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Does Public Long-Term Care Expenditure Improve Care-Related Quality of Life in England?

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CHE Research Paper 172

Does public long-term care expenditure improve care-related quality of life in England?

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Abstract

Public long-term care (LTC) systems are common across Organisation for Economic Co-operation and Development countries and they provide services to support people experiencing difficulties with their activities of daily living. This study investigates the marginal effect of changes in public LTC expenditure on care-related quality of life (CRQoL) in England. The public LTC programme for people aged 18 or older in England is called Adult Social Care (ASC) and it is provided and managed by local authorities. We collect data on outcomes and characteristics of public ASC users, and on public ASC expenditure and characteristics of local authorities across England in 2017/18. We employ an instrumental variable approach using conditionally exogenous elements of the public funding system to estimate the effect of public ASC expenditure on users' CRQoL. Our findings show that increasing public ASC expenditure by £1,000 per user generates 0.0031 additional CRQoL. These results suggest that public ASC is effective in increasing users' quality of life but only to a relatively small extent. Combined with other findings on the effect of LTC expenditure on mortality, this study can inform policy makers in the UK and around the world about whether social care provides good value for money.

Keywords: long-term care; marginal productivity; quality of life; public expenditure; cross-section; instrumental variables.

JEL classification: H53; I38; D24; C21; C26.

1. Introduction

Long-term care (LTC) consists of medical and social services for individuals with chronic conditions or disability that have difficulties with their activities of daily living (e.g. Lipszyc et al., 2012, National Institute on Aging, 2017). LTC systems are common across Organisation for Economic Co-operation and Development (OECD) countries to address the failure of unregulated LTC markets (Forder et al., 1996, Finkelstein and McGarry, 2006), and public spend on LTC in most of these countries is considerable. In 2017, for example, the Netherlands, the Nordic countries and Switzerland were among those spending the most on public LTC, i.e. between 2.5% and 4% of GDP. The provision of public LTC has the primary goal of improving quality of life (Fernandez et al., 2011). In addition, LTC aims to support the health care sector in achieving a better allocation of resources by providing less costly alternatives to hospitalisation (Rhee et al., 2015, Villalobos Dintrans, 2018). This implies that LTC may have the indirect effect of improving health outcomes by allowing a more cost-effective use of health care resources.

As the primary goal of LTC, quality of life is improved by promoting wellbeing and independence through support in specialised facilities and at home. Improving quality of life confers positive societal value in itself, but it also has wider economic benefits. For example, improving the quality of life of LTC users of working age, or increasing the participation of informal carers in the job market, may improve labour productivity (Rhee et al., 2015, Villalobos Dintrans, 2018). Other benefits may derive from intergenerational transfers when LTC services enable grandparents to provide parenting support (Loury, 2006, Compton and Pollak, 2014, Adermon et al., 2018). Therefore, from a number of perspectives, it is important to address the question of whether and to what extent public LTC expenditure improves quality of life.

Few empirical studies explore the effect of LTC services on quality of life. Forder et al. (2014b) analyse the effect of English public home care services for users aged 65 and above on care-related quality of life (CRQoL), as measured by the adult social care outcome toolkit (ASCOT), and find a beneficial effect. The focus of their study is narrow since, in England, public expenditure for home care services for users aged 65 and above is a small proportion (8.2% in 2017/18) of the total LTC expenditure. The study uses a survey sample of 301 users, and employs an instrumental variable (IV) approach using the type of local authority (LA) as an instrument. The type of LA is argued to capture the eligibility policy across LAs which is assumed to have no direct impact on CRQoL. The follow-up study by Forder et al. (2018a) investigates the effect of formal community care services (e.g. home care, day care) on CRQoL, and also finds a beneficial effect. This study, however, does not distinguish the effect of public and private LTC expenditure. It builds on the previous study by extending the analysis to all community care services, although this is still a relatively small proportion (34.6% in 2017/18) of total public LTC expenditure, in England, and by using a larger survey sample of 622 users. It also relaxes the assumption of no direct effect of the LA eligibility policy on CRQoL, but it makes the implicit assumption of no peer effects among LTC users by using the average level of resource use within each LA as an instrument. In addition, in both studies, the authors use some current LTC outcomes (e.g. activities of daily living, home adaptations) as control variables which may generate a bad control problem (Angrist and Pischke, 2008, p. 47).

Other studies focus on the effects of public LTC on different outcomes including mortality and health care resources. For example, Watkins et al. (2017) suggest that lower public LTC expenditure is associated with higher mortality. Some studies find a substitution effect between social and health care services and that an increase in LTC services, such as nursing homes, may improve hospital outcomes, for example, by reducing delayed discharges (e.g. Fernandez and Forder, 2008, Forder, 2009, Gaughan et al., 2015, Forder et al., 2018a).

This study investigates the extent to which public LTC expenditure in England improves CRQoL. The public LTC programme for people aged 18 or older in England is called Adult Social Care (ASC), and it is provided by LAs to support individuals that meet need and financial eligibility criteria. Public ASC is structured to provide a range of services including: adult long-term care (ALTC) services which aim to support users over an unspecified and generally long period of time;¹ adult short-term care services which are time-limited and mostly aim to maximise independence to reduce the need for ALTC; assistive equipment, adaptations and technologies such as smoke alarm for hearing impaired users, shower chair for disabled users, and telecare, respectively; information and early intervention services to inform and signpost potential and existing users; and auxiliary ASC activities such as front-line assessment and review of users. ALTC users (simply users from now on) may receive all these ASC services. Therefore, our focus on the effect of total public ASC expenditure on these users may inform the key policy question of what gain (loss) in CRQoL is likely to be obtained by investing (disinvesting) public money in the ASC sector. In addition, it may help to inform the policy question of whether committing resources from the ASC budget to specific ASC programmes may produce more value for money. However, users' main form of support is ALTC, which consists of support services (e.g. physical support, learning disability support) delivered through residential care, nursing care, and community care settings. We therefore investigate also whether public ALTC expenditure, which is a major proportion of public ASC expenditure (74% in 2017/18), improves users' CRQoL.

Our empirical strategy employs a multilevel IV approach to analyse a large representative sample of 49,907 users in 2017/18. Like the multilevel approach suggested by Bhalotra (2007) and Farahani et al. (2010), we measure CRQoL, our dependent variable, at the user level, while public ASC expenditure, our key independent variable, is measured at the more aggregate LA level. We argue that user-level data allow us to account for the heterogeneity in CRQoL which is not due to public ASC expenditure with higher precision, and that the relevant level of expenditure for decision makers is the LA level (which is also the most granular available). Therefore, our findings are still relevant to these decision makers and those in other countries following a similar decision-making process. Moreover, our IV approach avoids potential bad control problems by excluding current ASC outcomes from the set of controls and relaxes the assumptions of no direct effect of LA eligibility policy on CRQoL and of no peer effects among LTC users as in previous studies (Forder et al., 2014b, Forder et al., 2018b). We use the council tax base at the LA level as our preferred instrument to estimate the exogenous effect of public ASC (and ALTC) expenditure on CRQoL. The council tax is a primary source of revenues for LAs to fund ASC services and we argue that the council tax base at the LA level is related to LTC needs and outcomes only indirectly through LAs' socio-economic characteristics and, of course, public ASC (and ALTC) expenditure. Therefore, conditional on controlling for socio-economic characteristics, the council tax base captures exogenous factors reflecting the urban development across LAs that can be used to instrument public ASC expenditure. Our IV approach is inspired by other studies using exogenous elements of the funding system as instruments to identify the effect of expenditure on outcomes (e.g. Goodspeed, 2000, Hægeland et al., 2012, Andrews et al., 2017, Claxton et al., 2018, Gigliotti and Sorensen, 2018).

The paper is structured as follows. Section 2 provides a brief overview of the institutional background and the funding system, and Section 3 introduces the theoretical background. Section 4 describes the data sources and variables, and Section 5 illustrates the empirical strategy. Section 6 shows the results, and Section 7 discusses and concludes.

¹ More precisely, ALTC is a sub-category of LTC where the latter includes services, which aim to support individuals over either a short or long period of time.

2. Institutional background

In England, 152 LAs are responsible for ASC within their locality. LAs provide public ASC services directly or through external organisations, free of charge to users with sufficiently high needs, and savings and assets below £14,250. Users co-pay for public ASC services if they meet the needs eligibility criteria but their savings and assets are between £14,250 and £23,250. Regardless of their needs, however, individuals are ineligible for public ASC services if their savings and assets are above £23,250. While a minimum level of care and support is set nationally through the Care Act 2014, eligibility criteria may vary across LAs depending on their local policies. Forder et al. (2014b) suggest that such eligibility criteria may vary systematically by type of LA which may share similar market conditions, culture and administrative organisation including county, London (inner and outer), metropolitan and unitary LAs.

Ineligible individuals for public ASC services might still have their ASC services arranged and managed by their LA but they will bear the full costs of the services received (NHS Digital, 2019).² Moreover, they can still purchase ASC services from private providers. Private ASC expenditure is not insignificant, estimated at £10.9 billion in 2016/17 (National Audit Office, 2018), but it is substantially lower than the public ASC expenditure which, in the same year, was above £20 billion (The King's Fund, 2018). All individuals, whether receiving formal ASC or not, may receive informal care from family and friends. Its value in the UK is estimated at £132 billion a year, going far beyond formal ASC expenditure (Buckner and Yeandle, 2015). However, ASC still represents a major source of expenditure for LAs compared to other key local services such as children's support and housing (National Audit Office, 2018).

2.1 Sources of public funding

Our IV strategy is based on conditionally exogenous characteristics of the local funding system and, therefore, this paragraph describes the sources of funding for LA services including ASC. In England, LAs fund their services through revenues from council tax and business rates, grants from central government, and user contributions (Amin-Smith et al., 2018, Brien, 2018). Of the £94.5 billion spent on LA services in 2017/18, 29% was funded from council tax, 15.5% from retained business rates, 53% from governmental grants, and 2.5% from reserves and other items such as inter-LA transfers (Department for Communities and Local Government, 2017b). Revenues from local taxes are not ring-fenced, while grants from the government may or may not be ring-fenced.

