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Consumption and Health-based Indicators of Well-being for Lower Tier Local Authorities in England

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Keywords: well-being measures, inequality, small area estimation, health, consumption

JEL classification: D63, E21, E24, I12, R13

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Consumption and Health-based Indicators of Well-being for Lower Tier Local Authorities in England*

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Abstract

In this paper we present estimates of economic well-being for local authorities in England Our measure is designed to reflect life-time consumption, the disutility of work and unemployment, and health state and life expectancy. Our well-being metric combines each of these factors using an expected utility framework. We extend the approach of Jones & Klenow (2016) to reflect a distinction between expected life in good health and expected life in poor health and to distinguish between private and public consumption. The analysis is presented for lower tier local authority areas (LTLAs), but it is possible to produce figures for larger geographic areas or for other aggregates of LTLAs such as rural areas or cities. The current results are provided for fiscal year 2015-6, reflecting availability of administrative income data, and are for lower-tier local authority areas (LTLAs) in England. Broadly speaking the LTLAs with the highest well-being are in areas surrounding London while the lowest levels of well-being are found in Northern England.

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1 Introduction

In this paper we present estimates of economic well-being in each local authority in England. Our measure is designed to reflect life-time consumption, the disutility of work and unemployment, and health state and life expectancy. It is to be preferred to cruder indicators of well-being such as *per capita* consumption for several reasons. Drawing on the work of Jones & Klenow (2016), it reflects the distribution of resources, being based on the assumption that the marginal utility of household consumption is diminishing in consumption. This means that the estimated aggregate level of well-being is decreasing in the inequality of consumption. Secondly, as noted above, it takes account of time use. Thirdly, it depends on health state, distinguishing life in poor health from life in good health. Finally reflects the fact that people may derive pleasure from life itself. This implies that people with high life expectancy may have a high base-line level of life-time well-being even before any account is taken of the extra consumption that they are able to enjoy.

The analysis is presented for lower tier local authority areas (LTLAs), but it is possible to produce figures for larger geographic areas or for other aggregates of LTLAs such as rural areas or cities. The estimates are based on data for the financial year 2015-2016; they show the expected life-time well-being of young adults in each small area, using the actual experience of old people to represent the prospects for young people. Thus, if they are to be useful, they should not be sensitive to the year on which they are based. The stability of them with reference to the base year can, however, be assessed only when data become available to allow their calculation for other years.

We draw inferences from our results for the levelling-up agenda. We suggest that if the aim is to increase well-being levels in deprived areas, that may be achieved more cheaply by improving health than by transfer payments.

The estimates are produced using three main data sources. The ONS Living Costs and Food Survey (LCFS) provides information on household consumption, based on a sample of just over four thousand households in England and drawn from only a sub-sample of the LTLAs. The Annual Population Survey (APS), constructed using Labour Force Survey data provides information on labour input and thus on the utility derived from leisure. The ONS has provided the demographic data required; these show population and life expectancy by age and sex for each local authority. Data on health state are, however, available only to the broader classification of upper-tier local authorities or UTLAs.

The small sample of the LCFS means that small area techniques have to be used to produce estimates of household consumption based on indicator covariates which are available for middle layer super output areas (MSOAs), fine subdivisions of LTLAs[1]. Although the APS does provide data for all the small areas of interest we similarly use small area techniques to produce the estimates of the disutility of work used in the calculation of our estimates of well-being. The APS also provides data on health state, but we use ONS estimates which adjust these to reflect divergences between the survey figures and the health states reported in the 2011 Census.

This paper proceeds as follows. Section 2 discusses related literature. In section 3 we set out the theoretical structure of the indicator. In section 4 we discuss our data and in section 5 show how we value a year of life. Section 6 presents the modelling techniques needed to produce our indicator. Section 7 presents the small area estimation models we use, and Section 8 discusses our measures of well-being. In section 9 we explore their relationship with small area income and health-adjusted life expectancy. The relationship between our indicators and the official indicators of multiple deprivation is considered in section 10. Section 11 concludes. The small area well-being indicators by local authority are presented in detail in an appendix.

2 Literature review

Significant efforts in recent decades have been dedicated to developing alternative measures of well-being or welfare as an alternative to GDP or GDP per capita. The Sen-Stiglitz-Fitoussi Commission report was a relatively recent attempt to put forward practical alternatives (Stiglitz et al. 2009). One approach has been to construct dashboards consisting of a wide range of indicators reflecting different aspects of wellbeing such as the ONS National Well-being dashboard,[2] or the OECD Better Life Initiative.[3] An advantage of GDP per capita is the simplicity of a single number, and many attempts have been made to create composite measures that combine multiple dimensions in a single index such as the UN Human Development Index (HDI) which combines income,

[1]There are 315 LTLAs in England. These are subdivided into 6791 MSOAs and aggregated to 151 UTLAs

[2]ONS (2019) Measures of National Well-being Dashboard.

[3]OECD Better Life Initiative. The OECD also produces a Better Life Index that aggregates 24 indicators covering 11 topics. The default is to give each topic a weighting of 1.

life expectancy, and literacy. Ravallion (2012) has criticised what he calls “mashup indices” like the HDI because of the arbitrary way in which they combine different elements together (see also Fleurbaey (2009)).

This study is related to work by Nordhaus & Tobin (1972). They developed an alternative measure to GNP called a “Measure of Economic Welfare” (per capita) that adjusted total national output to include items that improved well-being such as the value of unpaid work and leisure time, and subtract a measure of negative externalities from urbanisation and congestion. While we address health we leave the question of externalities for future study.

Becker et al. (2005) combine income and life expectancy in a utility function to estimate the effect of longevity on the evolution of well-being across countries over time. They find that life expectancy gains between 1960 and 2000 have been of the same order of magnitude as the gains to income, and they also find a more significant reduction in inequality over this period than is apparent from just looking at income.

Fleurbaey (2009) also constructs a composite measure of well-being measure using an expected utility framework for 24 OECD countries. He starts with GDP per capita and makes adjustments for leisure, the risk of unemployment, health, household size, inequality, the consumption of fixed capital, and a sustainability correction that adjusts for natural resource depletion and greenhouse gas emissions. He uses the idea of compensating variation to make cross-country comparisons. When countries differ in some non-income dimension he fixes a reference level for this dimension and for each country calculates the willingness to pay of the population to obtain this reference level. He finds that their final index of living standards is highly correlated with GDP per capita, but that the adjustments have a substantial effect on the ranking of countries.

Our work builds on and develops the approach of Jones & Klenow (2016) who combine data on consumption, leisure and life expectancy using the standard economics of expected utility to calculate a summary measure of well-being at the country level based on an index of equivalent consumption. This approach allows for a theoretically consistent quantification of different aspects of well-being in contrast to more arbitrary approaches. We show that, extended to include health effects, it can be applied at a local authority level in England. While the results are found to be correlated with those derived from indices of multiple deprivation publshed by the Ministry of Housing, Communities and Local Government (2019) there are material deviations.

3 Theory

We make the assumption that each individual adult has a utility function defined over consumption and leisure, broadly following Jones & Klenow (2016), but, unlike them, we separate public and private annual consumption (c_t^{pub} and c_t^{priv}). The fraction of time allocated to leisure and home production is represented as $\tilde{l}_t$. Following Billingham et al. (2019) we do not treat unemployment as leisure, but instead assume that people who declare themselves to be unemployed derive disutility from their circumstances equivalent to that which would follow from a thirty-hour working week. Finally, in an important innovation, we present results both on the assumption that utility is independent of health and on the assumption that people in poor health derive less utility from life than do those in good health. h_t measures the state of health of the individual; our data distinguish two states, good and poor, with good health represented by $h_t = 1$ and poor health a value below one which we calibrate subsequently.

A key consequence of the focus on expected life-time utility is that the utility function needs to include a constant term[4] which can be thought of representing the joy of living independently of consumption levels. But with the utility function, log consumption that we use, very low levels of consumption may imply that the overall level of utility is negative, despite the constant term. In such circumstances consumption is too low for life to be worth living.

The instantaneous utility function is assumed to take the following functional form

$$U(c_t, \tilde{l}_t, h_t) = h_t \left[\bar{u} + \alpha \log c_t^{priv} + (1-\alpha) \log c_t^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_t)^{\frac{1+\varepsilon}{\varepsilon}} \right] \tag{1}$$

Utility is assumed to increase in the logarithm of consumption, with a unit elasticity of substitution between public and private consumption. α is the share of expenditure on private consumption in total consumption expenditure. ε is the constant Frisch elasticity of labour supply and θ is the utility weight on leisure or home production. $\bar{u}$ measures the joy of living. In any analysis which reflects only marginal decisions, it is not relevant, but it does influence the role of life expectancy in life-time well-being relative to consumption and leisure (Murphy & Topel 2006). With the utility function set out here it does not guarantee that utility is positive, but it does allow one to calculate levels of consumption below which utility is negative. With the specification we have

[4]See also Murphy and Topel (2006).

used here, the health state affects the utility derived from consumption and leisure as well as from the joy of living. This reflects the point that people in poor health can have spending patterns dictated by the need to offset the effects of poor health, so the utility derived from any given level of consumption, as well as the joy of living, is reduced. If health effects are not to be taken into account, h is set to 1 for everyone.

The utility function is extended to produce a value for life-time utility as

$$U^{life-time} = \sum_{t=0}^{t_{max}} \beta^t \rho_t U(c_t, \tilde{l}_t, h_t). \tag{2}$$

Here β is the discount factor and ρ_t is the probability of surviving from year 0 to year t. Thus equation (2) shows the life time utility of a young person and it is clear that the constant term in the utility function, $\bar{u}$, influences this. Substituting in the functional form for the utility function, we have, with $t = 0$ representing the start of adult life at age 20[5],

$$U^{life-time} = \sum_{t=0}^{t_{max}} \beta^t \rho_t h_t \left(\bar{u} + \alpha \log c_t^{priv} + (1-\alpha) \log c_t^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_t)^{\frac{1+\varepsilon}{\varepsilon}} \right)$$

Jones & Klenow (2016) make the assumption that the future consumption of a current young adult (whose age we set to zero) should be modelled by looking at the current consumption of an older adult, age τ, and applying a growth rate of g to that. The labour input of a current young adult when aged t is assumed to be the same as that of a current adult aged τ. The estimates are therefore produced on the assumption that there will be no change to labour force participation or unemployment. With the additional assumption that both public and private consumption grow at the same rate, life-time utility can be written as

$$U^{life-time} = \sum_{\tau=0}^{t_{max}} \beta^\tau \rho_t h_t \left(\bar{u} + \alpha \log c_\tau^{priv} + (1-\alpha) \log c_\tau^{pub} + g(\tau-1) - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_\tau)^{\frac{1+\varepsilon}{\varepsilon}} \right) \tag{3}$$

With this assumption and suitable assumptions about the parameters, $\alpha, \beta, \varepsilon, \theta, \bar{u}$ and g, the measure of well-being can be produced from cross-sectional data. We further assume that there is no *per capita* growth and that the discount factor is 1.

The expression in equation (3) relates of course to an individual. But, working

[5]We choose the age of twenty rather than eighteen because the demographic data are available only in five-year bands.

from average estimates the logs of private and public consumption and of the leisure term together with population average survival probabilities and health states, it is possible to produce an approximate mean value for a particular sub-population. The focus of our work is on the populations of different LTLAs. Men and women have different survival rates, health states and labour supply patterns. Their consumption may also differ but we can observe only household consumption and thus consumption per effective household member. For our measure of life-time well-being we evaluate $U^{life-time}$ separately for men and women; we use the average of these two to represent life-time well-being in the LTLA in question. With the superscripts m and f referring to men and women respectively our measure of individual well-being is

$$\begin{aligned} U^{life-time} = & \frac{1}{2}\sum_{\tau=0}^{T_{\max}} \rho_t^f h_t^f \left[\bar{u} + \alpha \log c_\tau^{priv} + (1-\alpha)\log c_\tau^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_\tau^f)^{\frac{1+\varepsilon}{\varepsilon}} \right] \\ & + \frac{1}{2}\sum_{\tau=0}^{T_{\max}} \rho_t^m h_t^m \left[\bar{u} + \alpha \log c_\tau^{priv} + (1-\alpha)\log c_\tau^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_\tau^m)^{\frac{1+\varepsilon}{\varepsilon}} \right] \end{aligned}$$

reflecting the fact that we can observe labour supply, health status and survival rates separately for men and women. Consumption is derived from household data and it is not possible to distinguish men from women.

Our focus is not on individual well-being but on the average level of well-being in each LTLA. We evaluate this using local survival rates and health status information. We model the mean of log c_τ^{priv} and the means of the labour supply terms for men and women on an individual/ household basis using the MSOA-specific covariates. We then produce MSOA means by weighting the individual fitted values by the household population weights in the APS. We further weight the MSOA means, again using the household population weights, to give mean values for each LTLA.

We make the simplifying assumption that the age effects are common to all LTLAs. We also need to address the fact that data are available not for individual ages but for age bands. Thus the small area vital statistics allow us to work out the number of life years an individual may expect to spend in each age band. Similarly the consumption and labour supply figures are assumed to be uniform within each age band.

Jones & Klenow (2016) evaluate equation (3) for childhood as well as their adult life-time. They are not clear, however, how the consumption of each child is identified or how childhood utility relates to adult utility; they do say, however, that they assume children do not work, with time spent in education being treated as leisure. In the results we present here, we evaluate the expression only over adult life. We use U_k to denote the mean value of the measure of well-being in LTLA$_k$ In evaluating this we are making the assumption that survival rates, health status and consumption of individuals are independent of each other. In fact there are positive correlations between these three variables. But, in the absence of small area life tables for people with different consumption or income levels, it is not possible to take account of this inter-dependency.

The data for life-time utility are themselves not obviously capable of interpretation. We therefore work out the equivalent variation in private consumption; the multiple of private consumption in England as a whole which would be required to deliver the same level of life-time well-being as that observed in the LTLA in question. The average level of well-being for England is calculated by weighting the LTLA figures by their adult populations. The value of the measure of well-being averaged across England is, with ω_k the LTLA weights

$$U^{Eng} = \sum_k \omega_k U_k^{life-time} \tag{4}$$

The model we have used for both private consumption and leisure is that the age effects are the same for all LTLAs; the variation across LTLAs is taken to be independent of age. Public consumption is taken to be invariant across age and also across LTLAs.[6] We may therefore write equation 4, L^f_{kt} and L^m_{kt}representing the number of life years a female and male resident of LTLA k can expect to enjoy in age band t.

$$U^{Eng} = \sum_k \omega_k \left[\frac{\sum_{\tau=0}^{\tau_{\max}} L^f_{kt} h^f_{kt} \left\{ \bar{u}^f_k + \alpha \log c^{age}_\tau + -\left(\frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^f_\tau)^{\frac{1+\varepsilon}{\varepsilon}}\right)^{age} \right\}}{2} + \frac{\sum_{\tau=0}^{\tau_{\max}} L^m_{kt} h^m_{kt} \left\{ \bar{u}^m_k + \alpha \log c^{age}_\tau + -\left(\frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^m_\tau)^{\frac{1+\varepsilon}{\varepsilon}}\right)^{age} \right\}}{2} \right]$$

Here $\bar{u}^f_k$ and $\bar{u}^m_k$ represent the age-independent components of women's and men's life-time utility respectively in each LTLA k; these include the constant in the utility term, the regional and area random effects for $\log c^{priv}_t$ and the two labour supply terms,

[6]The two largest components of public consumption are health and education. Consumption of health services rises in old age- but we make the assumption that this is necessary to offset a decline in utility rather than increase utility over that of someone who does not require health treatment. Consumption of publicly provided education takes place largely before the age of twenty, but the benefits are enjoyed throughout adult life. Other components of public consumption like policing are probably higher in areas where the need is greatest but, as with health, this is best seen as offsetting adverse circumstances rather than conferring a particular advantage.

and the utility derived from public consumption. The age-dependent terms are shown separately. If private consumption in England is scaled by a term λ_n life-time well-being becomes

$$
\begin{aligned}
U^{Eng}(\lambda_n) &= \sum_k \omega_k \left(U_k + \frac{\alpha \log(\lambda_n)}{2} \sum_{\tau=0}^{\tau_{\max}} (L^f_{kt} h^f_{kt} + L^m_{kt} h^m_{kt}) \right) \\
&= U^{Eng} + \alpha \log(\lambda_n) \sum_k \omega_k \frac{\sum_{\tau=0}^{\tau_{\max}} \left\{ L^f_{kt} h^f_{kt} + L^m_{kt} h^m_{kt} \right\}}{2}
\end{aligned}
$$

If therefore we want to find the adjustment to private consumption needed to equate the average level of well-being in England with the level of well-being in LTLA k, we can choose λ_k such that

$$
U_k = U^{Eng} + \alpha \log(\lambda_k) \sum_n \omega_n \frac{\sum_{\tau=0}^{\tau_{\max}} \left\{ L^f_{nt} h^f_{nt} + L^m_{nt} h^m_{nt} \right\}}{2}
$$

giving

$$
\log(\lambda_k) = \frac{U_k - U^{Eng}}{\alpha \sum_n \omega_n \frac{\sum_{\tau=0}^{\tau_{\max}} \left\{ L^f_{nt} h^f_{nt} + L^m_{nt} h^m_{nt} \right\}}{2}} \tag{5}
$$

As Jones & Klenow (2016) point out, it would also be possible to work out the compensating variation, putting the focus on how far the consumption level in region k needed to change to align life-time well-being there with the average in England. With our data, as with theirs, that is likely to show greater variability because the denominator of (5) is given by the demographic statistics for the area in question rather than for England as a whole. The term α in the denominator should be noted. This reflects the fact that, with the log utility homogeneous in the logs of public and private consumption the effects of any change in private consumption alone are down-weighted relative to any change which affects both public and private consumption equiproportionately. In the appendix we show how it is possible to evaluate the variances of the $\log(\lambda_k)$ so as to give an idea of the accuracy of the estimates.

4 Data

Our study draws on multiple sources of data. We rely on the Living Costs and Food Survey (LCFS) for estimates of household consumption. ONS has kindly made available a version of this with expenditure (in eighty-four categories) scaled to be consistent with the aggregate national accounts. The survey provides LTLA and MSOA identifiers. We use the OECD equivalence scale which gives a weight of one to the first adult in the household, 0.7 to subsequent adults and 0.5 to children, to compute the equivalent consumption of the individual adult household members. This survey identifies 4,028 households in England with usable records, providing data for 268 of the 315 LTLAs, although in some cases there is only one household in each LTLA.

Small area estimation techniques described below are used to estimate log consumption as a function of age. This allows us to impute figures for the LTLAs for which there are no observations, and we also use the imputed rather than the observed figures for the LTLAs for which data are available. Since there is a relatively small number of households in the survey in each LTLA, we are forced to work with age bands rather than individual ages and estimate only a single set of age effects for the whole country. We consider those aged 20-29 in a single group and then use five-year bands, but with a single category once again for those aged eighty and over.

Data on work and leisure are provided by the Annual Population Survey (APS). This covers all of the LTLAs with a minimum of 37 men and 49 women in each LTLA. Like the LCFS, the version of the APS we use allows us to identify the LTLA and MSOA of the respondents.

We make the assumption that people who are unemployed work for thirty-two hours during the week, reflecting the observation noted above, that unemployed people do not regard themselves as being at leisure. As with consumption, we model the work/leisure term using small area covariates and use fitted rather than observed terms in the production of our estimates. Both these data sources cover financial year 2015/16.

Office for National Statistics (2021*a*) provides estimates of life expectancy by five-year age bands for both men and women based on average demographic data for 2014 to 2016. We recover survival probabilities from these. Office for National Statistics (2021*b*) provides population estimates for each LTLA.

Finally, Office for National Statistics (2019*a*) provides estimates of healthy and total life expectancy for upper tier local authorities (UTLAs) for the period 2016-2018 and they have kindly supplied us with the demographic data that underlie these estimates, showing the proportion of the population in each age band in good or poor health. There are 151 UTLAs representing a coarser classification than LTLAs. We make the assumption that people in the LTLAs have the health characteristics of the relevant UTLA.

