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DISCUSSION PAPER

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Keywords: Subjective wellbeing, longitudinal data, summary measures

JEL classification: C23, C25, I31

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* The views expressed are those of the authors and may not reflect the views of the Office for National Statistics or the wider UK Government.

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Abstract

In this paper we derive new measures of Subjective Wellbeing (SWB) in the UK using self-reported responses to the General Health Questions (GHQs) in the UK Household Longitudinal Study (UKHLS), for the period 2009-2020. Our study makes three main empirical contributions. First, we draw a consistent picture of changes in wellbeing over time by exploiting the longitudinal nature of the survey. We thus offer new evidence that cannot otherwise be revealed by looking at the annual snapshots produced by other types of surveys. Second, we provide a detailed breakdown of the trends by examining twelve aspects of SWB in different UK regions, with elements that are conventionally regarded as direct measures of wellbeing (e.g., general happiness), and elements that directly reflect the state of wellbeing (e.g., sleep, confidence). Thereby, we provide a more complete picture of changes in wellbeing in the UK compared to most empirical studies. Third, we establish a method to quantify categorical SWB responses accounting for the impact of individual-specific and regional factors. The resulting summary measure, in the form of adjusted balance statistics, is therefore expected to be more informative than simple aggregation implied by most empirical studies. Our results show that subjective wellbeing in the UK has followed a downward trend since 2014, both at the national and regional level, and for most of the dimensions of wellbeing. This is in contrast with the picture shown by other UK data where the decline has only happened in more recent years.

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1. Introduction

Improving wellbeing and standards of living across the UK is at the core of the policy agenda, receiving a further boost with the publication of the 'Levelling up' White Paper. While productivity is key in achieving a higher level of prosperity, there are other social outcomes that matter and need to be taken into account to understand wellbeing. Distributional aspects across regions and demographic groups are considered increasingly important as the debate focuses on the inclusiveness of growth and levelling up. Since the financial crisis, productivity has flatlined in the UK and regional disparities in productivity have accentuated, making the UK one of the most spatially unequal countries in the OECD (McCann, 2020). Research provides support for the assumption that individuals displaying higher levels of wellbeing also tend to report higher levels of labour productivity (Isham and Jackson, 2020). However, measuring wellbeing is challenging largely because it is difficult to quantify. The important relationship between wellbeing and productivity, the need to better understand how wellbeing varies across UK regions and across time, and the need to have a better measure to quantify wellbeing to inform policymaking prompt us to undertake this study.

Our study aims to answer the following questions: (a.) How do responses to different SWB metrics relate to each other and is there evidence to suggest possible unobserved common factors that drive SWB experiences? (b.) What are the most significant factors that drive SWB? Do we observe different drivers for different aspects of SWB? Are there any regional differences and how do they compare with national results? (c.) How does the trend of different SWB metrics change over time? Is there any regional difference in such trends? As well as providing answers to these questions, we also provide an example to illustrate how one can obtain weights that account for heterogeneity in individuals' SWB experience in response to a set of observables and discuss an alternative method for adjustment.

In this paper, we measure subjective wellbeing (SWB) in the UK and the regions using individual level data from the UK Household Longitudinal Study (UKHLS). The General Health Questionnaire (GHQ) in the UKHLS provide different perspectives on individual SWB covering aspects such as happiness, enjoyment with daily life and activities, accomplishments or ability to overcome problems and difficulties, and stress. It has a more comprehensive coverage of different dimensions of wellbeing compared to some other surveys, such as the ONS's Annual Population Survey (APS) which captures only four general dimensions of personal wellbeing.