Council tax is levied on the occupation of domestic properties or on their ownership if empty (Sandford, 2018b). LAs fully retain council tax revenues and can also control the amount of revenues in each financial year by setting the budget requirement. The latter is divided by the tax base to calculate the amount of taxation. The council tax base is defined through a national classification which categorises domestic properties into bands: from 'band A' for properties with the lowest sale value to 'band H' for properties with the highest sale value, where sale values are based on a 1991 national valuation (Sandford, 2018c). The council tax base is therefore calculated as the number of 'band D' equivalent domestic properties, i.e. the number of all domestic properties expressed as 'band D' properties. In the calculation of the number of 'band D' equivalent properties, a 'band D' property counts as a whole property and properties in any lower- (higher-) band count as less (more) than one property. For example, a 'band A' property counts as 0.67 'band D' property and a 'band H' property as two 'band D' properties (Department for Communities and Local Government, 2017a). LAs have no control on the levels of tax base because banding is set by the central government and, therefore, it cannot be manipulated by LAs to meet their LTC needs. However, LAs can grant exemptions and discounts depending on property and individuals' characteristics, respectively. For

² On average, these users only represent a small proportion (6%) across LAs.

example, properties which are unoccupied because of the person having gone to live in a care home are exempted from council tax, or individuals living alone or having a severe mental impairment are entitled to a council tax discount. However, only 3% of the total council tax base in 2017 was subject to exemptions and discounts due to LTC needs (Ministry of Housing, Communities and Local Government, 2018). Given the partial control on council tax revenues only through the budget requirement rather than the council tax base, LAs were enabled to charge additional council tax amounts, known as precepts, to fund ASC services. Most LAs have been charging an ASC precept since 2015.

Business rates are levied on the occupation of non-domestic properties (e.g. restaurants, barber shops) or on their ownership if empty (Sandford, 2018a). Compared to council tax, LAs have relatively little control over business rates because both tax rates and tax base are set centrally by the government. Tax rates are simple multipliers, while the tax base reflects the hypothetical annual rents of non-domestic properties, which are re-valuated nationally every year. In addition, only 50% of business rates revenues are retained by LAs, and the remaining part is transferred to the central government (Sandford, 2018c).³ The share of business rates revenues that LAs retain is subject to a tariff and top-up system, which redistributes part of these revenues across LAs on the basis of a national needs assessment. LAs can allow also business rates exemptions and discounts. For example, small businesses are exempt from the business rates tax and charities have a discount on their business rates tax of no less than 80%.

Moreover, LAs receive a number of grants from central government (Cromarty, 2019). Ring-fenced grants that aim to support ASC (e.g. improved Better Care Fund, ASC support grant) are distributed across LAs according to the ASC relative needs formula (Department for Communities and Local Government, 2014). This formula includes a constant amount per capita across LAs and a number of top-ups, which account for needs through age, socio-economic deprivation, and rurality. The needs formula adjusts also for labour costs through the area cost adjustment (ACA) index.

Finally, LAs can charge fees for services, where some fees are set nationally (Sandford, 2018c). Revenues from fees are retained locally but are treated as a contribution for the specific services paid for and cannot be used for other purposes.

3. Theoretical framework

Following Forder et al. (2018a), the utility (u_{ij}) of a user i in LA j can be expressed as a generic function (u) of several factors:

$$u_{ij} = u \left\{ \underset{-}{n_{ij}}, \underset{+}{g_j} \left[\underset{+}{k_j}, \underset{+}{t_j} \left(\underset{+}{z_j} \right) \right], \underset{+}{e_{ij}^{public}} \left(\underset{+}{n_{ij}}, \underset{-}{g_j}, \underset{+}{t_j} \right), \underset{+}{e_{ij}^{private}} \left(\underset{+}{n_{ij}}, \underset{-}{e_{ij}^{public}}, \underset{-}{c_{ij}} \right), \underset{+}{c_{ij}} \left(\underset{+}{n_{ij}}, \underset{-}{e_{ij}^{public}}, \underset{-}{e_{ij}^{private}} \right), \underset{?}{r_{ij}}, \underset{+}{U_{ij}} \right\}. \quad (1)$$

First, users with high needs (n_i) have lower utility. We argue that there exists an eligibility effect across LAs (g_j) on user utility which is due to the level of financial protection offered, since this reduces uncertainty about future LTC costs (Department of Health, 2015). Eligibility effects may vary across LAs mostly based on the generosity of their policy (k_j) (Forder et al., 2014b), and local tax revenues (t_j). In turn, tax revenues are more likely to increase with more favourable local market conditions (z_j).

³ Recent reforms are gradually granting higher fiscal autonomy to local authorities allowing them to retain 100% of the business rates tax revenues (The King's Fund, 2018).

Moreover, the user's utility tends to increase with the amount of the ASC services received, which can be expressed in terms of public ASC expenditure (e_{ij}^{public}), private ASC expenditure ($e_{ij}^{private}$) and informal care (c_{ij}). We argue that public ASC expenditure for each user is likely to be higher in the presence of higher user needs and tax revenues, but lower if more individuals are eligible for public ASC services in the presence of a fixed budget. Instead, private ASC expenditure and informal care are likely to increase with user needs and if the amount of alternative ASC services is reduced. For example, if public ASC services cannot fully meet users' needs, users will purchase additional private services or demand more informal care (Puthenparambil and Kröger, 2016, Urwin et al., 2019). We argue that public ASC expenditure is not affected directly by private ASC expenditure and informal care, while private ASC expenditure and informal care are directly affected by public ASC expenditure. This is because the level of public ASC services is decided by LAs considering mostly user needs, while users make decisions on the amount of private ASC services and informal care based in part on the amount of publicly funded support. Also, utility depends on other factors unrelated to ASC (r_{ij}) such as, for example, living in a safe area due to proximity to a police station.

As Becker (1981) suggests, the user's utility is likely to be higher if the utility of informal carers (U_{ij}) increases. Similarly to the user's utility, U_{ij} can be expressed as:

$$U_{ij} = U \left\{ \underset{-}{N_{ij}}, \underset{+}{g_j}, \underset{+}{E_{ij}^{public}} \left(\underset{+}{N_{ij}}, \underset{-}{g_j}, \underset{+}{t_j} \right), \underset{+}{E_{ij}^{private}} \left(\underset{+}{N_{ij}}, \underset{-}{E_{ij}^{public}} \right), \underset{-}{c_{ij}} \left(\underset{+}{N_{ij}}, \underset{-}{e_{ij}^{public}}, \underset{-}{e_{ij}^{private}} \right), \underset{?}{R_{ij}}, \underset{+}{u_{ij}} \right\}. \quad (2)$$

The carer's utility is a generic function (U) of the carer's caring-related needs (N_{ij}), the eligibility policy (g_j), the public (E_{ij}^{public}) and private ($E_{ij}^{private}$) carer services received, the informal care provided (c_{ij}), other factors unrelated to ASC (R_{ij}), and the utility of the user (u_{ij}). By replacing (2) into (1), we obtain:

$$u_{ij} = u \left[\underset{+}{expenditure_{ij}^{public}} \left(\underset{+}{n_{ij}}, \underset{+}{N_{ij}}, \underset{-}{g_j}, \underset{+}{t_j} \right), \underset{-}{n_{ij}}, \underset{-}{N_{ij}}, \underset{+}{g_j}, \underset{+}{e_{ij}^{private}}, \underset{+}{E_{ij}^{private}}, \underset{+}{c_{ij}}, \underset{?}{r_{ij}}, \underset{?}{R_{ij}} \right], \quad (3)$$

where $expenditure_{ij}^{public}$ is the public ASC expenditure including both user (e_{ij}^{public}) and carer (E_{ij}^{public}) expenditure and therefore affected by both n_{ij} and N_{ij} in addition to g_j and t_j . Our empirical analysis focuses on the effect of the public ASC (or ALTC) expenditure on the user's utility, which we refer to as the marginal productivity of public ASC expenditure on CRQoL.⁴

4. Data

Our data are from various sources in the public domain, which are detailed in Table A1 of the Appendix includes the links to the data.

4.1 Survey data

Our primary source of data is the Adult Social Care Survey (ASCS). This is an annual cross-sectional survey administered from January to March by post since 2010/11. The target population of the ASCS includes users aged 18 and above receiving ALTC services that are funded or managed by the LA following an assessment of needs (NHS Digital, 2018). The target population includes users receiving physical, sensory, memory and cognition, learning disability, mental health or social

⁴ Note that the concept of marginal productivity used in this study differs from the traditional economic concept of productivity, which refers to technical or allocative efficiency considering how well inputs are transformed into outputs rather than outcomes (Koopmans, 1951, Jacobs et al., 2006).

support through community, residential or nursing care. The ASCS selects a stratified random sample that is representative of the target population (NHS Digital, 2017a).

The ASCS questionnaire asks questions about service satisfaction, quality of life including CRQoL through ASCOT, service knowledge and information, health, needs in relation to home and surroundings, and help received on top of LA services.⁵ LAs complement this information with their own data on user demographic characteristics, setting and type of care, and information on the type of questionnaire sent. The ASCS' response rate has always been above 30%, which is argued to be adequate for a postal survey (Malley and Fernandez, 2012, van Leeuwen et al., 2014). The ASCS is therefore recommended for the evaluation of local and national policies, and it is currently used for performance monitoring and research purposes (King and Wittenberg, 2015, Rand and Malley, 2017).

Our sample is based on the ASCS sample in 2017/18, which is the most recent sample at the time of writing. From the original sample including 201,969 users, we remove users who did not respond to the survey (136,954), users for which information on sample stratum, type of support and demographics was suppressed for privacy reasons (1,856), and users who did not respond to questions used in our analysis (13,252). The final sample includes 49,907 users.