These data are similarly presented in five-year bands consistent with our consumption and labour supply data. They are centred on 2017, slightly later than our micro data but we do not see this as a material source of error.

Our small area estimation is carried out using covariates available for all MSOAs and kindly provided to us through the Office for National Statistics Secure Research Service. The covariates we use are i) log average electricity consumption, ii) log average house price and iii) mean of log income in each MSOA. The income data are reported per household after adjusting for household size and relate only to income from benefits, from self-employment or subject to PAYE tax; they are experimental data. The data source provides decile points, and we use the means of the logs of these decile points to represent approximately the mean of log income. Data were also available on household gas consumption but we did not find that these were helpful. These covariates are available only for fiscal year 2015-6.

Public consumption and consumption by non-profit institutions serving households (NPISH) are allocated on a *per capita* basis to the population aged eighteen and over.[7] ONS data sources do make available allocations of education, health and social services consumption to households on the basis of the ages of the individuals in those households. Thus while they do not reflect the actual consumption of health services by individual survey respondents, they do show higher figures for old respondents than for young respondents, based on the greater use that old and older people make of health services. For many purposes this is an appropriate representation of health service consumption. We take the view, however, that old people make more use of health services from young people to offset factors that would lead to a decline in their well-being rather than as a means of adding to their well-being, and thus see it as inappropriate to give higher values for instantaneous well-being to old people than to young people simply because of their greater health service consumption. The UK national accounts[8] show consumption of £422,374m by the public sector and NPISH and consumption of £1,200,598m by households, That would give a share of household consumption in the total of 0.74. However such a calculation fails to take account of the economies of scale in private

[7]The LCFS provides a count of the population in age groups with the youngest group being aged 18-30. Our treatment of public consumption therefore assumes that it is spread evenly among the population aged eighteen and over, even though we focus on the well-being of those aged twenty and over.

[8]It is not possible to calculate figures specific to England since the fiscal year data are available only for the whole country.

consumption associated with living in households. A better metric is to infer the value of α from the level of consumption per effective household member and relate this to public consumption *per capita*. This reflects the economies of scale in consumption that multi-person households provide.

Using population data from the APS we find a figure of £8,507 for public/NPISH consumption per adult, which is assumed to be independent of age. The level of private consumption per effective household member, calculated after scaling the LCFS survey consumption figures to be consistent with the national accounts, was £27,770 giving a value of α of 0.77.

5 The Value of Leisure and the Value of a Life Year

5.1 The Value of Leisure

While the utility function has been set out on an individual rather than a household basis, albeit for an individual whose private consumption is the private consumption of the household divided by the effective household size, in order to derive a value for the parameter θ consistent with the data we need to consider the situation of a household. We calibrate our parameter a household whose effective size, as measured by the OECD equivalence scale is N_τ . The utility of the household is assumed to be the sum of the utilities of its two adult members.

With C_τ^{priv} equal to total household consumption, consumption per effective member is $c_\tau^{priv} = C_\tau^{priv}/N_\tau$. The single period maximization problem the household faces is

$$\begin{aligned}\underset{C_\tau^{priv},\,\tilde{l}_\tau}{Max}\; L \;=\; & 2\left[\bar{u} + \alpha\log(C_\tau^{priv}/N_\tau^*) + (1-\alpha)\log c_\tau^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}\left\{(1-\tilde{l}_\tau^m)^{\frac{1+\varepsilon}{\varepsilon}} + (1-\tilde{l}_\tau^f)^{\frac{1+\varepsilon}{\varepsilon}}\right\}\right] \\ & +\lambda\left[w_t^f(1-\tau)(1-\tilde{l}_t^f) + (w_t^m(1-\tau)(1-\tilde{l}_t^m) - C_t\right]\end{aligned}$$

Differentiating with respect to C_t^{priv}

$$\lambda = 2\alpha/C_t^{priv}; \tag{6}$$

with respect to $\tilde{l}_t^f$

$$\lambda w_t^f(1-\tau) = \theta(1-\tilde{l}_t^f)^{\frac{1}{\varepsilon}}, \tag{7}$$

and with respect to $\tilde{l}^m_\tau$

$$\lambda w^m_t(1-\tau) = \theta(1-\tilde{l}^m_t)^{\frac{1}{\varepsilon}}, \tag{8}$$

If θ is to be the same for both men and women, then this model carries with it the implication that the labour input of men relative to that of women will be inversely proportional to the wage rates earned on a full weekly basis. Of course such a framework completely fails to do justice to the issues of time allocation within the household. But, rather than distract from the main focus of our work, we add together equations (7) and (8) to give, with $\varepsilon = 1$

$$\frac{2\alpha(1-\tau)}{C^{priv}_\tau}\left\{w^f_t + w^m_t\right\} = \theta(2-\tilde{l}^f_\tau - \tilde{l}^m_\tau)$$

Thus

$$\theta = \frac{2\alpha(1-\tau)}{C^{priv}_\tau}\frac{(w^f_t + w^m_t)}{(2-\tilde{l}^f_\tau - \tilde{l}^m_\tau)} \tag{9}$$

It should be noted here that, the wage rates are those earned on the assumption of zero leisure time. Thus, with consumption measured on an annual, the wage rates are actual hourly earnings of women and men respectively grossed up to annual rates on the assumption of 112 hours worked per week rather than the actual working week.

We have $\alpha = 0.77$; we set $\tau = 0.32$ reflecting the standard rate of tax of 20% and employees' National Insurance contributions of 12% on earnings between £155 and £815 per week in fiscal year 2015-2016. Consistent with this, wages are measured exclusive of employers' National Insurance contributions. We find household consumption of £54,361 for a household with reference person aged 30-54, and total annual wage income of £54,281 an average household. According to the Annual Population Survey an average woman in this age group shows spends 24.7% of a 112 hour week working while an average man spends 34.5% of the week working. This implies that $\theta = 2.49$. This is well below the 14.2 used by Jones & Klenow (2016). However we also present in appendix C results computed using θ=14.2. The correlation coefficient between the measure of well-being shown there and our main results is 0.992.

5.2 The Value of a Life Year

The results of the exercise are sensitive to the value put on a life year. This in turn depends not only on the utility derived from consumption and leisure, but also on the value of the constant term $\bar{u}$ in the utility function. Murphy & Topel (2006) show that the value of an individual life-year can be evaluated as utility divided by the marginal utility of consumption plus net saving. We do not have good data on saving as a function of age, and therefore focus on the ratio of utility to marginal utility. But we need a separate observation on the value of life in order to evaluate a life year and thus apply the approach set out by Murphy & Topel (2006).

Thomas (2018) suggests that the value of a prevented fatality in the UK was £1.6m in 2010 prices, pointing to a figure of £1.78m in 2015 prices. To make use of this we need to estimate a model of consumption per effective household member using the consumption data in the Living Costs and Food Survey for financial year 2015-2016 so as to show how consumption varies with age (Office for National Statistics & Dept for Environment Food and Rural Affairs 2021). Combining this with life tables we can then evaluate the expected value of life and thus the constant in the utility function.

We scale total household consumption as reported in the LCFS to be consistent with the figure for household consumption in the national accounts financial year 2015-2016. We then estimate a model which explains consumption by the age of the household reference person. As noted earlier, we group all households with heads aged at least twenty but less than thirty into a single group. For older people we use five-year bands which match those of the small area demographic data. There is, however, a single group for those aged eighty and over. We explain consumption as a function of age by means of a random effects model so as to be coherent with the model estimated subsequently and shown in table 1.

We calculate the expected number of life years in each age band from the 2015-2017 life tables for England released in 2020.[9] The proportions of the population enjoying good or very good health are provided by the ONS from the 2011 Census.[10] The Census generally shows higher proportions in good health than are shown by the Annual Population Survey, and forms the basis for the small area data provided by the ONS.

The proportion of time spent working is derived from the 2015 Annual Population Survey (Office for National Statistics 2020). It was not possible to estimate the sort of mixed model used in the small area work, so we simply used the mean in each age group. As before we aggregated everyone aged twenty to thirty into a single group. We also used a single group for those aged sixty-five and over, consistent with the age classification provided in the data set. We take the average of the proportions of time

[9] ONS (2021) National life tables: England

[10] ONS (2021) Health and disability-free census prevalence

spend working for men and women. In these calculations people who report themselves as unemployed are assumed to be working for thirty-two hours a week. The maximum possible working week is set to 112 hours.

One complication in valuing a life year with our model is that we distinguish public and private consumption goods. We have assumed that public consumption is allocated uniformly, with the implication that, if the utility function parameter is based on the average share of public consumption in the total, some people will consume too much public good and others will consumer too little. We value life in terms of private consumption rather than total consumption and choose a value of $\bar{u}$ to align this to numerical valuations drawn from other sources.

With an assumption of no discounting and no *per capita* growth, the value of a life in terms of private consumption is given as the ratio of total utility to the marginal utility of private consumption:

$$V^{life} = \sum_{\tau=0}^{\tau_{max}} \frac{L_\tau^f \left\{ \bar{u} + \alpha \log c_\tau^{priv} + (1-\alpha)\log c_\tau^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_\tau^f)^{\frac{1+\varepsilon}{\varepsilon}} \right\} c_\tau^{priv}}{2\alpha} + \sum_{\tau=0}^{\tau_{max}} \frac{L_\tau^m \left\{ \bar{u} + \alpha \log c_\tau^{priv} + (1-\alpha)\log c_\tau^{pub} - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}_\tau^m)^{\frac{1+\varepsilon}{\varepsilon}} \right\} c_\tau^{priv}}{2\alpha}$$

It should be noted that the health variable, h_τ enters both into the level of utility and the marginal utility of consumption. Someone in poor health has both a lower level of utility and a lower marginal utility of consumption. As a result the value of life, given by the ratio of the two, is unaffected.

We assume that the figure of £1.78m represents the value put on the life of a forty-year old as representative of an "average" member of the population [11]. With both types of consumption measured at an annual rate in pounds, this suggests a value of $\bar{u} = -8.64$.[12]

In order to interpret this we might ask how low private consumption has to be for utility to be negative and thus life not worth living. We look solely at consumption, and therefore calculate a figure for someone who is not working and not looking for work.

[11]The average of men's and women's life expectancy at 40, adjusted for health status in 2014-16 was 38.6 years implying, with no discounting, a price per life year of £46,114. This compares with figure of £30,000 thought to be used by the National Institute of Clinical Excellence when deciding what health interventions should be approved.

[12]With $\theta = 14.2$ $\bar{u} = -8.25$

With this assumption the level of private consumption consistent with utility of zero is £4,988 p.a. per effective household member[13]. This compares with mean consumption per effective adult of £27,770. Obviously there is a risk of over-interpretation of the utility function, but this calculation does suggest that the value of $\bar{u}$ is plausible.

5.3 Health States and Utility

Office for National Statistics (2019a) uses the 2011 Census as its basic source of data on health states. These data have the advantage over the data collected in the Annual Population Survey in that they provide information on people aged 70 and over (and also on children but that is not relevant to our study) but to estimate the impact of health state on well-being we also need information on the quality-adjusted life years (QALYs) associated with the two categories of health state we define (very good or good and fair, poor or very poor). Palmer et al. (2021) estimates the expected number of QALYs enjoyed by men and women at age 20 in the UK at 56.16 and 59.57 respectively. Using the UK life tables for 2014-2016 and the 2011 Census estimates of the proportion of the population enjoying good or very good health,[14] we find life expectancies at age 20 of 60.3 years for men and 63.9 years for women, and healthy life expectancies of 44.7 and 46.4 years respectively. We set the value of h_t to 1 for years in very good/good health and 0.75 for years in fair/poor/very poor health. This gives 56.4 expected QALYs for men and 59.6 for women, corresponding approximately to the figures provided by Palmer et al. (2021).

6 Mixed Estimation for Small Areas

We use mixed estimation (Harville 1977) to model our private consumption and labour supply data, making the assumption that the small area averages can be represented by a mixture of fixed and random effects. The fixed effects arise from the three explanatory variables, log mean house price, log mean electricity use and mean log income. There is also a constant term. We represent these fixed effects by the array, **X**. We assume that, in addition to an idiosyncratic term, ε, there are random effects associated with age, government office region (GOR) and LTLA. These random effects

[13] With c_x as the threshold, we have $ln(c_x) = (8.64 - (1 - \alpha)ln(c^{pub}))/\alpha$ with c^{pub}=£8507 and $\alpha = 0.77$. With $\theta = 14.2$ the level of private consumption delivering zero utility falls to £2,997 p.a.

[14] ONS (2021) Health and disability-free census prevalence.

are represented by the vectors $\mathbf{v}_1$ to $\mathbf{v}_3$, and the arrays $\mathbf{Q}_1$ to $\mathbf{Q}_3$, whose structure is known, map them to the observations in question.

The model is

$$\mathbf{y} = \boldsymbol{X\beta} + \mathbf{Q}_1\mathbf{v}_1 + \mathbf{Q}_2\mathbf{v}_2 + \mathbf{Q}_3\mathbf{v}_3 + \varepsilon.$$

where $\mathbf{y}$ is the vector of variables we wish to model- log of consumption per household or the labour terms. We model these independently since they come from two unconnected data sets. We use separate models of the labour terms, $\frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^f_\tau)^{\frac{1+\varepsilon}{\varepsilon}}$ and $\frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^m_\tau)^{\frac{1+\varepsilon}{\varepsilon}}$, for men and for women. This is slightly different from using distinct fixed and random effects for men and women because we also allow the estimate of the idiosyncratic variance to differ in the two cases. Modelling the consumption and labour terms in the way in which they enter the utility function, rather than focusing on consumption and labour supply directly, ensures that we can estimate the mean level of well-being by averaging fitted values across the population of each LTLA. We assume that the various random terms are homoscedastic. Elbers et al. (2003) extend the model to address heteroscedasticity but with our error structure, we are not also be able to explore this.

The Stata command, *mixed* makes it possible to estimate β and the variances of the random terms, σ_1^2, σ_2^2, σ_3^2 and σ_ε^2 by means of maximum likelihood, with the assumption that the random effects are independent of each other. The programme also allows us to estimate fitted values for LTLA k for any given age, τ, in region reg as

$$\hat{\mathbf{y}}_{k,\tau} = \boldsymbol{X_k}\hat{\boldsymbol{\beta}} + \mathbf{Q}_1\hat{\mathbf{v}}_{1,\tau} + \mathbf{Q}_2\hat{\mathbf{v}}_{2,reg} + \mathbf{Q}_3\hat{\mathbf{v}}_{3,k} \tag{10}$$

where $\mathbf{X_k}$ is the mean value of the exogenous variables for LTLA k, $\hat{\mathbf{v}}_{1,\tau}$ is a vector which contains the estimated age random effect for the relevant age group and zeros otherwise. $\hat{\mathbf{v}}_{2,reg}$ and $\hat{\mathbf{v}}_{3,k}$ are similarly defined for the random effects for region and LTLA. Here it should be noted that the random effects can be estimated only for the LTLAs for which there are data. For other areas the fitted value of the dependent variable has to be calculated with the assumption that these take their expected value of zero. This issue arises only with the LTLA fixed effects when producing estimates of consumption, since there is a full set of observations for both random age terms $\mathbf{v}_1$, and regional terms, $\mathbf{v}_2$. There are also data from all LTLAs in the APS.

Production of estimate standard errors is an essential part of small area estimation. This is discussed in appendix D. The standard errors that we derive there reflect uncertainty in the vital statistics as well as uncertainty in the values of log consumption and the leisure variable. They relate to the means for each LTLA and thus, of course suppress variation within each LTLA.

7 Models

Our parameter estimates are shown in table 1[15]. The models are estimated on individual data; the fixed effects relate to explanatory variables observed at the middle layer super output area (MSOA). We were unable to estimate models with small area effects for MSOAs, probably because some of those included in the LCFS sample have very small numbers of observations.

The parameter estimates show that all three covariates are strong indicators of effective household consumption (although log of mean gas use was not). Log of mean house price is at most only marginally significant as an indicator of men's work input. The age and LTLA random effects are clearly important but that of the regional effects is small relative to its standard error. The variances of the LTLA random effects are only a small fraction of the residual variances- 3% for consumption and only 0.2% for the equation estimating women's work. But it must be remembered that the impact of the residual variance on the variance of an LTLA estimate declines with the number of observations, because, by construction, the residual shocks are independent of each other. As a result, for an average LTLA, with 67,000 men and 70,000 women,[16] the impact of the uncertainty associated with the area effect is large compared with that associated with the residual.

8 Results

Our local area well-being estimate represent the multiple of private consumption in England as a whole which would be required to deliver the same level of life-time well-being as that observed in a particular LTLA. This well-being metric is a consumption-equivalent measure, and represents the answer to the question: How much would the log of consumption of the average person with average health-adjusted life expectancy have

[15]Parameter estimates when θ=14.2 are shown in table A2 of the Appendix

[16]This ratio of women to men is similar to that shown in the mid-year population estimates for people aged 18 and over.

Table 1: Mixed-mode Parameter Estimates for Log (consumption) and the Labour Input Variables for Men and Women

	(1) log(Consumption)	(2) Work: men	(3) Work: women
Fixed effects			
mean(log net income)	0.917***	0.0609***	0.0395***
	(9.67)	(15.86)	(14.89)
log (mean electricity use)	0.349***	0.0404***	0.0000646
	(4.47)	(12.85)	(0.03)
log(mean house prices)	0.0996**	-0.00218	0.00115
	(2.70)	(-1.56)	(1.32)
Constant	-3.187***	-0.829***	-0.365***
	(-3.51)	(-21.14)	(-13.92)
Random effects			
log(s.d. age categories)	-1.671***	-2.834***	-3.453***
	(-7.81)	(-14.97)	(-18.22)
log(s.d regions)	-3.012***	-6.511***	-7.279***
	(-8.07)	(-10.73)	(-7.72)
log(s.d. lower tier local authorities)	-2.357***	-5.051***	-5.630***
	(-14.15)	(-50.05)	(-46.13)
log(s.d residua)	-0.497***	-2.226***	-2.523***
	(-43.27)	(-908.20)	(-1087.10)
N	4028	83531	93163

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

to change to align their life-time well-being with someone living in say Stoke-on-Trent, the lowest-rated local authority, or Elmbridge, the highest-rated one, taking into account the differences in health-adjusted life expectancy in these local authorities?

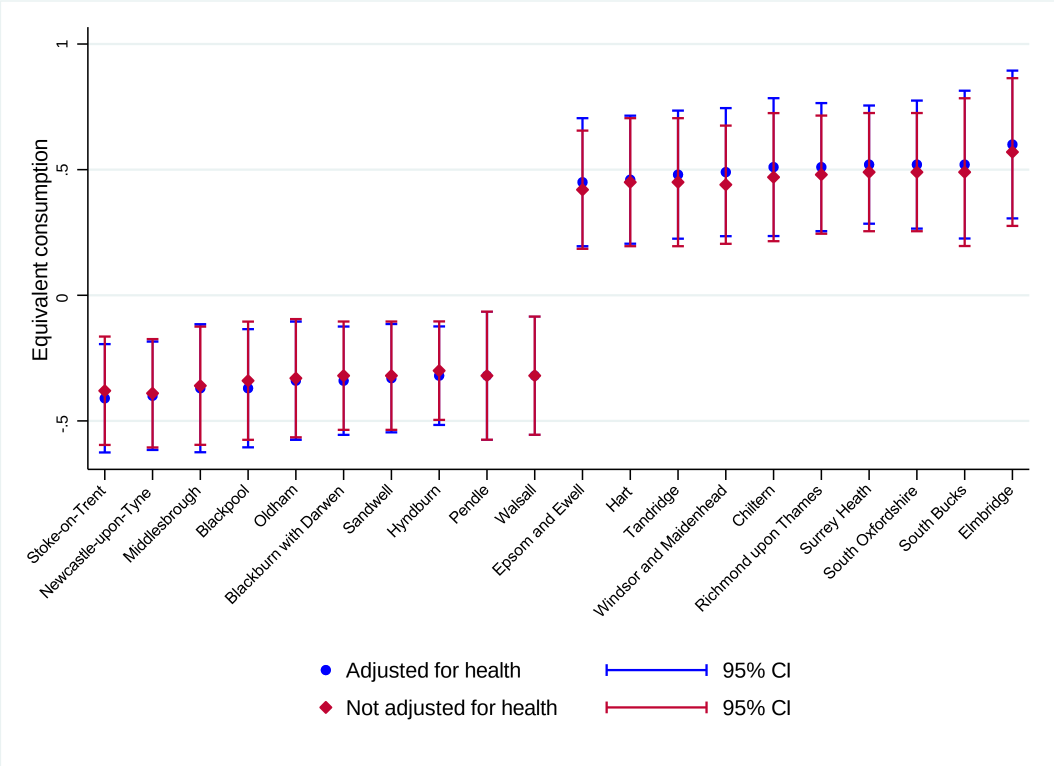
Table A1 in appendix B presents the full results while table A3 in appendix C shows the results with $\theta = 14.2$. The estimates are calculated using equation (5) and averaging across men and women. We show results both without any influence from health effects and with the assumption that on average people not in good health enjoy only 75% of the utility of those in good health. The first five columns of the tables in appendix B show the results with no adjustment for health status, while the second group of five columns shows the results after making an adjustment for health status.

