes	No
	Disability deprivation: quartile 2	LA	Yes	No
	Disability deprivation: quartile 3	LA	Yes	No
	Disability deprivation: quartile 4 (most deprived)	LA	Yes	No
	People aged 18-64 claiming Disability Living Allowance	LA	Yes	Yes
	People aged 65 or older claiming Attendance Allowance	LA	Yes	Yes
	Single-person households aged 0-64	LA	Yes	Yes
	Single-person households aged 65 or older	LA	Yes	Yes
	People in household with 0.5 to 1.0 persons per bedroom	LA	Yes	No
	People in household with 1.0 to 1.5 persons per bedroom	LA	Yes	No
	People in household with over 1.5 persons per bedroom	LA	Yes	No
	People who are house owners	LA	Yes	Yes
	Population density per 10,000 people	LA	Yes	Yes
	People who are in routine occupation	LA	Yes	Yes
	People who never worked and are long-term unemployed	LA	Yes	Yes
	Education deprivation: quartile 2	LA	Yes	No
	Education deprivation: quartile 3	LA	Yes	No
	Education deprivation: quartile 4 (most deprived)	LA	Yes	No
	Income deprivation: quartile 2	LA	Yes	No
	Income deprivation: quartile 3	LA	Yes	No
	Income deprivation: quartile 4 (most deprived)	LA	Yes	No
	People with income support	LA	Yes	Yes
	People with pension credit	LA	Yes	Yes
Carer needs	Female carers	LA	Yes	Yes
	Carers aged 65 or older	LA	Yes	Yes
	Carers of non-white ethnicity	LA	Yes	Yes
	Carers who did not state ethnicity	LA	Yes	Yes
	Carers with Physical impairment	LA	Yes	Yes
	Carers with sight or hearing loss	LA	Yes	Yes
	Carers with long-standing illness	LA	Yes	Yes
	Carers who is retired	LA	Yes	Yes
	Carers who is employed	LA	Yes	Yes
	Carers who is self-employed	LA	Yes	Yes

Control variable	Level	Longo et al. (2021)	New model (2)
Carers who is unemployed	LA	Yes	Yes
Carers who is not in paid work because of caring role	LA	Yes	No
Carers who is in paid work but do not feel supported by their employer	LA	Yes	No
Carers who is self-employed but unable to balance work and caring role	LA	Yes	No
Carers with financial difficulties because of caring role	LA	Yes	No
Carers who do not live with care recipient	LA	Yes	Yes
Carers in caring role between 6 months and 1 year	LA	Yes	No
Carers in caring role for more than 1 year	LA	Yes	No
Carers who provide personal care	LA	Yes	No
Carers who provide physical help	LA	Yes	No
Carers who provide other practical help	LA	Yes	No
Carers who provide help with medicines	LA	Yes	No
Carers who provide emotional support	LA	Yes	No
Total number of control variables		84	47

Longo et al. (2021)= regression (1) as proposed by Longo et al. (2021), New model (2)=regression (2) in this study, LA=variable measured at the local authority-level; Ind=variable measured at the individual level, Yes=included, No=not included.

Table C2 – Full second-stage results in all financial years.

