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The impact and cost of adult social care: marginal effects of changes in funding

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1 Introduction

The funding of social care is a long-debated issue. Since the 1997 Royal Commission, a range of Government and other reviews have considered the funding and reform of the social care system in England. A key issue considered in these reports is the likely increase in the overall costs of social care might in the future due to 'external' pressures such as the ageing and the changing prevalence of long-term conditions. Another important line of enquiry, central to the Dilnot and Barker reviews, has been on how care should be funded and paid for, including the role of the private funding as well as funding from the public purse.

There has been less consideration of what an appropriate level and type of support should be, for a given level of need. For example, what number of hours of home care is appropriate for people with different combinations of need? What should a care home placement be considered? The Care Act 2014 determines that care should be provided to meet needs and support achievement of wellbeing. It provides a framework definition of what constitutes 'eligible' need. But it does not directly indicate how those needs should be met, nor what the cost of an appropriate package of care ought to be.

There are distinct challenges in answering this question, not least because there is a paucity of information on the comparative effectiveness of types of social care for people with different levels of need. People are guided by professional judgement as regards the levels of support provided by the public system currently. Important considerations are about the level of support needed to achieve activities of daily living for functionally impaired people, balancing risk and safety issues and helping to support independence. In other words, the focus has been on the severity of need of the individual, not (necessarily) the (cost) effectiveness of different care options.

In the determination of the global public budgets for social care, Government spending reviews are especially mindful of the expected changes in need in the population in the future. There appears to have been less debate about whether there should be changes to the 'care offer', that is, how much support people should be funded to receive (adjusted for need). The relative lack of research and analysis on the comparative benefits (and costs) of social care has limited our ability to debate these questions. The amount of benefit from particular types of care is implicitly assumed, as based on professional judgement (Fernandez and Snell 2014, Fernandez, Snell et al. 2016), but unlike costs which can be measured in pounds, there has been little basis for systematically comparing the benefits of care, either as between types of care, as between people with different needs, or between public spending on social care as opposed to other care spending (e.g. on health care). An important implication of a closer consideration of the benefits of care, as well as the needs of the individual, is that public funding decisions would very likely differ as a result.

This paper aims to bring together estimates of the comparative benefits of public expenditure on social care. In particular, we seek to estimate the net benefits that come from changes in funding of social care (changes relative to current spending levels). The law of diminishing returns generally means that the benefits of each additional £1 of social care expenditure are smaller than the same

£1 change from a lower baseline of expenditure. In other words, spending an extra £1 per annum produces more benefit overall but the extra benefit is smaller than the benefit from each prior £1 of current spending. The benefit of the last £1 spent is referred to as the *marginal* benefit. Public funds are scarce and have an 'opportunity cost'; the last £1 (or more) could be spent elsewhere and could produce benefits in an alternative use that exceeded the value of benefits lost on social care. By the same argument, public money spent elsewhere could be more effectively used – bring more marginal benefit – by funding social care.

A further aim of this paper is to consider the implications of these findings for social care funding policy when a cost-effectiveness approach is taken. There are important implications for future social care spending, noting that real terms social care public funding has fallen significantly behind public funding of health care recently. In particular, we have seen real terms reductions in social care funding, whilst health care expenditure has continued with real terms increases (during the period of austerity).

This paper draws on the results of a number of recent QORU and other studies, primarily the Identifying the Impact of Adult Social Care (IIASC) project, which collected survey data about people using publicly-funded social care (Forder, Malley et al. 2016), and from analysis of local authority expenditure on social care.

An important innovation that allows us to make comparative judgements of the benefit of social care is the development of generic, comprehensive outcome measurement systems. These tools allow us to measure the effects of social care using a common metric or 'currency', so that the impact of different forms of care spending can be compared. Furthermore, these measurement tools allow us to place a common value on the effects of social care.

In this study, we use the Adult Social Care Outcomes Tool (ASCOT) (Malley, Towers et al. 2012, Netten, Burge et al. 2012) for this purpose. ASCOT allows us to estimate benefits in the currency of social care 'quality-of-life adjusted life years' (QALYs). Recent research has estimated the value of a given social care (ASCOT) QALY as compared with the value of a QALY, using the standard metric (EQ-5D[1]), as commonly used in the assessment of the benefits of health care. They are estimated to have a very similar value.

The IIASC study provided estimates of the cost-effective of community-based social care using ASCOT QALYs. The Measuring Outcomes for Public Service Users (MOPSU) project collected data on ASCOT QALYs for people in care homes (Netten, Beadle-Brown et al. 2010, Netten, Trukeschitz et al. 2012).

Public funds for (adult) social care can be used in a range of ways, and allocated between a number of service-need groups. Changes in public expenditure can be used to change the intensity of service utilisation for existing service users. For example, additional funding could be used to increase the number of hours of home care provided to people with a given level of assessed need. Alternatively, changes in public expenditure can be used to change the numbers of people eligible for services in each service-need group. For example, LAs could lower the needs-eligibility threshold to allow more people to be eligible for (lower-need) services. In this study, we assess how changes in expenditure would likely be used in actual practice.

Some particular issues concern the assessment of marginal cost-effectiveness in social care. First, the impact of social care is not limited to the direct recipient (the service user). (Informal) carers and/or

[1] The EuroQol five dimensions measure.

(other) family members are also significantly affected. To allow for these wider effects, we drew on results from the IIASC study regarding the impact of services used by the cared-for person on the *carer's* quality of life, as measured using the ASCOT carers scale: SCRQoL-C.

Second, residential care services incorporate not just direct care benefits but also accommodation benefits. Since the latter benefits are not specific to people with care needs, we focused just on care benefits in the analysis. Information about rents and other living costs was used to calculate a unit cost for care home services net of accommodation costs.

Third, social care benefits are measured in ASCOT SCRQoL terms in the studies used to provide figures for this analysis. An 'exchange rate' was therefore required for comparative valuations of ASCOT QALYs and EQ-5D QALYs, as noted above.

2 Estimation of net marginal effects

To calculate the impact of changes in social care expenditure, we need to combine estimates of (a) how social care expenditure is used with (b) the estimated impact of specific services on care-related quality of life of both services users and carers. The following summarises how these estimates were made.

2.1 How social care expenditure is used

In this analysis, we estimated how changes in total expenditure affect (a) the numbers of people supported in community and residential care, and (b) the average intensity (expenditure per service user) of that care. Details of this regression analysis are given in Methods Appendix (especially Annex 2).

Table 1 shows the average level of net public expenditure per LA in the sample. Over the period, net expenditure on community services and residential care were about equal. The other costs that make up total net expenditure include strategic management, assessment and care planning, and a range of other costs.

Table 1. Net public expenditure on adult social care, mean per sample LA over period 2010/11 to 2013/14

	Mean (£ million)	**Proportion**
Net expenditure on community care services	37.83	38%
Net expenditure on residential care services	37.78	38%
Net total expenditure (all adult social care)	99.65	100%

Although average expenditure on services is about equal, we would expect any *marginal* changes in expenditure to be mainly used for community services in the current needs-based allocation system. This expectation is based on the way that resources are used for the highest-need groups first (those in care homes) and then on community services.

The results give marginal expenditure allocations as reported in Table 2. Changes in total net expenditure had significant effects on the numbers of people supported either in residential care or the community, but did not significantly affect intensity of support.

Using the point estimates, the results suggested that about three-quarters of marginal changes in total net expenditure impact on numbers supported with community services and about one-

quarter on residential care. As expected, the results are significantly different from a 50%-50% allocation at the margin.[2]

Table 2. Marginal effects of a change in total net public expenditure

	£ change in service expenditure following £1 change in total net expenditure	Proportion of marginal change spent on services
Net expenditure on community care services – numbers supported	0.73***	73%
Net expenditure on residential care services – numbers supported	0.27***	27%
Net expenditure on community care services – intensity per person	Not sig	0%
Net expenditure on residential care services – intensity per person	Not sig	0%

The proportions in Table 2 were used in the resource allocation analysis below: i.e. when considering an increase in expenditure of, say, £1000, then £730 would go on community-based services and the rest on residential care.