In each subgroup the column marked “Rank” shows the ranking of the area’s equivalent consumption in England. The second column shows the log of the equivalent consumption followed by its standard error. The fourth and fifth columns show life expectancy at twenty and its standard error. The second group of results shows the same variables but after adjusting for health status. This means that expected time in poor health is counted at only 75% of expected time in good health, with utility adjusted on the same basis. The rank correlation between the two measures of equivalent variation is 0.99.

Here we present the results graphically. Figure 1 shows the small area estimates of well-being for the top and bottom ten LTLAs in England ranked using the measure that adjusts for health and with increasing rank associated with increasing well-being.

Figure 1 shows that there is wide variation in well-being across England, and there is a statistically significant difference between, for example, a group of local authorities at the very top and a group at the very bottom. Of course, as the figure shows, there is not a statistically significant difference between each of the areas within these two groupings. The null hypothesis of well-being equality in Elmbridge and Epsom and Ewell cannot be rejected for example. The value of equivalent income or well-being (λ) of -0.41 for Stoke-on-Trent means that average private consumption for the UK would need to be adjusted downwards by 0.41 log units or 0.34% for it to be equal to well-being in Stoke-on-Trent. Similarly, the well-being measure of 0.60 for Elmbridge implies that average private consumption for the UK would need to be adjusted upwards by 0.60 log units or 82% for the UK average to equal the level of well-being in Elmbridge. Figure 2 shows the health adjusted well-being measure for all local authorities as well as life

Figure 1: Equivalent consumption: top and bottom 10 local authorities



Source: Authors' calculations from ONS and HMRC data.
Note: Top and bottom 10 local authorities ranked by equivalent income adjusted for health.

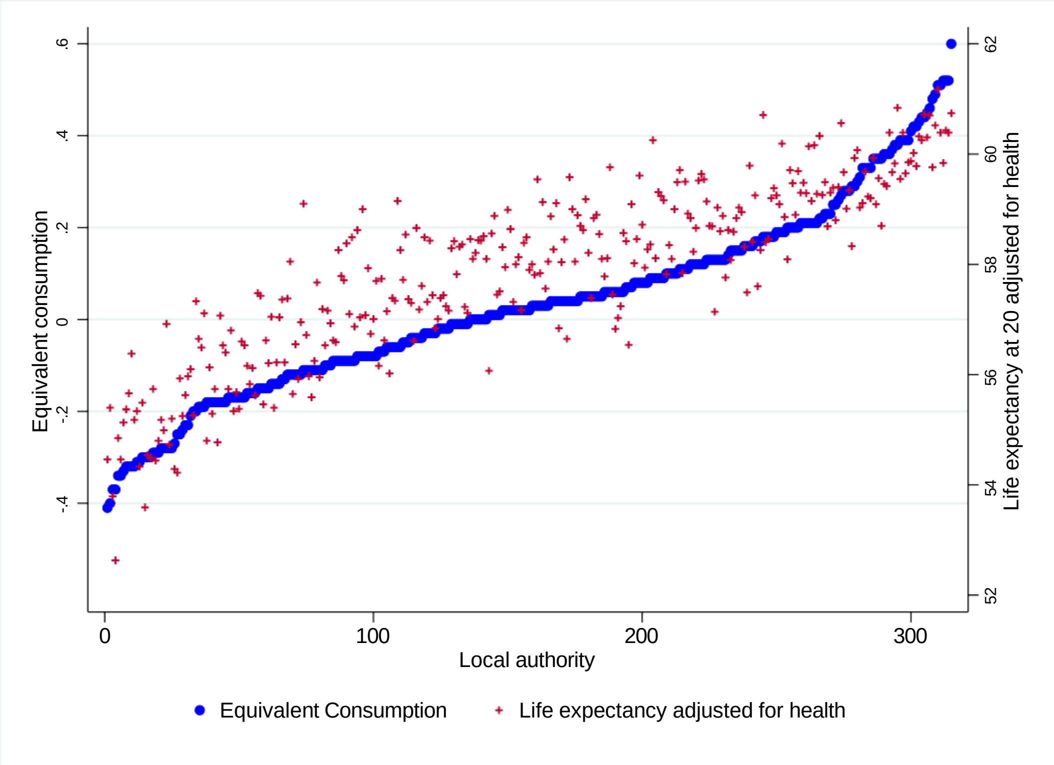
expectancy at age 20 adjusted for health.

9 The Relationship with Income and Life-expectancy

We now explore the statistical relationship between the well-being measure and the two major correlates of it, the geometric mean of income[17] in each LTLA and the health-adjusted life expectancy at age 20. The correlations are shown in table 2. We can see that health-adjusted life expectancy is more strongly related to the well-being measure than is income, stressing the importance of terms which relate to health in any measure of well-being. We also see a marked correlation between health-adjusted life expectancy and the geometric mean of income- a point frequently commented on. It is beyond the scope of this work to say whether or how far the causation runs from income to life expectancy.

[17]Well-being is of course dependent on consumption rather than income. But given that we have modelled data for consumption and that income is a strong correlate of consumption as table 2 shows, we consider a reduced form in which income is taken as a driving variable.

Figure 2: Equivalent consumption and life expectancy



Source: Authors' calculations from ONS and HMRC data.

Table 2: Correlations between Income, Health-adjusted Life Expectancy and the Well-being Measure

	log(Geometric Mean Income)	Health-adj Lfe Exp.
Health-adj Lfe Exp.	0.72	
Well-being Measure	0.88	0.87

In table 3 we explore in more detail the relationship between the two driving variables and the well-being measure. Model 1 shows the influence of life expectancy on the well-being measure assuming implicitly that the causation behind the correlation of table 2 runs from life expectancy to income, perhaps because good health makes high earnings possible. In that case one extra year of life expectancy raises well-being by 0.11 units. Alternatively in model 2 we see the effect of a unit increase in log income on the well-being measure, assuming that all of the correlation between income and life expectancy is causative from the former. In that case a 1 per cent increase in income raises well-being by 0.016 units. Finally in model 3 we see the influence of the two variables on well-being, with the assumption that the statistical connection between the two is not causative in either direction. In that case a 1 per cent increase in income raises well-being by 0.01 units while an increase in life expectancy of one year raises the well-being measure by 0.06 units.

Table 3: Explaining the Well-being Measure by Income and Health-adjusted Life Expectancy

	Model 1	Model 2	Model 3
Health-adj. Life Exp. at 20.	0.109***		0.059***
	(31.2)		(17.2)
Log(GM Income)		1.641***	0.998***
		(34.0)	(19.6)
Constant	-6.262***	-16.671***	-13.555***
	(-31.0)	(-34.0)	(-34.3)
R^2	0.756	0.787	0.890
N	315	315	315

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We can then explore the life-time costs and benefits of raising well-being by either increasing health-adjusted life expectancy or by raising income throughout life. A 1 percentage point increase in income has to persist for the whole of the life course to have the effect on well-being described. In Stoke-on-Trent a 1 per cent increase in the geometric mean of income costs £222 per year. With no discounting this amounts to £13,211 over the 59.52 years of expected life shown in appendix B for Stoke on Trent. This raises well-being by between 0.01 and 0.0164 log units, with the first figure taken from model 3 and the second from model 2. An increase in health-adjusted life expectancy of 1 year would raise well-being by between 0.06 (model 3) and 0.1 units (model 2) at the assumed cost of £46,114, implying that the expenditure of £13,211 on raising health-adjusted expected life would increase well-being by between 0.017 and 0.031 units. That suggests that improvements to health offer a cheaper way of levelling up life-time well-being in deprived areas than do direct increases in income, assuming of course that it is possible to identify interventions which raise life expectancy as required. Of course this does not rule out the possibility, discussed by Marmot (2016), that both life expectancy and income may be a product of circumstances, and that the best intervention would be to improve people's circumstances in depressed local authorities.

10 The Relationship with Indices of Multiple Deprivation

Since 2000 the Office for National Statistics has published indices of multiple deprivation (IMD). These reflect seven domains: income, employment, education, health, crime, barriers to housing and the living environment. They are made available for lower layer super output areas (LSOAs), splitting England up into 34,753 areas. Rankings for LTLAs are produced by the ONS from these. We use the 2019 figures[18]

In table 4 we show the rank correlations at LTLA level between our indicator of well-being (Well-being), the geometric mean of income (GM Income) calculated from the income data used in our calculations, the first decile of the income data (1st decile) and the Indicator of Multiple Deprivation and its components. Our well-being indicator has a rank correlation of 0.88 with the Indicator of Multiple Deprivation which is fairly high but also leaves room to suggest that the two variables are measuring different things.

This distinction can be seen more clearly by looking at the rank correlations between the income component of the IMD[19] and three other indicators, our well-being measure, the geometric mean of income, the first decile point of income and the complete IMD. We can see that the rank correlation between the IMD income component and the full IMD is very high at 0.98. but that the IMD income measure is more weakly correlated with the two income indicators (the geometric mean and the first decile) taken directly from our input data than it is with our computed well-being measure. Thus it is likely that a large part of the divergence between the ranking of our measure of well-being and the ranking shown in the IMD arises from the fact that the two income indicators are ranked very differently. Our aim is to reflect the average well-being in the area while the IMD is designed to focus on the extent to which low incomes are widespread and there is no reason why the rankings of these two should be strongly correlated. It is worth noting, however, that even the ranking of the bottom decile of income is not strongly correlated in rank with the IMD income indicator. We should also draw attention to the strength of the rank correlation between our well-being indicator and the IMD Health indicator. This probably indicates the influence of healthy life expectancy and overall life expectancy on our well-being indicator.

[18]See https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019.

[19]We focus on the rank, by LTLA of the average score of each LTLA. The score is the proportion of the population receiving means-tested benefits

Table 4: Rank Correlations between Income Indicators and Components of Indicators of Multiple Deprivation

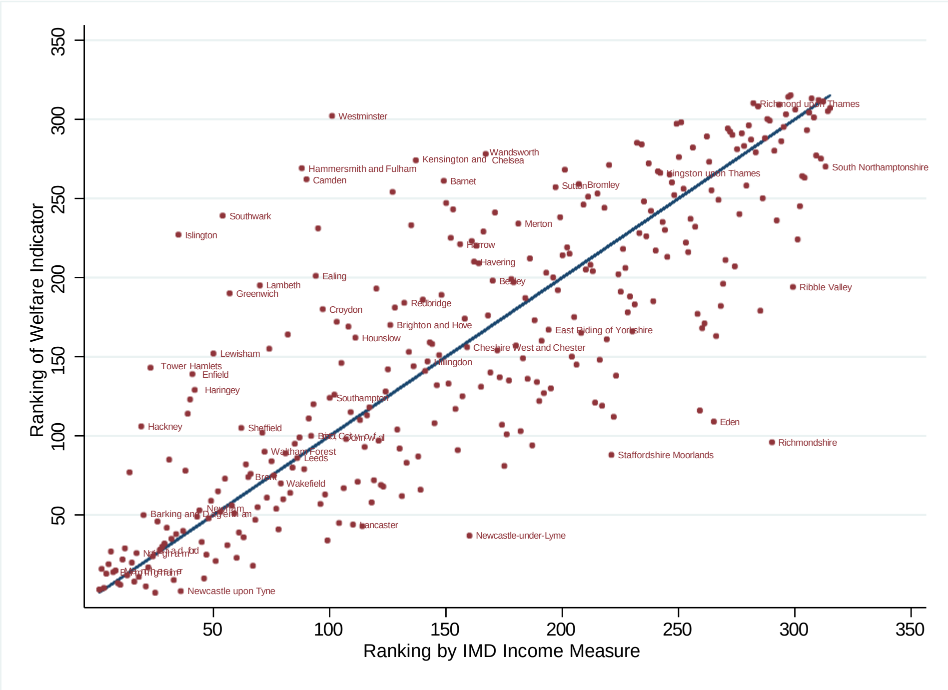
	Well-being	GM Income	1st decile	IMD	IMD Inc.	IMD Emp.	IMD Edc.	IMD Health	IMD Crime	IMD Barr.
GM Income	0.87									
1st decile	0.70	0.86								
IMD	0.84	0.77	0.70							
IMD Inc.	0.82	0.72	0.67	0.98						
IMD Emp.	0.87	0.80	0.66	0.95	0.96					
IMD Edc.	0.79	0.81	0.57	0.80	0.75	0.81				
IMD Health	0.89	0.80	0.60	0.92	0.89	0.94	0.82			
IMD Crime	0.47	0.31	0.34	0.72	0.74	0.61	0.47	0.58		
IMD Barr.	-0.42	-0.34	-0.10	-0.20	-0.23	-0.38	-0.34	-0.43	-0.11	
IMD Liv	0.26	0.31	0.49	0.42	0.36	0.29	0.09	0.25	0.23	0.16

We now examine in more detail the relationship between our measure of well-being and the IMD. We focus on the relationship between our measure and the IMD income measure. As we see above it is very closely correlated with the overall IMD and the fact that it is not a composite measure makes it easier to interpret.

Figure 3 shows the relationship between the ranking of each LTLA by our measure of well-being (taking into account state of health) and its ranking by the IMD income measure. While the graph shows that there is a good correlation (0.86) it is nevertheless also striking that there is considerable variation in the relative ranking. A number of London boroughs and particularly some in the inner suburbs are ranked much more highly by well-being than by the IMD income measure. Extreme examples are provided by Westminster, Kensington and Chelsea and Camden. The Ribble Valley is an example of a LTLA ranked fairly favourably by the IMD but not by well-being. Perhaps the most extreme example is Westminster which is ranked 299/315 by our well-being measure but only 101/315 when ranked by the IMD income measure. The income measure used in IMD income is measured by the proportion of the population in households receiving means-tested benefits or classified as asylum seekers receiving support. Our well-being measure, on the other hand, is designed to be indicative of the average level of well-being in the area in question.

But we also note that life expectancy is generally rising in income: if household incomes in Westminster were low we should expect to see low life expectancy. In fact in Westminster we find a life expectancy at birth for 2014-2016 (average of men and women) of 84.2 while in England as a whole it is 81.4. Indeed life expectancy at birth in Westminster is exceeded only by that in five other LTLAs[20]. While this is not in any sense a proof, it is consistent with the idea that IMD income is not very representative of the status of the area as a whole.

Figure 3: LTLAs ranked by the Well-being Measure and by the Income Component of the Index of Multiple Deprivation



Source: Authors' calculations from ONS and HMRC data.

11 Conclusions

This work has demonstrated, that, subject to a number of reasonable approximations, it is possible to compute well-being measures, which reflect consumption, leisure and expected life in good and poor health, for local authorities in England. We find substantial variation in well-being across England, with well-being in Stoke-on -Trent equivalent to an adult consumption level of half the national average while the level of well-being in Elmbridge in Surrey is equivalent to a level of consumption more than twice the national average once variations in health and life expectancy are taken into account.

Our data show the widely-observed strong statistical relationship between income and health-adjusted life expectancy. It is nevertheless possible to examine how far the

[20] Camden, Harrow, Kensington and Chelsea in London and Hart and Chiltern outside London.

welfare measure is sensitive to each of these. Even if the correlation between the two is assumed not to be causative our estimates suggest that policies to raise healthy life expectancy in deprived areas offer a cheaper means of raising life-time welfare than do direct income transfers.

We also observe that there is a clear relationship between our indicator and the indices of multiple deprivation. Nevertheless some of London's inner suburbs are highly ranked by our indicator and ranked low by the indices of multiple deprivation. That reflects the fact that the indices of multiple deprivation are designed to show a strong degree of inequality aversion. But, given the high life expectancy observed in the suburbs in question it also raises questions about the specification of the indices.

Bannister & Mourmouras (2017) have extended the framework at a national level to reflect some aspects of environmental pollution and sustainability. Clearly, if capital, broadly defined, is being decumulated, then sustainable consumption will be lower than our figures based on 2015 data. Adjustments for broad externalities, such as green-house gas emissions, are logically applied on a proportionate basis. But our work can be developed to reflect the local environment given suitable prices or costs for key features of the local environment. One issue which will need attention is that prices often reflect health effects; our modelling framework already takes these into account.

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A Matching LTLA classifications

The demographic data at LTLA level identify 307 LTLAs in England while the other data sets with which we have worked identify 315 LTLAs. The differences arise entirely because of the treatment of Buckinghamshire and Northamptonshire. In 2020 a new unitary authority was set up for Buckinghamshire while until then there had been four authorities, Aylesbury Vale, Chiltern, S. Bucks and Wycombe. These four are identified in the rest of our data, and we assume that the life tables provided for Buckinghamshire apply to these local authorities.

In 2020 Northamptonshire was reorganised with two authorities, North Northamptonshire and West Northamptonshire instead of the previous seven. The former comprises Corby, East Northamptonshire, Kettering and Wellingborough, while the latter is made up of Daventry, Northampton and South Northamptonshire. We have again assumed that the life tables for the consolidated authorities are relevant to their pre-2020 components.

The income data are provided to a slightly finer classification of local authorities which we need to consolidate to reach our 315 authorities. Thus West Suffolk is comprised of Forest Heath and St Edmundsbury, East Suffolk of Suffolk Coastal and Waveney. Bournemouth, Christchurch and Poole is an agglomeration of the three towns, while East Dorset, North Dorset Purbeck, West Dorset and Weymouth are combined to produce Dorset. Finally Taunton Deane and West Somerset are combined to produce Somerset. We have used the arithmetic average of the income points across the component data in order to generate figures for the aggregated local authorities.