Variable		2017/18			2018/19			2019/20		
		Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)
Public adult social care expenditure per user	LA	0.003***	0.008**	0.006***	0.002**	0.011***	0.006***	0.002**	0.008**	0.009***
		(0.001)	(0.008)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.003)
Public adult social care expenditure per user squared	LA		-0.0002	-0.0004**		-0.0004*	-0.0003*		-0.0003	-0.0004**
			(0.0001)	(0.0002)		(0.0003)	(0.0002)		(0.0002)	(0.0002)
County	LA	0.017			0.007			0.009		
Metropolitan district	LA	0.016			-0.003			0.003		
Unitary authority	LA	0.0234*			0.016			0.016		
Proportion of eligible users	LA		0.055	0.0518***		0.1056***	0.0525***		0.0694*	0.0806***
Female user	Ind	-0.0083***	-0.0081***	-0.0082***	-0.0083***	-0.0083***	-0.0082***	-0.0051**	-0.0051**	-0.0052**
User aged 65 or older	Ind	0.0371***	0.0368***	0.0370***	0.0368***	0.0366***	0.0366***	0.0277***	0.0275***	0.0274***
User of non-white ethnicity	Ind	-0.0308***	-0.0307***	-0.0317***	-0.0343***	-0.0339***	-0.0354***	-0.0240***	-0.0237***	-0.0239***
User who did not state ethnicity	Ind	-0.0240**	-0.0234**	-0.0220**	-0.0230***	-0.0215***	-0.0217***	-0.0152**	-0.0133*	-0.0155**
User whose questionnaire was in non-English European languages	Ind	-0.092	-0.090	-0.089	0.0922***	0.0926***	0.0903***	0.005	0.006	0.008
User whose questionnaire was in South Asian languages	Ind	-0.0732***	-0.0755***	-0.0626**	-0.014	-0.028	-0.032	-0.0356*	-0.029	-0.0458**
User whose questionnaire was in Middle Eastern languages	Ind	-0.1199**	-0.1236**	-0.1210**	-0.1694**	-0.1647**	-0.1710**	-0.1934***	-0.1955***	-0.1822***
User who received sensory support	Ind	0.013	0.013	0.013	-0.008	-0.009	-0.008	-0.004	-0.004	-0.006
User who received support with memory and cognition	Ind	0.0265***	0.0261***	0.0264***	0.0255***	0.0254***	0.0261***	0.0292***	0.0300***	0.0313***
User who received learning disability support	Ind	0.1257***	0.1242***	0.1256***	0.1031***	0.1001***	0.1092***	0.0959***	0.0946***	0.0984***
User who received mental health support	Ind	0.0139**	0.0145***	0.0141**	0.0187***	0.0194***	0.0190***	0.0198***	0.0202***	0.0191***
User who received social support	Ind	-0.003	-0.004	-0.004	0.014	0.013	0.012	0.002	0.001	-0.002
User who did not receive help with questionnaire	Ind	0.0159***	0.0158***	0.0162***	0.0092**	0.0092**	0.0088**	0.0147***	0.0146***	0.0151***
User whose questionnaire was read by someone else	Ind	0.0312***	0.0313***	0.0314***	0.0352***	0.0354***	0.0354***	0.0374***	0.0375***	0.0381***
User whose questionnaire was translated by someone else	Ind	0.0081***	0.0081***	0.0082***	-0.001	-0.001	0.000	-0.001	-0.001	-0.001
User whose questionnaire was only filled in by someone else	Ind	-0.0153***	-0.0152***	-0.0151***	-0.0161***	-0.0159***	-0.0164***	-0.0151***	-0.0150***	-0.0147***
User whose questionnaire was talked through with someone else	Ind	-0.0195***	-0.0195***	-0.0194***	-0.0200***	-0.0199***	-0.0203***	-0.0159***	-0.0158***	-0.0156***
User whose questionnaire was answered without asking by someone else	Ind	-0.0645***	-0.0644***	-0.0644***	-0.0615***	-0.0612***	-0.0613***	-0.0520***	-0.0519***	-0.0516***
User who received an easy-read questionnaire	Ind	0.017	0.018	0.016	0.0403***	0.0436***	0.0331***	0.0447***	0.0458***	0.0415**
Users who cannot manage personal hygiene by themselves in past year	LA	0.0001	0.001		0.001	0.001		0.0003	0.0002	
Users who cannot manage continence by themselves in past year	LA	-0.0002	0.0002		0.001	0.001		-0.00002	0.00004	
Users who cannot dress by themselves in past year	LA	0.0004	-0.001		-0.0003	0.001		-0.002	-0.0027*	
Users who cannot feed by themselves in past year	LA	-0.002	-0.001		0.0003	0.001		0.0001	0.001	
Users who cannot ambulate by themselves in past year	LA	0.0001	0.0004		-0.001	-0.003		0.001	0.0034*	
Users who cannot manage personal hygiene by themselves in past two years	LA	-0.0004	-0.001		0.001	0.002		0.001	0.001	
Users who cannot manage continence by themselves in past two years	LA	0.0037**	0.0034**		0.0002	-0.0002		-0.001	-0.002	
Users who cannot dress by themselves in past two years	LA	0.000	0.002		-0.001	-0.001		-0.001	0.001	
Users who cannot feed by themselves in past two years	LA	-0.0035**	-0.0048***		-0.0003	0.002		-0.0026**	-0.0025**	
Users who cannot ambulate by themselves in past two years	LA	-0.002	-0.0032*		0.0004	0.001		0.002	0.001	
People who are sight impaired	LA	-0.017	-0.003		0.003	0.010		-0.0290*	-0.009	
People who are hearing impaired 2010	LA	-0.003	0.001		-0.0223**	-0.0303**		0.012	0.009	
People who are sight and hearing impaired	LA	0.052	0.045		0.0938*	0.1014*		-0.032	-0.013	
People aged 65 or older with dementia	LA	0.002	0.003		-0.001	0.002		0.005	0.0094**	
People whose disability limits daily activities a little	LA	-0.013	-0.017		-0.012	-0.0205*		0.003	-0.005	
People whose disability limits daily activities a lot	LA	0.0330***	0.0397***		-0.002	0.009		0.004	0.014	
Disability deprivation 2015: quartile 2	LA	0.002	0.002		-0.003	-0.003				
Disability deprivation 2015: quartile 3	LA	0.005	0.014		-0.003	0.013				