2.2 SCRQoL impact analysis

2.2.1 Community-based care

The IIASC study provided a range of estimates of the SCRQoL impact of community-based services for people with physical and sensory impairment (PSI) and people with mental health (MH) problems. Although the study also collected information on people with learning disabilities, this sub-sample was not large enough to give estimates of cost-effectiveness. We have therefore assumed that the marginal impact of services for the PSI and MH is a reasonable approximation of the effects of all adult social care. Details are in Forder et al. (2018).[3]

Figure 1 reports the effects of (additional) care expenditure per person on that person's care related quality of life. The figure shows the amount of improvement in care related quality of life (y-axis) that is expected to result from use of care, with the intensity of that care given on the x-axis. Intensity is the amount of community-based services used each week, expressed in total cost terms. The three different curves apply to people with different levels of need (high, low, or average). As expected, people with high need gain more from care services (service intensity) than people with low need. Furthermore, the effect is diminishing, that is, gains in SCRQoL from the first hours of care per week are greater than from the last hour.[4] This result is important because it implies that resources are more effective when used to support additional people rather than used to give

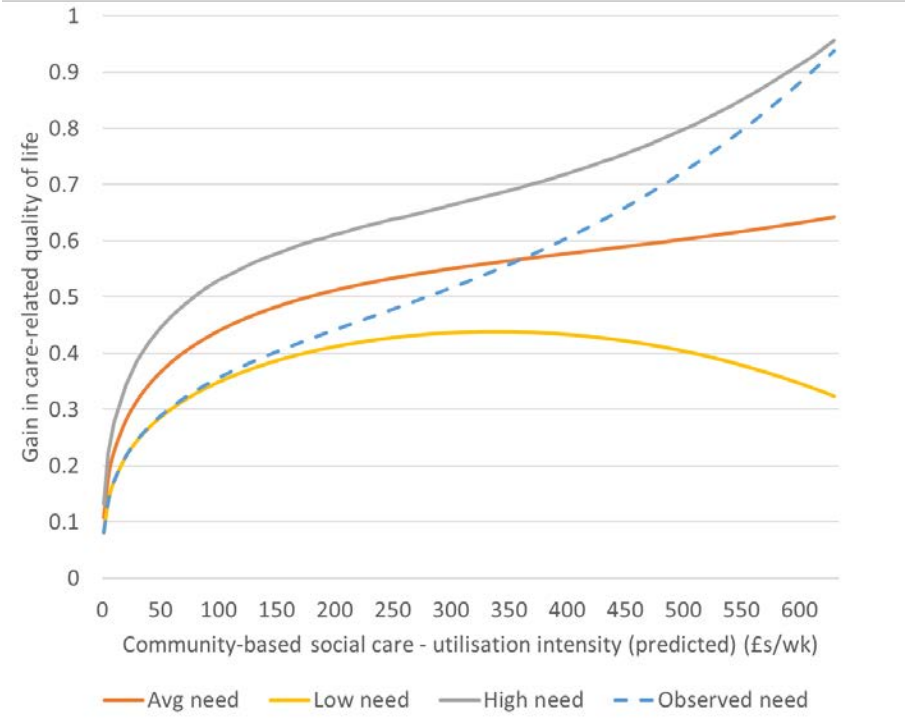
[2] We expect changes in total expenditure to simultaneously affect different service areas so did not hold other spending constant in the estimation. Nonetheless, when a model was estimated with other spending constant, we found a significant substitution effect of residential care on marginal community care spending (i.e. more spent on residential care means less on community care), but no significant effect the other way around. This result is consistent with our understanding of how the care system works by allocating resources to the highest need groups. Increased support for high-need groups would displace support for lower-need groups.

[3] Specifically, we used the results of the cube-root transformed interaction model, reported in Table 7 of Forder et al. (2018).

[4] In the figure, for high-needs groups there is a suggestion of a positive marginal effect for very high utilisation levels. We should note that this apparent positive affect only applies to the few people with above the 90th percentile and high need, and we should probably discount this result.

current recipients a greater intensity of support. We enlarge on the implications of this result in the discussion.

Figure 1. The impact of community-based care utilisation on care related quality of life – by baseline need.



Source: Forder et al. (2018), Figure 4.

2.2.2 Care homes

We used results from the MOPSU study to derive an estimate of the impact of care home services on care-related quality of life. Details are given in Netten et al. (2010, 2012). The MOPSU study found that improvement in ASCOT SCRQoL associated with care home use was just under 0.6. This figure, however, concerns the care home population at the time of the study. The study also sampled people who had mental capacity and were in the lower-need range of the care home population. In this analysis we have assumed that the improvement in SCRQoL was 5% higher than the original result to better reflect the typical care home resident at present.

Although the average gross expenditure on local authority-supported care home places was around £550 per week (at the time of this analysis), a little over 30% of gross expenditure is recovered as fees. Moreover, some proportion of care home costs go to cover accommodation benefits. Since we do not measure these benefits, we instead focused on the care-related quality of life implications. We assumed a corresponding cost of that care to be £300 per week. This figure is in line with the total cost minus reasonable expenditures on rent, costs of living, etc. Furthermore, the fee contribution made by many LA-supported residents can be regarded as a contribution to the accommodation benefits.

2.2.3 Carer SCRQoL

The analysis of the impact on carers' quality of life of services provided to the cared-for person in the IIASC study was conducted in a very similar fashion to the service user analysis. These results are unpublished and should be treated as tentative (they are separately identified below).

In this case, the newly-developed carer quality of life measure, ASCOT SCRQoL-C, was used. Because this measure is not yet preference weighted, we needed to make assumptions about the relative valuation of SCRQoL and SCRQoL-C. In other words, we needed to consider how an improvement from the worst possible state to the best possible state on the carer SCRQoL-C measure compares to the same improvement on the service user SCRQoL measure. The carer measure was designed to correspond closely to the service user measure so we would expect similar valuations, but this has not yet been tested experimentally.

In this analysis, therefore, we used two scenarios: where SCRQoL-C is, respectively, of equal value to SCRQoL, and three-quarters the value of SCRQoL.

The IIASC study provided results regarding the impact of community-based social care on carer quality of life. We do not have estimates of the marginal benefit to carers of *care home* services. Instead, we used a minimum estimate based on the benefit that accrues from the community services analysis in IIASC for the higher intensity of care received in care homes.[5] This calculation, however, makes no allowance for the different nature of care, and particularly that the cared-for person lives in the care home, not cohabiting with the carer.

3 Marginal cost effectiveness

We are interested in the impact of *changes* in social care expenditure (rather than, say, the total effect). As outlined above, this information is highly relevant for policy makers in deciding whether to increase or decrease levels of public funding.

For this purpose, we estimated the change in the total number of social care QALYs generated per year for a change in (recurrent) public funding per year. We use a theoretical model to combine the various estimates described above. The derivation of this resultant formula is described in the Methods Appendix.[6]

The tables below give the results. A number of assumptions are made in these calculations of cost-effectiveness and results are presented for different sets of assumptions. The standard way to present cost-effectiveness results is in the form of the annual cost of achieving an improvement in care-related quality of life from no quality of life at all[7] to full health or wellbeing. Estimates of cost-effectiveness are widely available for a range of health care interventions, and are usually measured using the Euro-Qol EQ-5D health-related quality of life scale. Social care QALYs using ASCOT are similarly calculated and can also be expressed in equivalent cost per EQ-5D QALYs using an 'exchange rate' between the currency of ASCOT and EQ-5D. We converted the social care results into equivalent cost per EQ-5D QALYs using the formula estimated by Stevens et al. (2018): EQ-5D-3L= -0.04044 + (0.964833*ASCOT).

Table 3 gives the base case (Scenario 1), which has the following assumptions:

[5] Specifically the effect of: a care home level of intensity of care (£300 per week) compared to high-intensity community-based care (£219 per week). This comes to 0.08 on the ASCOT carers scale.
[6] We use equation (2) for this calculation.
[7] In the literature this is the state which is valued as equivalent to being dead.