B LTLA Estimates of Well-being: Main Model

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Adur	216	0.1	0.14	62.5	0.26	220	0.12	0.14	58.66	0.25
Allerdale	58	-0.15	0.12	61.03	0.22	62	-0.14	0.12	57.05	0.22
Amber Valley	96	-0.08	0.11	61.58	0.18	91	-0.09	0.11	57.1	0.20
Arun	146	0.01	0.12	61.93	0.17	154	0.02	0.12	58.13	0.18
Ashfield	60	-0.14	0.14	60.4	0.18	61	-0.15	0.14	56.21	0.19
Ashford	249	0.17	0.12	62.53	0.19	247	0.18	0.12	58.46	0.19
Aylesbury Vale	286	0.33	0.12	63.91	0.09	292	0.36	0.12	60.39	0.14
Babergh	230	0.13	0.14	63.23	0.21	228	0.13	0.14	59.03	0.22
Barking and Dagenham	57	-0.15	0.13	60.24	0.18	50	-0.17	0.13	55.38	0.26
Barnet	269	0.22	0.13	63.98	0.12	261	0.21	0.13	59.29	0.27
Barnsley	53	-0.15	0.11	60.52	0.14	49	-0.17	0.12	55.68	0.18
Barrow-in-Furness	46	-0.16	0.14	59.42	0.27	56	-0.16	0.14	55.62	0.26
Basildon	228	0.12	0.11	61.59	0.16	231	0.13	0.11	57.76	0.17
Basingstoke and Deane	289	0.34	0.12	62.46	0.16	289	0.35	0.12	58.7	0.17
Bassetlaw	107	-0.06	0.12	60.89	0.2	104	-0.07	0.12	56.62	0.20
Bath and North East Somerset	237	0.15	0.11	62.97	0.15	242	0.17	0.11	59.25	0.19
Bedford	135	-0.01	0.11	62.24	0.17	141	0	0.11	58.51	0.28
Bexley	199	0.07	0.12	62.54	0.14	198	0.08	0.12	58.46	0.19
Birmingham	16	-0.28	0.1	60.43	0.07	14	-0.3	0.1	55.49	0.12
Blaby	186	0.05	0.14	63.07	0.21	182	0.05	0.14	58.84	0.22
Blackburn with Darwen	7	-0.32	0.11	59.02	0.19	6	-0.34	0.11	54.46	0.20
Blackpool	4	-0.34	0.12	57.52	0.19	4	-0.37	0.12	52.63	0.21
Bolsover	41	-0.17	0.14	59.99	0.23	41	-0.18	0.14	55.74	0.23
Bolton	32	-0.21	0.11	60.22	0.13	32	-0.21	0.11	56.1	0.17
Boston	73	-0.11	0.12	60.91	0.26	71	-0.12	0.12	56.55	0.26
Bournemouth, Christchurch and Po	129	-0.02	0.14	62.14	0.1	132	-0.01	0.14	58.32	0.13
Bracknell Forest	295	0.36	0.12	63.6	0.21	294	0.38	0.13	59.83	0.22
Bradford	26	-0.24	0.1	60.24	0.1	28	-0.25	0.1	55.93	0.15
Braintree	217	0.11	0.11	62.11	0.17	219	0.12	0.11	58.23	0.17
Breckland	104	-0.06	0.12	62.08	0.17	103	-0.07	0.12	57.74	0.19
Brent	69	-0.12	0.11	63.06	0.14	74	-0.11	0.11	59.1	0.28
Brentwood	291	0.34	0.14	63.06	0.22	287	0.35	0.15	59.09	0.21
Brighton and Hove	165	0.03	0.11	61.88	0.14	170	0.04	0.11	58.04	0.19
Bristol, City of	99	-0.07	0.1	61.26	0.11	100	-0.08	0.1	57.01	0.16
Broadland	183	0.05	0.13	62.89	0.17	171	0.04	0.13	58.45	0.19
Bromley	263	0.2	0.12	63.5	0.12	259	0.21	0.12	59.3	0.21
Bromsgrove	163	0.03	0.12	62.42	0.2	177	0.05	0.13	58.7	0.21
Broxbourne	222	0.11	0.12	63.51	0.22	223	0.12	0.13	59.54	0.22
Broxtowe	168	0.03	0.12	62.22	0.19	160	0.03	0.12	57.81	0.20
Burnley	10	-0.31	0.14	59.36	0.24	12	-0.31	0.14	55.34	0.23
Bury	61	-0.14	0.12	60.33	0.16	64	-0.14	0.12	56.22	0.18
Calderdale	84	-0.1	0.14	60.9	0.15	84	-0.1	0.14	56.93	0.18
Cambridge	227	0.12	0.15	62.74	0.21	230	0.13	0.15	58.88	0.22
Camden	267	0.21	0.15	64.73	0.18	262	0.21	0.15	60.14	0.30
Cannock Chase	37	-0.18	0.12	61.16	0.21	43	-0.18	0.13	57.07	0.22
Canterbury	149	0.01	0.13	61.97	0.17	149	0.02	0.13	57.95	0.18
Carlisle	64	-0.14	0.14	61.36	0.2	66	-0.13	0.14	57.36	0.20
Castle Point	206	0.09	0.12	61.65	0.21	209	0.1	0.12	57.82	0.21

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Central Bedfordshire	255	0.19	0.11	63.11	0.13	260	0.21	0.11	59.48	0.19
Charnwood	114	-0.05	0.12	62.71	0.16	112	-0.05	0.12	58.54	0.18
Chelmsford	265	0.21	0.13	63.3	0.16	265	0.21	0.13	59.28	0.16
Cheltenham	133	-0.01	0.11	62.32	0.19	145	0.01	0.11	58.88	0.20
Cherwell	274	0.25	0.12	62.27	0.17	276	0.28	0.12	59.01	0.19
Cheshire East	213	0.1	0.1	62.49	0.11	218	0.12	0.1	58.84	0.20
Cheshire West and Chester	139	0	0.1	61.72	0.11	156	0.02	0.11	58.39	0.19
Chesterfield	105	-0.06	0.1	60.51	0.21	102	-0.07	0.1	56.16	0.21
Chichester	244	0.17	0.12	63.12	0.18	248	0.18	0.12	59.2	0.19
Chiltern	311	0.48	0.12	63.91	0.09	311	0.51	0.13	60.39	0.14
Chorley	138	0	0.12	61.33	0.19	135	-0.01	0.12	57.12	0.19
Colchester	180	0.05	0.12	61.97	0.15	187	0.06	0.12	58.11	0.16
Copeland	115	-0.05	0.14	60.53	0.26	115	-0.04	0.15	56.61	0.25
Corby	56	-0.15	0.12	59.13	0.29	63	-0.14	0.12	55.4	0.28
Cornwall	94	-0.08	0.1	61.95	0.09	98	-0.08	0.1	57.93	0.14
Cotswold	275	0.26	0.13	63.51	0.23	279	0.29	0.14	59.93	0.23
County Durham	65	-0.13	0.11	60.23	0.09	59	-0.15	0.11	55.46	0.14
Coventry	43	-0.17	0.1	61.03	0.12	47	-0.17	0.1	56.8	0.16
Craven	204	0.08	0.14	63.1	0.28	207	0.09	0.15	59.24	0.27
Crawley	224	0.11	0.14	62.57	0.23	225	0.13	0.14	58.7	0.22
Croydon	182	0.05	0.12	62.39	0.12	180	0.05	0.13	58.21	0.20
Dacorum	271	0.24	0.13	63.3	0.17	271	0.25	0.13	59.39	0.18
Darlington	59	-0.15	0.12	60.58	0.21	55	-0.16	0.12	56.12	0.22
Dartford	190	0.06	0.12	61.14	0.21	192	0.06	0.12	57.24	0.21
Daventry	231	0.13	0.12	62.74	0.22	232	0.14	0.13	58.62	0.24
Derby	48	-0.16	0.12	61.14	0.14	51	-0.17	0.12	56.6	0.18
Derbyshire Dales	218	0.11	0.12	62.73	0.23	211	0.1	0.12	58.1	0.24
Doncaster	54	-0.15	0.1	60.27	0.12	48	-0.17	0.1	55.34	0.16
Dorset	210	0.09	0.14	63.38	0.1	208	0.09	0.14	59.16	0.18
Dover	144	0.01	0.11	61.39	0.19	146	0.01	0.11	57.45	0.19
Dudley	18	-0.28	0.12	61.41	0.12	23	-0.28	0.12	56.92	0.16
Ealing	214	0.1	0.13	62.84	0.14	201	0.08	0.13	57.94	0.23
East Cambridgeshire	247	0.17	0.13	63.33	0.22	249	0.18	0.13	59.38	0.23
East Devon	164	0.03	0.13	63.16	0.18	188	0.06	0.13	59.76	0.19
East Hampshire	290	0.34	0.12	63.44	0.19	288	0.35	0.12	59.56	0.19
East Hertfordshire	301	0.39	0.12	63.86	0.17	300	0.41	0.12	59.87	0.18
East Lindsey	49	-0.16	0.12	60.89	0.18	52	-0.17	0.12	56.53	0.20
East Northamptonshire	202	0.08	0.14	62.34	0.22	202	0.08	0.14	58.27	0.23
East Riding of Yorkshire	162	0.03	0.12	62.15	0.11	167	0.04	0.12	58.27	0.14
East Staffordshire	76	-0.11	0.14	61.3	0.19	81	-0.11	0.14	57.19	0.21
East Suffolk	152	0.02	0.14	62.81	0.13	151	0.02	0.14	58.64	0.16
Eastbourne	118	-0.04	0.14	62.26	0.21	111	-0.05	0.14	57.72	0.22
Eastleigh	257	0.19	0.11	63.59	0.19	258	0.2	0.11	59.69	0.19
Eden	108	-0.06	0.13	63.4	0.3	109	-0.06	0.13	59.15	0.28
Elmbridge	315	0.57	0.15	64.31	0.18	315	0.6	0.15	60.74	0.19
Enfield	142	0	0.13	62.76	0.13	139	0	0.13	58.44	0.23
Epping Forest	246	0.17	0.12	62.3	0.18	246	0.18	0.13	58.4	0.18
Epsom and Ewell	305	0.42	0.12	63.82	0.24	306	0.45	0.13	60.3	0.23

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Erewash	93	-0.09	0.12	61.64	0.19	83	-0.1	0.12	57.16	0.20
Exeter	119	-0.04	0.12	61.69	0.2	130	-0.01	0.12	58.42	0.21
Fareham	221	0.11	0.12	62.95	0.18	224	0.13	0.12	59.14	0.18
Fenland	117	-0.04	0.12	61.02	0.22	120	-0.03	0.12	57.32	0.23
Folkestone and Hythe	161	0.03	0.11	61.54	0.2	164	0.03	0.11	57.56	0.20
Forest of Dean	157	0.02	0.13	62.32	0.22	176	0.04	0.13	58.89	0.22
Fylde	132	-0.01	0.14	61.5	0.24	127	-0.02	0.14	57.24	0.23
Gateshead	21	-0.27	0.12	59.86	0.15	25	-0.28	0.12	55.2	0.19
Gedling	101	-0.07	0.12	62.09	0.18	101	-0.08	0.12	57.7	0.19
Gloucester	103	-0.07	0.12	60.68	0.2	113	-0.05	0.12	57.37	0.20
Gosport	127	-0.03	0.14	61.49	0.24	131	-0.01	0.14	57.82	0.23
Gravesham	258	0.19	0.12	62.11	0.21	254	0.2	0.12	58.09	0.21
Great Yarmouth	34	-0.19	0.12	60.87	0.22	35	-0.19	0.12	56.65	0.22
Greenwich	197	0.07	0.12	61.44	0.15	190	0.06	0.12	56.83	0.21
Guildford	303	0.4	0.12	63.84	0.18	303	0.43	0.12	60.32	0.18
Hackney	126	-0.03	0.13	61.41	0.19	106	-0.06	0.13	56.02	0.26
Halton	47	-0.16	0.12	59.5	0.19	42	-0.18	0.12	54.77	0.25
Hambleton	239	0.15	0.12	63.7	0.2	240	0.16	0.12	59.79	0.22
Hammersmith and Fulham	268	0.22	0.15	62.37	0.19	269	0.23	0.16	58.69	0.27
Harborough	266	0.21	0.13	63.41	0.21	263	0.21	0.13	59.15	0.22
Haringey	134	-0.01	0.12	62.74	0.17	129	-0.01	0.12	58.29	0.22
Harlow	124	-0.03	0.12	61.24	0.25	126	-0.02	0.12	57.44	0.23
Harrogate	250	0.17	0.14	63.1	0.16	250	0.19	0.15	59.25	0.18
Harrow	232	0.14	0.11	64.7	0.15	221	0.12	0.11	59.52	0.23
Hart	309	0.45	0.13	64.73	0.21	307	0.46	0.13	60.7	0.21
Hartlepool	23	-0.26	0.11	59.39	0.23	19	-0.29	0.11	54.44	0.23
Hastings	75	-0.11	0.12	59.82	0.23	77	-0.11	0.12	55.59	0.24
Havant	184	0.05	0.13	62.34	0.19	193	0.06	0.13	58.57	0.19
Havering	212	0.09	0.12	62.44	0.13	210	0.1	0.12	58.35	0.19
Herefordshire, County of	86	-0.09	0.11	62.43	0.15	94	-0.08	0.12	58.62	0.18
Hertsmere	251	0.18	0.13	62.96	0.21	251	0.19	0.13	59.09	0.20
High Peak	141	0	0.14	61.74	0.22	134	-0.01	0.14	57.23	0.23
Hillingdon	173	0.04	0.11	62.7	0.14	147	0.01	0.11	57.51	0.22
Hinckley and Bosworth	176	0.04	0.12	62.81	0.19	178	0.05	0.12	58.62	0.21
Horsham	296	0.36	0.13	63.66	0.18	293	0.37	0.13	59.67	0.19
Hounslow	179	0.05	0.12	62.6	0.15	162	0.03	0.13	57.84	0.33
Huntingdonshire	256	0.19	0.12	63.42	0.16	256	0.2	0.12	59.47	0.18
Hyndburn	6	-0.32	0.13	59.69	0.24	9	-0.32	0.13	55.66	0.23
Ipswich	71	-0.11	0.12	61.7	0.19	79	-0.11	0.12	57.67	0.19
Isle of Wight	62	-0.14	0.12	62.17	0.17	57	-0.15	0.12	57.48	0.20
Islington	234	0.14	0.15	61.83	0.19	227	0.13	0.15	57.14	0.26
Kensington and Chelsea	280	0.28	0.15	65.42	0.2	274	0.27	0.15	60.56	0.30
Kettering	156	0.02	0.12	61.93	0.22	158	0.02	0.12	57.9	0.23
Kings Lynn and West Norfolk	160	0.02	0.12	62.4	0.17	153	0.02	0.13	58	0.19
Kingston upon Hull, City of	27	-0.24	0.11	58.74	0.14	27	-0.25	0.11	54.22	0.19
Kingston upon Thames	260	0.2	0.12	63.81	0.18	266	0.22	0.12	60.33	0.26
Kirklees	100	-0.07	0.12	61.11	0.1	99	-0.08	0.12	56.74	0.15

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Knowsley	14	-0.29	0.12	58.98	0.18	16	-0.3	0.12	54.54	0.20
Lambeth	211	0.09	0.13	61.43	0.16	195	0.07	0.13	56.54	0.25
Lancaster	40	-0.18	0.11	60.68	0.18	44	-0.18	0.11	56.53	0.18
Leeds	88	-0.09	0.09	60.73	0.08	86	-0.09	0.09	56.59	0.13
Leicester	12	-0.3	0.12	60.02	0.13	11	-0.32	0.12	55.18	0.18
Lewes	219	0.11	0.14	63.75	0.21	212	0.1	0.14	59	0.22
Lewisham	158	0.02	0.12	61.59	0.15	152	0.02	0.12	57.32	0.32
Lichfield	140	0	0.13	62.45	0.19	138	0	0.13	58.21	0.21
Lincoln	15	-0.29	0.13	60	0.24	18	-0.29	0.13	55.74	0.24
Liverpool	13	-0.29	0.11	58.92	0.1	13	-0.31	0.11	54.33	0.14
Luton	92	-0.09	0.11	60.99	0.17	76	-0.11	0.11	55.97	0.18
Maidstone	238	0.15	0.12	62.36	0.16	238	0.16	0.12	58.32	0.17
Maldon	245	0.17	0.14	62.16	0.27	244	0.17	0.15	58.26	0.26
Malvern Hills	143	0	0.13	62.75	0.22	150	0.02	0.13	58.99	0.23
Manchester	17	-0.28	0.11	58.16	0.11	15	-0.3	0.11	53.59	0.16
Mansfield	38	-0.18	0.14	60.34	0.2	39	-0.18	0.14	56.13	0.21
Medway	174	0.04	0.11	60.75	0.13	172	0.04	0.11	56.65	0.18
Melton	170	0.04	0.11	63.35	0.28	168	0.04	0.12	59.11	0.27
Mendip	136	0	0.12	62.67	0.2	136	0	0.12	58.46	0.22
Merton	236	0.15	0.12	62.9	0.16	234	0.15	0.13	58.59	0.25
Mid Devon	200	0.08	0.13	63.11	0.23	214	0.11	0.14	59.71	0.24
Mid Suffolk	259	0.19	0.13	64.01	0.2	255	0.2	0.13	59.71	0.20
Mid Sussex	276	0.26	0.12	63.64	0.17	275	0.28	0.12	59.67	0.18
Middlesbrough	3	-0.36	0.12	58.21	0.19	3	-0.37	0.13	53.79	0.21
Milton Keynes	188	0.05	0.11	61.54	0.14	189	0.06	0.11	57.45	0.18
Mole Valley	300	0.39	0.12	63.52	0.22	301	0.42	0.12	60.02	0.22
New Forest	252	0.18	0.11	64.16	0.15	252	0.19	0.11	60.19	0.16
Newark and Sherwood	131	-0.02	0.13	61.76	0.19	125	-0.02	0.13	57.39	0.19
Newcastle upon Tyne	1	-0.39	0.11	59.73	0.14	2	-0.4	0.11	55.4	0.18
Newcastle-under-Lyme	35	-0.19	0.12	61.22	0.19	37	-0.19	0.12	57.11	0.21
Newham	67	-0.13	0.11	61.69	0.16	53	-0.16	0.11	56.16	0.27
North Devon	123	-0.04	0.14	61.61	0.21	133	-0.01	0.14	58.36	0.22
North East Derbyshire	111	-0.05	0.14	61.84	0.2	108	-0.06	0.14	57.34	0.21
North East Lincolnshire	50	-0.15	0.12	60.6	0.17	46	-0.17	0.12	55.74	0.20
North Hertfordshire	272	0.24	0.14	62.61	0.18	272	0.25	0.14	58.8	0.18
North Kesteven	181	0.05	0.12	63.51	0.18	166	0.04	0.12	58.87	0.20
North Lincolnshire	81	-0.1	0.11	61.21	0.16	67	-0.13	0.11	56.22	0.20
North Norfolk	145	0.01	0.13	62.9	0.2	140	0	0.13	58.43	0.21
North Somerset	148	0.01	0.1	62.15	0.15	157	0.02	0.11	58.49	0.18
North Tyneside	85	-0.1	0.11	60.5	0.15	80	-0.11	0.11	55.95	0.18
North Warwickshire	121	-0.04	0.14	61.19	0.25	122	-0.03	0.14	57.44	0.25
North West Leicestershire	208	0.09	0.12	62.2	0.2	205	0.09	0.12	58.11	0.21
Northampton	130	-0.02	0.11	61.11	0.15	128	-0.02	0.11	57.16	0.18
Northumberland	98	-0.08	0.1	61.34	0.12	93	-0.09	0.11	56.87	0.16
Norwich	63	-0.14	0.11	61.34	0.21	65	-0.14	0.11	57.04	0.21
Nottingham	28	-0.23	0.11	59.66	0.14	26	-0.27	0.11	54.29	0.17