For each user in the final sample, we calculate the utility-weighted ASCOT score as a measure of CRQoL and this is our dependent variable. The ASCOT is a validated tool (e.g. Malley and Fernandez, 2012, van Leeuwen et al., 2015, Rand et al., 2017) that is recommended by the National Institute for Health and Care Excellence (NICE) in the UK for the evaluation of ASC interventions (NICE, 2018), and it is used routinely by LAs and government (Forder et al., 2014a). It comprises eight domains: control over daily life, personal cleanliness and comfort, food and drink, personal safety, social participation and involvement, occupation, accommodation cleanliness and comfort, and dignity. Each domain contains four possible responses reflecting the level of need: no needs, trivial needs, some needs and high needs. The resulting utility-weighted CRQoL score (Netten et al., 2012) has an upper bound of one, is anchored to zero which indicates dead, and can take negative values for states worse than dead.

We also use the ASCS data to construct several dummy variables to capture user characteristics and related needs. These include demographic variables such as: a gender dummy for female users (reference: male users); an age dummy for users older than 65 (reference: users aged 65 or younger); two ethnicity dummies for non-white users and users who did not state ethnicity, respectively (reference: white users); three language dummies indicating whether the survey questionnaire was translated in a non-English European language, South Asian language, and Middle Eastern language, respectively (reference: questionnaire in English). We obtain five dummies for the type of support received indicating sensory, memory and cognition, learning disability, mental health and social support, respectively (reference: physical support). We measure the respondent's cognitive status as a proxy for needs using: six dummies capturing the type of help respondents received with completing the questionnaire including whether no help was received, the questionnaire was read by someone else, the questionnaire was translated by someone else, questionnaire's answers were written by someone else, the questionnaire was talked through with someone else, and the questionnaire was answered by someone else without asking; and a dummy indicating whether the respondent completed the easy-read version of the questionnaire which is designed for users with higher needs. We obtain three more dummies to capture whether the user received informal care, additional private LTC services or both. Finally, we use ASCS data from

⁵ The questionnaire can be found at this link: <https://digital.nhs.uk/data-and-information/data-collections-and-data-sets/data-collections/social-care-user-surveys/social-care-user-survey-guidance-2017-18>

2015/16 and 2016/17 to construct the LA-level proportion of users who are unable to carry out various activities of daily living including manage personal hygiene by themselves, manage continence by themselves, dress by themselves, feed by themselves, and ambulate by themselves.⁶

In addition, we use data from the Survey of Social Carers in England (SACE) in 2016/17 on carer characteristics and related needs. The SACE is a biennial cross-sectional survey distributed from October to November by post since 2012/13. The target population of the SACE includes informal unpaid carers aged 18 and above who either received or did not receive LA support (NHS Digital, 2017b). Since we are unable to link ASCS and SACE data at the individual level, we use SACE data to construct variables on carer characteristics at the LA level. These include the proportion of carers who are female (reference: male), aged 65 and above (reference: aged 18 to 64), and of non-white or unspecified ethnicity (reference: white ethnicity); and the proportion of carers who have a severe condition such as physical disability, sight or hearing impairment, and long-standing condition. Moreover, we include the proportion of carers who are retired, employed, self-employed, or unemployed; the proportion of carers who are retired or unemployed because of the caring role, in paid work but do not feel supported by their employer, and self-employed but unable to balance work and caring role. Other variables are the proportion of carers who have financial difficulties because of their caring role (reference: no financial difficulties), who live with the care recipient (reference: do not live with the care recipient), and who were in their caring role for less than six months or between six months and a year (reference: cared for more than a year). We include also the proportion of carers who provide help with basic activities of daily living such as personal care, physical care, other practical help (e.g. cooking meals), help with medicine, and emotional support. Finally, we include the proportion of carers who care for 20 hours or more per week although caring time may vary, who care for 20 to 49 hours per week, who care for no less than 50 hours per week, who care for other amounts of time (reference: care for less than 20 hours per week).

4.2 Public ASC and LTC expenditure per user

We use the ASC Finance Return in 2017/18 to obtain data about ASC expenditure for each LA. This is for services which are funded or managed by the LA for users aged 18 and above and it includes expenditure for ALTC services, adult short-term care services, assistive equipment, adaptations and technologies, information and early intervention services, and auxiliary ASC activities. Public ASC expenditure includes also expenditure for commissioning and delivery services (e.g. strategic business direction, business planning) because these are sunk costs for the provision of core ASC services. In addition, we obtain public ALTC expenditure for each LA. Both public ASC and ALTC expenditure include the expenditure for in-house and contracted-out services, as well as for services provided by voluntary organisations funded through grants. We use Short and Long Term Support data return to obtain the number of (ALTC) users in 2017/18, which represents the target population of the ASCS.

With these data, we calculate public ASC and ALTC expenditure per user at LA level by dividing current (ASC or ALTC) expenditure, i.e. gross (ASC or ALTC) expenditure minus (ASC or ALTC) capital charges, by the number of users. These are our key independent variables of interest.

4.3 Other local authority characteristics

We control for the eligibility effect across LAs through four dummies indicating the type of LA including county, outer London, metropolitan and unitary LA (reference: inner London LA). We further account for the needs of the local population using several LA characteristics including the proportion of people: whose disability limits daily activities a lot and a little in 2011 (reference: whose disability does not limit daily activities); who are registered as having vision impairment in

⁶ We use past rather than current activities of daily living to avoid the bad control problem (Angrist and Pischke, 2008, p. 47).

2016/17, hearing impairment in 2010, or both vision and hearing impairment in 2016/17; aged 65 or above with dementia in 2017/18; claiming for the disability living allowance in 2017/18, and claiming for the attendance allowance in 2017/18. We control also for disability deprivation quartiles in 2015 (reference: least deprived quartile).

Moreover, we control for socio-economic factors including tenure through the proportion of households composed of only one person aged from zero to 64 and aged 65 and above in 2011 (reference: proportion of households with more than one person). We use also the proportion of people: who are house owners in 2011; living in household with an occupancy between 0.5 and one person per bedroom, between one and 1.5 persons per bedroom, over 1.5 persons per bedroom in 2011 (reference: living in household with an occupancy of up to 0.5 person per bed); receiving income support in 2017/18, and receiving pension credit in 2017/18. In addition, we control for education and income deprivation quartiles in 2015 (reference: least deprived quartile).

Finally, concerning the instruments, we calculated the council tax base per user as the number of 'band D' equivalent domestic properties divided by the number of users in each LA. We calculate a proxy of the business rates tax base per user as the number of non-domestic properties divided by the number of users in each LA. Finally, the ACA index in 2013/14 is measured at the LA level.

4.4 Descriptive statistics

Table 1 shows descriptive statistics for variables measured at the user level. Users' CRQoL is on average 0.822 and its standard deviation is 0.192 (23% of the average), which indicates a substantial variability across users. Most users are female (58.2%), older than 65 years old (57.2%), and white (90%). Most users received physical support (54.8%) and learning disability support (28%), and smaller proportions of users received mental health (8.3%), memory and cognition (5.2%), social (2.2%) and sensory support (1.6%). 80.6% of users received informal care, 36.7% received additional private LTC services, while 32.4% received both of these forms of care.

Table 2 shows descriptive statistics for variables measured at the LA level. On average, LAs spend £140.4 million for ASC and £106.6 million to provide ALTC services to 5,627 users. On average, this translates into a public ASC expenditure per user of £26,000, which substantially varies across LAs with a standard deviation of £5,000 per user, i.e. 18% of the average. On average, public expenditure for ALTC services amounts to £19,000 per user and this varies across LAs with a standard deviation of £3,000 per user. Substantial variability in both expenditure and CRQoL, as mentioned above, warrants the analysis of these two key variables in the cross-sectional case.

Out of 149 LAs in our sample, 55 are unitary LAs, 36 are metropolitan districts, 26 are counties and 20, and 12 are outer and inner London boroughs, respectively. Data on activities of daily living in the past two years (2016/17 and 2015/16) suggest that, on average, a higher proportion of users cannot manage personal hygiene by themselves (44.3% and 43.3%) and a relatively minor proportion cannot feed by themselves (8.3% and 7.8%). Information on socio-economic characteristics suggests that, on average, 30.6% of households only include a person, and 62.1% are house owners. Descriptive statistics on (informal unpaid) carer characteristics show that, on average, 68.8% of carers are female and 44% are aged 65 and above. Only a minority of carers do not live with the care recipient (24.9%), and most of the carers have been in their caring role for more than a year (97.2%). Most carers carry out intensive tasks such as personal care (68.8%), physical help (57.7%) or other practical help (92.5%). Most carers also care for 20 or more hours per week (73.2%), and 11.8% care for other unspecified amounts of time. Finally, as regards our instruments, LAs have on average 26.6 equivalent 'band D' domestic properties per user and 1.3 non-domestic properties per user. The ACA index is on average 1.041, and it varies from 1.000 to 1.198.