- Allocation of expenditure to low- and high-level community services (comm) is in the ratio of community to care home services (i.e. 0.73)
- SCRQoL-C = 0.75 x SCRQoL
- Care homes have care costs of £300 p.w.
- There are no integration cost-reduction effects

The table shows the marginal benefits and costs that accrue for each additional service user (main columns one and two). As well as the cost to gain one social care QALY, the table also shows the marginal benefit in ASCOT QALY improvement[8] terms per £1000 of additional expenditure. The £1000 change is for illustration, noting that the effects on ASCOT SCRQoL (QALY) scale in direct proportion to the amount of the change (e.g. a £1 change would be one-thousandth of the effect).

These alternative scenarios are considered:

- Scenario 2: base case but with 1:1 weighting of SCRQoL-C (Table 4)
- Scenario 3: base case but with 20% integration savings (effectively meaning that £800 is the actual net cost from the original £1000 spent on social care) (Table 5)

The additional scenarios capture the additional benefits of the original extra £1000 spent on services. As a result, they produce higher marginal benefit per extra expenditure or, equivalently, less extra cost to achieve an additional QALY.

In the base case, the main result is that the incremental cost-effectiveness of social care considering only direct service user effects is £19,940 in ASCOT QALYs or **£20,670** in equivalent EQ-5D QALYs.

When account is made for estimated carer effects, we factor in an additional 0.016 ASCOT QALYs from the original £1000 spent on service users. As a result, with a 0.75 weight, the revised figure for incremental cost-effectiveness is £15,120 in ASCOT QALYs or **£15,670** in equivalent EQ-5D QALYs.

When factoring in benefits from integration we are reducing the net costs of care (rather than adding health benefits). This assumes that savings on NHS expenditure are returned to the social care system (which may not be the case, although the working of the Better Care Fund is consistent with this idea). We have assumed a 20% cost saving from integration in line with the literature so each £1000 spent on social care actually costs £800. Incorporating this effect gives a cost of **£12,540** for each extra EQ-5D QALY.

[8] Since we assume no mortality effects, the social care QALY is just the quality adjustment component i.e. the change in ASCOT social-care related quality of life (SCRQoL).

Table 3. Marginal benefits and costs – per person and per extra £1000: base case

	Per person		Per £1000 extra	
	Extra QoL per extra person	**Extra cost per person per week**	**Allocation of extra £1000**	**Weighted MB/£1000+ (cost-effectiveness)**
Service user effects				
Low-need service over no service	0.34	90.00	533.85	0.039
High-need service over low-need service	0.12	130.00	197.45	0.003
Residential over high-need comm	0.17	110.70	268.70	0.008
Subtotal: +MB per extra £1000				0.050
Subtotal: Cost-effectiveness (ASCOT)				£19,940
Subtotal: Cost-effectiveness (EQ-5D)				**£20,670**
Carer effects				
Low-need service over no service	0.11	92.11	0	0.012
High-need service over low-need service	0.05	127.18	0	0.001
Residential over high-need comm	0.06	110.70	0	0.003
Subtotal				0.016
Running total: +MB per extra £1000				0.066
Running total: Cost-effectiveness (ASCOT)				£15,120
Running total: Cost-effectiveness (EQ-5D)				**£15,670**
Integration benefits				
All	0%		0	
All effects				
Total: Cost-effectiveness (ASCOT)				£15,120
Total: Cost-effectiveness (EQ-5D)				**£15,670**

Table 4. Marginal benefits and costs – per person and per extra £1000: base case but with 1x SCRQoL-C value

	Per person		Per £1000 extra	
	Extra QoL per extra person	**Extra cost per person per week**	**Allocation of extra £1000**	**Weighted MB/£1000+ (cost-effectiveness)**
Service user effects				
Low-need service over no service	0.23	91.66	533.85	0.026
High-need service over low-need service	0.18	117.52	197.45	0.006
Residential over high-need comm	0.23	90.82	268.70	0.013
Subtotal: +MB per extra £1000				0.045
Subtotal: Cost-effectiveness (ASCOT)				£22,360
Subtotal: Cost-effectiveness (EQ-5D)				**£23,170**
Carer effects				
Low-need service over no service	0.16	91.66	0	0.018
High-need service over low-need service	0.07	117.52	0	0.002
Residential over high-need comm	0.03	90.82	0	0.002
Subtotal				0.022
Running total: +MB per extra £1000				0.067
Running total: Cost-effectiveness (ASCOT)				£14,900
Running total: Cost-effectiveness (EQ-5D)				**£15,440**
Integration benefits				
All	0%		0	
All effects				
Total: Cost-effectiveness (ASCOT)				£14,900
Total: Cost-effectiveness (EQ-5D)				**£15,440**

Table 5. Marginal benefits and costs – per person and per extra £1000: base case but with 20% integration cost benefits

	Per person		Per £1000 extra	
	Extra QoL per extra person	**Extra cost per person per week**	**Allocation of extra £1000**	**Weighted MB/£1000+ (cost-effectiveness)**
Service user effects				
Low-need service over no service	0.34	90.00	533.85	0.039
High-need service over low-need service	0.12	130.00	197.45	0.003
Residential over high-need comm	0.17	110.70	268.70	0.008
Subtotal: +MB per extra £1000				0.050
Subtotal: Cost-effectiveness (ASCOT)				£19,940
Subtotal: Cost-effectiveness (EQ-5D)				**£20,670**
Carer effects				
Low-need service over no service	0.11	92.11	0	0.012
High-need service over low-need service	0.05	127.18	0	0.001
Residential over high-need comm	0.06	110.70	0	0.003
Subtotal				0.016
Running total: +MB per extra £1000				0.066
Running total: Cost-effectiveness (ASCOT)				£15,120
Running total: Cost-effectiveness (EQ-5D)				**£15,670**
Integration benefits				
All	20%		-200	
All effects				
Total: Cost-effectiveness (ASCOT)				£12,100
Total: Cost-effectiveness (EQ-5D)				**£12,540**

The cost effectiveness of additional spending depends on the how the money is used (as between changing intensity and changing the numbers of people supported). As noted above, our analysis suggests that changes in expenditure affect only numbers supported. Alternatively, if all additional expenditure went to increasing intensity then the incremental cost-effectiveness ratio would be different. These calculations are reported in Table 6. Specifically, with all expenditure going to intensity, the cost would be **£53,470** per additional EQ-5D QALY (just considering direct service user effects).

Suppose half of the additional expenditure went to access and the other half to intensity. In that case, the average incremental cost-effectiveness ratio would be **£29,820** in EQ-5D QALYs (just considering direct service user effects).

Table 6. Marginal benefits and costs of an increase in intensity (per extra £1000): direct service user effects only

	Per person	Per £1000 extra	
	Extra QoL per extra person	**Allocation of extra £1000**	**Weighted MB/£1000+ (cost-effectiveness)**
Service user effects			
Low-need service over no service	0.021	730.00	0.015
High-need service over low-need service	0.015	270.00	0.004
+MB per extra £1000			0.019
Cost-effectiveness (ASCOT)			£51,590
Cost-effectiveness (EQ-5D)			**£53,470**

4 Discussion

Estimating the marginal benefit per extra pound for adult social care is an ambitious undertaking, especially given the relative paucity of data and evidence. The main results regarding the impact of social care on service user SCRQoL are taken from the IIASC study and the MOPSU study. The limitations of the analyses in those studies should be noted. In particular, certain assumptions have been made in those analyses, and changes to those assumptions would give different results.

Furthermore, the results presented above are based on *estimates* of effect sizes and are subject to statistical error. Estimates can vary from the true effect by chance, due to the characteristics of the sample that was draw. Confidence intervals give us a sense of the size of the error, and are conventionally established at a 95% probability.[9] To illustrate the confidence intervals in this analysis, we can use the example of the impact of community-based care services at the low-level of intensity (£90 per week).[10] In this case, the impact of a new care recipient is an improvement of care-related quality of life of 0.34. The 95% confidence interval range is: 0.06 to 0.62. In other words, our point estimate could be somewhat higher or lower than the true effect. We proceed using each point estimate – the centre of the confidence interval range – accepting that there is uncertainty as regard the actual effects. This approach is inherent to statistical analyses – further data and analysis would be required to improve the precision. Pragmatically, in lieu of further analysis, point estimates are the most suitable indicators available.