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Nuneaton and Bedworth	33	-0.21	0.12	61.07	0.18	34	-0.2	0.12	57.33	0.20
Oadby and Wigston	150	0.01	0.12	62.46	0.27	148	0.02	0.12	58.31	0.27
Oldham	5	-0.33	0.12	59.52	0.14	5	-0.34	0.12	54.85	0.17
Oxford	261	0.2	0.14	62.83	0.2	268	0.23	0.15	59.49	0.22
Pendle	8	-0.32	0.12	60.53	0.23	10	-0.32	0.12	56.38	0.23
Peterborough	91	-0.09	0.11	60.95	0.17	82	-0.1	0.11	56.53	0.19
Plymouth	77	-0.11	0.11	61.11	0.14	75	-0.11	0.11	56.72	0.19
Portsmouth	39	-0.18	0.1	60.43	0.16	45	-0.18	0.1	56.4	0.20
Preston	29	-0.23	0.14	60.06	0.19	31	-0.23	0.14	55.97	0.19
Reading	175	0.04	0.12	61.51	0.19	186	0.06	0.12	57.78	0.22
Redbridge	192	0.06	0.14	63.05	0.14	184	0.05	0.14	58.55	0.21
Redcar and Cleveland	31	-0.21	0.12	60.26	0.19	30	-0.23	0.12	55.63	0.21
Redditch	66	-0.13	0.14	61.73	0.25	69	-0.12	0.14	58.05	0.25
Reigate and Banstead	281	0.28	0.12	62.39	0.17	281	0.31	0.13	59.03	0.18
Ribble Valley	198	0.07	0.14	62.83	0.27	194	0.07	0.14	58.42	0.26
Richmond upon Thames	310	0.47	0.13	64.48	0.17	310	0.51	0.14	61.17	0.23
Richmondshire	87	-0.09	0.11	62.79	0.27	96	-0.08	0.12	59	0.27
Rochdale	19	-0.27	0.12	59.4	0.15	20	-0.29	0.12	54.8	0.18
Rochford	215	0.1	0.12	63.55	0.21	216	0.11	0.12	59.5	0.20
Rossendale	55	-0.15	0.12	60.78	0.26	60	-0.15	0.12	56.62	0.25
Rother	169	0.04	0.13	62.59	0.22	159	0.03	0.13	58	0.23
Rotherham	36	-0.18	0.11	60.18	0.13	33	-0.2	0.11	55.26	0.17
Rugby	120	-0.04	0.13	62.33	0.21	121	-0.03	0.13	58.43	0.22
Runnymede	283	0.31	0.12	63.14	0.23	283	0.33	0.12	59.68	0.23
Rushcliffe	241	0.16	0.12	63.61	0.18	236	0.15	0.12	59.03	0.19
Rushmoor	235	0.15	0.12	62.11	0.22	241	0.16	0.12	58.41	0.21
Rutland	240	0.16	0.15	64.47	0.32	245	0.18	0.15	60.71	0.37
Ryedale	203	0.08	0.13	63.18	0.28	206	0.09	0.13	59.31	0.28
Salford	22	-0.27	0.1	59.47	0.14	24	-0.28	0.1	54.73	0.18
Sandwell	9	-0.32	0.11	59.86	0.13	7	-0.33	0.11	55.13	0.16
Scarborough	80	-0.1	0.11	61.38	0.2	89	-0.09	0.11	57.71	0.21
Sedgemoor	147	0.01	0.14	62.79	0.18	144	0.01	0.14	58.56	0.21
Sefton	68	-0.12	0.11	60.79	0.13	73	-0.12	0.11	56.95	0.16
Selby	223	0.11	0.14	62.46	0.22	226	0.13	0.15	58.69	0.23
Sevenoaks	299	0.39	0.13	63.86	0.18	298	0.39	0.13	59.65	0.19
Sheffield	106	-0.06	0.1	61.43	0.09	105	-0.06	0.1	57.15	0.15
Shropshire	207	0.09	0.1	62.53	0.11	203	0.09	0.1	58.36	0.15
Slough	90	-0.09	0.11	61.04	0.22	72	-0.12	0.11	55.92	0.24
Solihull	166	0.03	0.11	62.89	0.15	174	0.04	0.11	59	0.17
Somerset West and Taunton	137	0	0.14	62.27	0.17	137	0	0.14	58.1	0.21
South Bucks	314	0.49	0.15	63.91	0.09	314	0.52	0.15	60.39	0.14
South Cambridgeshire	262	0.2	0.12	64.21	0.17	264	0.21	0.12	60.16	0.19
South Derbyshire	196	0.07	0.12	61.48	0.2	191	0.06	0.12	57.03	0.21
South Gloucestershire	220	0.11	0.12	63.55	0.12	222	0.12	0.12	59.64	0.16
South Hams	194	0.06	0.13	63.69	0.21	204	0.09	0.14	60.25	0.22
South Holland	110	-0.05	0.14	61.85	0.21	107	-0.06	0.14	57.39	0.22
South Kesteven	187	0.05	0.14	62.59	0.17	175	0.04	0.14	58.05	0.19

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
South Lakeland	178	0.04	0.12	63.42	0.2	179	0.05	0.12	59.18	0.20
South Norfolk	226	0.12	0.12	63.44	0.18	217	0.11	0.12	58.92	0.19
South Northamptonshire	270	0.23	0.12	63.53	0.22	270	0.23	0.12	59.3	0.24
South Oxfordshire	313	0.49	0.12	63.85	0.17	313	0.52	0.13	60.43	0.19
South Ribble	172	0.04	0.13	62.42	0.2	165	0.03	0.13	58.05	0.20
South Somerset	205	0.08	0.12	62.99	0.16	200	0.08	0.12	58.72	0.20
South Staffordshire	125	-0.03	0.12	62.78	0.18	119	-0.03	0.12	58.49	0.21
South Tyneside	30	-0.22	0.12	59.91	0.17	29	-0.24	0.12	55.25	0.19
Southampton	128	-0.02	0.11	61.1	0.15	124	-0.02	0.11	57.01	0.19
Southend-on-Sea	95	-0.08	0.11	61.24	0.16	95	-0.08	0.11	57.04	0.18
Southwark	243	0.16	0.12	61.85	0.16	239	0.16	0.12	57.49	0.33
Spelthorne	282	0.31	0.12	62.63	0.21	284	0.33	0.13	59.23	0.21
St Albans	298	0.38	0.11	63.82	0.18	299	0.39	0.11	59.85	0.18
St Helens	45	-0.16	0.11	59.59	0.16	38	-0.18	0.11	54.8	0.19
Stafford	189	0.05	0.13	62.36	0.18	185	0.05	0.13	58.1	0.20
Staffordshire Moorlands	89	-0.09	0.14	61.98	0.2	88	-0.09	0.14	57.79	0.22
Stevenage	171	0.04	0.11	61.03	0.23	181	0.05	0.11	57.39	0.22
Stockport	233	0.14	0.1	62.15	0.12	233	0.15	0.1	58.08	0.16
Stockton-on-Tees	25	-0.26	0.12	60.2	0.16	21	-0.28	0.12	55.18	0.19
Stoke-on-Trent	2	-0.38	0.11	59.51	0.14	1	-0.41	0.11	54.46	0.17
Stratford-on-Avon	195	0.07	0.13	63.07	0.18	196	0.07	0.13	59.09	0.20
Stroud	229	0.13	0.13	62.26	0.18	235	0.15	0.13	58.84	0.19
Sunderland	20	-0.27	0.12	59.54	0.13	17	-0.3	0.12	54.49	0.16
Surrey Heath	312	0.49	0.12	63.3	0.21	312	0.52	0.12	59.84	0.21
Sutton	254	0.18	0.1	62.61	0.15	257	0.2	0.1	58.9	0.21
Swale	153	0.02	0.11	61.08	0.18	155	0.02	0.11	57.17	0.19
Swindon	248	0.17	0.11	61.91	0.15	243	0.17	0.11	57.6	0.18
Tameside	44	-0.17	0.11	59.73	0.14	40	-0.18	0.11	55.29	0.17
Tamworth	51	-0.15	0.12	61.6	0.25	58	-0.15	0.12	57.43	0.25
Tandridge	308	0.45	0.13	63.22	0.23	308	0.48	0.13	59.76	0.23
Teignbridge	191	0.06	0.12	62.98	0.17	199	0.08	0.12	59.61	0.19
Telford and Wrekin	42	-0.17	0.12	61.09	0.16	36	-0.19	0.12	56.49	0.19
Tendring	122	-0.04	0.11	60.59	0.19	123	-0.03	0.11	56.84	0.18
Test Valley	292	0.34	0.12	63.29	0.19	291	0.36	0.12	59.42	0.19
Tewkesbury	201	0.08	0.13	63.02	0.22	213	0.1	0.13	59.49	0.22
Thanet	82	-0.1	0.12	60.47	0.18	85	-0.09	0.12	56.62	0.18
Three Rivers	273	0.24	0.14	63.3	0.21	273	0.26	0.15	59.4	0.21
Thurrock	177	0.04	0.12	61.09	0.18	169	0.04	0.12	56.84	0.20
Tonbridge and Malling	287	0.33	0.12	63.37	0.19	285	0.33	0.12	59.2	0.19
Torbay	113	-0.05	0.11	61.27	0.18	114	-0.04	0.11	57.3	0.21
Torridge	74	-0.11	0.12	61.76	0.26	92	-0.09	0.13	58.49	0.26
Tower Hamlets	167	0.03	0.12	61.03	0.18	143	0.01	0.12	56.07	0.29
Trafford	225	0.12	0.11	62.38	0.14	229	0.13	0.11	58.6	0.18
Tunbridge Wells	284	0.32	0.14	63.26	0.2	282	0.33	0.14	59.11	0.20
Uttlesford	279	0.28	0.14	63.37	0.23	277	0.28	0.15	59.34	0.22
Vale of White Horse	293	0.35	0.11	64.32	0.18	295	0.38	0.12	60.84	0.20
Wakefield	83	-0.1	0.1	60.41	0.12	70	-0.12	0.1	55.65	0.16

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

	No Adjustment for Health					Adjusted for Health				
Local Authority	Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Walsall	11	-0.3	0.1	60.3	0.13	8	-0.32	0.1	55.37	0.17
Waltham Forest	79	-0.1	0.12	62	0.16	90	-0.09	0.12	58.38	0.28
Wandsworth	278	0.28	0.13	62.28	0.15	278	0.29	0.13	58.33	0.26
Warrington	112	-0.05	0.11	60.9	0.14	117	-0.04	0.11	57.18	0.17
Warwick	159	0.02	0.12	63.12	0.18	163	0.03	0.12	59.13	0.20
Watford	209	0.09	0.14	61.53	0.23	215	0.11	0.14	57.84	0.22
Waverley	304	0.41	0.11	63.78	0.19	304	0.44	0.11	60.25	0.20
Wealden	242	0.16	0.12	63.64	0.16	237	0.15	0.12	58.95	0.19
Wellingborough	116	-0.04	0.13	61.61	0.24	118	-0.04	0.13	57.61	0.25
Welwyn Hatfield	253	0.18	0.12	62.71	0.2	253	0.19	0.12	58.86	0.20
West Berkshire	297	0.36	0.12	63.22	0.17	296	0.39	0.13	59.55	0.20
West Devon	155	0.02	0.13	62.97	0.28	173	0.04	0.14	59.58	0.27
West Lancashire	70	-0.12	0.12	61.63	0.19	68	-0.12	0.12	57.38	0.19
West Lindsey	151	0.01	0.14	62.65	0.21	142	0	0.14	58.1	0.22
West Oxfordshire	277	0.27	0.14	63.44	0.19	280	0.3	0.15	60.07	0.21
West Suffolk	185	0.05	0.14	63.09	0.16	183	0.05	0.14	58.9	0.18
Westminster	306	0.44	0.14	64.59	0.17	302	0.42	0.15	59.78	0.28
Wigan	52	-0.15	0.11	59.99	0.12	54	-0.16	0.11	55.83	0.16
Wiltshire	264	0.2	0.1	62.92	0.09	267	0.22	0.1	59.26	0.14
Winchester	288	0.33	0.14	63.87	0.19	286	0.35	0.15	59.93	0.19
Windsor and Maidenhead	307	0.44	0.12	63.54	0.18	309	0.49	0.13	60.52	0.19
Wirral	72	-0.11	0.1	60.37	0.12	78	-0.11	0.1	56.25	0.16
Woking	285	0.33	0.11	62.91	0.23	290	0.36	0.12	59.46	0.23
Wokingham	302	0.4	0.12	63.74	0.16	305	0.44	0.13	60.72	0.18
Wolverhampton	24	-0.26	0.11	59.86	0.14	22	-0.28	0.11	54.99	0.17
Worcester	78	-0.11	0.14	61.96	0.22	87	-0.09	0.14	58.26	0.23
Worthing	193	0.06	0.1	61.77	0.2	197	0.08	0.11	58.02	0.20
Wychavon	154	0.02	0.12	63.41	0.19	161	0.03	0.12	59.54	0.20
Wycombe	294	0.36	0.12	63.91	0.09	297	0.39	0.13	60.39	0.14
Wyre	97	-0.08	0.14	61.32	0.2	97	-0.08	0.14	57.08	0.20
Wyre Forest	102	-0.07	0.11	61.95	0.21	110	-0.06	0.11	58.26	0.22
York	109	-0.06	0.1	62.27	0.15	116	-0.04	0.11	58.66	0.18

Table A.1: Indicators of Well-being for Lower Tier Local Authorities in England

C LTLA Estimates of Well-being. High Leisure Value Variant: θ=14.2

Table A.2: Mixed-mode Parameter Estimates for Log (consumption) and the Labour Input Variables for Men and Women

	(1) log(Consumption)	(2) Work: men	(3) Work: women
Fixed effects			
mean(log net income)	0.917***	0.347***	0.225***
	(9.67)	(15.87)	(14.90)
log(mean electricity use)	0.349***	0.230***	0.000403
	(4.47)	(12.86)	(0.03)
log(mean house prices)	0.0996**	-0.0125	0.00649
	(2.70)	(-1.57)	(1.30)
Constant	-3.187***	-4.721***	-2.083***
	(-3.51)	(-21.14)	(-13.92)
Random Effects			
log(s.d. age categories)	-1.671***	-1.093***	-1.712***
	(-7.81)	(-5.78)	(-9.03)
log(s.d. regions)	-3.012***	-4.770***	-5.546***
	(-8.07)	(-7.87)	(-5.83)
log(s.d. lower tier local authorities)	-2.357***	-3.312***	-3.891***
	(-14.15)	(-32.80)	(-31.88)
log(s.d. residual)	-0.497***	-0.487***	-0.783***
	(-43.27)	(-198.65)	(-337.57)
N	4028	83531	93163

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	No Adjustment for Health					Adjusted for Health				
Local Authority	Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Adur	228	0.1	0.14	62.5	0.26	229	0.11	0.14	58.66	0.25
Allerdale	34	-0.17	0.12	61.03	0.22	39	-0.16	0.12	57.05	0.22
Amber Valley	73	-0.09	0.11	61.58	0.18	72	-0.1	0.11	57.1	0.20
Arun	173	0.02	0.12	61.93	0.17	180	0.03	0.12	58.13	0.18
Ashfield	59	-0.13	0.14	60.4	0.18	61	-0.13	0.14	56.21	0.19
Ashford	256	0.15	0.12	62.53	0.19	252	0.15	0.12	58.46	0.19
Aylesbury Vale	284	0.25	0.12	63.91	0.09	286	0.27	0.12	60.39	0.14
Babergh	235	0.12	0.14	63.23	0.21	235	0.12	0.15	59.03	0.22
Barking and Dagenham	72	-0.09	0.13	60.24	0.18	67	-0.11	0.13	55.38	0.26
Barnet	277	0.2	0.13	63.98	0.12	270	0.2	0.13	59.29	0.27
Barnsley	63	-0.12	0.11	60.52	0.14	57	-0.13	0.12	55.68	0.18
Barrow-in-Furness	62	-0.12	0.14	59.42	0.27	64	-0.12	0.14	55.62	0.26
Basildon	222	0.09	0.11	61.59	0.16	223	0.1	0.11	57.76	0.17
Basingstoke and Deane	292	0.28	0.12	62.46	0.16	291	0.3	0.12	58.7	0.17
Bassetlaw	114	-0.05	0.12	60.89	0.2	111	-0.05	0.12	56.62	0.20
Bath and North East Somerset	261	0.15	0.11	62.97	0.15	262	0.17	0.11	59.25	0.19
Bedford	112	-0.05	0.11	62.24	0.17	116	-0.04	0.11	58.51	0.28
Bexley	205	0.06	0.12	62.54	0.14	199	0.06	0.12	58.46	0.19
Birmingham	25	-0.2	0.1	60.43	0.07	23	-0.22	0.1	55.49	0.12
Blaby	178	0.03	0.14	63.07	0.21	179	0.03	0.14	58.84	0.22
Blackburn with Darwen	10	-0.26	0.11	59.02	0.19	10	-0.27	0.11	54.46	0.20
Blackpool	3	-0.31	0.12	57.52	0.19	2	-0.32	0.12	52.63	0.21
Bolsover	33	-0.17	0.14	59.99	0.23	35	-0.17	0.14	55.74	0.23
Bolton	32	-0.17	0.11	60.22	0.13	37	-0.17	0.11	56.1	0.17
Boston	85	-0.08	0.12	60.91	0.26	84	-0.08	0.12	56.55	0.26
Bournemouth, Christchurch and Po	149	0	0.14	62.14	0.1	156	0.01	0.14	58.32	0.13
Bracknell Forest	296	0.3	0.12	63.6	0.21	298	0.32	0.13	59.83	0.22
Bradford	27	-0.18	0.1	60.24	0.1	30	-0.18	0.1	55.93	0.15
Braintree	213	0.08	0.11	62.11	0.17	216	0.08	0.11	58.23	0.17
Breckland	79	-0.09	0.12	62.08	0.17	78	-0.09	0.12	57.74	0.19
Brent	78	-0.09	0.11	63.06	0.14	85	-0.08	0.11	59.1	0.28
Brentwood	288	0.27	0.14	63.06	0.22	287	0.28	0.15	59.09	0.21
Brighton and Hove	223	0.09	0.11	61.88	0.14	225	0.1	0.11	58.04	0.19
Bristol, City of	116	-0.04	0.1	61.26	0.11	115	-0.04	0.1	57.01	0.16
Broadland	177	0.03	0.13	62.89	0.17	173	0.03	0.13	58.45	0.19
Bromley	262	0.15	0.12	63.5	0.12	256	0.16	0.12	59.3	0.21
Bromsgrove	138	-0.01	0.12	62.42	0.2	144	0	0.13	58.7	0.21
Broxbourne	218	0.08	0.12	63.51	0.22	221	0.09	0.13	59.54	0.22
Broxtowe	193	0.05	0.12	62.22	0.19	189	0.04	0.12	57.81	0.20
Burnley	7	-0.28	0.14	59.36	0.24	7	-0.28	0.14	55.34	0.23
Bury	66	-0.11	0.12	60.33	0.16	66	-0.11	0.12	56.22	0.18
Calderdale	84	-0.08	0.14	60.9	0.15	92	-0.07	0.14	56.93	0.18
Cambridge	230	0.11	0.15	62.74	0.21	234	0.11	0.15	58.88	0.22
Camden	275	0.2	0.15	64.73	0.18	269	0.2	0.15	60.14	0.30
Cannock Chase	30	-0.17	0.12	61.16	0.21	33	-0.17	0.13	57.07	0.22
Canterbury	180	0.03	0.13	61.97	0.17	185	0.04	0.13	57.95	0.18
Carlisle	37	-0.16	0.14	61.36	0.2	45	-0.15	0.14	57.36	0.20
Castle Point	199	0.06	0.12	61.65	0.21	200	0.06	0.12	57.82	0.21

Table A.3: Indicators of Well-being for Lower Tier Local Authorities in England: High Leisure Value Variant