We start by looking at how different SWB assessments relate to each other by means of polychoric correlations both at the national and regional level. Polychoric correlation measures the level of agreement between two normally distributed continuous latent variables with observed ordinal values. We also question whether surveys that focus on using happiness, or a few life-satisfaction related questions, are sufficient to fully understand wellbeing. We check whether there is evidence that self-reported subjective wellbeing is truly multi-dimensional, or if it could be summarized by some common factors. If strong correlations among the SWB metrics are found, we argue that this may indicate the presence of common factors and thus it may be possible to reduce the number of SWB metrics. Next, we employ a discrete choice model to look at the drivers of subjective wellbeing in the UK overall and in the UK regions. These go beyond measures of output and productivity outcomes present in official statistics and provide implications in terms of the factors that drive these aggregate differences.

Finally, we quantify and aggregate self-reported individual responses to SWB questions in the manner of balance statistics. The UNECE guideline (2019) defines sentiment indicators as "indicators that reflect opinions, attitudes or expectation of survey respondents". The report has divided sentiment indicators into two main groups: economic and socio-economic. The summary indicator this paper attempts to construct belongs to the latter. This type of sentiment indicator is usually based on the assessment of current situation, opinion on certain issues or future expectation provided by individuals and households. In the context of wellbeing, it could be the assessment or perception of an individual's life or aspects of life. Socio-economic sentiment indicators on wellbeing can provide useful information for policymaking. We also discuss ways to adjust a summary measure of subjective wellbeing metric for heterogeneity. As we believe that individuals' SWB experiences are affected by a set of observables including individual specific and regional economic conditions, we construct weights that reflect heterogeneity of SWB experiences in response to these observables. We also discuss an alternative approach for adjustment, constructing weights that reflect the heterogeneity of SWB experiences in response to unobservable factors.

Since 2011 the UK Office for National Statistics (ONS) has published a dashboard of measures for the different aspects of life in the UK in terms of national wellbeing[1]. Results from ONS show that, average ratings of life satisfaction, happiness and anxiety had been increasing in the UK since 2011 and only

[1] These are part of ONS's Measuring National Well-being (MNW) programme. The programme began in November 2010 with the aim of developing and publishing an accepted and trusted set of National Statistics, which help people understand and monitor well-being

started to deteriorate from 2019. We also re-examine the patterns of SWB metrics separately and the overall trend of SWB in the UK and the UK regions over time using the UKHLS in this paper.

The organisation of this paper is as follows. Section 2 describes the data and provides background information on the UKHLS, and on characteristics of our sample. We also explain the twelve General Health Questions of SWB examined in this paper and our choices of individual drivers of SWB. Section 3 presents the methods we use in our analysis. This section includes the polychoric correlation first proposed by Olsson (1979), the discrete choice model we use for conditional analysis and the method we use to construct summary measures of SWB. In Section 4 we present our empirical results. We present both unconditional and conditional analysis, as well as trends in SWB metrics for the UK and UK regions. Section 5 concludes, and we discuss avenues for further research in Section 6.

2. Data

The UK Household Longitudinal Study (UKHLS), also known as Understanding Society, is a longitudinal survey of about 40,000 households in the United Kingdom, covering members of these households in England, Scotland, Wales and Northern Ireland (NI). The study began in 2009-2010 and followed on from the British Household Panel Survey (BHPS) which was conducted between 1991 and 2008. The study is representative of the UK population. In this research we use a total of ten waves of the UKHLS data. The latest wave of the survey we draw upon covers the years 2019-2020. In the appendix we provide more detailed background information on the survey. We focus the sample for our analysis on Original Members (OSMs) only. They are survey members who are followed through the life of the study. This allows us to track respondents over all ten waves. See Appendix A for more information on the sample members.

The UKHLS covers a wide range of variables referring to: demographic characteristics, socio-economic characteristics, education, employment status and employment history, income and its sources, geography, health, household characteristics, type of housing and accommodation, caring responsibilities, and a series of (self-assessed) variables on different aspects of wellbeing and life satisfaction.[2] Among these variables are the twelve General Health Questions (GHQ) that ask individual respondents their experience in twelve aspects of SWB. Table A.1 shows the question text and choice of responses. Compared to other existing UK surveys that collect similar information on

[2]See https://www.understandingsociety.ac.uk/documentation/mainstage/dataset-documentation/index-terms for the thematic areas the UKHLS covers.