The results of the analysis provide evidence about the cost-effectiveness of social care. As the analysis shows, much depends in this regard on how changes in expenditure are targeted. The LA expenditure analysis in this paper suggested that expenditure changes predominantly lead to changes in the numbers of people supported (especially lower need), rather than changes in the intensity of care per person. As such, the analysis reported here assumes additional expenditure will increase just numbers of recipients, albeit as distributed between recipients of community-based care and care home services.

The results for the improvement in SCRQoL from care home services comes from the MOPSU study. This study was only able to engage with residents with relatively low levels of need compared to the

[9] Confidence intervals define an upper and lower estimated value such that if the 'true' effect lies outside this range, then a sampling event (giving a point estimate) has occurred which had a probability of 5% (or less) of happening by chance.

[10] This is the observed need result, using the base model reported in Table 2 of Forder et al. (2018). This is essentially equivalent to the dashed line in Figure 1 above.

overall care home population. We have made a small adjustment to better represent the typical care home resident, but this is probably an under-estimate of SCRQoL gained by care home residents. Assuming higher values of the SCRQoL benefits makes quite a difference to overall cost-effectiveness estimates, as do differences in the assumed unit cost of care in a care home.

The benefits to carers of services for cared-for people are also important. Social care affects carers significantly and we should account for the beneficial effects on the quality of life of carers. The IIASC analysis in this regard represents a contribution to what is an under-researched area. Nonetheless, given the lack of previous evidence for comparison, the findings in this regard are more tentative.

There is a particular lack of evidence about the impact on carers of people going into residential care. We know that the breakdown of carer relationships is a prime factor in care home admissions, so this is likely to be a significant effect. Given the lack of evidence, we extrapolated to estimate care home effects on carer SCRQoL-C, but these are cautious estimates.

Another under-researched issue is the mortality impacts of social care. Some tentative modelling suggests that assuming different mortality effects will make a relatively small difference to recurrent amounts of additional social care QALYs for additional recurrent expenditure (as we consider here), but more work is required to confirm this result.

The implication of substitution benefits of social care on health care can also be added. We assumed a figure of 20p saving in the £1, which is based on the relatively limited research in this area (e.g. Fernandez and Forder 2008, Forder 2009, Gaughan, Gravelle et al. 2015).

Overall, the analysis produced (point) estimates of social care incremental cost-effectiveness of slightly under £21,000 per extra QALY if we consider just direct service user effects and as low as £12,540 if the collateral benefits to cares and the NHS are added. This supposes that changes in funding change the numbers of service users. If some of the change in expenditure was used to alter intensity, the cost of achieving SCRQoL improvement would be much higher (to over £53,000 if all expenditure was targeted on intensity). Our analysis, nonetheless, suggests that the first situation holds. What then are the policy implications?

4.1 Policy implications

The results can guide a number of policy decisions. The first concerns the priority given to resources for high-need and low-need groups, when working from a fixed total budget. Marginal cost-effectiveness information can be used to find the combination of support for high- and low- need groups that maximises the gain in care-related quality of life (or simply 'wellbeing') in the population of people that could benefit from social care. The maximisation of quality of life gain might not be the (only) objective of policy makers; there is particular discussion in the literature about the equity implications of such a strategy (e.g. whether additional weight should be given to the care-related quality of life of people with high-levels of need). Nonetheless, we can comment on the current allocation of care and support, by need, given the assumed goal of wellbeing maximisation.

As far as community-based services are concerned, the results suggest that the distribution of care resources between high and low need as sampled in the IIASC study is not much different from what the 'ideal' would be if we were seeking to maximise care-related quality of life. The results suggest that slightly too much support is given to high-need groups compared to the 'ideal', but if we allow for some additional weighting of SCRQoL gain for high-need people, then that would require a further shift of support for those people compared to the equally-weighted case. In other words,

these results do not suggest the need to revise assessment and care planning policy regarding the targeting of support between higher and lower need groups.

A more vexed question is about the best allocation of support as between care homes and community-based care. The evidence about the incremental benefits of care home services compared to high-need community-based care is perhaps too tentative to comment with any confidence on the implications for resource allocation.

The results also inform a second policy issue: determining the size of the total budget for social care in England. In particular, the analysis can cast some light on the question of whether to increase or decrease the total public budget for social care. The public social care system vies for public funding against the range of other government spending areas. There is, in other words, an opportunity cost of additional public funding of care. Clearly, we do not have the evidence to be able to compare social care spending against the range of all possible alternative uses – we do not have *comparable* cost-effectiveness information for other public services or for the impact of additional public funding, such as through taxation, on the wider economy.

Nonetheless, progress can be made by setting a threshold to represent the average opportunity cost of social care spending (which is, in effective, a willingness to pay for social care). This approach has been adopted in assessing these questions for health care where a cost-effectiveness threshold is used by NICE and others to assess whether spending on (new) healthcare activity is warranted. The exact value of this threshold varies but a working range is £20,000 to £30,000 per health (EQ-5D) QALY. Some recent research suggests that the NHS is more cost-effective than this threshold, which implies that more than one QALY would be gained from extra investment of £20,000.[11]

Since we can value social care spending using the same outcomes metrics (equivalent EQ-5D QALYs), we can argue that the same opportunity cost threshold could be used to judge the level of social care spending. As outlined above, we find (using the point estimates) that the cost per QALY of current social care expenditure[12] is around £20,000 per QALY if we consider only direct effects on service users. When account of carer and integration effects in made, the cost for a total increase of one QALY (adding the service user and carer benefits) is considerably lower than this figure. In other words, further expenditure on social care (as covered in the studies described above) would be in the cost-effective range as defined by NICE (relative to notional cost-effectiveness of other public spending). Where the incremental cost-effectiveness of additional spending is below the threshold, that expenditure should increase, with savings made elsewhere (for spending that is less cost-effective, above the threshold).

We can also reflect on experience with public funding and expenditure as between health care and social care. Given their similarity we might think about them competing for the same budget allocation (rather than as alternatives for all public spending). During the period of austerity, from 2009/10 to 2016/17 NHS total health expenditure in England increased from £110.2bn to £120.5bn in real terms (2016/17 prices).[13] Adult social care gross current expenditure reduced from £18.8bn

[11] https://www.nice.org.uk/news/blog/carrying-nice-over-the-threshold

[12] Although noting that we have not accounted for all social care spending; rather we have *sampled* activity in accordance with the methodologies of the IIASC and MOPSU projects.

[13] Harker, R (2018) NHS Funding and Expenditure, House of Commons library, briefing paper CBP0724, 13 April 2018
(https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0ahUKEwjT557vp6jbAhVH1xQKHezFDJoQFghyMAY&url=http%3A%2F%2Fresearchbriefings.files.parliament.uk%2Fdocuments%2FSN00724%2FSN00724.pdf&usg=AOvVaw3Y_7KGScFrQfnRFTvz8VxP)

to £17.5bn in real terms.[14] With similar (diminishing) marginal cost-effectiveness at the beginning of the period, there would be no clear-cut case, on this basis alone, for reducing the public funding of one area and increasing public funding on the other. There may be other reasons for prioritising NHS spending of course, or there may have been a relative improvement in the productivity of the NHS over the period, but otherwise, social care spending would be left at a higher (better) marginal cost-effectiveness position than health care spending following this observed change in expenditure. Accordingly, further prioritisation of social care would produce more total QALYs for the same overall cost.[15]

As noted above, much would depend on how additional funding would be spent on social care. In particular, it would be important to use additional funding to improve access to care, not intensity. Also, as with any analysis of this kind, there are caveats and statistical uncertainty. For example, if we use values at the lower confidence interval estimate for the effectiveness of social care, this gives a much higher cost per QALY than the point estimates, significantly weakening the arguments for prioritising social care. As such, these results are tentative – they also urgently underline the need for further work on the estimation of the marginal effects of social care services. But broadly, these results suggest that the marginal cost-effectiveness of social is in line with that for health care, and in the range that NICE would consider to be cost-effective.