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Central Bedfordshire	244	0.13	0.11	63.11	0.13	251	0.15	0.11	59.48	0.19
Charnwood	106	-0.06	0.12	62.71	0.16	107	-0.06	0.12	58.54	0.18
Chelmsford	258	0.15	0.13	63.3	0.16	258	0.16	0.13	59.28	0.16
Cheltenham	136	-0.01	0.11	62.32	0.19	149	0.01	0.11	58.88	0.20
Cherwell	270	0.19	0.12	62.27	0.17	275	0.21	0.12	59.01	0.19
Cheshire East	198	0.05	0.1	62.49	0.11	202	0.07	0.1	58.84	0.20
Cheshire West and Chester	119	-0.04	0.1	61.72	0.11	128	-0.02	0.11	58.39	0.19
Chesterfield	131	-0.02	0.1	60.51	0.21	123	-0.03	0.1	56.16	0.21
Chichester	252	0.14	0.12	63.12	0.18	253	0.15	0.12	59.2	0.19
Chiltern	310	0.38	0.12	63.91	0.09	311	0.41	0.13	60.39	0.14
Chorley	123	-0.03	0.12	61.33	0.19	121	-0.03	0.12	57.12	0.19
Colchester	164	0.02	0.12	61.97	0.15	172	0.02	0.12	58.11	0.16
Copeland	105	-0.06	0.14	60.53	0.26	108	-0.06	0.15	56.61	0.25
Corby	54	-0.13	0.12	59.13	0.29	60	-0.13	0.12	55.4	0.28
Cornwall	95	-0.07	0.1	61.95	0.09	99	-0.07	0.1	57.93	0.14
Cotswold	273	0.2	0.13	63.51	0.23	276	0.21	0.14	59.93	0.23
County Durham	65	-0.11	0.11	60.23	0.09	62	-0.13	0.11	55.46	0.14
Coventry	64	-0.12	0.1	61.03	0.12	63	-0.12	0.1	56.8	0.16
Craven	221	0.09	0.14	63.1	0.28	222	0.1	0.15	59.24	0.27
Crawley	227	0.09	0.14	62.57	0.23	227	0.1	0.14	58.7	0.22
Croydon	171	0.02	0.12	62.39	0.12	167	0.02	0.13	58.21	0.20
Dacorum	254	0.15	0.13	63.3	0.17	255	0.16	0.13	59.39	0.18
Darlington	55	-0.13	0.12	60.58	0.21	52	-0.14	0.12	56.12	0.22
Dartford	174	0.03	0.12	61.14	0.21	178	0.03	0.12	57.24	0.21
Daventry	212	0.07	0.12	62.74	0.22	210	0.08	0.13	58.62	0.24
Derby	60	-0.12	0.12	61.14	0.14	58	-0.13	0.12	56.6	0.18
Derbyshire Dales	195	0.05	0.12	62.73	0.23	187	0.04	0.12	58.1	0.24
Doncaster	58	-0.13	0.1	60.27	0.12	49	-0.15	0.1	55.34	0.16
Dorset	217	0.08	0.14	63.38	0.1	218	0.09	0.14	59.16	0.18
Dover	161	0.01	0.11	61.39	0.19	164	0.02	0.11	57.45	0.19
Dudley	14	-0.24	0.12	61.41	0.12	14	-0.25	0.12	56.92	0.16
Ealing	225	0.09	0.13	62.84	0.14	211	0.08	0.13	57.94	0.23
East Cambridgeshire	238	0.12	0.13	63.33	0.22	240	0.13	0.13	59.38	0.23
East Devon	183	0.04	0.13	63.16	0.18	197	0.06	0.13	59.76	0.19
East Hampshire	294	0.29	0.12	63.44	0.19	293	0.3	0.12	59.56	0.19
East Hertfordshire	299	0.31	0.12	63.86	0.17	299	0.32	0.12	59.87	0.18
East Lindsey	48	-0.14	0.12	60.89	0.18	48	-0.15	0.12	56.53	0.20
East Northamptonshire	187	0.04	0.14	62.34	0.22	190	0.05	0.14	58.27	0.23
East Riding of Yorkshire	165	0.02	0.12	62.15	0.11	170	0.02	0.12	58.27	0.14
East Staffordshire	53	-0.14	0.14	61.3	0.19	55	-0.14	0.14	57.19	0.21
East Suffolk	168	0.02	0.14	62.81	0.13	168	0.02	0.14	58.64	0.16
Eastbourne	139	0	0.14	62.26	0.21	135	-0.01	0.14	57.72	0.22
Eastleigh	260	0.15	0.11	63.59	0.19	261	0.16	0.11	59.69	0.19
Eden	82	-0.08	0.13	63.4	0.3	86	-0.08	0.13	59.15	0.28
Elmbridge	315	0.46	0.15	64.31	0.18	315	0.48	0.15	60.74	0.19
Enfield	167	0.02	0.13	62.76	0.13	162	0.02	0.13	58.44	0.23
Epping Forest	245	0.14	0.12	62.3	0.18	247	0.14	0.13	58.4	0.18
Epsom and Ewell	308	0.36	0.12	63.82	0.24	308	0.38	0.13	60.3	0.23

Table A.3: Indicators of Well-being for Lower Tier Local Authorities in England: High Leisure Value Variant

Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Erewash	75	-0.09	0.12	61.64	0.19	74	-0.09	0.12	57.16	0.20
Exeter	135	-0.01	0.12	61.69	0.2	152	0.01	0.12	58.42	0.21
Fareham	220	0.09	0.12	62.95	0.18	224	0.1	0.12	59.14	0.18
Fenland	117	-0.04	0.12	61.02	0.22	119	-0.03	0.12	57.32	0.23
Folkestone and Hythe	154	0.01	0.11	61.54	0.2	154	0.01	0.11	57.56	0.20
Forest of Dean	159	0.01	0.13	62.32	0.22	176	0.03	0.13	58.89	0.22
Fylde	124	-0.03	0.14	61.5	0.24	120	-0.03	0.14	57.24	0.23
Gateshead	15	-0.24	0.12	59.86	0.15	15	-0.25	0.12	55.2	0.19
Gedling	83	-0.08	0.12	62.09	0.18	81	-0.08	0.12	57.7	0.19
Gloucester	93	-0.07	0.12	60.68	0.2	106	-0.06	0.12	57.37	0.20
Gosport	129	-0.02	0.14	61.49	0.24	134	-0.01	0.14	57.82	0.23
Gravesham	269	0.19	0.12	62.11	0.21	268	0.19	0.12	58.09	0.21
Great Yarmouth	43	-0.15	0.12	60.87	0.22	46	-0.15	0.12	56.65	0.22
Greenwich	216	0.08	0.12	61.44	0.15	203	0.07	0.12	56.83	0.21
Guildford	305	0.35	0.12	63.84	0.18	303	0.37	0.12	60.32	0.18
Hackney	142	0	0.13	61.41	0.19	118	-0.03	0.13	56.02	0.26
Halton	35	-0.16	0.12	59.5	0.19	31	-0.18	0.12	54.77	0.25
Hambleton	229	0.1	0.12	63.7	0.2	232	0.11	0.12	59.79	0.22
Hammersmith and Fulham	276	0.2	0.15	62.37	0.19	277	0.22	0.16	58.69	0.27
Harborough	263	0.16	0.13	63.41	0.21	257	0.16	0.13	59.15	0.22
Haringey	144	0	0.12	62.74	0.17	137	-0.01	0.12	58.29	0.22
Harlow	122	-0.03	0.12	61.24	0.25	125	-0.02	0.12	57.44	0.23
Harrogate	241	0.13	0.14	63.1	0.16	244	0.14	0.15	59.25	0.18
Harrow	253	0.14	0.11	64.7	0.15	238	0.12	0.11	59.52	0.23
Hart	304	0.35	0.13	64.73	0.21	302	0.36	0.13	60.7	0.21
Hartlepool	24	-0.21	0.11	59.39	0.23	24	-0.22	0.11	54.44	0.23
Hastings	108	-0.06	0.12	59.82	0.23	103	-0.06	0.12	55.59	0.24
Havant	190	0.04	0.13	62.34	0.19	196	0.05	0.13	58.57	0.19
Havering	210	0.07	0.12	62.44	0.13	208	0.07	0.12	58.35	0.19
Herefordshire, County of	44	-0.15	0.11	62.43	0.15	51	-0.14	0.12	58.62	0.18
Hertsmere	246	0.14	0.13	62.96	0.21	248	0.14	0.13	59.09	0.20
High Peak	140	0	0.14	61.74	0.22	133	-0.01	0.14	57.23	0.23
Hillingdon	188	0.04	0.11	62.7	0.14	163	0.02	0.11	57.51	0.22
Hinckley and Bosworth	148	0	0.12	62.81	0.19	148	0.01	0.12	58.62	0.21
Horsham	298	0.31	0.13	63.66	0.18	297	0.32	0.13	59.67	0.19
Hounslow	156	0.01	0.13	62.6	0.15	139	0	0.13	57.84	0.33
Huntingdonshire	257	0.15	0.12	63.42	0.16	259	0.16	0.12	59.47	0.18
Hyndburn	6	-0.28	0.13	59.69	0.24	6	-0.28	0.13	55.66	0.23
Ipswich	81	-0.08	0.12	61.7	0.19	88	-0.08	0.12	57.67	0.19
Isle of Wight	71	-0.09	0.12	62.17	0.17	69	-0.1	0.12	57.48	0.20
Islington	240	0.12	0.15	61.83	0.19	231	0.11	0.15	57.14	0.26
Kensington and Chelsea	279	0.21	0.15	65.42	0.2	272	0.2	0.15	60.56	0.30
Kettering	141	0	0.12	61.93	0.22	142	0	0.12	57.9	0.23
Kings Lynn and West Norfolk	157	0.01	0.12	62.4	0.17	147	0	0.13	58	0.19
Kingston upon Hull, City of	36	-0.16	0.11	58.74	0.14	34	-0.17	0.11	54.22	0.19
Kingston upon Thames	255	0.15	0.12	63.81	0.18	263	0.17	0.12	60.33	0.26
Kirklees	115	-0.04	0.12	61.11	0.1	113	-0.05	0.12	56.74	0.15

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Knowsley	12	-0.25	0.12	58.98	0.18	13	-0.25	0.12	54.54	0.20
Lambeth	207	0.07	0.13	61.43	0.16	191	0.05	0.13	56.54	0.25
Lancaster	46	-0.15	0.11	60.68	0.18	47	-0.15	0.11	56.53	0.18
Leeds	99	-0.07	0.09	60.73	0.08	97	-0.07	0.09	56.59	0.13
Leicester	21	-0.21	0.12	60.02	0.13	20	-0.23	0.12	55.18	0.18
Lewes	233	0.11	0.14	63.75	0.21	226	0.1	0.14	59	0.22
Lewisham	170	0.02	0.12	61.59	0.15	165	0.02	0.12	57.32	0.32
Lichfield	121	-0.04	0.13	62.45	0.19	117	-0.04	0.13	58.21	0.21
Lincoln	16	-0.23	0.13	60	0.24	19	-0.23	0.13	55.74	0.24
Liverpool	19	-0.22	0.11	58.92	0.1	18	-0.23	0.11	54.33	0.14
Luton	110	-0.06	0.11	60.99	0.17	91	-0.08	0.11	55.97	0.18
Maidstone	251	0.14	0.12	62.36	0.16	250	0.15	0.12	58.32	0.17
Maldon	239	0.12	0.14	62.16	0.27	241	0.13	0.15	58.26	0.26
Malvern Hills	118	-0.04	0.13	62.75	0.22	122	-0.03	0.13	58.99	0.23
Manchester	28	-0.18	0.11	58.16	0.11	27	-0.19	0.11	53.59	0.16
Mansfield	42	-0.15	0.14	60.34	0.2	42	-0.16	0.14	56.13	0.21
Medway	189	0.04	0.11	60.75	0.13	188	0.04	0.11	56.65	0.18
Melton	145	0	0.12	63.35	0.28	145	0	0.12	59.11	0.27
Mendip	155	0.01	0.12	62.67	0.2	151	0.01	0.12	58.46	0.22
Merton	226	0.09	0.12	62.9	0.16	219	0.09	0.13	58.59	0.25
Mid Devon	206	0.06	0.13	63.11	0.23	215	0.08	0.14	59.71	0.24
Mid Suffolk	265	0.17	0.13	64.01	0.2	264	0.17	0.13	59.71	0.20
Mid Sussex	278	0.21	0.12	63.64	0.17	279	0.22	0.13	59.67	0.18
Middlesbrough	4	-0.3	0.12	58.21	0.19	4	-0.3	0.13	53.79	0.21
Milton Keynes	158	0.01	0.11	61.54	0.14	153	0.01	0.11	57.45	0.18
Mole Valley	301	0.33	0.12	63.52	0.22	301	0.35	0.12	60.02	0.22
New Forest	242	0.13	0.11	64.16	0.15	245	0.14	0.11	60.19	0.16
Newark and Sherwood	137	-0.01	0.13	61.76	0.19	131	-0.01	0.13	57.39	0.19
Newcastle upon Tyne	2	-0.31	0.11	59.73	0.14	3	-0.31	0.11	55.4	0.18
Newcastle-under-Lyme	29	-0.18	0.12	61.22	0.19	32	-0.17	0.12	57.11	0.21
Newham	100	-0.07	0.11	61.69	0.16	70	-0.1	0.11	56.16	0.27
North Devon	127	-0.02	0.14	61.61	0.21	140	0	0.14	58.36	0.22
North East Derbyshire	111	-0.05	0.14	61.84	0.2	105	-0.06	0.14	57.34	0.21
North East Lincolnshire	39	-0.16	0.12	60.6	0.17	36	-0.17	0.12	55.74	0.20
North Hertfordshire	266	0.17	0.14	62.61	0.18	267	0.18	0.14	58.8	0.18
North Kesteven	179	0.03	0.12	63.51	0.18	174	0.03	0.12	58.87	0.20
North Lincolnshire	88	-0.08	0.11	61.21	0.16	75	-0.09	0.11	56.22	0.20
North Norfolk	166	0.02	0.13	62.9	0.2	158	0.01	0.13	58.43	0.21
North Somerset	143	0	0.1	62.15	0.15	157	0.01	0.11	58.49	0.18
North Tyneside	77	-0.09	0.11	60.5	0.15	71	-0.1	0.11	55.95	0.18
North Warwickshire	90	-0.08	0.14	61.19	0.25	100	-0.07	0.14	57.44	0.25
North West Leicestershire	191	0.04	0.12	62.2	0.2	192	0.05	0.12	58.11	0.21
Northampton	126	-0.03	0.11	61.11	0.15	127	-0.02	0.11	57.16	0.18
Northumberland	96	-0.07	0.1	61.34	0.12	89	-0.08	0.11	56.87	0.16
Norwich	98	-0.07	0.11	61.34	0.21	96	-0.07	0.11	57.04	0.21
Nottingham	40	-0.16	0.11	59.66	0.14	29	-0.18	0.11	54.29	0.17

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Local Authority	No Adjustment for Health Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Adjusted for Health Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Nuneaton and Bedworth	22	-0.21	0.12	61.07	0.18	26	-0.2	0.12	57.33	0.20
Oadby and Wigston	181	0.04	0.12	62.46	0.27	183	0.04	0.12	58.31	0.27
Oldham	5	-0.29	0.12	59.52	0.14	5	-0.3	0.12	54.85	0.17
Oxford	268	0.19	0.14	62.83	0.2	274	0.21	0.15	59.49	0.22
Pendle	8	-0.27	0.12	60.53	0.23	11	-0.27	0.12	56.38	0.23
Peterborough	87	-0.08	0.11	60.95	0.17	80	-0.08	0.11	56.53	0.19
Plymouth	94	-0.07	0.11	61.11	0.14	90	-0.08	0.11	56.72	0.19
Portsmouth	51	-0.14	0.1	60.43	0.16	54	-0.14	0.11	56.4	0.20
Preston	17	-0.23	0.14	60.06	0.19	21	-0.23	0.14	55.97	0.19
Reading	176	0.03	0.12	61.51	0.19	182	0.04	0.12	57.78	0.22
Redbridge	215	0.08	0.14	63.05	0.14	209	0.07	0.14	58.55	0.21
Redcar and Cleveland	38	-0.16	0.12	60.26	0.19	38	-0.17	0.12	55.63	0.21
Redditch	61	-0.12	0.14	61.73	0.25	65	-0.11	0.14	58.05	0.25
Reigate and Banstead	280	0.22	0.12	62.39	0.17	281	0.24	0.13	59.03	0.18
Ribble Valley	147	0	0.14	62.83	0.27	143	0	0.14	58.42	0.26
Richmond upon Thames	309	0.37	0.13	64.48	0.17	310	0.39	0.14	61.17	0.23
Richmondshire	80	-0.08	0.11	62.79	0.27	93	-0.07	0.12	59	0.27
Rochdale	26	-0.2	0.12	59.4	0.15	25	-0.21	0.12	54.8	0.18
Rochford	203	0.06	0.12	63.55	0.21	201	0.06	0.12	59.5	0.20
Rossendale	49	-0.14	0.12	60.78	0.26	53	-0.14	0.12	56.62	0.25
Rother	172	0.02	0.13	62.59	0.22	160	0.01	0.13	58	0.23
Rotherham	50	-0.14	0.11	60.18	0.13	43	-0.16	0.11	55.26	0.17
Rugby	74	-0.09	0.13	62.33	0.21	83	-0.08	0.13	58.43	0.22
Runnymede	282	0.23	0.12	63.14	0.23	282	0.25	0.12	59.68	0.23
Rushcliffe	237	0.12	0.12	63.61	0.18	233	0.11	0.12	59.03	0.19
Rushmoor	234	0.11	0.12	62.11	0.22	239	0.13	0.12	58.41	0.21
Rutland	231	0.11	0.15	64.47	0.32	237	0.12	0.15	60.71	0.37
Ryedale	208	0.07	0.13	63.18	0.28	212	0.08	0.13	59.31	0.28
Salford	23	-0.21	0.1	59.47	0.14	22	-0.23	0.1	54.73	0.18
Sandwell	13	-0.24	0.11	59.86	0.13	12	-0.26	0.11	55.13	0.16
Scarborough	92	-0.08	0.11	61.38	0.2	101	-0.07	0.11	57.71	0.21
Sedgemoor	152	0.01	0.14	62.79	0.18	150	0.01	0.14	58.56	0.21
Sefton	69	-0.1	0.11	60.79	0.13	76	-0.09	0.11	56.95	0.16
Selby	214	0.08	0.14	62.46	0.22	220	0.09	0.15	58.69	0.23
Sevenoaks	300	0.32	0.13	63.86	0.18	300	0.32	0.13	59.65	0.19
Sheffield	151	0	0.1	61.43	0.09	146	0	0.1	57.15	0.15
Shropshire	192	0.05	0.1	62.53	0.11	194	0.05	0.1	58.36	0.15
Slough	76	-0.09	0.11	61.04	0.22	68	-0.11	0.11	55.92	0.24
Solihull	185	0.04	0.11	62.89	0.15	193	0.05	0.11	59	0.17
Somerset West and Taunton	132	-0.02	0.14	62.27	0.17	130	-0.02	0.14	58.1	0.21
South Bucks	312	0.4	0.15	63.91	0.09	312	0.42	0.15	60.39	0.14
South Cambridgeshire	249	0.14	0.12	64.21	0.17	249	0.15	0.12	60.16	0.19
South Derbyshire	202	0.06	0.12	61.48	0.2	195	0.05	0.12	57.03	0.21
South Gloucestershire	232	0.11	0.12	63.55	0.12	236	0.12	0.12	59.64	0.16
South Hams	194	0.05	0.13	63.69	0.21	206	0.07	0.14	60.25	0.22
South Holland	102	-0.07	0.14	61.85	0.21	94	-0.07	0.14	57.39	0.22
South Kesteven	184	0.04	0.14	62.59	0.17	181	0.03	0.14	58.05	0.19

Table A.3: Indicators of Well-being for Lower Tier Local Authorities in England: High Leisure Value Variant