SWB[3], the UKHLS asks a more comprehensive set of questions that covers different aspects of SWB. Our analysis focuses on these self-assessed measures, and we combine the two negative categories and recode the categorical responses such that they rank from the lowest SWB to the highest. See panel A of Table A.2 for the textual description of the three categorical responses to each SWB metric.

Our analysis considers both an unbalanced and a balanced panel of respondents. The unbalanced panel contains all respondents who have responded to the survey at least once and have given valid answers to all twelve GHQs, as well as the questions from which we derive individual specific factors. We condition the SWB responses on these factors when we conduct regression analysis. See Panel B of Table A.2 for these individual factors. Table 2.1 contains the number of observations in our sample across waves and interview years. We see that each wave spans across three different years (over 24 months). We observe fewer observations in 2020 which is the last interview year in our sample period. There are a total of 327,752 observations in the unbalanced panel. While we try to use the maximum sample size where possible for our analysis, especially for the regional analysis, we have chosen to limit our analysis to a balanced panel of respondents when we adjust summary measures of SWB metrics for heterogeneity as this requires us to model SWB metrics for each respondent. Since we only have ten waves of data, using the maximum number of observations for each respondent results in a balanced panel that contains a total of 7,321 respondents who have responded to all waves of UKHLS. This amounts to about 73,210 observations. The balanced panel represents just over 22 per cent of the total sample.

Table 2.2 breaks down the total number of observations in the balanced sample, by wave and by region. For the sample as a whole, the largest number of observations are for the South-East (11,239), followed by the North-West (8,786), the South-West (8,039), the East of England (7,566), the West Midlands (6,348), and the East Midlands (6,101). The regions with fewer observations for the overall period are Wales and Northern Ireland with 2,772 and 2,263 observations respectively. We are aware that the reduced number of observations by region would hinder valid inference being drawn from regional analysis using the balanced panel. Hence, we decide to focus our regional analysis on the unbalanced panel and to provide insights into SWB across different UK regions using this larger

[3] The ONS's Annual Population Survey (APS) has covered aspects of SWB since 2011. The survey asks about experience in terms of *"Life satisfaction"*, *"Happiness"*, *"Worthwhile" and "Anxiety*". Each year the APS indicators of personal wellbeing represent a snapshot of the wellbeing of individuals across the country. The APS is not a longitudinal survey however, and therefore does not allow us to track changes to individuals' wellbeing over time.

sample. But for the analysis of unadjusted balance statistics of SWB, we use both the unbalanced and balanced sample.

The use of longitudinal data allows us to track respondents' wellbeing over time, unlike other surveys that illustrate changes to individual wellbeing using cross-section level data. The latter type of survey is less suited if one wants to understand how individual SWB varies in response to observed as well as unobserved factors that may affect SWB movements over time. Research has also shown that individuals with repeated participation in surveys tend to answer in a different way to those that only participate occasionally. Kim and Binder (2021) show that when surveys rely on repeat participants, this raises the possibility that survey participation may affect future responses, perhaps by prompting information acquisition between survey waves.

Table 2.1 Number of observations across UKHLS waves and interview years in the unbalanced panel

wave	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
1	19,996	17,553	1,167	0	0	0	0	0	0	0	0	0	38,716
2	0	22,556	16,152	666	0	0	0	0	0	0	0	0	39,374
3	0	0	21,047	14,627	724	0	0	0	0	0	0	0	36,398
4	0	0	0	19,579	13,538	1,019	0	0	0	0	0	0	34,136
5	0	0	0	0	18,191	13,223	983	0	0	0	0	0	32,397
6	0	0	0	0	0	17,654	12,295	912	0	0	0	0	30,861
7	0	0	0	0	0	0	16,787	13,872	1,077	0	0	0	31,736
8	0	0	0	0	0	0	0	16,310	12,429	1,373	0	0	30,112
9	0	0	0	0	0	0	0	0	15,002	11,378	1,183	0	27,563
10	0	0	0	0	0	0	0	0	0	14,458	11,227	774	26,459
Total	19,996	40,109	38,366	34,872	32,453	31,896	30,065	31,094	28,508	27,209	12,410	774	327,752

Note: While the survey fieldwork period for each wave is 24 months, every individual is interviewed at approximately 12-month intervals.