5. Empirical methods

To identify the marginal productivity of public ASC expenditure on CRQoL using the available data described in Section 4, equation (3) can be estimated empirically by OLS through the following multilevel regression:

$$CRQoL_{ij} = \mu + \beta \text{expenditure}_j^{public} + \gamma n_{ij} + \delta N_j + \theta g_j + \omega P_{ij} + \phi c_{ij} + \alpha_j + \varepsilon_{ij}, \quad (4)$$

where the dependent variable is the CRQoL of user i ($=1, \dots, I$) living in LA j ($=1, \dots, J$), μ is the intercept, $\text{expenditure}_j^{public}$ is the average public ASC expenditure per user in LA j , n_{ij} is a vector of user- and LA-level variables capturing user needs, N_j is a vector of LA-level variables capturing carer needs, g_j is a vector of dummies indicating the type of LA, P_{ij} is a dummy indicating whether the user purchases additional ASC services privately, c_{ij} is a vector of user- and LA-level variables capturing the use of informal care, and α_j and ε_{ij} are the LA- and user-level error term, respectively. We estimate regression (4) using the survey weight and we cluster standard errors to account for sample stratification and within-LA correlations.⁷

The key coefficient of interest in (4) is β which captures the marginal productivity of public ASC expenditure on CRQoL across LAs. Since $\text{expenditure}_j^{public}$ is measured at the LA level, $\hat{\beta}$ indicates the effect of a marginal increase of public ASC expenditure per user across LAs on the CRQoL of an average user. For example, a $\hat{\beta} > 0$ means that a marginal increase in the public ASC expenditure per user across LAs improves CRQoL of an average user. β is identified under the assumption that (a) CRQoL is a good measure of utility, (b) the utility function u_{ij} in (3) is linear in the parameter and additively separable, and (c) we observe perfectly all variables illustrated in equation (3) that may be correlated with both expenditure and utility (e.g. needs, eligibility). Conditions (a) and (b) are commonly assumed. Condition (c) implies that $\text{expenditure}_j^{public}$ is likely to be endogenous in practice. More precisely, we argue that $\hat{\beta}$ from (4) is likely to be downwardly biased. For example, suppose (LTC) needs are unobserved. For simplicity, assume that all variables are fixed except CRQoL, public ASC expenditure per user and the unobserved needs. Higher public ASC expenditure per user is likely to occur where needs are high, and it is also the case that users with high needs have lower outcomes. This implies that $\hat{\beta}$ will capture the beneficial effect on CRQoL of higher public ASC expenditure as well as the detrimental effect on CRQoL of higher needs.

We address this endogeneity through an IV approach which estimates equation (4) two-stage least squares (2SLS) and uses the survey weight and clusters standard errors as described above.⁸ Our preferred instrument is the council tax base *before exemptions and discounts* per user at the LA level (Section 2.1 explains council tax in greater detail). We argue that the council tax base is likely to be relevant and exogenous (Stock and Watson, 2011; p. 421). It is likely to be relevant, i.e. correlated with public ASC expenditure, because it is a key determinant of council tax

⁷ The survey weight is calculated as the product of a design, a unit non-response and a post-stratification weight. The design weight takes account of sample stratification (NHS Digital, 2018), and it is calculated by stratum and LA as the eligible population divided by the number of respondents (NHS Digital, 2017a). The unit non-response weight is predicted using a logit regression where the dependent variable is a dummy variable equal to one if the user responded to the survey and the independent variables include age, support setting, primary support reason, survey stratum, a dummy indicating whether the user received the easy-read version of the questionnaire, and LA dummies. Finally, the post-stratification weight is calculated using the total population by age, support setting and primary support reason.

⁸ Rice et al. (2002) suggest that the 2SLS estimator is consistent in multilevel models where covariates may be correlated with the group-level error term (α_j)

revenues which, in turn, are a major source of funding for ASC services across LAs. Conditional on socio-economic characteristics, it is likely to reflect market factors, z_j in equation (1) and, therefore, it is likely to be exogenous because it is unrelated to CRQoL and unobserved factors which impact CRQoL, such as needs.

We argue that LAs are unable to manipulate the council tax base (before exemptions and discounts) because the banding of domestic properties which determines the tax base is set nationally and not locally (as discussed in greater detail in Section 2.1). This implies that LAs cannot link their council tax base to their LTC needs.⁹ However, the council tax base can be indirectly related to needs and outcomes across LAs through their socio-economic status. This is because, for example, wealthier LA populations may afford houses with high sale value and, therefore, the total council tax base in these LAs may be higher than average. After netting out the correlation with socio-economic characteristics, however, the council tax base across LAs is likely to be driven by market factors reflecting the urban development within LAs. Urban development can be argued to be mostly a historical artefact and independent from current health and LTC outcomes and needs. For example, a greater tangible cultural heritage (e.g. historical buildings, monuments, parks) in a LA is likely to increase properties' value and, in turn, the council tax base. To address potential endogeneity concerns of the council tax base we control for a rich set of socio-economic characteristics as well as other variables correlated with socio-economic status including needs and eligibility as described in Section 4. On this basis, the exogenous marginal increase in public ASC expenditure estimated using the council tax base as an instrument will correspond to a real marginal increase in expenditure which may, in turn, impact on CRQoL.

Additional instruments are the business rates tax base per user and the ACA index (Section 2.1 provides more details on these variables). These instruments are likely to be relevant and exogenous under similar arguments used for the council tax base. For example, LAs with more businesses are likely to have a larger business rates tax base and, in turn, more business rates revenues to be spent also on local ASC services. Conditional on socio-economic status, a larger business rates tax base is likely to reflect factors, such as touristic attractions, which are unrelated to LTC outcomes and needs. Similarly, a greater ACA index is likely to increase the funding from central ASC grants and, conditional on socio-economic status, the labour cost captured by ACA index is likely to reflect living standards (e.g. appealing neighbourhoods, multicultural environment) which are unlikely to be related to LTC outcomes and needs.

5.1 Sensitivity analysis

We test the robustness of our findings when all variables are measured at the LA level by estimating the following regression by 2SLS:

$$CRQoL_j = \tau + \rho \text{expenditure}_j^{\text{public}} + \psi n_j + \lambda N_j + \pi g_j + \sigma P_j + \zeta c_j + \eta_j, \quad (5)$$

where τ is the intercept, and all variables and the error term, η_j , vary only at the LA level. The estimated marginal productivity is now captured by $\hat{\rho}$ which is interpreted similarly to $\hat{\beta}$ in equation (5).

In addition, we test the robustness of our results to different assumptions about the missing data due to item non-response. Our main analysis in equation (4) assumes that missing data due to item non-response are missing completely at random (MCAR). We relax this assumption and assume that data are missing at random (MAR) by imputing the missing data using multiple imputation-chained

⁹ In turn, this can be argued to be a reason for the introduction of the ASC precept as discussed in Section 2.1.

equation (MICE) with predictive mean matching. More details about the imputation model are provided in Table A2 of the Appendix.

6. Results

Table 3 shows our key findings. Column 1 includes the results for the OLS regression, which suggest that £1,000 increase in public ASC expenditure per user increases on average CRQoL by 0.0019. This result is statistically significant at the 1% level. As discussed in Section 5, however, this estimate is likely to be (downwardly) biased because public ASC expenditure per user is likely to be endogenous. Column 2 of Table 3 includes the results from the IV regression when the council tax base per user is used as an instrument. It suggests that £1,000 increase in public ASC expenditure per user increases on average CRQoL by 0.0031, and this result is statistically significant at the 1% level. The first-stage F statistic (robust to clustering) is equal to 399.8 (far beyond the critical value of 10) suggesting that the council tax base per user is a relevant instrument. Column 3 and 4 of Table 3 include OLS and IV results, respectively, when public expenditure in ALTC is analysed. They suggest that £1,000 increase in public ALTC expenditure per user increases on average CRQoL by 0.002 when OLS is estimated and by 0.0044 when IV is estimated. Table A3 in the Appendix shows the first stage results and it suggests that when all instruments are used, i.e. council tax base per user, business rates tax base per user and ACA index, the null hypothesis of validity of the over-identified restrictions is not rejected which suggests that instruments are likely to be exogenous.

Table 3 includes also the estimated coefficients on control variables, which for brevity, we comment only if statistically significant at the 1% or 5% level. In column 2, we find that female users are associated with 0.009 lower CRQoL compared to male users. Similarly, we find lower CRQoL for users of non-white ethnicity (-0.031) and those who did not state their ethnicity (-0.023) compared to white users, and for users who received a questionnaire translated in a South Asian language (-0.07) compared to those who received an English questionnaire. Users older than 65 years old are associated on average 0.039 higher CRQoL compared to younger users, similarly to users who received memory and cognition (0.024), and learning disability (0.122) compared to users who received physical support. Users who did not receive help with the questionnaire, those whose questionnaire was read or translated by someone else are associated with 0.017, 0.030 and 0.07 higher CRQoL, respectively. CRQoL tends to be lower for those whose questionnaire was only filled in (-0.014), talked through (-0.019) or answered without asking (-0.064) by someone else.

LAs with one percentage point higher proportion of users who could not feed by themselves one and two years ago have on average users with 0.226 and 0.409 lower CRQoL, respectively. Instead, LAs with one percentage point higher proportion of users who could not manage continence by themselves two years ago have on average users with 0.428 higher CRQoL. LAs with one percentage point higher proportion of people whose disability limits daily activities a lot and people aged between 18 and 64 claiming disability living allowance have on average users with 1.069 and 0.661 lower CRQoL, respectively. LAs with one percentage point higher proportion of people who never worked and are long-term unemployed are associated with 0.557 higher CRQoL. Moreover, LAs with one percentage point higher proportion of carers with financial difficulties due to the caring role have on average 0.099 lower CRQoL. Finally, users who received private LTC services have on average 0.051 lower CRQoL, and those who received both informal care and private LTC services have on average 0.027 higher CRQoL.

Table 4 shows the results of the sensitivity analysis. LA-level regressions estimated by OLS and 2SLS produce results which are qualitatively similar but smaller in magnitude compared to those from our primary specifications. This suggests that estimates from LA-level data may be affected by aggregation bias (Cameron and Trivedi, 2005, p. 480). The multiple imputation analysis under the MAR assumption produces results which are mostly similar to those from our primary specifications

described above. This suggests that results are robust to different assumptions on the missing data mechanism.