		No Adjustment for Health					Adjusted for Health			
Local Authority	Rank	Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Rank	Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
South Lakeland	182	0.04	0.12	63.42	0.2	184	0.04	0.12	59.18	0.20
South Norfolk	219	0.09	0.12	63.44	0.18	213	0.08	0.12	58.92	0.19
South Northamptonshire	243	0.13	0.12	63.53	0.22	243	0.13	0.12	59.3	0.24
South Oxfordshire	314	0.42	0.12	63.85	0.17	314	0.44	0.13	60.43	0.19
South Ribble	163	0.02	0.13	62.42	0.2	159	0.01	0.13	58.05	0.20
South Somerset	204	0.06	0.12	62.99	0.16	198	0.06	0.12	58.72	0.20
South Staffordshire	107	-0.06	0.12	62.78	0.18	104	-0.06	0.12	58.49	0.21
South Tyneside	31	-0.17	0.12	59.91	0.17	28	-0.18	0.12	55.25	0.19
Southampton	125	-0.03	0.11	61.1	0.15	124	-0.02	0.11	57.01	0.19
Southend-on-Sea	101	-0.07	0.11	61.24	0.16	98	-0.07	0.11	57.04	0.18
Southwark	248	0.14	0.12	61.85	0.16	242	0.13	0.12	57.49	0.33
Spelthorne	290	0.28	0.12	62.63	0.21	292	0.3	0.13	59.23	0.21
St Albans	297	0.31	0.11	63.82	0.18	296	0.31	0.11	59.85	0.18
St Helens	47	-0.15	0.11	59.59	0.16	40	-0.16	0.11	54.8	0.19
Stafford	186	0.04	0.13	62.36	0.18	186	0.04	0.13	58.1	0.20
Staffordshire Moorlands	70	-0.09	0.14	61.98	0.2	73	-0.09	0.14	57.79	0.22
Stevenage	160	0.01	0.11	61.03	0.23	171	0.02	0.11	57.39	0.22
Stockport	247	0.14	0.1	62.15	0.12	246	0.14	0.1	58.08	0.16
Stockton-on-Tees	11	-0.26	0.12	60.2	0.16	9	-0.27	0.12	55.18	0.19
Stoke-on-Trent	1	-0.32	0.11	59.51	0.14	1	-0.34	0.11	54.46	0.17
Stratford-on-Avon	150	0	0.13	63.07	0.18	155	0.01	0.13	59.09	0.20
Stroud	224	0.09	0.13	62.26	0.18	230	0.11	0.13	58.84	0.19
Sunderland	20	-0.22	0.12	59.54	0.13	17	-0.23	0.12	54.49	0.16
Surrey Heath	313	0.4	0.12	63.3	0.21	313	0.42	0.12	59.84	0.21
Sutton	250	0.14	0.1	62.61	0.15	254	0.15	0.1	58.9	0.21
Swale	162	0.01	0.11	61.08	0.18	166	0.02	0.11	57.17	0.19
Swindon	267	0.18	0.11	61.91	0.15	265	0.18	0.11	57.6	0.18
Tameside	52	-0.14	0.11	59.73	0.14	50	-0.15	0.11	55.29	0.17
Tamworth	41	-0.16	0.12	61.6	0.25	44	-0.16	0.12	57.43	0.25
Tandridge	307	0.36	0.13	63.22	0.23	309	0.38	0.13	59.76	0.23
Teignbridge	196	0.05	0.12	62.98	0.17	207	0.07	0.12	59.61	0.19
Telford and Wrekin	45	-0.15	0.12	61.09	0.16	41	-0.16	0.12	56.49	0.19
Tendring	134	-0.01	0.11	60.59	0.19	138	-0.01	0.11	56.84	0.18
Test Valley	295	0.29	0.12	63.29	0.19	294	0.31	0.12	59.42	0.19
Tewkesbury	209	0.07	0.13	63.02	0.22	217	0.08	0.13	59.49	0.22
Thanet	109	-0.06	0.12	60.47	0.18	110	-0.05	0.12	56.62	0.18
Three Rivers	274	0.2	0.14	63.3	0.21	273	0.21	0.15	59.4	0.21
Thurrock	169	0.02	0.12	61.09	0.18	161	0.02	0.12	56.84	0.20
Tonbridge and Malling	286	0.26	0.12	63.37	0.19	283	0.26	0.12	59.2	0.19
Torbay	128	-0.02	0.11	61.27	0.18	129	-0.02	0.11	57.3	0.21
Torridge	97	-0.07	0.12	61.76	0.26	112	-0.05	0.13	58.49	0.26
Tower Hamlets	197	0.05	0.12	61.03	0.18	177	0.03	0.12	56.07	0.29
Trafford	211	0.07	0.11	62.38	0.14	214	0.08	0.11	58.6	0.18
Tunbridge Wells	289	0.28	0.14	63.26	0.2	288	0.28	0.14	59.11	0.20
Uttlesford	281	0.22	0.14	63.37	0.23	280	0.23	0.15	59.34	0.22
Vale of White Horse	293	0.29	0.11	64.32	0.18	295	0.31	0.12	60.84	0.20
Wakefield	91	-0.08	0.1	60.41	0.12	77	-0.09	0.1	55.65	0.16

Table A.3: Indicators of Well-being for Lower Tier Local Authorities in England: High Leisure Value Variant

Local Authority	Rank	No Adjustment for Health: Equiv. Inc.	S.E.	Lfe Exp. at 20	S.E.	Rank	Adjusted for Health: Equiv. Inc.	S.E.	Health-adj. Lfe Exp. at 20	S.E.
Walsall	9	-0.26	0.1	60.3	0.13	8	-0.27	0.1	55.37	0.17
Waltham Forest	67	-0.1	0.12	62	0.16	82	-0.08	0.12	58.38	0.28
Wandsworth	271	0.19	0.13	62.28	0.15	271	0.2	0.13	58.33	0.26
Warrington	86	-0.08	0.11	60.9	0.14	95	-0.07	0.11	57.18	0.17
Warwick	130	-0.02	0.12	63.12	0.18	132	-0.01	0.12	59.13	0.20
Watford	201	0.06	0.14	61.53	0.23	205	0.07	0.14	57.84	0.22
Waverley	306	0.35	0.11	63.78	0.19	306	0.38	0.11	60.25	0.20
Wealden	236	0.12	0.12	63.64	0.16	228	0.11	0.12	58.95	0.19
Wellingborough	113	-0.05	0.13	61.61	0.24	114	-0.04	0.13	57.61	0.25
Welwyn Hatfield	259	0.15	0.12	62.71	0.2	260	0.16	0.13	58.86	0.20
West Berkshire	287	0.27	0.12	63.22	0.17	289	0.28	0.13	59.55	0.20
West Devon	146	0	0.13	62.97	0.28	169	0.02	0.14	59.58	0.27
West Lancashire	56	-0.13	0.12	61.63	0.19	56	-0.13	0.12	57.38	0.19
West Lindsey	153	0.01	0.14	62.65	0.21	141	0	0.14	58.1	0.22
West Oxfordshire	272	0.19	0.14	63.44	0.19	278	0.22	0.15	60.07	0.21
West Suffolk	175	0.03	0.14	63.09	0.16	175	0.03	0.14	58.9	0.18
Westminster	311	0.39	0.14	64.59	0.17	305	0.37	0.15	59.78	0.28
Wigan	57	-0.13	0.11	59.99	0.12	59	-0.13	0.11	55.83	0.16
Wiltshire	264	0.17	0.1	62.92	0.09	266	0.18	0.1	59.26	0.14
Winchester	285	0.26	0.14	63.87	0.19	284	0.27	0.15	59.93	0.19
Windsor and Maidenhead	303	0.35	0.12	63.54	0.18	307	0.38	0.13	60.52	0.19
Wirral	89	-0.08	0.1	60.37	0.12	87	-0.08	0.1	56.25	0.16
Woking	283	0.25	0.11	62.91	0.23	285	0.27	0.12	59.46	0.23
Wokingham	302	0.34	0.12	63.74	0.16	304	0.37	0.13	60.72	0.18
Wolverhampton	18	-0.23	0.11	59.86	0.14	16	-0.25	0.11	54.99	0.17
Worcester	68	-0.1	0.14	61.96	0.22	79	-0.09	0.14	58.26	0.23
Worthing	200	0.06	0.1	61.77	0.2	204	0.07	0.11	58.02	0.20
Wychavon	133	-0.01	0.12	63.41	0.19	136	-0.01	0.12	59.54	0.20
Wycombe	291	0.28	0.12	63.91	0.09	290	0.3	0.13	60.39	0.14
Wyre	103	-0.06	0.14	61.32	0.2	102	-0.07	0.14	57.08	0.20
Wyre Forest	104	-0.06	0.11	61.95	0.21	109	-0.05	0.12	58.26	0.22
York	120	-0.04	0.1	62.27	0.15	126	-0.02	0.11	58.66	0.18

Table A.3: Indicators of Well-being for Lower Tier Local Authorities in England: High Leisure Value Variant

D Standard Errors

In this appendix we explain how we evaluate the standard errors of the small area estimates. There are four components prone to sampling errors. First of all, the expected number of person-years spent in each age band is derived from what are data-based estimates of the true survival rates of the population. Secondly, the proportion of people in good health in each age band is measured by a sample survey. Thirdly the estimates of both age and area influences on consumption are model-based and fourthly so too are the estimates of leisure time. These four components are assumed to be independent of each other because they are measured from independent surveys or similar sources such as mortality records.

The life-time measure of well-being where L_τ is the expected number of life-years spent in age band τ, dependent of course on the width of each band as well as on survival rates, h_τ is the health indicator set as $h_\tau = \pi_{h,\tau} + 0.75 \times (1 - \pi_{h,\tau}) = 0.75 + 0.25\pi_{h,\tau}$ with $\pi_{h,\tau}$ representing the proportion of people in age band τ in good health. β is the discount factor set equal to 1 and g is the growth rate of consumption set to zero. Instantaneous utility depends on private and public consumption, with the latter assumed uniform on a *per capita* basis. A constant term represents the joy of living. Utility also depends on leisure time, $\tilde{l}_\tau$ measured as a fraction of the total waking time available. Here we focus on the derivation of the standard error of the estimate for women, indicated with a superscript, f. We then combine it with similar estimates for men and thus derive the standard error of the estimate of life time well-being averaged across men and women.

$$U^{life-time,f} = \sum_{\tau=0}^{\tau_{max}} \beta^\tau L^f_t h^f_t \left\{ \bar{u} + \alpha \log c^{priv}_\tau + (1-\alpha)\log c^{pub}_\tau + g(\tau - 1) - \frac{\theta\varepsilon}{1+\varepsilon}(1 - \tilde{l}^f_\tau)^{\frac{1+\varepsilon}{\varepsilon}} \right\} \quad (11)$$

With $U^f_\tau = L^f_t h^f_t \left\{ \bar{u} + \alpha \log c^{priv}_\tau + (1-\alpha)\log c^{pub}_\tau + -\frac{\theta\varepsilon}{1+\varepsilon}(1 - \tilde{l}^f_\tau)^{\frac{1+\varepsilon}{\varepsilon}} \right\}$ we can write

$$U^{life-time,f} = \sum_{\tau=0}^{\tau_{max}} L^f_\tau h^f_\tau U^f_\tau$$

Here the L^f_τ will be correlated across different age groups for the obvious reason that the mortality rate early on has implications for the number of life years spent in each subsequent age band. h^f_τ are uncorrelated across age bands at least if the sampling is random. The U^f_τ show age effects but since these are derived from a random effects model, the age effects in different age bands will be independent of each other. The models used to fit consumption and leisure depend on fixed effects which are LTLA specific and random regional and local area effects. These obviously apply to all age groups in each LTLA. We set $\mathbf{H}^f$ as the column vector of the h^f_τ and $\hat{\mathbf{H}}^f$ as the matrix with the h^f_τ on its leading diagonal and zeros elsewhere. $\mathbf{L}^f$ is the column vector with elements L^f_τ and $\mathbf{U}^f$ the column vector with elements U^f_τ. As with $\hat{\mathbf{H}}^f$ we use circumflexes to represent matrices with $\mathbf{L}^f$ and $\mathbf{U}^f$ on their leading diagonal. Then

$$U^{life-time,f} = \mathbf{U}^{f\prime}\hat{\mathbf{H}}^f\mathbf{L}^f = \mathbf{U}^{f\prime}\hat{\mathbf{L}}^f\mathbf{H}^f = \mathbf{L}^{f\prime}\hat{\mathbf{H}}^f\mathbf{U}^f \tag{12}$$

These three expressions allow us to work out $V(U^{life-time,f})$. The assumption that the estimation errors of the components are independent of each other means we can write

$$V(U^{life-time,f}) = \mathbf{U}^{f\prime}\hat{\mathbf{H}}^f V(\mathbf{L}^f)\hat{\mathbf{H}}^f\mathbf{U}^f + \mathbf{U}^{f\prime}\hat{\mathbf{L}}^f V(\mathbf{H}^f)\hat{\mathbf{L}}^f\mathbf{U}^f + \mathbf{L}^{f\prime}\hat{\mathbf{H}}^f V(\mathbf{U}^f)\hat{\mathbf{H}}^f\mathbf{L}^f \tag{13}$$

This requires us to measure each of $V(\mathbf{H}^f)$, $V(\mathbf{L}^f)$ and $V(\mathbf{U}^f)$. We discuss these in turn.

D.1 The Proportion of People in Good Health

With $h^f_\tau = 0.75 + 0.25\pi^f_{h,\tau}$ it follows immediately that $V(h^f_\tau) = 0.0625V(\pi^f_{h,\tau})$. The variance of the proportion in good health is calculated directly using the expression for the variance of a variable generated by a binomial distribution. The proportions in good health for each age band are provided by ONS as is the unweighted base population- the sample size of the survey- denoted by $s^f_{h,\tau}$. An adjustment is also needed to take account of the design effect- the fact that the sample in the Annual Population Survey is clustered. This is denoted by $d^f_{h,\tau}$.

$$V(\pi^f_{h,\tau}) = \frac{\pi^f_{h,\tau}(1-\pi^f_{h,\tau})}{s^f_{h,\tau}d^{f2}_{h,\tau}} \tag{14}$$

$V(\mathbf{H}^\mathbf{f})$ is then a matrix with $0.0625V(\pi_{h,\tau})$ on its leading diagonal and zero elsewhere, since the proportions of people in good health in each age band and for each sex are estimated independently of each other.

D.2 Life Years

As noted earlier L^f_τ is the expected number of woman-years lived in age band, τ; also l^f_τ is the number of survivors from a given cohort to the start of age band τ.

The expected time spent in age band τ is given as

$$L^f_\tau = t_\tau((1-a_\tau)l^f_{\tau+1} + a_\tau l^f_\tau)\ \tau < T \tag{15}$$
$$L^f_T = l^f_T/m^f_T \tag{16}$$

Here t_τ is the length of the interval in question, $a_\tau t_\tau$ represents the time that people who die during the interval in equation are assumed to spend alive. a_τ is set to 0.5 for all intervals except the first year of life for which it is set to 0.1. This reflects the fact that most deaths in the first year of life occur soon after birth. m^f_τ is the annual mortality rate equal to the number of deaths d^f_τ divided by the initial population, n^f_τ. l^f_τ is the number of people alive at the the start of interval τ. l^f_τ satisfies the recursion $l^f_{\tau+1} = (1 - q^f_\tau)l^f_\tau = p^f_\tau l^f_\tau$ where q^f_τ shows the death rate in interval τ of those alive at the start of the interval and p^f_τ is the probability of surviving to the end of period τ conditional on being alive at the start of it. The number of life years in age band T is calculated from the assumption that, for this population, there is a constant mortality rate.

It then follows that (Office for National Statistics 2019*b*)

$$V(p^f_\tau) = V(q^f_\tau) = \frac{t^2_\tau m^f_\tau(1 - a_\tau t_\tau m^f_\tau)}{n^f_\tau(1 + (1 - a_\tau)t_\tau m^f_\tau)^3} \quad 0 < \tau < T \tag{17}$$

while

$$V\left(m^f_T\right) = \frac{4}{m^{f2}_T d_T} \tag{18}$$

The death rates in successive intervals are independent of each other since the intervals do not overlap (Chiang 1979). This means that $p^f_{\tau+j},\ j \geq 0$, and l^f_τ are independent of each other. It also follows that

$$V(l^f_\tau) = l^{f2}_\tau \sum_{i=1}^{\tau-1} \frac{V(p^f_i)}{p^{f2}_i} \tag{19}$$

and

$$Cov(l^f_\tau, l^f_{\tau+k}) = V(l^f_\tau)l^f_{\tau+k}/l^f_t \quad 0 < \tau < \tau + k < T \tag{20}$$

since $l^f_{\tau+k}/l^f_\tau$ is the probability of surviving from the start of period τ to the start of period $\tau + k$.

e^f_τ denotes the expectation of life at the start of period τ. Since $L^f_T = l^f_T e^f_T$ it follows that

$$V(L^f_T) = Var(e^f_T)l^{f2}_T + e^{f2}_T V(l^f_T) \tag{21}$$

where $e^f_T = 1/m^f_T$ and $Var(e^f_T) = Var(m_T)/4$. (Silcocks et al. 2001)

Next we evaluate $Cov(L^f_\tau, L^f_T)$

$$Cov(L^f_\tau, L^f_T) = t_\tau e^f_T(a_\tau V(l^f_\tau)l^f_T/l^f_\tau + [1 - a_\tau]V(l^f_{\tau+1})l^f_T/l^f_{\tau+1}) \tag{22}$$

and

$$\begin{aligned} Var(L^f_\tau) &= Var\{t_\tau((1-a_\tau)l^f_{\tau+1} + a_\tau l^f_\tau)\} \\ &= t^2_\tau Var\{(a_\tau l^f_\tau + (1-a_\tau)l^f_\tau p^f_\tau)\} \\ &= t^2_\tau(V(l^f_\tau)(a_\tau + (1-a_\tau)p^f_\tau)^2 + t^2_\tau(1-a_\tau)^2 l^{f2}_\tau Var(p^f_\tau) \end{aligned} \tag{23}$$

Finally we can write

$$\begin{aligned} Cov(L^f_\tau, L^f_{\tau+k}) &= Cov(t_\tau((1-a_\tau)l^f_{\tau+1} + a_\tau l^f_\tau), t_\tau((1-a_\tau)l^f_{\tau+k+1} + a_{\tau+k+1}l^f_{\tau+k}) \\ &= t_\tau t_{\tau+k}\{a_\tau a_{\tau+k}V(l^f_\tau)l^f_{\tau+k}/l^f_\tau + (1-a_\tau)a_{\tau+k}V(l^f_\tau)l^f_{\tau+k}/l^f_{\tau+1} \\ &\quad +(1-a_{\tau+k})a_\tau V(l^f_\tau)l^f_{\tau+k+1}/l^f_\tau + (1-a_\tau)(1-a_{\tau+k})V(l^f_{\tau+k+1})l^f_{\tau+k+1}/l^f_{\tau+1}\} \end{aligned} \tag{24}$$

D.3 Instantaneous Utility

With no *per capita* growth we have

$$U^f_\tau = \bar{u} + \alpha \log c^{priv}_\tau + (1-\alpha)\log c^{pub}_\tau - \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^f_\tau)^{\frac{1+\varepsilon}{\varepsilon}} \tag{25}$$

We work directly in terms of the well-being component associated with leisure rather than leisure time itself. Thus we write

$$\tilde{z}^f_{i,\tau,k} = \frac{\theta\varepsilon}{1+\varepsilon}(1-\tilde{l}^f_{\tau,i})^{\frac{1+\varepsilon}{\varepsilon}} \tag{26}$$

as representing the reduction in utility associated with a leisure fraction of $\tilde{l}^f_{\tau,i}$ for woman i in age band τ and LTLA k. As discussed in the text, we set $\theta = 2.49$ and ϵ=1. We then have

$$U^f_\tau = \bar{u} + \alpha \log c^{priv}_\tau + (1-\alpha)\log c^{pub}_\tau - \tilde{z}^f_\tau \tag{27}$$

The terms $\bar{u}$ and $\log c^{pub}_\tau$ are constants and $\tilde{l}^f_\tau$ and $\log(c_\tau)$ are independent of each other by assumption, so

$$V(U^f_\tau) = \alpha^2 V(\log c^{priv}_\tau) + V(\tilde{z}^f_\tau). \tag{28}$$

Similarly

$$Cov(U^f_\tau U^f_{\tau+m}) = \alpha^2 Cov(\log c^{priv}_\tau, \log c^{priv}_{\tau+m}) + Cov(\tilde{z}^f_\tau, \tilde{z}^f_{\tau+m}). \tag{29}$$

The mean of log consumption for age band τ in region j and LTLA, k, is, assuming that there are enough households in the LTLA for the idiosyncratic errors to be neglected, given as

$$\log(c_{\tau,k}) = X_k\beta_c + u_{c,\tau} + v_{c,j} + w_{c,k} \tag{30}$$

where the u_t, v_j and w_k are random effects associated with age band τ, region j and

LTLA k.

It then follows that

$$V(\log c^{priv}_{\tau,k}) = X'_k V(\beta_c) X_k + \sigma^2_{c,u} + \sigma^2_{c,v} + \sigma^2_{c,w} \tag{31}$$

where σ^2_u, σ^2_v and σ^2_w are derived by squaring the standard errors of the estimated random effect terms provided by the Stata post-estimation command, *predict ...., reses.* These are specific to the best linear estimates of u^*_τ, v^*_j and w^*_k also produced by Stata.