Table 2.2 Number of observations by region, balanced panel.

wave	North East	North West	Yorkshire & Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	Total
1	352	874	572	603	639	757	519	1,127	794	276	582	226	7,321
2	350	871	573	612	639	761	511	1,130	790	277	581	226	7,321
3	351	874	571	612	634	762	509	1,133	791	276	582	226	7,321
4	354	879	572	615	631	753	506	1,136	793	278	578	226	7,321
5	354	877	568	607	637	759	507	1,132	797	279	578	226	7,321
6	354	879	566	602	636	757	504	1,130	810	277	580	226	7,321
7	356	883	569	608	635	755	500	1,122	809	278	580	226	7,321
8	360	882	571	612	629	755	495	1,121	811	279	580	226	7,321
9	360	884	575	614	633	754	490	1,109	819	276	580	227	7,321
10	361	883	575	616	635	753	490	1,099	825	276	580	228	7,321
Total	3,552	8,786	5,712	6,101	6,348	7,566	5,031	11,239	8,039	2,772	5,801	2,263	73,210

3. Method

We discuss the methods we use to analyse SWB in this section. We conduct both an unconditional analysis and conditional analysis. For the unconditional analysis, we investigate pairwise correlations of responses among the twelve aspects of SWB captured by the GHQs via polychoric correlation without conditioning on any factors that may impact on respondents' SWB experiences. This allows us to draw some insights into whether there may exist some unobserved common factors that potentially drive these different aspects of SWB.

For the conditional analysis, we allow a set of individual factors that affect respondents' SWB by means of discrete choice models. The choice of factors is based on existing literature. Such analysis offers insights into the drivers of SWB and guides us on what factors one should consider when adjusting summary measures of SWB for heterogeneity. We also discuss ways to summarise SWB responses in the manner of balance statistics, both when we adjust for heterogeneity and when we do not. We then discuss the computation of a composite measure of SWB.

3.1 Polychoric correlation

Before we examine the determinants of respondents' self-assessed SWB, we first conduct a polychoric correlation analysis to examine how the different aspects of SWB relate to each other. Correlation between categorical variables was first suggested by Pearson (1901) in the form of tetrachoric correlation based on a 2×2 contingency table. The idea was then further developed by Olsson (1979) to include multiple categories in ordinal variables based on a $m_1 \times m_2$ contingency table where $m_1, m_1 > 2$ (see also Jöreskog (2004) and Koleniknov and Angeles (2004)). As pointed out in Koleniknov and Angeles (2004), the assumptions of the polychoric correlation estimation are very similar to those required to derive an ordered probit model. This method is centred on the assumption of a bivariate normal distribution. In this subsection, we follow Jöreskog (2004) and explain how polychcoric correlation is computed.

Suppose $y^{(1)^*}$ and $y^{(2)^*}$ are two latent responses that correspond to two SWB questions, underlying two ordinal variables $y^{(1)}$ and $y^{(2)}$, respectively. $y^{(1)}$ and $y^{(2)}$ are observed ordinal responses, each with m_1 and m_2 categories, obtained by categorising $y^{(1)^*}$ and $y^{(2)^*}$. Their contingency table is given by:

$$\begin{pmatrix} c_{11} & c_{12} & \cdots & c_{1m_2} \\ c_{21} & c_{21} & \cdots & c_{2m_2} \\ \vdots & \vdots & \ddots & \vdots \\ c_{m_1 1} & c_{m_1 2} & \cdots & c_{m_1 m_2} \end{pmatrix},$$

where $c_{p,s}$ is the number of cases in category p on variable 1, i.e., $y^{(1)}$ and category s in variable 2, i.e., $y^{(2)}$. Assuming $y^{(1)^*}$ and $y^{(2)^*}$ follow a standard bivariate normal distribution with mean zero, unit variance and correlation $\rho = corr\left(y^{(1)^*}, y^{(2)^*}\right)$. That is,

$$\begin{pmatrix} y^{(1)^*} \\ y^{(2)^*} \end{pmatrix} \sim N\left(0, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right), \qquad -1 \leq \rho \leq 1 \tag{3.1}$$