4.2 Caveats and final reflections

We are taking a societal cost-effectiveness perspective in this analysis. In particular, the gains from additional public expenditure accrue from people getting support who would otherwise have either had no support, or support consistent with people in a lower-need group. However, there is a significant private pay sector in social care, and public and private funding might be substitutes.

Clearly, if additional public expenditure just displaces private expenditure to the same amount there is no net change in total social care use. In this case any argument for changes in public funding would focus around (a) issues of redistribution and income inequality (e.g. social care might be funded to the optimal level *on average*, but where we see some population groups having to pay privately, and some not – is that appropriate?), and (b) questions about the efficiency of private financing e.g. the availability (or otherwise) of private insurance against care need risks. If private insurance is not available, risk averse people are likely to over-save to compensate. Arguments of this nature will also apply to other public services (e.g. healthcare) where people also have the option to pay privately for the service. A particular issue in relation to social care is the general paucity of our understanding and evidence about the scale of private funding of care.

The analysis in this paper has concentrated on mainstream social care and will not reflect the costs and benefits of more specialised areas of social care (which are often very high cost).

The estimates and the proportion of high and low-need people in the population is based on the IIASC study and may not be representative of the actual population. Indeed, we might have good reason to believe that the actual social care population has a higher proportion of high need people than in our samples. There is research looking at the engagement of hard-to-reach participants in

[14] NHS Digital, 2017, *Adult Social Care Activity and Finance Report: Detailed Analysis*, https://digital.nhs.uk/data-and-information/publications/statistical/adult-social-care-activity-and-finance-report/adult-social-care-activity-and-finance-report-england-2016-17.

[15] The number of additional QALYs from re-prioritising social care in this case would depend on the degree to which marginal cost-effectiveness diminishes in both areas. To note that if there is almost no change in marginal cost effectiveness over the range of expenditure levels we are considering, then re-prioritisation would not produce much gain.

studies, including those with high levels of need[16], but these have not so far produced large quantitative dataset.

Further analysis will be important, as noted above. The evidence base in social care regarding cost and outcome implications of service use is modest at best. The analysis above suggests that the opportunity cost of not using public funding in its most effective way can be very high.

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[16] For example, see https://www.qoru.ac.uk/about/research/engagement/.

Methods Appendix

Population social care-related quality of life (SCRQoL) is a function of the care services people use, their level of need and a range of non-need factors. To make the analysis more manageable, we can identity four needs groups in the population: people with no need, low need, moderate need and high need. In theory, four groups of services correspond to these levels of need: no services; lower-need community-based care; higher-need community care; and care home services. Eligibility thresholds are set to match services to needs.

In practice, however, the allocation rules in the care system mean that some people with a given level of assessed need might be using services that correspond to a lower level of need. In other words, there might be some unmet need in the system. As a result, changes in public funding can lead to a change in the number of people (by need group) getting different services. In particular, an increase in funding might lead more 'lower-need' people getting some services, through the lowering of eligibility thresholds. Conversely, eligibility thresholds might be tightened if funding is reduced. In the last five years, for example, there has been a significant reduction in the numbers of publicly-supported service users (particularly for non-residential care).

Additional public funding can also be used to vary the amount or intensity of support people receive. Previous research has shown a positive relationship between intensity (e.g. hours per week of home care) and outcomes (Forder, Malley et al. 2014). Although many people pay charges in the public care system, these are mainly related to their ability to pay (although capped by the total cost of care). Marginal changes in intensity would mainly fall on the public purse.

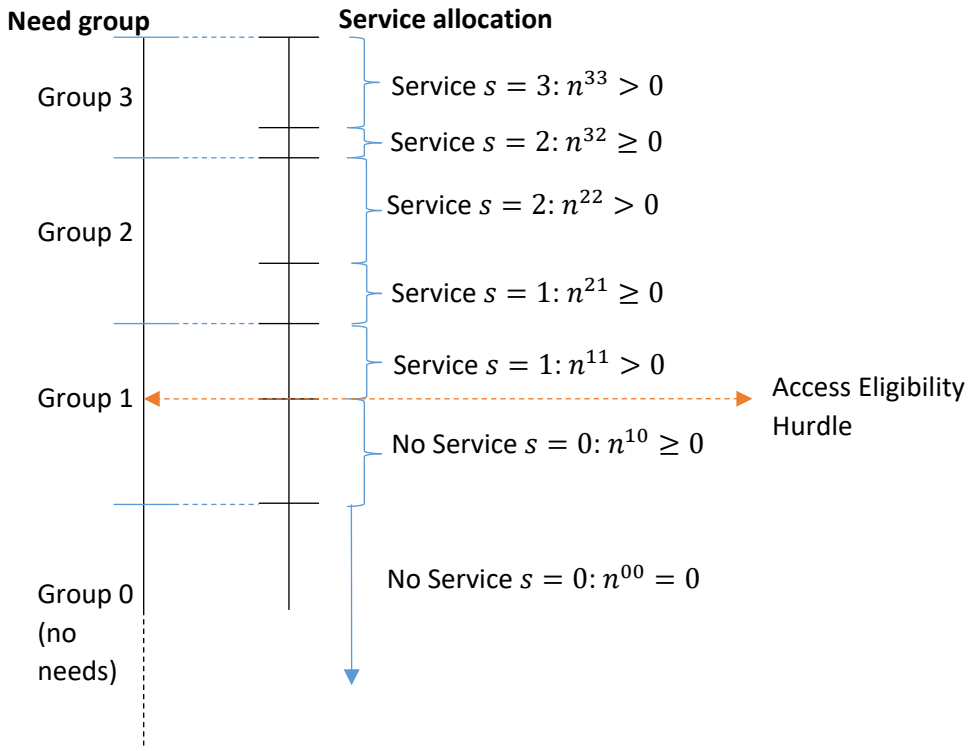
Grouping people by need and service, the total number of social care QALYs produced each year by the care system is:

$$Y = \sum_{g=0}^{4} \sum_{s=0}^{4} y^{gs}\left(x^{s}(E)\right) n^{gs}(E) \tag{1}$$

Where y^{gs} denotes the current SCRQoL of people in (one of the four) need groups g getting service type s. The amount of SCRQoL of each person depends on (is a function of) the intensity of service s (e.g. hours of care), x^{s}, which in turn is determined by the total (public) expenditure on social care, denoted E. The term n^{gs} is the number of people in need group g getting service s, which again depends on expenditure going into the care system. Graphically, allocation in the care system might be represented as described in Box 1.

Box 1. Allocation of support in the care system

Where people are getting the appropriate service type for their need, then the need group g will equal the service type s, e.g. n^{11}, n^{22} and n^{33}. Where there is unmet need then the service type is below the need level. Theoretical levels of unmet need are numbers of people: n^{32}, n^{21}, and n^{10}. In practice, given the needs-hurdle allocation rule in social care, we would expect high-needs groups to have good support: i.e. n^{32}, n^{21} will be near to zero. The eligibility-of-access hurdle in the care system mainly affects the distinction between some service and no service. However, there may be local supply or institutional factors that mean there is some unmet need in higher-need groups



The overall impact of marginal changes in expenditure on the outcomes of social care (on SCRQoL) is composed of the marginal changes across service-need groups and between changes in intensity and/or numbers of people supported. Changes in expenditure used to buy (or cut) access to services will change SCRQoL by the amount $y^{gs} - y^{gs-1}$ e.g. $y^{11} - y^{10}$. The number of additional supported users bought for each extra £1 of expenditure will be $£1/x^s$, where x^s is the intensity of the service measured in £s, effectively the unit cost of the service. Changes in expenditure used to add (cut) intensity result in changes in SCRQoL by the amount of the marginal effect of additional intensity on SCRQoL of $\frac{\Delta y^{gs}}{\Delta x^s}$, where Δ denotes a change in the corresponding variable. The cost of this change is the amount Δx^s, which is intensity measured in £s.