Variable		2017/18			2018/19			2019/20		
		Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)
Disability deprivation 2015: quartile 4 (most deprived)	LA	-0.001	0.010		0.006	0.020				
Disability deprivation 2019: quartile 2	LA							-0.002	0.006	
Disability deprivation 2019: quartile 3	LA							-0.009	-0.005	
Disability deprivation 2019: quartile 4 (most deprived)	LA							-0.014	-0.010	
People aged 18-64 entitled to Disability Living Allowance	LA	-0.0195**	-0.0178**	-0.0244***	-0.0141*	-0.0155*	-0.0183***	-0.012	-0.011	-0.0252*
People aged 65 or older entitled to Disability Living Allowance	LA	-0.0337*	-0.0571**	0.0114**	0.016	-0.012	0.005	0.001	-0.038	-0.003
People aged 65 or older entitled to Attendance Allowance	LA	-0.003	-0.0058*	-0.002	-0.001	-0.005	-0.001	-0.002	-0.0055*	-0.0001
Single-person households aged 0-64	LA	-0.002	-0.0033*	-0.002	-0.0004	-0.003	-0.0021*	-0.001	-0.001	-0.0037***
Single-person households aged 65 or older	LA	-0.002	-0.005	0.0002	0.0099**	0.0077*	0.001	0.002	-0.003	-0.001
People in household with 0.5 to 1.0 persons per bedroom	LA	-0.004	-0.003		-0.003	-0.001		-0.005	-0.0073*	
People in household with 1.0 to 1.5 persons per bedroom	LA	0.0004	0.001		-0.002	-0.002		0.002	0.001	
People in household with over 1.5 persons per bedroom	LA	-0.0058*	-0.0062*		-0.003	-0.002		-0.0062**	-0.0091**	
People who are house owners	LA	-0.001	-0.0003	-0.001	0.001	0.0003	-0.0002	-0.0003	-0.001	0.000
Population density per 10,000 people	LA	0.023	0.035	0.003	0.020	0.0608*	0.033	0.034	0.0600*	0.0648**
People who are in routine occupation	LA	-0.002	-0.001	-0.001	0.002	0.003	0.002	0.002	0.002	0.0048***
People who never worked and are long-term unemployed	LA	0.0070**	0.0086**	0.0053**	0.0066*	0.0083**	0.0054**	0.0065*	0.0097**	0.003
Education deprivation 2015: quartile 2	LA	0.003	0.009		0.008	0.008				
Education deprivation 2015: quartile 3	LA	-0.004	0.011		0.011	0.022				
Education deprivation 2015: quartile 4 (most deprived)	LA	-0.004	0.013		0.010	0.013				
Education deprivation 2019: quartile 2	LA				-0.011	-0.004		-0.0145**	-0.006	
Education deprivation 2019: quartile 3	LA				-0.016	-0.014		-0.013	0.003	
Education deprivation 2019: quartile 4 (most deprived)	LA				-0.018	0.003		-0.021	-0.003	
Income deprivation 2015: quartile 2	LA	-0.003	-0.013		0.0452**	0.0562**				
Income deprivation 2015: quartile 3	LA	-0.001	-0.011		0.0446*	0.0743**				
Income deprivation 2015: quartile 4 (most deprived)	LA	-0.007	-0.022		0.038	0.048				
Income deprivation 2019: quartile 2	LA				-0.034	-0.0486**		0.002	-0.008	
Income deprivation 2019: quartile 3	LA				-0.034	-0.0784**		0.005	-0.006	
Income deprivation 2019: quartile 4 (most deprived)	LA				-0.040	-0.0755**		0.001	-0.028	
People with income support	LA	-0.007	-0.014	-0.001	-0.002	-0.012	-0.005	-0.0400**	-0.0626***	-0.021
People with pension credit	LA	-0.0012	-0.0013	-0.0005	0.0004	-0.0011	-0.0020	0.0009	-0.0001	-0.0007
Female carers	LA	-0.0004	-0.00002	-0.0002	0.0002	-0.0004	-0.001	0.0003	0.0002	0.0004
Carers aged 65 or older	LA	-0.0001	0.0004	-0.00003	-0.0004	0.0002	0.0001	0.0001	-0.0003	0.0001
Carers of non-white ethnicity	LA	0.001	0.001	-0.0003	-0.0001	0.0001	-0.0001	-0.0001	-0.0004	-0.0002
Carers who did not state ethnicity	LA	0.0001	0.0003	0.0001	0.0003*	0.0009***	0.0001	0.0001	0.0003	0.0003*
Carers with Physical impairment	LA	0.001	0.0002	-0.0001	-0.0001	-0.001	0.0001	0.001	0.0027*	0.001
Carers with sight or hearing loss	LA	0.00002	-0.001	-0.0001	-0.001	-0.0022*	-0.001	-0.001	-0.001	0.001
Carers with long-standing illness	LA	0.0002	0.002	0.001	0.001	0.0024**	0.001	0.0004	-0.00001	-0.0001
Carers who is retired	LA	0.0003	-0.0001	0.001	0.001	0.002	0.001	-0.0002	-0.001	0.000002
Carers who is employed	LA	-0.00004	-0.0001	0.001	0.001	0.003	0.0003	0.002	0.000	0.001
Carers who is self-employed	LA	0.002	0.001	0.002	0.0040**	0.0048**	0.002	0.003	0.003	0.003
Carers who is unemployed	LA	-0.001	-0.003	-0.0001	0.001	0.002	-0.001	0.0001	-0.002	-0.001
Carers who is not in paid work because of caring role	LA	0.0004	0.001		-0.0004	-0.001		-0.0001	0.0002	
Carers who is in paid work but do not feel supported by their employer	LA	0.001	0.003		-0.001	0.001		-0.002	0.001	
Carers who is self-employed but unable to balance work and caring role	LA	-0.003	-0.003		-0.002	-0.001		-0.0070**	-0.0109***	
Carers with financial difficulties because of caring role	LA	-0.001	-0.001		-0.001	-0.0010*		-0.001	-0.0015**	
Carers who do not live with care recipient	LA	-0.0002	-0.0001	-0.0001	-0.001	-0.001	-0.0001	-0.0001	0.0001	0.0001