7. Discussion and conclusions

This paper has investigated the effect of public ASC (ALTC) expenditure on CRQoL and it finds that a £1,000 increase in public ASC (ALTC) expenditure per user increases on average CRQoL by 0.0031 (0.0044). This effect is relatively small if compared to the average CRQoL (0.4%) and it translates into a high cost per social care-quality-adjusted life year (SC-QALY) of £322,581 per SC-QALY ($=£1,000 \div 0.0031$). Previous studies suggest lower cost per SC-QALY. Forder et al. (2014b) find a cost per SC-QALY of £50,000, but this estimate refers to public home care services which are only a small proportion of public ASC expenditure (8.2% in 2017/18). Forder et al. (2018b) find a cost per SC-QALY of £15,000 and £19,000 for low-need and high-need users of community care services, respectively, which still represent a relatively small proportion of public ASC expenditure (34% in 2017/18). Moreover, estimates in the latter study are based on the extensive margin: from using no services to new service user. Therefore, results from previous studies are not directly comparable with ours and they suggest some potential reasons why our estimated cost per SC-QALY is substantially higher. For example, by considering the total public ASC expenditure, our estimate is likely to reflect a greater heterogeneity in the effectiveness on CRQoL across ASC services. Moreover, we analyse users accessing services which are more intensive compared to home care, such as residential and nursing care, and these users are more likely to have higher needs and lower CRQoL. Our higher estimated cost per SC-QALY may therefore reflect a higher heterogeneity in the effectiveness of ASC services along the CRQoL distribution if, for example, ASC is less effective when CRQoL is very low and gradually more effective as CRQoL increases. Moreover, if public ASC has little effect on CRQoL when this is low and it has the direct effect of reducing mortality of users with low CRQoL, this might be a further reason for a high estimated cost per SC-QALY.

To our knowledge, this is one of the first studies to provide a causal estimate of the effect of the total public ASC expenditure on quality of life in England. As discussed, the focus of existing studies is narrower (Forder et al., 2014b, Forder et al., 2018b). Our broader focus on the whole public ASC sector allows us to propose a novel identification strategy which uses conditionally exogenous elements of the public funding system as IVs. Unlike existing studies, we exclude current ASC outcomes measures (e.g. current activities of daily living, home adaptations) from the set of control variables to avoid the potential bad control problem (Angrist and Pischke, 2008, p. 47). Moreover, compared to the existing studies, we use data from a survey of users which includes a much larger representative sample of the ALTC population in England. We use survey data in 2017/18 because these are the most recent at the time of writing and they include a richer set of key variables, such as sample stratification category and primary support reason, which are missing in previous years' survey data available in the public domain. Future waves of the survey can be used to develop a panel data model to test the robustness of our results to different methods. This study also contributes to the literature on the effectiveness of public expenditure which mostly includes studies on health care (Martin et al., 2008, Claxton et al., 2018, Vallejo-Torres et al., 2018, Siverskog and Henriksson, 2019) and education sector (Hægeland et al., 2012, Hyman, 2017, Gigliotti and Sorensen, 2018).

Our findings can inform policy makers about the effects of changes in public ASC expenditure on quality of life. This is especially relevant in recent years, when the increasing demand of LTC due to, for example, population ageing and the lower availability of informal carers (Joshua, 2017) are expected to make LTC expenditure grow faster than health care expenditure (OECD, 2018). Policy makers around the world have therefore reformed their LTC systems in the attempt to contain costs (Joshua, 2017). For example, in the UK, public ASC expenditure was cut by 11% between 2009/10

and 2015/16 (Simpson, 2017), and the number of elderly individuals receiving public ASC fell by 40% between 2009 and 2015 (Seamer et al., 2019). Our findings suggest that, for fixed eligibility levels (i.e. for a given number of eligible individuals), cutting the amount or intensity of public ASC services across LAs can be expected to have had, on average, a small effect on quality of life. These findings may also inform other LTC policy makers across OECD countries, who also often operate at sub-national level with typically considerable autonomy over LTC service delivery (Colombo et al., 2011) and whose role is increasingly more important to reduce disparities within countries (Joshua, 2017).

However, our findings alone do not provide a full picture about the effects of public ASC expenditure. For example, they are unable to inform about the causal effects of cutting eligibility levels on CRQoL about which, at present, there is no empirical evidence. In addition, they cannot inform about causal effects of cuts on mortality. Although current empirical evidence suggests that public ASC expenditure might have a beneficial effect on mortality (Watkins et al., 2017), it is still unclear whether this effect is fully or partially indirect passing through the health care sector by allowing a more cost-effective use of health care resources. Future research is therefore needed to uncover eligibility effects on CRQoL and to better understand the effects of public ASC expenditure on mortality. This information can be used in combination with the findings in this study for the assessment of an opportunity costs threshold in the ASC sector which will aid judgment about the cost-effectiveness of alternative services and investments given current levels of funding.

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Tables and figures

Table 1 – Descriptive statistics of individual-level variables.

Variable at the user level	Mean	Std Err	Std Dev
Outcome			
Care-related quality of life	0.822	0.003	0.192
Gender			
Male user (ref)	41.8%	0.005	0.493
Female user	58.2%	0.005	0.493
Age			
User aged 65 years old or younger (ref)	42.8%	0.016	0.495
User older than 65 years old	57.2%	0.016	0.495
Ethnicity			
User of white ethnicity (ref)	90.0%	0.006	0.300
User of non-white ethnicity	8.3%	0.006	0.276
User who did not state ethnicity	1.7%	0.002	0.130
Language			
User whose questionnaire was in English (ref)	99.88%	0.0005	0.0351
User whose questionnaire was in non-English European languages	0.02%	0.0001	0.0142
User whose questionnaire was in South Asian languages	0.06%	0.0005	0.0254
User whose questionnaire was in Middle Eastern languages	0.04%	0.0002	0.0197
Type of support			
User who received physical support	54.8%	0.014	0.498
User who received sensory support	1.6%	0.001	0.124
User who received support with memory and cognition	5.2%	0.003	0.221
User who received learning disability support	28.0%	0.016	0.449
User who received mental health support	8.3%	0.005	0.276
User who received social support	2.2%	0.002	0.146
Help with questionnaire			
User who did not receive help with questionnaire	18.0%	0.005	0.384
User whose questionnaire was read by someone else	49.8%	0.006	0.500
User whose questionnaire was translated by someone else	23.7%	0.010	0.425
User whose questionnaire was only filled in by someone else	40.7%	0.004	0.491
User whose questionnaire was talked through with someone else	29.4%	0.003	0.456
User whose questionnaire was answered without asking by someone else	9.0%	0.003	0.287
Questionnaire version			
User who received a standard questionnaire (ref)	72.3%	0.016	0.448
User who received an easy-read questionnaire	27.7%	0.016	0.448
Other care received			
User who received informal care	80.6%	0.004	0.396
User who received private long-term care services	36.7%	0.006	0.482
User who received informal care and private long-term care services	32.4%	0.006	0.468
Observations		49,907	
Std Err=standard errors of the mean estimate, Std Dev=standard deviation, ref=reference category			
Means are estimated using the survey weight. Standard errors of the mean estimates are obtained taking into account survey stratification and clustering within local authorities.			

Table 2 – Descriptive statistics of local authority-level variables.

Variable at the local authority level	Mean	Std Dev	Min	Max
Expenditure and activity				
Public adult social care expenditure (£000s)	140,414	103,508	15,739	585,225
Public adult long-term care expenditure (£000s)	106,585	82,544	8,636	482,208
Number of adult long-term care users	5,627	4,085	415	22,585
Public adult social care expenditure (£000s) per user	26	5	15	43
Public adult long-term care expenditure (£000s) per user	19	3	11	28
Type of local authority				
Inner London borough (ref)	8.1%	0.273	0	1
Outer London borough	13.4%	0.342	0	1
County	17.4%	0.381	0	1
Metropolitan district	24.2%	0.430	0	1
Unitary authority	36.9%	0.484	0	1
Activities of daily living in the past two years				
Users who cannot manage personal hygiene by themselves 2016/17	44.3%	5.9%	26.2%	58.8%
Users who cannot manage continence by themselves 2016/17	23.1%	4.6%	10.9%	35.3%
Users who cannot dress by themselves 2016/17	33.4%	5.5%	18.0%	46.4%
Users who cannot feed by themselves 2016/17	8.3%	2.3%	2.6%	21.2%
Users who cannot ambulate by themselves 2016/17	26.6%	4.6%	14.6%	38.2%
Users who cannot manage personal hygiene by themselves 2015/16	43.3%	7.0%	3.9%	59.8%
Users who cannot manage continence by themselves 2015/16	22.1%	4.6%	3.9%	35.8%
Users who cannot dress by themselves 2015/16	32.2%	6.1%	3.9%	50.5%
Users who cannot feed by themselves 2015/16	7.8%	2.2%	3.9%	14.7%
Users who cannot ambulate by themselves 2015/16	25.8%	5.0%	3.9%	39.6%
Disability				
People who are sight impaired 2016/17	0.5%	0.2%	0.1%	1.3%
People who are hearing impaired 2010	0.4%	0.3%	0.0%	1.6%
People who are sight and hearing impaired 2016/17	0.04%	0.04%	0.00%	0.2%
People aged 65 and above with dementia	6.4%	0.5%	5.1%	9.2%
People whose disability does not limit daily activities (ref)	82.3%	3.3%	74.4%	88.8%
People whose disability limits daily activities a little	9.2%	1.4%	6.0%	12.3%
People whose disability limits daily activities a lot	8.4%	2.0%	4.7%	14.2%
Disability deprivation 2015: quartile 1 (ref: least deprived)	23.5%	0.425	0	1
Disability deprivation 2015: quartile 2	25.5%	0.437	0	1
Disability deprivation 2015: quartile 3	25.5%	0.437	0	1
Disability deprivation 2015: quartile 4 (most deprived)	25.5%	0.437	0	1
People aged 18-64 claiming Disability Living Allowance	2.6%	3.1%	0.4%	17.6%
People aged 65 and above claiming Attendance Allowance	2.4%	3.1%	0.4%	20.2%
Tenure				
Households with more than a person (ref)	69.4%	3.6%	53.5%	77.4%
Single-person households aged 0-64	18.6%	4.1%	11.9%	36.0%
Single-person households aged 65 and above	12.0%	2.1%	6.0%	16.7%
People in household with up to 0.5 persons per bedroom (ref)	13.7%	3.1%	5.4%	23.0%
People in household with 0.5 to 1.0 persons per bedroom	48.2%	5.6%	24.5%	55.1%
People in household with 1.0 to 1.5 persons per bedroom	21.7%	2.0%	16.9%	27.0%
People in household with over 1.5 persons per bedroom	16.4%	7.5%	6.8%	47.0%
People who are house owners	62.1%	11.4%	26.1%	80.9%
Socio-economic status				
Population density per 10,000 people	0.2722	0.3259	0.0063	1.5814
People who are students or in a non-routine occupation (ref)	82.7%	4.6%	72.6%	92.6%
People who are in routine occupation	11.2%	3.3%	4.0%	19.7%
People who never worked and are long-term unemployed	6.1%	2.6%	2.6%	14.3%
Education deprivation 2015: quartile 1 (ref: least deprived)	23.5%	0.425	0	1