The age random effects are orthogonal to each other by construction. This means that

$$Cov(\log c^{priv}_{\tau,k}, \log c^{priv}_{\tau+m,k}) = X'_k V(\beta_c) X_k + \sigma^2_{c,v} + \sigma^2_{c,w} \tag{32}$$

We use similar equations for the well-being associated with leisure, but do this separately for men and for women. The mean of the women's leisure term by age band is therefore given as

$$\tilde{z}^f_{\tau,k} = X_k \beta_f + u_{f,\tau} + v_{f,j} + w_{f,k} \tag{33}$$

Expressions can be constructed for $V(\tilde{z}^f_\tau)$ and $Cov(\tilde{z}^f_\tau, \tilde{z}^f_{\tau+m})$ in a manner similar to that for consumption, so we can write

$$V(U^f_\tau) = \alpha^2 \left\{ X'_k V(\beta_c) X_k + \sigma^2_{c,u} + \sigma^2_{c,v} + \sigma^2_{c,w} \right\} + \left\{ X'_k V(\beta_{lf}) X_k + \sigma^2_{lf,u} + \sigma^2_{lf,v} + \sigma^2_{lf,w} \right\} \tag{34}$$

and

$$Cov(U^f_\tau U^f_{\tau+m}) = \alpha^2 \left\{ X'_k V(\beta_c) X_k + \sigma^2_{c,v} + \sigma^2_{c,w} \right\} + \theta^2 (1 - \tilde{l}^f_\tau)^2_\varepsilon \left\{ X'_k V(\beta_{lf}) X_k + \sigma^2_{lf,v} + \sigma^2_{lf,w} \right\} \tag{35}$$

These expressions allow us to construct $V(\mathbf{U}^f)$ and thus, taken with the earlier expressions for $V(\mathbf{H}^f)$ and $V(\mathbf{L}^f)$, to evaluate the variance and the standard error of $U^{life-time,f}$. Analogous expressions can be written down for $V(U^m_\tau)$ and $Cov(U^m_\tau U^m_{\tau+m})$.

E The Average of Men's and Women's Life-time Well-being

We now address more generally issues raised by the need to work out the standard deviation of average well-being. The estimates of life years and prevalence of healthy life for the two sexes can be taken to be independent of each other, since they are constructed from different populations. Similarly the leisure figure can be assumed independent; the two models are estimated independently and there is no obvious way of exploring covariances arising from seemingly unrelated random effects estimation. But the consumption models are applied to households, not individuals, and, in any given LTLA, the same consumption figures are used for men and women. This creates obvious covariation which has to be taken into account when evaluating the average of men's and women's. life-time wellbeing.

$$U^{life-time,average} = 0.5(\mathbf{U}^{f\prime}\hat{\mathbf{H}}^f\mathbf{L}^f + \mathbf{U}^{m\prime}\hat{\mathbf{H}}^m\mathbf{L}^m) = 0.5(\mathbf{U}^{f\prime}\hat{\mathbf{L}}^f\mathbf{H}^f + \mathbf{U}^{m\prime}\hat{\mathbf{L}}^m\mathbf{H}^m) \quad (36)$$
$$= 0.5(\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f\mathbf{U}^f + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m\mathbf{U}^m)$$

We may write these expressions in matrix notation as

$$U^{life-time,average} = 0.5\begin{bmatrix}\mathbf{U}^{f\prime}\hat{\mathbf{H}}^f & 0\\ 0 & \mathbf{U}^m\hat{\mathbf{H}}^m\end{bmatrix}\begin{bmatrix}\mathbf{L}^f\\ \mathbf{L}^m\end{bmatrix} = 0.5\begin{bmatrix}\mathbf{U}^{f\prime}\hat{\mathbf{L}}^f & 0\\ 0 & \mathbf{U}^{m\prime}\hat{\mathbf{L}}^m\end{bmatrix}\begin{bmatrix}\mathbf{H}^f\\ \mathbf{H}^m\end{bmatrix}$$
$$= 0.5\begin{bmatrix}\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f & 0\\ 0 & \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m\end{bmatrix}\begin{bmatrix}\mathbf{U}^f\\ \mathbf{U}^m\end{bmatrix} \quad (37)$$

We can now see that, using the same logic as with equation (13) and with the covariances terms for **L** and **H** set to zero,

$$\begin{aligned} V(U^{life-time,average}) = {} & \frac{1}{4}\left\{\mathbf{U}^{f\prime}\hat{\mathbf{H}}^f V(\mathbf{L}^f)\hat{\mathbf{H}}^f\mathbf{U}^f + \mathbf{U}^{f\prime}\hat{\mathbf{L}}^f V(\mathbf{H}^f)\hat{\mathbf{L}}^f\mathbf{U}^f + \mathbf{L}^{f\prime}\hat{\mathbf{H}}^f V(\mathbf{U}^f)\hat{\mathbf{H}}^f\mathbf{L}^f\right\} \quad (38)\\ & + \frac{1}{4}\left\{\mathbf{U}^{m\prime}\hat{\mathbf{H}}^m V(\mathbf{L}^m)\hat{\mathbf{H}}^m\mathbf{U}^m + \mathbf{U}^{m\prime}\hat{\mathbf{L}}^m V(\mathbf{H}^m)\hat{\mathbf{L}}^m\mathbf{U}^m + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m V(\mathbf{U}^m)\hat{\mathbf{H}}^m\mathbf{L}^m\right\}\\ & + \frac{1}{4}\left\{\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f Cov(\mathbf{U}^f, \mathbf{U}^m)\hat{\mathbf{H}}^m\mathbf{L}^m + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m Cov(\mathbf{U}^m, \mathbf{U}^f)\hat{\mathbf{H}}^f\mathbf{L}^f\right\} \end{aligned}$$

We separate the terms for men and women as

$$\mathbf{\Lambda}^f = \left\{\hat{\mathbf{H}}^f V(\mathbf{L}^f)\hat{\mathbf{H}}^f + \hat{\mathbf{L}}^f V(\mathbf{H}^f)\hat{\mathbf{L}}^f\right\} \quad (39)$$

and

$$\Lambda^m = \left\{\hat{\mathbf{H}}^m V(\mathbf{L}^m)\hat{\mathbf{H}}^m + \hat{\mathbf{L}}^m V(\mathbf{H}^m)\hat{\mathbf{L}}^m\right\} \quad (40)$$

Expression (38) then reduces to

$$\begin{aligned} V(U^{life-time,average}) = {} & \frac{1}{4}\left\{\mathbf{U}^{f\prime}\mathbf{\Lambda}^f\mathbf{U}^f + \mathbf{L}^{f\prime}\hat{\mathbf{H}}^f V(\mathbf{U}^f)\hat{\mathbf{H}}^f\mathbf{L}^f\right\} \quad (41)\\ & + \frac{1}{4}\left\{\mathbf{U}^{m\prime}\Lambda^m\mathbf{U}^m + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m V(\mathbf{U}^m)\hat{\mathbf{H}}^m\mathbf{L}^m\right\}\\ & + \frac{1}{4}\left\{\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f Cov(\mathbf{U}^f, \mathbf{U}^m)\hat{\mathbf{H}}^m\mathbf{L}^m + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m Cov(\mathbf{U}^m, \mathbf{U}^f)\hat{\mathbf{H}}^f\mathbf{L}^f\right\} \end{aligned}$$

However, since our measure of well-being is the average of the measures for men and women, we also need to evaluate $Cov(U^f_\tau U^m_\tau)$ and $Cov(U^f_\tau U^m_{\tau+m}$.). The labour market terms in (25) are estimated independently of each other but the consumption terms are common to men and women. This means that, for the diagonal elements

$$Cov(U_\tau^f U_\tau^m) = \alpha^2 \left\{ X_k' V(\beta_c) X_k + \sigma^2_{c,u} + \sigma^2_{c,v} + \sigma^2_{c,w} \right\} \tag{42}$$

and, for the off-diagonal elements

$$Cov(U_\tau^f U_{\tau+m'}^m) = \alpha^2 \left\{ X_k' V(\beta_c) X_k + \sigma^2_{c,v} + \sigma^2_{c,w} \right\} \tag{43}$$

We also require the covariance matrix of the demographic terms in the subsequent calculation of the variance of the well-being measure. The latter terms are given in vector form as

$$0.5(\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m)$$

and the covariance matrix of this vector is

$$V\left\{0.5(\mathbf{L}^{f\prime}\hat{\mathbf{H}}^f + \mathbf{L}^{m\prime}\hat{\mathbf{H}}^m)\right\} = \frac{1}{4}(\mathbf{\Lambda}^f + \mathbf{\Lambda}^m) \tag{44}$$

since the men's and women's demographic terms are independent of each other.

F Weighting

Survey estimates are often produced using weighted data. In our situation we have varying availability of data. The survival and health data are generated for each UTLA and we assume that these data relate to the LTLAs which comprise the UTLA. The consumption and leisure data in contrast are generated for MSOAs- subdivisions of LTLAs. The LTLA fixed effect in equation (10) is the average across the MSOAs which comprise the LTLA of the fixed effects weighted by the number of households in each MSOA. The latter is estimated by the Annual Population Survey. Thus no further weighting is needed to compute the measure of well-being. At the same time it should be noted that no account is taken of any uncertainty in these population weights when evaluating the measure of well-being. ω represents the vector of weights with ω_k the weight of LTLA k.

G Equivalent Variation and Compensating Variation

G.1 Fitted Value

Jones & Klenow (2016) present their results in terms of equivalent variation; this shows the extent to which consumption in the United States needs to be scaled in order to deliver the same level of life-time well-being as is observed in the country with which the United States is being compared. While it would be possible to set an single LTLA as the basis for comparison in our work, it is more natural to make the basis of comparison the average level of utility across the LTLAs weighted by the size of their adult populations.

G.2 Variance

In order to estimate the variance of $\log(\lambda_q)$ we first set D_k to be the average of men's and women's health-weighted life expectancy in small area k, so that

$$\alpha \sum_k \omega_k \frac{\sum_{\tau=0}^{\tau_{\max}} \left\{ L_{kt}^f h_{kt}^f + L_{kt}^m h_{kt}^m \right\}}{2} = \alpha \sum_k \omega_k D_k$$

so that, from equation (5)

$$\log(\lambda_k) = \frac{U^k - U^{Eng}}{\alpha \sum_k \omega_k D_k} \tag{45}$$

We can now write

$$V(\log(\lambda_n)) = \left(\frac{U_n - U_{Eng}}{\alpha \sum_k \omega_k D_k} \right)^2 \left(\frac{V(U_n - U_{Eng})}{(U_n - U_{Eng})^2} + \frac{V(\alpha \sum_k \omega_k D_k)}{(\alpha \sum_k \omega_k D_k)^2} - 2 \frac{Cov(U_n - U_{Eng}, \alpha \sum_k \omega_k D_k)}{(\alpha \sum_k \omega_k D_k)(U_n - U_{Eng})} \right) \tag{46}$$

First we look at the covariance matrix of the life-time utilities in the different areas.

$$\begin{aligned} Cov(U_k, U_p) = {} & \frac{1}{4}(\mathbf{L}_k^{f\prime} \hat{\mathbf{H}}_k^f Cov(\mathbf{U}_k^f \mathbf{U}_p^f) \hat{\mathbf{H}}_p^f \mathbf{L}_p^f) + \frac{1}{4}(\mathbf{L}_k^{f\prime} \hat{\mathbf{H}}_k^f Cov(\mathbf{U}_k^f \mathbf{U}_p^m) \hat{\mathbf{H}}_p^m \mathbf{L}_p^m) \\ & + \frac{1}{4}(\mathbf{L}_k^{m\prime} \hat{\mathbf{H}}_k^m Cov(\mathbf{U}_k^m \mathbf{U}_p^f) \hat{\mathbf{H}}_p^f \mathbf{L}_p^f) + \frac{1}{4}(\mathbf{L}_k^{m\prime} \hat{\mathbf{H}}_k^m Cov(\mathbf{U}_k^f \mathbf{U}_p^m) \hat{\mathbf{H}}_p^m \mathbf{L}_p^m) \\ & + \sum_n \frac{1}{4}(\mathbf{L}_k^{f\prime} \hat{\mathbf{U}}_k^f Cov(\mathbf{H}_k^f \mathbf{H}_p^f) \hat{\mathbf{U}}_p^f \mathbf{L}_p^f) + \frac{1}{4}(\mathbf{L}_k^{m\prime} \hat{\mathbf{U}}_k^m Cov(\mathbf{H}_k^m \mathbf{H}_p^m) \hat{\mathbf{U}}_p^m \mathbf{L}_p^m) \\ & + \sum_n \frac{1}{4}(\mathbf{H}_k^{f\prime} \hat{\mathbf{U}}_k^f Cov(\mathbf{L}_k^f \mathbf{L}_p^f) \hat{\mathbf{U}}_p^f \mathbf{L}_p^f) + \frac{1}{4}(\mathbf{L}_k^{m\prime} \hat{\mathbf{U}}_k^m Cov(\mathbf{L}_k^m \mathbf{L}_p^m) \hat{\mathbf{U}}_p^m \mathbf{H}_p^m) \end{aligned} \tag{47}$$

Particular attention needs to be given to the terms $Cov(\mathbf{U}_k^f \mathbf{U}_p^f)$, $Cov(\mathbf{U}_k^f \mathbf{U}_p^m)$, $Cov(\mathbf{U}_k^m \mathbf{U}_p^f)$ and $Cov(\mathbf{U}_k^f \mathbf{U}_p^m)$. When $k = p$ the components of the variance matrices are discussed in section D.3. When $k \neq p$ covariances arise from the deterministic parts of the models of consumption and labour supply and, if they are in the same region, from the variances of the regional term. We construct an indicator δ_{kp} which takes a value 1 if both LTLAs are in the same region and zero otherwise. Thus, from the models of equation (25).

$$\begin{aligned}
Cov\left(U^f_{k,\tau}, U^f_{p,\tau}\right) &= \alpha^2\left\{X'_k V(\beta_c)X_p + \sigma^2_{c,u} + \delta_{kp}\sigma^2_{c,\upsilon}\right\} \\
&\quad +\theta^2(1-\tilde{l}^f_\tau)^2\left\{X'_k V(\beta_{lf})X_p + \sigma^2_{lf,u} + \delta_{kp}\sigma^2_{lf,\upsilon}\right\} && (48)\\
Cov\left(U^f_{k,\tau}, U^f_{p,\tau+t}\right) &= \alpha^2\left\{X'_k V(\beta_c)X_p + \delta_{kp}\sigma^2_{c,\upsilon}\right\} \\
&\quad +\theta^2(1-\tilde{l}^f_\tau)^2\left\{X'_k V(\beta_{lf})X_p + \delta_{kp}\sigma^2_{lf,\upsilon}\right\} && (49)\\
Cov\left(U^f_{k,\tau}, U^m_{p,\tau}\right) &= \alpha^2\left\{X'_k V(\beta_c)X_p + \sigma^2_{c,u} + \delta_{kp}\sigma^2_{c,\upsilon}\right\} && (50)\\
Cov\left(U^f_{k,\tau}, U^m_{p,\tau+t}\right) &= \alpha^2\left\{X'_k V(\beta_c)X_p + \delta_{kp}\sigma^2_{c,\upsilon}\right\} && (51)
\end{aligned}$$

When the covariance is evaluated for two different LTLAs but for people in the same age group we need to include the variation arising from the uncertainty in the age random effect. If the two LTLAs are drawn from the same region, we also need to include the variance of the region random effect. These come on top of the covariance arising from the deterministic parts of the models. But when we look at two different age bands, the variance term associated with the age random effect is absent. Only the consumption terms contribute to the covariance between the values for men and women since these are common to both sexes.

We set $V(D_k)$ as the the variance of the average of men's and women's health-adjusted life expectancy; referring back to (44) we see that

$$V(D_k) = \frac{1}{4}\mathbf{i}'(\boldsymbol{\Lambda}^f_k + \boldsymbol{\Lambda}^m_k)\mathbf{i} \tag{52}$$

and

$$\begin{aligned}
Cov(D_k, D_n) = \sum_n \delta_{k,n} &\left[\frac{1}{4}\left(\mathbf{L}^{f'}_k Cov\left(\mathbf{H}^f_k \mathbf{H}^f_n\right)\mathbf{L}^f_n\right) + \frac{1}{4}\left(\mathbf{L}^{m'}_k Cov\left(\mathbf{H}^m_k \mathbf{H}^m_n\right)\mathbf{L}^m_n\right)\right. \qquad (53)\\
&\left. + \frac{1}{4}\left(\mathbf{H}^{f'}_k Cov\left(\mathbf{L}^f_k \mathbf{L}^f_n\right)\mathbf{H}^f_n\right) + \frac{1}{4}\left(\mathbf{H}^{m'}_k Cov\left(\mathbf{L}^m_k \mathbf{L}^m_n\right)\mathbf{H}^m_n\right)\right]
\end{aligned}$$

Finally we need to evaluate $Cov(U_n - U_{Eng}, \alpha \sum_k \omega_k D_k)$. The only source of covariation is that the demographic terms are common to both composite variables. We evaluate

$Cov(U_k, D_p)$

$$U_k = 0.5(\mathbf{L}^{f'}_k \hat{\mathbf{H}}^f_k \mathbf{U}^f_k + \mathbf{L}^{m'}_k \hat{\mathbf{H}}^m_k \mathbf{U}^m_k) \tag{54}$$

remembering that we have set $\Lambda^f_k = V\left(\mathbf{L}^{f'}_k \hat{\mathbf{H}}^f_k\right)$ and $\Lambda^m_k = V\left(\mathbf{L}^{m'}_k \hat{\mathbf{H}}^m_k\right)$

$$D_p = (\mathbf{L}^{f'}_p \hat{\mathbf{H}}^f_p + \mathbf{L}^{m'}_p \hat{\mathbf{H}}^m_p)\mathbf{i} \tag{55}$$

It then follows that, since for non-zero covariances, $\Lambda^f_k = \Lambda^f_p$ and $\Lambda^m_k = \Lambda^m_p$

$$Cov(U_k, D_p) = \frac{1}{2}\ \mathbf{U}_k^f \boldsymbol{\Lambda}_k^f + \mathbf{U}_k^m \boldsymbol{\Lambda}_k^m\ \mathbf{i} \tag{56}$$

We now write $\mathbf{U}^*$ as the covariance matrix of the life-time utilities of the small areas, so that the element in row k and column p is $Cov(U_k, U_p)$, and $\mathbf{D}^*$ as the covariance matrix of expected health-adjusted life expectancy, so that the element in row k and column p is $Cov(D_k, D_p)$. We also define $\mathbf{W}^*$ as the matrix whose element in row k and column p is equal to $Cov(U_k D_p)$.$\mathbf{\Omega}$ is the matrix each of whose rows is set equal to the vector of area weights ω'.

The covariance matrix of $\mathbf{u}$-U_{Eng} is then given as

$$Cov\,(\mathbf{u} - U_{Eng}) = (\mathbf{I} - \mathbf{\Omega})\mathbf{U}^*(\mathbf{I} - \mathbf{\Omega})' \tag{57}$$

and the diagonal elements of this give us the values of $V\,(U_n - U_{Eng})$ for the different n. Similarly, with $\mathbf{d}$ the vector of health-adjusted life expectancies in the different areas so that

$$\sum_k \omega_k D_k = \omega \mathbf{d} \tag{58}$$

This means we can compute

$$V \quad \sum_k \omega_k D_k \quad = \omega \mathbf{D}^* \omega' \tag{59}$$

which is of course the same for all the areas.

Finally the column vector of covariances is computed as

$$Cov(\mathbf{u} - U_{Eng}, \alpha \sum_k \omega_k D_k) = \alpha(\mathbf{I} - \mathbf{\Omega})\mathbf{W}^* \omega' \tag{60}$$

These variances can of course also be evaluated without the health adjustment by setting the weight on life years in poor health equal to one rather than a lower value.