Taking the potential effects together for different need groups, the total impact of a change in expenditure is given by the following equation:

$$\frac{\Delta Y}{\Delta E} \cong \frac{\partial Y}{\partial E} \tag{2}$$
$$= \frac{y^{11} - y^{10}}{x^1}\frac{\partial E^{1n}}{\partial E} + \frac{y^{22} - y^{21}}{x^2 - x^1}\frac{\partial E^{2n}}{\partial E} + \frac{y^{33} - y^{32}}{x^3 - x^2}\frac{\partial E^{3n}}{\partial E}$$
$$+ \frac{\partial y^{11}}{\partial x^1}\frac{\partial E^{1x}}{\partial E} + \frac{\partial y^{22}}{\partial x^2}\frac{\partial E^{2x}}{\partial E} + \frac{\partial y^{33}}{\partial x^3}\frac{\partial E^{3x}}{\partial E}$$

A more formal derivation of this equation is given in Annex 1. The term $\frac{\Delta Y}{\Delta E}$ is just the inverse incremental cost-effectiveness ratio (ICER) for social care overall: i.e. the change in the total number of social care QALYs generated per year for a change in (recurrent) public funding per year.

The term $y^{gs} - y^{gs-1}$ is the difference in SCRQoL for people of need level g getting service s as opposed to getting service $s-1$. The differential $\frac{\partial y^{ss}}{\partial x^s}$ is the effect of changes in intensity on SCRQoL i.e. corresponding to $\frac{\Delta y^{gs}}{\Delta x^s}$. Estimates of these numbers are available from the IIASC and MOPSU studies.

As discussed above, additional expenditure can be used to change access or intensity for each of the need groups in the population. The terms $\frac{\partial E^{sn}}{\partial E}$ and $\frac{\partial E^{sx}}{\partial E}$ are the share of additional expenditure going to service type s to increase extensiveness and intensiveness respectively. We estimated these numbers using an analysis of recent spending patterns by local authorities. A description of this LA expenditure analysis is given in Annex 2.

Throughout reference has mainly been to an *increase* in expenditure, but the above calculations work equally well for decreases in expenditure (which are the negative, producing reductions in SCRQoL).

4.3 Mortality effects

Although a very under-researched area, we might speculate that benefits from social care also arise in terms of improved survival, especially for people in care homes. Given the health-endangering level of need of people in care homes, without this service we might expect higher mortality rates. If care homes do improve survival relative to the alternative service options (i.e. high-intensity home care), then these benefits should be factored in as further improvements in y^{33}. At the same time, greater survival will mean additional recurrent costs and so fewer additional people supported for a given increase in funding as compared to the case where there are no survival benefits. The net effect of a greater survival rate will depend on the relative value of the specific ICER of being in a care home against being dead with the ICER of supporting more people in care homes who were previously in the community getting high-need support (without mortality effects). Preliminary modelling suggests that this will be a small effect: i.e. different assumptions about survival will not matter too much in terms of overall cost-effectiveness.

4.4 Integration benefits

There is a small (but growing) evidence base that health and social care services are substitutes to a certain degree. As such, an increase in expenditure on one sector should reduce demand on the other, and vice versa. In terms of the present analysis, suppose that an increase in expenditure on social care leads to an equivalent reduction in required health care expenditure according to the ratio $\sigma \leq 1$: $\Delta E^{HC} = \sigma \Delta E^{SC}$. We can factor in these 'integration' benefits in two ways. First, we can assume these are cashable savings that are returned to social care. Accordingly, the effective cost of additional social care is reduced in line with the degree of substitution σ. Second, we can assume

that the freed-up resource is used elsewhere in the health care system and generates a health-related quality of life benefit. For ease of exposition, we adopt the first approach in this calculation, although the latter is more likely in practice. If the marginal cost-effectiveness of public expenditure in health and social care turns out to be about the same, then these two approaches will produce largely equivalent results.

Annex 1. Conceptual framework

Population social care-related quality of life (SCRQoL) in local authority k is:

$$Y_k = y_{1k}(E_k) + y_{2k}(E_k) + \cdots + y_{N_k^S}(E_k) + y_{N_k^S+1,k} + \cdots + y_{N_k} \quad (3)$$

where y_{ik} is the quality of life of person $i = 1, \ldots, N_k$ in LA k where N_k is the total population. There are N_k^S service users and their quality of life will be a function of total net public expenditure on social care made in the LA, denoted E_k. Their current quality of life will also depend on their underlying needs as well as the contribution of services. Rather than specify need per person, we can define $g = 0,1, \ldots, G$ need groups in the population, going from no-needs up to severe need. Services are provided to support people with care needs.

Services are provided to people in accordance with their need. However, due to budget constraints, not all people in some need groups will receive public support, particularly people with low levels of need. Moreover, due to uncertainty and differential interpretation, the match between service types and need may not be exact.

Suppose that there are $s = 0,1,2, \ldots, S$ 'types' of services that in theory correspond to people in each of the $S = G$ groups, where the $s = 0$ group is 'no-service' as it corresponds to 'no-needs'.

Grouping people by need and service, (3) can be re-written as:

$$Y_k = \sum_{g=0}^{G} \sum_{s=0}^{S} y_k^{gs}(E_k) n_k^{gs}(E_k) \quad (4)$$

where n_k^{gs} is the number of people in group g getting service s. Likewise y_k^{gs} denotes the quality of life of people in need group g getting service type s.

In total, there are $N^g = \sum_{s=0}^{S} n_k^{gs}$ people in need group g. Furthermore there are $\eta^s = \sum_{g=0}^{G} n_k^{gs}$ people using service s, who can be distributed across need groups other than $g = s$. Given the needs-based allocation system in social care, we can assume that people receiving service s might be in need group $g = s$ and the need group one high. In other words, people some people might be getting the 'right' type of service, but others might be getting a type that is really appropriate for a person with lower needs i.e.: $s = \{g, g-1\}$. However, no-one gets service types that are two steps or more below their need level. We make this assumption despite budget constraints, because rather than giving group g services of type $g-2$, any rationing would occur with fewer people in group $g-1$ being offered services $g-1$. It would those people in group $g-1$ that would be getting service $g-2$ as a consequence.

Therefore (suppressing the LA subscript k):

$$Y_k = y^{00} n^{00} \quad (5)$$

$$+ y^{10}(N^1 - n^{11}) + y^{11} n^{11}$$

$$+y^{21}(N^2 - n^{22}) + y^{22}n^{22}$$
$$+y^{32}(N^3 - n^{33}) + y^{33}n^{33}$$
$$+ \cdots + y^{ss-1}(N^s - n^{ss}) + y^{ss}n^{ss} + \cdots$$
$$+ y^{SS-1}(N^S - n^{SS}) + y^{SS}n^{SS}$$

We consider four need groups: no-needs, low, moderate and high (i.e. $G = 4$), and three service types (plus no service) – see also Box 1 in the main text.

The mechanism for improving the outcomes of service recipients of given need is to increase the intensity of support. In this case, $\frac{\partial y^{gs}}{\partial E} = \frac{\partial y^{gs}}{\partial x^s}\frac{\partial x^s}{\partial E}$, where x^{gs} is the intensity of service provision for each individual service recipient.