Variable at the local authority level	Mean	Std Dev	Min	Max
Education deprivation 2015: quartile 2	25.5%	0.437	0	1
Education deprivation 2015: quartile 3	25.5%	0.437	0	1
Education deprivation 2015: quartile 4 (most deprived)	25.5%	0.437	0	1
Income deprivation 2015: quartile 1 (ref: least deprived)	23.5%	0.425	0	1
Income deprivation 2015: quartile 2	25.5%	0.437	0	1
Income deprivation 2015: quartile 3	25.5%	0.437	0	1
Income deprivation 2015: quartile 4 (most deprived)	25.5%	0.437	0	1
People with income support	1.7%	1.8%	0.2%	10.8%
People with pension credit	6.6%	7.6%	1.3%	43.3%
Informal unpaid carer characteristics				
Male carers (ref)	31.2%	3.3%	20.6%	39.8%
Female carers	68.8%	3.3%	60.2%	79.4%
Carers aged 18-64 (ref)	56.0%	9.1%	33.5%	81.2%
Carers aged 65 and above	44.0%	9.1%	18.8%	66.5%
Carers of white ethnicity (ref)	80.7%	19.2%	23.5%	100.0%
Carers of non-white ethnicity	12.8%	17.8%	0.0%	71.5%
Carers who did not state ethnicity	6.4%	9.7%	0.0%	67.3%
Carers with Physical impairment	20.5%	4.0%	13.9%	50.0%
Carers with sight or hearing loss	16.5%	3.5%	0.0%	24.3%
Carers with long-standing illness	28.6%	4.6%	0.0%	41.0%
Carers who is retired	50.4%	7.8%	23.1%	65.5%
Carers who is employed	18.9%	4.2%	7.9%	29.4%
Carers who is self-employed	4.8%	2.1%	0.9%	16.7%
Carers who is unemployed	21.3%	4.5%	12.4%	36.4%
Carers who is not in paid work because of caring role	22.3%	7.2%	10.2%	52.0%
Carers who is in paid work but do not feel supported by their employer	3.9%	1.6%	0.0%	12.5%
Carers who is self-employed but unable to balance work and caring role	1.5%	0.9%	0.0%	4.9%
Carers with no financial difficulties because of caring role (ref)	53.4%	7.0%	34.1%	68.9%
Carers with financial difficulties because of caring role	46.6%	7.0%	31.0%	65.9%
Carers who live with care recipient (ref)	75.1%	8.1%	41.4%	90.1%
Carers who do not live with care recipient	24.9%	8.1%	9.9%	58.6%
Carers in caring role for less than 6 months (ref)	0.5%	0.6%	0.0%	4.6%
Carers in caring role between 6 months and 1 year	2.3%	1.1%	0.0%	5.0%
Carers in caring role for more than 1 year	97.2%	1.4%	93.7%	100.0%
Carers who provide personal care	68.8%	6.3%	23.9%	82.1%
Carers who provide physical help	57.7%	6.0%	16.5%	71.0%
Carers who provide other practical help	92.5%	2.9%	82.2%	98.4%
Carers who provide help with medicines	76.7%	5.7%	52.2%	90.3%
Carers who provide emotional support	84.0%	3.4%	69.8%	93.5%
Carers who care for no more than 19 hours per week (ref)	14.9%	6.0%	5.4%	43.2%
Carers who care for 20 hours or more although may vary	6.8%	2.0%	0.0%	15.1%
Carers who care for 20 to 49 hours per week	15.5%	3.1%	9.0%	24.1%
Carers who care for no less than 50 hours per week	50.9%	8.0%	28.4%	75.5%
Carers who care for other unspecified amounts of time	11.8%	4.9%	0.0%	24.3%
Instruments				
Council tax base per user	26.6	7.9	13.5	56.5
Business rates tax base per user	1.3	0.6	0.4	4.0
Area cost adjustment index in 2013/14	1.041	0.058	1.000	1.198
Observations	149			
Std Dev=standard deviation, ref=reference category				

Table 3 – OLS and IV results

Variable		(1)	(2)	(3)	(4)
		Adult Social Care		Adult long-term care	
		OLS	IV	OLS	IV
	Current expenditure (£000s) per user	0.0019*** (0.0006)	0.0031*** (0.0009)	0.0020*** (0.0008)	0.0044*** (0.0013)
user needs (n _{ij})	Female user	-0.009***	-0.009***	-0.009***	-0.009***
	User older than 65 years old	0.039***	0.039***	0.039***	0.039***
	User of non-white ethnicity	-0.031***	-0.031***	-0.031***	-0.030***
	User who did not state ethnicity	-0.023**	-0.023**	-0.023**	-0.023**
	User whose questionnaire was in non-English European languages	-0.112	-0.110	-0.112	-0.109
	User whose questionnaire was in South Asian languages	-0.071***	-0.070***	-0.072***	-0.071***
	User whose questionnaire was in Middle Eastern languages	-0.095	-0.096	-0.095	-0.095
	User who received sensory support	0.014	0.014	0.014	0.014
	User who received support with memory and cognition	0.024***	0.024***	0.025***	0.024***
	User who received learning disability support	0.123***	0.122***	0.124***	0.124***
	User who received mental health support	0.011*	0.011*	0.011*	0.011*
	User who received social support	-0.005	-0.006	-0.005	-0.005
	User who did not receive help with questionnaire	0.017***	0.017***	0.017***	0.017***
	User whose questionnaire was read by someone else	0.030***	0.030***	0.030***	0.030***
	User whose questionnaire was translated by someone else	0.007**	0.007**	0.007**	0.007**
	User whose questionnaire was only filled in by someone else	-0.014***	-0.014***	-0.014***	-0.014***
	User whose questionnaire was talked through with someone else	-0.019***	-0.019***	-0.019***	-0.019***
	User whose questionnaire was answered without asking by someone else	-0.064***	-0.064***	-0.064***	-0.064***
	User who received an easy-read questionnaire	0.019	0.020*	0.018	0.018
	Users who cannot manage personal hygiene by themselves 2016/17	-0.003	0.023	-0.006	0.043
	Users who cannot manage continence by themselves 2016/17	-0.123	-0.136	-0.130	-0.163
	Users who cannot dress by themselves 2016/17	0.140	0.128	0.146	0.130
	Users who cannot feed by themselves 2016/17	-0.211*	-0.226**	-0.223**	-0.266**
	Users who cannot ambulate by themselves 2016/17	0.098	0.106	0.115	0.153
	Users who cannot manage personal hygiene by themselves 2015/16	-0.076	-0.056	-0.080	-0.045
	Users who cannot manage continence by themselves 2015/16	0.387**	0.428***	0.396**	0.488***
	Users who cannot dress by themselves 2015/16	-0.056	-0.068	-0.037	-0.039
	Users who cannot feed by themselves 2015/16	-0.339**	-0.409**	-0.364**	-0.535***
	Users who cannot ambulate by themselves 2015/16	-0.182	-0.248	-0.198	-0.349**
	People who are sight impaired 2016/17	-1.812	-1.365	-2.304*	-2.015
	People who are hearing impaired 2010	-0.481	-0.602	-0.239	-0.184
	People who are sight and hearing impaired 2016/17	6.051	5.702	6.611	6.600
	People aged 65 and above with dementia	0.068	0.006	-0.060	-0.339
	People whose disability limits daily activities a little	-1.852*	-1.654	-2.021**	-1.834*
	People whose disability limits daily activities a lot	-0.991**	-1.069**	-0.977**	-1.116**
	Disability deprivation 2015: quartile 2	-0.004	-0.004	-0.003	-0.001
	Disability deprivation 2015: quartile 3	-0.011	-0.009	-0.010	-0.006
	Disability deprivation 2015: quartile 4 (most deprived)	-0.016	-0.017	-0.015	-0.016
	People aged 18-64 claiming Disability Living Allowance	-0.581**	-0.661***	-0.523**	-0.610***
	People aged 65 and above claiming Attendance Allowance	0.044	0.011	0.069	0.032
	Single-person households aged 0-64	-0.100	-0.079	-0.063	0.024
	Single-person households aged 65 and above	0.219	0.086	0.318	0.173
People in household with 0.5 to 1.0 persons per bedroom	-0.351	-0.439	-0.279	-0.367	
People in household with 1.0 to 1.5 persons per bedroom	0.082	0.146	0.057	0.156	
People in household with over 1.5 persons per bedroom	-0.419	-0.549*	-0.321	-0.459	
People who are house owners	-0.033	-0.026	-0.016	0.020	
Population density per 10,000 people	0.001	-0.003	0.007	0.005	
People who are in routine occupation	-0.136	-0.190	-0.084	-0.129	
People who never worked and are long-term unemployed	0.466*	0.557**	0.428*	0.564**	
Education deprivation 2015: quartile 2	-0.006	-0.004	-0.008	-0.005	
Education deprivation 2015: quartile 3	-0.010	-0.007	-0.010	-0.005	
Education deprivation 2015: quartile 4 (most deprived)	-0.016	-0.012	-0.015	-0.007	
Income deprivation 2015: quartile 2	-0.002	-0.004	-0.002	-0.007	
Income deprivation 2015: quartile 3	0.001	-0.001	0.000	-0.006	