Variable		2017/18			2018/19			2019/20		
		Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)	Longo et al. (2021)	New model (2) with all covariates	New model (2)
Carers in caring role between 6 months and 1 year	LA	-0.003	-0.006		-0.002	-0.0002		0.006	0.0176**	
Carers in caring role for more than 1 year	LA	-0.004	-0.006		-0.002	-0.0027**		0.007	0.0140**	
Carers who provide personal care	LA	0.0003	-0.0002		-0.0003	-0.0003		0.001	0.001	
Carers who provide physical help	LA	0.0004	0.0002		0.001	0.0004		-0.001	-0.001	
Carers who provide other practical help	LA	-0.001	-0.00003		-0.0004	0.0004		0.00001	-0.00001	
Carers who provide help with medicines	LA	0.0002	0.001		0.0002	0.0004		0.0004	0.0019*	
Carers who provide emotional support	LA	-0.0001	-0.001		-0.0016*	-0.0030**		-0.0002	-0.001	
Constant		1.5166***	1.5850***	0.6875***	1.0470***	0.9109**	0.7168***	0.201	-0.269	0.5752***
Observations		52,602	52,602	52,602	55,570	55,570	55,570	50,441	50,441	50,441
Variance inflation factor on ASC expenditure per user		5.3	93.2	18.4	5.5	104.0	22.2	9.1	73.1	26.4
Variance inflation factor on ASC expenditure per user squared		-	10.9	3.2	-	16.5	4.7	-	9.6	3.2
F-test of expenditure and its square's p-value		-	0.053	0.007	-	0.007	0.004	-	0.069	0.002
First-stage Kleibergen-Paap rk Wald F statistic		434.3	9.1	15.8	398.6	6.7	10.9	408.9	7.9	7.4
First-stage Sanderson-Windmeijer F statistic on ASC expenditure per user		434.3	16.3	26.4	398.6	11.4	18.8	408.9	13.7	13.6
First-stage Sanderson-Windmeijer F statistic on ASC expenditure per user squared		-	35.2	31.7	-	13.2	22.7	-	17.7	11.1
First-stage Sanderson-Windmeijer F statistic on proportion of eligible users		-	19.9	27.1	-	11.9	18.6	-	15.4	13.1
Over-identification test		0.595	0.521	0.580	0.715	0.863	0.871	0.777	0.705	0.334