A small increase in budget E_k will have the following impact:

$$\begin{aligned}&\frac{\partial Y}{\partial E} \\ &= \sum_{s=1}^{S}\left[(y^{ss} - y^{ss-1})\frac{\partial n^{ss}}{\partial E}\right] \\ &+ \sum_{s=1}^{S-1}\left[\frac{\partial y^{ss}}{\partial x^s}n^{ss} + \frac{\partial y^{s+1s}}{\partial x^s}\frac{\partial x^s}{\partial E}(N^{s+1} - n^{s+1s+1})\right]\frac{\partial x^{ss}}{\partial E} + \frac{\partial y^{ss}}{\partial x^s}\frac{\partial x^s}{\partial E}n^{ss}\end{aligned} \tag{6}$$

Where η_k^s is the total expenditure per service s (regardless of need group). In the case with four need groups and three service types (plus no service) we have:

$$\begin{aligned}&\frac{\partial Y}{\partial E} \\ &= (y^{11} - y^{10})\frac{\partial n^{11}}{\partial E} + (y^{22} - y^{21})\frac{\partial n^{22}}{\partial E} + (y^{33} - y^{32})\frac{\partial n^{33}}{\partial E} \\ &+ \left(\frac{\partial y^{11}}{\partial x^1}n^{11} + \frac{\partial y^{21}}{\partial x^1}(N^2 - n^{22})\right)\frac{\partial x^1}{\partial E} \\ &+ \left(\frac{\partial y^{22}}{\partial x^2}n^{22} + \frac{\partial y^{32}}{\partial x^2}(N^3 - n^{33})\right)\frac{\partial x^2}{\partial E} \\ &+ \frac{\partial y^{33}}{\partial x^3}n^{33}\frac{\partial x^3}{\partial E}\end{aligned} \tag{7}$$

There are a range of options for how additional (or reduced) budget is used. It can be used to increase recipients of the three service types and/or the intensity of provision of each service.

Total expenditure is:

$$\begin{aligned}&E = E^{1n} + E^{2n} + E^{3n} + E^{1x} + E^{2x} + E^{3x} = n^1x^1 + n^2x^2 + n^3x^3 \\ &= (n^{11} + n^{21})x^1 + (n^{22} + n^{32})x^2 + n^{33}x^3 \\ &= (n^{11} + N^2 - n^{22})x^1 + (n^{22} + N^3 - n^{33})x^2 + n^{33}x^3\end{aligned} \tag{8}$$

where E^{sn} is expenditure on numbers supported of service s and E^{sx} is on intensity of service s.

Assuming all the budget is spent, we have the condition:

$$\begin{aligned}&\Pi \\ &= E^{1n} + E^{2n} + E^{3n} + E^{1x} + E^{2x} + E^{3x} \\ &- [(n^{11} + N^2 - n^{22})x^1 + (n^{22} + N^3 - n^{33})x^2 + n^{33}x^3] = 0\end{aligned} \tag{9}$$

Differentiating: $\frac{\partial n^{ss}}{\partial E} = \frac{\partial n^{ss}}{\partial E^{sn}}\frac{\partial E^{sn}}{\partial E} = \left(-\frac{\frac{\partial \Pi}{\partial E^{sn}}}{\frac{\partial \Pi}{\partial n^{ss}}}\right)\frac{\partial E^{sn}}{\partial E}$ which is just the additional amount of the total budget spent on changing the number of people supported to use service s multiplied by the (unit) cost i.e. the number of additional service users that a marginal increase in expenditure will buy. Also, $\frac{\partial n^{33}}{\partial E} = \frac{1}{(x^3 - x^2)}\frac{\partial E^{3n}}{\partial E}$, and $\frac{\partial n^{22}}{\partial E} = \frac{1}{(x^2 - x^1)}\frac{\partial E^{2n}}{\partial E}$, and $\frac{\partial n^{11}}{\partial E} = \frac{1}{x^1}\frac{\partial E^{1n}}{\partial E}$ Similarly, $\frac{\partial x^s}{\partial E} = \frac{\partial x^s}{\partial E^{sx}}\frac{\partial E^{sx}}{\partial E} = \left(-\frac{\frac{\partial \Pi}{\partial E^{sx}}}{\frac{\partial \Pi}{\partial x^s}}\right)\frac{\partial E^{sx}}{\partial E}$ and so $\frac{\partial x^3}{\partial E} = \frac{1}{n^{33}}\frac{\partial E^{3x}}{\partial E}$, with $\frac{\partial x^2}{\partial E} = \frac{1}{(n^{22} + N^3 - n^{33})}\frac{\partial E^{2x}}{\partial E}$ and $\frac{\partial x^1}{\partial E} = \frac{1}{(n^{11} + N^2 - n^{22})}\frac{\partial E^{1x}}{\partial E}$.

Suppose the difference in effect of an increase in intensity of the same service s on people in need group s and $s+1$ is $\frac{\partial y^{s+1s}}{\partial x^s} = \frac{\partial y^{ss}}{\partial x^s}\gamma^{s+1s}$ where $\gamma^{s+1s} \geq 1$.

$$\begin{aligned}&\frac{\partial Y}{\partial E} \\ &= \frac{y^{11} - y^{10}}{x^1}\frac{\partial E^{1n}}{\partial E} + \frac{y^{22} - y^{21}}{x^2 - x^1}\frac{\partial E^{2n}}{\partial E} + \frac{y^{33} - y^{32}}{x^3 - x^2}\frac{\partial E^{3n}}{\partial E} \\ &+ \frac{n^{11} + \gamma^{21}(N^2 - n^{22})}{n^{11} + N^2 - n^{22}}\frac{\partial y^{11}}{\partial x^1}\frac{\partial E^{1x}}{\partial E} \\ &+ \frac{n^{22} + \gamma^{32}(N^3 - n^{33})}{n^{22} + N^3 - n^{33}}\frac{\partial y^{22}}{\partial x^2}\frac{\partial E^{2x}}{\partial E} \\ &+ \frac{\partial y^{33}}{\partial x^3}\frac{\partial E^{3x}}{\partial E}\end{aligned} \tag{10}$$

If there is negligible difference in effect i.e. $\gamma^{s+1s} = 1$, then (10) becomes equation (2) given in the main text.

Annex 2. LA expenditure analysis

A five-year panel dataset of 150 local authorities was constructed (using data downloaded from NASCIS) which included variables on:

- net public expenditure on all adult social care: E_{kt}
- net expenditure on residential care: E_{kt}^r
- net expenditure on community-based care: E_{kt}^c
- supported service users by service type: residential, n_k^r and community n_k^c
- a range of control factors, including LA population size, affluence and need indicators: Z_{kt}
- a local factor price variable (mean wage rates): w_{kt}

Four models fixed effect, instrumental variables models were estimated (using 2-step GMM). Instruments for total net public expenditure were the one-year lagged values of that variable and mean wage rates (squared). Instrumental variables were used to account for the interdependence of total expenditure and service-specific expenditure. In this case, an IV model can help determine the causal effect of increased total expenditure on service-specific expenditure.

In what follows, the βs are the regression coefficients. The subscripts k and t denote the LA and time respectively, the latter running between 2009/10 and 2013/14. The α terms are the time-invariant fixed effect for each LA and e is the independent error.

1. Expenditure on community care (using the natural log or ln), as a function of total expenditure:

$$lnE_{kt}^{c} = \beta_0^{cn} + \beta_1^{cn}\widehat{lnE_{kt}}(E_{kt-1}, w_{kt-1}) + \beta_2^{cn}t + \beta_3^{cn}w_{kt} + \beta_4^{cn}Z_{kt} + \alpha_k^{cn} + e_{kt}^{cn} \quad (11)$$

2. Expenditure on residential care (using the natural log or ln), as a function of total expenditure:

$$lnE_{kt}^{r} = \beta_0^{rn} + \beta_1^{rn}\widehat{lnE_{kt}}(E_{kt-1}, w_{kt-1}) + \beta_2^{rn}t + \beta_3^{rn}w_{kt} + \beta_4^{rn}Z_{kt} + \alpha_k^{rn} + e_{kt}^{rn} \quad (12)$$

3. Expenditure on community care intensity (log), as a function of total expenditure:

$$ln\left(\frac{E_{kt}^{c}}{n_k^{c}}\right) = \beta_0^{cx} + \beta_1^{cx}\widehat{lnE_{kt}}(E_{kt-1}, w_{kt-1}) + \beta_2^{cx}t + \beta_3^{cx}w_{kt} + \beta_4^{cx}Z_{kt} + \alpha_k^{cx} + e_{kt}^{cx} \quad (13)$$

4. Expenditure on residential care intensity (log), as a function of total expenditure:

$$ln\left(\frac{E_{kt}^{r}}{n_k^{r}}\right) = \beta_0^{rx} + \beta_1^{rx}\widehat{lnE_{kt}}(E_{kt-1}, w_{kt-1}) + \beta_2^{rx}t + \beta_3^{rx}w_{kt} + \beta_4^{rx}Z_{kt} + \alpha_k^{rx} + e_{kt}^{rx} \quad (14)$$

We cannot identify expenditure on high and low-needs groups in community-based care. Therefore we made the assumption that the ratio of marginal expenditure between high and low community care was the same as the ratio between all community and residential care.