	Variable	(1)	(2)	(3)	(4)
		Adult Social Care		Adult long-term care	
		OLS	IV	OLS	IV
	Income deprivation 2015: quartile 4 (most deprived)	-0.006	-0.011	-0.006	-0.017
	People with income support	-0.418	-0.256	-0.478	-0.229
	People with pension credit	0.324*	0.341*	0.301*	0.307*
Carer needs (N _j)	Female carers	-0.058	-0.029	-0.067	-0.021
	Carers aged 65 and above	-0.025	-0.033	-0.019	-0.026
	Carers of non-white ethnicity	0.061	0.083*	0.053	0.085**
	Carers who did not state ethnicity	0.038	0.034	0.036	0.026
	Carers with Physical impairment	0.050	0.045	0.049	0.041
	Carers with sight or hearing loss	0.032	0.061	0.030	0.085
	Carers with long-standing illness	0.064	0.092	0.051	0.092
	Carers who is retired	-0.039	-0.105	-0.015	-0.118
	Carers who is employed	-0.054	-0.115	-0.025	-0.110
	Carers who is self-employed	0.135	0.102	0.168	0.142
	Carers who is unemployed	-0.129	-0.217	-0.098	-0.234
	Carers who is not in paid work because of caring role	0.054	0.059	0.056	0.068
	Carers who is in paid work but do not feel supported by their employer	-0.020	0.026	-0.071	-0.043
	Carers who is self-employed but unable to balance work and caring role	-0.150	-0.137	-0.122	-0.064
	Carers with financial difficulties because of caring role	-0.085*	-0.099**	-0.069	-0.077*
	Carers who do not live with care recipient	0.008	0.003	0.018	0.023
	Carers in caring role between 6 months and 1 year	-0.105	-0.281	-0.128	-0.505
	Carers in caring role for more than 1 year	-0.087	-0.194	-0.131	-0.395
	Carers who provide personal care	0.038	0.035	0.044	0.043
	Carers who provide physical help	0.025	0.028	0.007	-0.010
	Carers who provide other practical help	0.013	0.015	0.030	0.056
	Carers who provide help with medicines	0.042	0.069	0.023	0.056
	Carers who provide emotional support	-0.074	-0.080	-0.074	-0.084
	Eligibility (E _j)	Outer London borough	-0.003	-0.004	0.001
County		0.016	0.011	0.018	0.012
Metropolitan district		0.017	0.015	0.019	0.017
Unitary authority		0.024	0.021	0.026	0.021
Private social care (P _{ij}) and informal care (C _{ij})	User who received informal care	0.003	0.003	0.003	0.003
	User who received private long-term care services	-0.051***	-0.051***	-0.051***	-0.050***
	User who received informal care and private long-term care services	0.027***	0.027***	0.027***	0.027***
	Carers who care for 20 hours or more although may vary	-0.014	-0.022	-0.016	-0.034
	Carers who care for 20 to 49 hours per week	-0.057	-0.109	-0.052	-0.148
	Carers who care for no less than 50 hours per week	-0.025	-0.057	-0.024	-0.088
	Carers who care for other unspecified amounts of time	-0.045	-0.081	-0.042	-0.110
Constant	2.122***	2.366***	2.076***	2.503***	
Observations		49,907	49,907	49,907	49,907
First stage Kleibergen-Paap rk Wald F statistic		-	399.8	-	316.2

The dependent variable is the care-related quality of life. The Instrumental variable in column (2) and (4) is the council tax base per user. All regressions are weighted using the survey weight. Standard errors are clustered within LAs and strata, they are reported in parenthesis.

*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.1

Table 4 – Results of the sensitivity analysis

Variable	(1) LA-level analysis		(3) Multiple imputation	
	OLS	IV	OLS	IV
Public adult social care expenditure (£000s) per user	0.0010* (0.0005)	0.0017*** (0.0006)	0.0017*** (0.0005)	0.0026*** (0.0008)
First stage Kleibergen-Paap rk Wald F statistic	-	30.3	-	-
Over-identification test (Hansen J statistic) p-value	-	0.109	-	-
Public adult long-term care expenditure (£000s) per user	0.0012* (0.0007)	0.0026*** (0.0008)	0.0018*** (0.0007)	0.0037*** (0.0011)
First stage Kleibergen-Paap rk Wald F statistic	-	27.3	-	-
Over-identification test (Hansen J statistic) p-value	-	0.108	-	-
Observations	149	149	63,159	63,159
The dependent variable is the care-related quality of life. Estimated coefficients on control variables are not reported. The instrument used in column (2) and (4) is the council tax base per user. All regressions are weighted using the survey weight. Standard errors are clustered within LAs and strata, and they are reported in parenthesis. The Hansen J statistic is estimated when all instruments are used including council tax base per user, business rate tax base per user and ACA index.				
*** = p-value<0.01, ** = p-value<0.05, * = p-value<0.1				

Appendix

Table A1 – Sources of data

Variable	Original unit	Unit of analysis	Financial year	Source of data	Link	Date of last access
Care-related quality of life, gender, age, ethnicity, language, type of adult social care support, help with questionnaire, questionnaire version, private and informal care received	Individual	Individual	2017/18	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/2017-18	21/05/2020
Activities of daily living in the past two years	Individual	Local authority	2016/17, 2015/16			
Informal unpaid carer characteristics	Individual	Local authority	2016/17	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/personal-social-services-survey-of-adult-carers-in-england-2016-17	21/05/2020
Public adult social care, adult long-term care expenditure, adult long-term care activity volumes	Local authority	Local authority	2017/18	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/2017-18	21/05/2020
Vision impairment	Local authority	Local authority	2016/17	NHS Digital: Registered Blind and Partially Sighted People	https://digital.nhs.uk/data-and-information/publications/statistical/registered-blind-and-partially-sighted-people-england-2016-17	21/05/2020
Hearing impairment	Local authority	Local authority	2010	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	21/05/2020
Dementia	Local authority	Local authority	2017/18	NHS Digital: Recorded Dementia Diagnoses March 2018	https://digital.nhs.uk/data-and-information/publications/statistical/recorded-dementia-diagnoses/march-2018	21/05/2020
Population characteristics across local authorities	LSOA	Local authority	2011	2011 Census	https://census.ukdataservice.ac.uk/get-data/aggregate-data	21/05/2020
Income deprivation, disability deprivation, education deprivation	LSOA	Local authority	2015	Ministry of Housing, Communities & Local Government website	http://opendatacommunities.org/resource?uri=http%3A%2F%2Fopendatacommunities.org%2Fdata%2Fsocietal-wellbeing%2Fimd%2Findices	21/05/2020
Council tax base	Local authority	Local authority	2017/18	Government website	https://www.gov.uk/government/statistics/council-tax-levels-set-by-local-authorities-in-england-2017-to-2018	21/05/2020
Business rate tax base	Local authority	Local authority	2017/18	Government website	https://www.gov.uk/government/statistics/non-domestic-rating-stock-of-properties-and-update-of-2017-revaluation-statistics	21/05/2020
Area cost adjustment index	Local authority	Local authority	2013/14	National archive	https://webarchive.nationalarchives.gov.uk/20140505105851/http://www.local.communities.gov.uk/finance/1314/CalcFFs.pdf	21/05/2020

Table A2 – Imputation model

Imputed variable	Type of variable	Missing data	Main
Question 3a - ASCOT: control over daily life	Categorical	2.60%	Yes
Question 4a - ASCOT: personal cleanliness and comfort	Categorical	2.36%	Yes
Question 5a - ASCOT: food and drink	Categorical	3.21%	Yes
Question 6a - ASCOT: accommodation cleanliness and comfort	Categorical	2.63%	Yes
Question 7a - ASCOT: personal safety	Categorical	2.63%	Yes
Question 8a - ASCOT: social participation and involvement	Categorical	3.05%	Yes
Question 9a - ASCOT: occupation	Categorical	3.90%	Yes
Question 11 - ASCOT: dignity	Categorical	4.97%	Yes
Gender	Dummy	0.01%	Yes
Ethnicity	Categorical	1.34%	Yes
Language	Categorical	0.16%	Yes
User who did not receive help with questionnaire	Dummy	5.06%	Yes
User whose questionnaire was read by someone else	Dummy	5.06%	Yes
User whose questionnaire was translated by someone else	Dummy	5.06%	Yes
User whose questionnaire was only filled in by someone else	Dummy	5.06%	Yes
User whose questionnaire was talked through with someone else	Dummy	5.06%	Yes
User whose questionnaire was answered without asking by someone else	Dummy	5.06%	Yes
User who received informal care	Dummy	4.96%	Yes
User who received private long-term care services	Dummy	6.96%	Yes
Question 1 - Overall satisfaction	Categorical	2.31%	No
Question 2 - Quality of life	Categorical	2.55%	No
Question 2b - Care and support services improve quality of life	Dummy	4.12%	No
Question 10 - Feeling about having help	Categorical	4.72%	No
Question 12 - Level of difficulty in finding information	Categorical	5.53%	No
Question 13 - Health in general	Categorical	2.56%	No
Question 14.1 - EQ-5D-3L: pain or discomfort	Categorical	3.47%	No
Question 14.2 - EQ-5D-3L: anxiety or depression	Categorical	4.30%	No
Question 15.a - Get around indoors by yourself	Categorical	3.26%	No
Question 15.b - Get in and out of a bed by yourself	Categorical	3.05%	No
Question 15.c - Feed by yourself	Categorical	3.15%	No
Question 15.d - Deal with finances and paperwork by yourself	Categorical	3.74%	No
Question 16.a - Wash all over by yourself	Categorical	3.22%	No
Question 16.b - Get dressed and undressed by yourself	Categorical	3.36%	No
Question 16.c - Use the toilet by yourself	Categorical	3.42%	No
Question 16.d - wash your face and hands by yourself	Categorical	3.07%	No
Question 17 - Home design to meet needs	Categorical	3.49%	No
Question 18 - Getting around outside of your home	Categorical	4.89%	No
Observations	63,159		

The proportion of missing data refers to item non-responses. The "Main analysis" column indicates whether the variable was included in the main analysis: "No" means that the variable was only used in the imputation model. The imputation model includes the following covariates with non-missing values: user older than 65 years old, user who received physical support, user who received sensory support, user who received support with memory and cognition, user who received learning disability support, user who received mental health support, user who received social support, user who received an easy-read questionnaire, user who received residential care (not included in the main analysis), and user who received nursing care (not included in the main analysis), and local authority dummies (not included in the main analysis). All variables with missing data are added as covariates to the imputation model once their missing values are imputed. All variables are imputed using predictive mean matching with 10 nearest neighbours to draw from. Ten datasets were imputed for the analysis.