Longo et al. (2021)= regression (1) as proposed by Longo et al. (2021), New model (2) with all covariates=regression (2) in this study including all the control variables used by Longo et al. (2021), New model (2)=regression (2) in this study, LA=local-authority level variable, Ind=individual-level variable.

The dependent variable is the user care-related quality of life measured at the individual level. In the new model (2), we subtract the mean from public adult social care expenditure per user to interpret its estimated coefficient as the marginal effect at mean expenditure rather than at zero. The Instrumental variable in the model by Longo et al. (2021) is the council tax base per user. The instruments in the new model (2) proposed in this study are the council tax base per user, its square, and the local authority-type dummies. In the model by Longo et al. (2021), the over-identification test is run by using the business rates tax base per user and the Area Cost Adjustment index as additional instruments. All regressions are weighted using the survey weight. Standard errors are clustered within LAs and strata, and they are reported in parenthesis.

*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.10

Appendix D

D1. Sensitivity analysis using 2015/16 and 2016/17 data

As a sensitivity analysis, we estimate regression (2) using data from the financial years 2015/16 and 2016/17. Data from these two financial years are used in a sensitivity analysis because they do not include the survey weight and the stratum variable. These two variables are key for making inference with survey data. Therefore, using the available variables included in these datasets, we construct the survey weight and stratum variable by making some assumptions. However, variables constructed on assumptions are prone to measurement error. Therefore, we use estimates from these data to obtain a qualitative indication about the robustness of the results in the main analysis. Table D1 and Table D2 report the key results of this sensitivity analysis. The estimated parameters of key interest on ASC expenditure per user and its square, as well as the marginal effects at multiple values of ASC expenditure per user are similar to the results for 2017/18, 2018/19 and 2019/20.

Table D1 – Key second-stage results for 2015/16 and 2016/17.

Variable	New model (2)	
	2015/16	2016/17
Public adult social care expenditure per user	0.008***	0.007***
	(0.003)	(0.002)
Public adult social care expenditure per user squared	-0.0004*	-0.0003
	(0.0002)	(0.0002)
Observations	59,891	60,441
F-test of expenditure and its square's p-value	0.007	0.006
First stage Kleibergen-Paap rk Wald F statistic	10.9	14.6
Over-identification test's p-value	0.319	0.223

New model (2)=regression (2) in this study.
The dependent variable is the user care-related quality of life measured at the individual level. In the new model, we subtract the mean from public adult social care expenditure per user to interpret its estimated coefficient as the marginal effect at mean expenditure rather than at zero. The Instrumental variables are the council tax base per user, its square, and the local authority type dummies. Results on control variables are not reported. All regressions are weighted using the survey weight. Standard errors are clustered within LAs and strata, and they are reported in parenthesis.
*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.10

Table D2 – Marginal effects at multiple values of ASC expenditure per user for 2015/16 and 2016/17.

Public adult social care expenditure per user	2015/16		2016/17	
	Value	Marginal effect	Value	Marginal effect
No expenditure	0.0	0.025**	0.0	0.023**
At the min value	14.2	0.015***	16.5	0.014**
At the mean	23.2	0.008***	26.6	0.007***
At the max value	45.1	-0.008	47.3	-0.003

*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.10

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