The following are model results for the LA analysis. The following variables were used:

- Natural log of net expenditure on community care
- Natural log of net expenditure on residential care
- Natural log of net expenditure on community care per service user
- Natural log of net expenditure on residential care per resident

Instruments were: one-year lagged net total expenditure and one-year lagged mean wage rate (squared).

The IV models satisfied the over- and under- identification tests and the instruments were not 'weak', with *F*-tests of greater than 10.

In the analysis we dropped one LA (due to its atypical characteristics) and there were 12 missing cases. In using lagged variables the final sample was 583 cases (with an average of 3.9 observations per LA).

Expenditure on community care

Dep var: Natural log of net expenditure on community care

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	1.935798	0.3976308	4.87	0
year 2010	-0.0028792	0.0348092	-0.08	0.934
year 2011	-0.0613213	0.0316518	-1.94	0.053
year 2012	-0.0239001	0.0158546	-1.51	0.132
mean wage	-0.0000754	0.0007172	-0.11	0.916
mean wage (sq)	3.74E-08	3.41E-07	0.11	0.913
Attend All per 65+ (ln)	-0.2734075	0.2059501	-1.33	0.184
Pop 65+	-2.56E-06	2.32E-06	-1.11	0.269
Pop 16 to 64	8.96E-07	2.42E-06	0.37	0.711
Pen crd per 65+ (ln)	0.4449757	0.3111986	1.43	0.153
F-test	16.05			0
Underidentification test (Kleibergen-Paap rk LM statistic):	11.905			0.0026
Weak identification test (Kleibergen-Paap rk Wald F statistic):	10.599			
Endogeneity test of endogenous regressors:	4.415			0.9911
N	584			

Expenditure on residential care

Dep Var: Natural log of net expenditure on residential care

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	0.7121362	0.2779701	2.56	0.01
year 2010	0.0047647	0.0348194	0.14	0.891
year 2011	0.0290961	0.0287806	1.01	0.312
year 2012	0.0162851	0.0148914	1.09	0.274
mean wage	-0.0001853	0.0006498	-0.29	0.775
mean wage (sq)	-1.95E-08	3.15E-07	-0.06	0.951
Attend All per 65+ (ln)	0.1707692	0.1494442	1.14	0.253
Pop 65+	1.96E-06	1.85E-06	1.06	0.289
Pop 16 to 64	3.29E-06	2.09E-06	1.58	0.115
Pen crd per 65+ (ln)	-0.1902161	0.2474919	-0.77	0.442
F-test	5.7			0
Underidentification test (Kleibergen-Paap rk LM statistic):	11.905			0.0026
Weak identification test (Kleibergen-Paap rk Wald F statistic):	10.599			
Endogeneity test of endogenous regressors:	0.485			0.4861
N	584			

Expenditure on community care intensity per service user

Dep Var: Natural log of net expenditure on community care per service user

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	0.8017021	0.6184379	1.3	0.195
year 2010	-0.2351927	0.0657646	-3.58	0
year 2011	-0.1702886	0.060209	-2.83	0.005
year 2012	-0.0573152	0.0304079	-1.88	0.059
mean wage	-0.0003842	0.0012825	-0.3	0.764
mean wage (sq)	6.95E-07	6.35E-07	1.09	0.274
Attend All per 65+ (ln)	-0.0121638	0.2850387	-0.04	0.966
Pop 65+	-2.88E-06	4.81E-06	-0.6	0.55
Pop 16 to 64	-0.0000135	4.46E-06	-3.02	0.003
Pen crd per 65+ (ln)	-0.1419338	0.5372378	-0.26	0.792
F-test	11.46			0
Underidentification test (Kleibergen-Paap rk LM statistic):	11.905			0.0026
Weak identification test (Kleibergen-Paap rk Wald F statistic):	10.599			
Endogeneity test of endogenous regressors:	0.022			0.881
N	584			

Expenditure on residential care intensity/cost per service user

Dep Var: Natural log of net expenditure on residential care per resident

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	0.4023367	0.3076463	1.31	0.191
year 2010	-0.0602995	0.0385495	-1.56	0.118
year 2011	-0.0275436	0.0318684	-0.86	0.387
year 2012	-0.0049332	0.0163381	-0.3	0.763
mean wage	-0.000683	0.0006679	-1.02	0.306
mean wage (sq)	4.07E-07	3.30E-07	1.23	0.218
Attend All per 65+ (ln)	0.2183914	0.1690286	1.29	0.196
Pop 65+	2.57E-06	2.16E-06	1.19	0.235
Pop 16 to 64	5.78E-06	2.27E-06	2.54	0.011
Pen crd per 65+ (ln)	0.0113871	0.2806871	0.04	0.968
F-test	5.74			0
Underidentification test (Kleibergen-Paap rk LM statistic):	11.905			0.0026
Weak identification test (Kleibergen-Paap rk Wald F statistic):	10.599			
Endogeneity test of endogenous regressors:	2.037			0.1535
N	584			

Expenditure on community care, given residential care expenditure

Dep Var: Natural log of net expenditure on residential care

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	0.7938217	0.3649522	2.18	0.03
year 2010	0.0027355	0.0331863	0.08	0.934
year 2011	0.0255684	0.0286609	0.89	0.372
year 2012	0.0152297	0.0144124	1.06	0.291
mean wage	-0.000126	0.0006694	-0.19	0.851
mean wage (sq)	-4.84E-08	3.27E-07	-0.15	0.882
Attend All per 65+ (ln)	0.1468586	0.1647936	0.89	0.373
Pop 65+	1.99E-06	1.78E-06	1.12	0.264
Pop 16 to 64	3.38E-06	2.11E-06	1.61	0.108
Pen crd per 65+ (ln)	-0.140507	0.281007	-0.5	0.617
Pred net expt comm (ln)	-0.0255191	0.0706737	-0.36	0.718
F-test	5.43			0
Underidentification test (Kleibergen-Paap rk LM statistic):	10.561			0.0051
Weak identification test (Kleibergen-Paap rk Wald F statistic):	10.383			
Endogeneity test of endogenous regressors:	0.078			0.7807
N	584			

Expenditure on residential care, given community care expenditure

Dep var: Natural log of net expenditure on community care

Var	Coef.	Std. Err.	z	P>|z|
Total net expend (log)	2.194225	0.4113473	5.33	0
year 2010	-0.0183461	0.0376747	-0.49	0.626
year 2011	-0.0715808	0.0333045	-2.15	0.032
year 2012	-0.0264559	0.0167228	-1.58	0.114
mean wage	0.0002304	0.0007728	0.3	0.766
mean wage (sq)	-1.38E-07	3.67E-07	-0.38	0.707
Attend All per 65+ (ln)	-0.2761027	0.1792558	-1.54	0.123
Pop 65+	-2.60E-06	2.30E-06	-1.13	0.259
Pop 16 to 64	1.51E-06	2.54E-06	0.6	0.551
Pen crd per 65+ (ln)	0.5515849	0.3118495	1.77	0.077
Pred net expt res (ln)	-0.146399	0.0692932	-2.11	0.035
F-test	14.75			0
Underidentification test (Kleibergen-Paap rk LM statistic):	12.329			0.0021
Weak identification test (Kleibergen-Paap rk Wald F statistic):	8.97			
Endogeneity test of endogenous regressors:	6.318			0.012
N	584			