Table A3 – First-stage results of the primary IV approach

Variable		(1)	(2)	(3)	(4)
		Adult social care OLS	Adult social care IV	Adult long-term care OLS	Adult long-term care IV
instruments	Council tax base per user	0.693*** (0.035)	0.666*** (0.041)	0.485*** (0.485)	0.489*** (0.033)
	Business rate tax base per user		-0.114 (0.249)		-0.073 (0.208)
	Area cost adjustment index for older adult 2013/14		23.847*** (8.983)		-0.8230 (7.804)
user needs (n _{ij})	Female user	0.004	0.005	-0.007	-0.006
	User older than 65 years old	0.075	0.070	0.033	0.034
	User of non-white ethnicity	0.028	0.022	-0.021	-0.022
	User who did not state ethnicity	-0.069	-0.082	-0.147	-0.146
	User whose questionnaire was in non-English European languages	-0.513	-0.528	-0.531	-0.532
	User whose questionnaire was in South Asian languages	0.581	0.336	0.671	0.662
	User whose questionnaire was in Middle Eastern languages	0.341*	0.326*	0.021	0.020
	User who received sensory support	0.120	0.124	0.035	0.037
	User who received support with memory and cognition	0.075	0.056	0.004	0.006
	User who received learning disability support	0.521*	0.501	-0.015	-0.021
	User who received mental health support	-0.097	-0.100	-0.054	-0.055
	User who received social support	0.200**	0.200**	0.098	0.098
	User who did not receive help with questionnaire	-0.022	-0.026	-0.016	-0.016
	User whose questionnaire was read by someone else	-0.045*	-0.043*	-0.034*	-0.034*
	User whose questionnaire was translated by someone else	-0.034	-0.035	-0.011	-0.010
	User whose questionnaire was only filled in by someone else	-0.021	-0.018	-0.019	-0.019
	User whose questionnaire was talked through with someone else	0.014	0.016	0.012	0.012
	User whose questionnaire was answered without asking by someone else	-0.065*	-0.061*	-0.020	-0.020
	User who received an easy-read questionnaire	-0.373	-0.360	0.083	0.090
	Users who cannot manage personal hygiene by themselves 2016/17	11.711**	12.494**	3.575	3.633
	Users who cannot manage continence by themselves 2016/17	0.024	-2.523	6.149	6.248
	Users who cannot dress by themselves 2016/17	-19.733***	-20.346***	-14.170**	-14.403**
	Users who cannot feed by themselves 2016/17	-3.758	-3.634	6.523	6.458
	Users who cannot ambulate by themselves 2016/17	-0.461	2.722	-10.954	-10.787
	Users who cannot manage personal hygiene by themselves 2015/16	-6.911	-7.040	-7.496	-7.651
	Users who cannot manage continence by themselves 2015/16	6.099	9.003	-9.137	-9.133
	Users who cannot dress by themselves 2015/16	-7.793	-9.013	-12.213*	-11.919*
	Users who cannot feed by themselves 2015/16	18.983**	17.292**	41.718***	41.672***
	Users who cannot ambulate by themselves 2015/16	12.365	11.406	31.666***	31.547***
	People who are sight impaired 2016/17	-407.1***	-406.728***	-137.469**	-135.791**
	People who are hearing impaired 2010	-69.038	-42.109	-143.0***	-144.7***
	People who are sight and hearing impaired 2016/17	983.726***	1,034.489***	484.458**	487.812**
	People aged 65 and above with dementia	69.209**	59.858*	126.639***	126.194***
	People whose disability limits daily activities a little	69.462	121.998*	89.487*	89.489*
	People whose disability limits daily activities a lot	-25.586	-5.168	-7.135	-7.936
	Disability deprivation 2015: quartile 2	-0.335	-0.371	-0.874**	-0.861**
	Disability deprivation 2015: quartile 3	0.186	0.165	-0.755	-0.703
	Disability deprivation 2015: quartile 4 (most deprived)	-0.151	-0.258	-0.425	-0.385
	People aged 18-64 claiming Disability Living Allowance	36.039***	31.263***	13.778	13.829
	People aged 65 and above claiming Attendance Allowance	37.347**	34.737*	21.378	21.053
	Single-person households aged 0-64	-33.836***	-27.471***	-47.039***	-46.654***
	Single-person households aged 65 and above	-41.821**	-36.994*	-48.967**	-49.456**
People in household with 0.5 to 1.0 persons per bedroom	24.712	38.193**	0.852	-0.449	
People in household with 1.0 to 1.5 persons per bedroom	-3.676	2.689	-4.779	-4.822	
People in household with over 1.5 persons per bedroom	41.962***	48.242***	8.973	8.352	
People who are house owners	-18.844***	-18.058***	-23.417***	-23.351***	
Population density per 10,000 people	0.964	1.039	-1.259	-1.301	
People who are in routine occupation	-2.346	3.726	-15.562*	-16.261**	
People who never worked and are long-term unemployed	-33.610*	-22.740	-25.149	-26.506	
Education deprivation 2015: quartile 2	-0.462	-0.256	-0.055	-0.072	
Education deprivation 2015: quartile 3	-1.075**	-0.803	-1.236***	-1.267***	
Education deprivation 2015: quartile 4 (most deprived)	-0.421	-0.459	-1.481**	-1.480**	
Income deprivation 2015: quartile 2	1.564***	1.448***	1.588***	1.586***	
Income deprivation 2015: quartile 3	2.507***	2.190***	2.822***	2.804***	
Income deprivation 2015: quartile 4 (most deprived)	3.621***	3.474***	3.793***	3.781***	
People with income support	-68.859***	-83.410***	-54.360**	-52.804**	
People with pension credit	-9.8120	-4.3410	0.9950	1.1680	

Variable		(1)	(2)	(3)	(4)
		Adult social care OLS	Adult social care IV	Adult long-term care OLS	Adult long-term care IV
Carer needs (N _i)	Female carers	-11.421***	-13.103***	-9.847***	-9.649***
	Carers aged 65 and above	-4.784*	-2.891	-4.932**	-4.922**
	Carers of non-white ethnicity	-9.056***	-8.512***	-6.819***	-6.754***
	Carers who did not state ethnicity	-0.337	0.786	1.504	1.460
	Carers with Physical impairment	1.842	2.003	2.375	2.273
	Carers with sight or hearing loss	-5.191	-8.781	-9.155*	-9.050*
	Carers with long-standing illness	-23.938***	-22.117***	-16.756***	-17.025***
	Carers who is retired	47.986***	46.861***	36.369***	35.925***
	Carers who is employed	45.254***	44.404***	30.679***	30.155***
	Carers who is self-employed	9.159	5.071	-2.520	-2.649
	Carers who is unemployed	60.750***	61.907***	46.316***	46.180***
	Carers who is not in paid work because of caring role	-3.863	-5.373*	-4.743**	-4.721**
	Carers who is in paid work but do not feel supported by their employer	-26.470***	-30.177***	-2.800	-2.757
	Carers who is self-employed but unable to balance work and caring role	20.611	26.427	-2.072	-3.111
	Carers with financial difficulties because of caring role	-0.405	0.266	-5.339**	-5.271**
	Carers who do not live with care recipient	8.324**	7.200**	1.468	1.419
	Carers in caring role between 6 months and 1 year	39.485	22.286	78.365***	79.570***
	Carers in caring role for more than 1 year	10.414	-8.484	52.893***	53.816***
	Carers who provide personal care	0.589	-0.892	-1.526	-1.561
	Carers who provide physical help	6.348**	7.490**	13.010***	12.933***
Carers who provide other practical help	-26.933***	-28.086***	-28.106***	-28.052***	
Carers who provide help with medicines	-13.669***	-15.243***	-6.533*	-6.418	
Carers who provide emotional support	13.277**	14.784***	10.258**	10.182**	
Eligibility (g _i)	Outer London borough	2.651***	5.429***	0.119	0.024
	County	4.005***	7.744***	2.709**	2.595
	Metropolitan district	4.529***	8.276***	2.655***	2.628*
	Unitary authority	5.566***	9.155***	3.872***	3.820***
Private social care (P _i) and informal care (C _i)	User who received informal care	0.011	0.011	-0.001	0.000
	User who received private long-term care services	-0.012	-0.010	-0.052	-0.050
	User who received informal care and private long-term care services	0.001	-0.002	0.031	0.030
	Carers who care for 20 hours or more although may vary	3.166	4.618	4.920	4.818
	Carers who care for 20 to 49 hours per week	19.979***	22.517***	22.693***	22.818***
	Carers who care for no less than 50 hours per week	11.571**	14.881***	15.228***	15.248***
	Carers who care for other unspecified amounts of time	17.144***	20.315***	18.561***	18.587***
Constant	-12.134	-53.737	-39.486	-37.750	
Observations	49,907	49,907	49,907	49,907	
First stage Kleibergen-Paap rk Wald F statistic	399.8	159.6	316.2	110.0	
Over-identification test (Hansen J statistic) p-value	-	0.583	-	0.436	
The dependent variable is public adults social care expenditure in column (2) and (3), and public long-term care expenditure in column (4) and (5). 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<0.1					