The polychoric correlation is the off-diagonal element in their covariance (correlation) matrix. In our analysis of the SWB responses in UKHLS, $m_1 = m_2 = m$ because there are the same number of response categories to each SWB question. Let $\alpha_j^{(1)}$ and $\alpha_j^{(2)}$ be the categorising thresholds of the $y^{(1)^*}$ and $y^{(2)^*}$, respectively (with $j = 1, \cdots, m_1 - 1$ for $y^{(1)^*}$, and $j = 1, \cdots, m_2 - 1$) for $y^{(2)^*}$):

$$\alpha_1^{(1)} < \alpha_2^{(1)} < \cdots < \alpha_{m_1-1}^{(1)} \text{ and } \alpha_1^{(2)} < \alpha_2^{(2)} < \cdots < \alpha_{m_2-1}^{(2)}$$

with $\alpha_0^{(1)}, \alpha_0^{(2)} = -\infty$ and $\alpha_{m_1}^{(1)} = \alpha_{m_2}^{(2)} = \infty$. Such that

$$y^{(k)} = j \quad when\ \alpha_{j-1}^{(k)} < y^{(k)^*} < \alpha_j^{(k)}$$

where $k = 1, 2$, denote SWB question k. Let $\pi_{p,s}$ be the probability that an observation falls in category p on variable 1, i.e., $y^{(1)}$ and category s in variable 2, i.e., $y^{(2)}$; and θ denotes the vector contains all the parameters, so $\theta = (\alpha_1^{(1)}, \alpha_2^{(1)}, \cdots, \alpha_{m_1-1}^{(1)}, \alpha_1^{(2)}, \alpha_2^{(2)}, \cdots, \alpha_{m_2-1}^{(2)}, \rho)$. The probability, $\pi_{p,s}$ is given by:

$$\pi_{p,s}(\theta) = P\left(y^{(1)} = p, y^{(2)} = s\right) = \int_{\alpha_{p-1}^{(1)}}^{\alpha_p^{(1)}} \int_{\alpha_{s-1}^{(2)}}^{\alpha_s^{(2)}} \phi_2(u, v) du\, dv \tag{3.2}$$

where $\phi_2(u, v)$ is the standard bivariate normal density of $y^{(1)^*}$ and $y^{(2)^*}$ with correlation ρ, i.e.,

$$\phi_2(u,v) = \frac{1}{2\pi\sqrt{1-\rho^2}} exp\left[-\frac{1}{2(1-\rho^2)}(u^2 - 2\rho uv + v^2)\right] \quad (3.3)$$

The polychoric correlation, ρ, can be estimated by maximizing the log-likelihood function

$$l = \sum_{r=1}^{m_1}\sum_{s=1}^{m_2} n_{p,s}\, ln\pi_{p,s}(\theta) \quad (3.4)$$

As explained in Jöreskog (2004), polychoric correlation is obtained by a two-step estimation. The thresholds are estimated in the first step using univariate marginal distributions of the latent variables. The polychoric correlation coefficient is estimated from the bivariate distributions for given thresholds. We refer readers to Jöreskog (2004) for more detailed explanation of the estimation procedure.

Polychoric correlation measures the level of agreement between two normally distributed continuous latent variables with observed ordinal values. The coefficient has values between 0 and +/-1, with 0 indicating no correlation and +/-1 indicating perfect correlation. A positive (negative) value indicates positive (negative) correlation. The correlation coefficients will not only tell us how the twelve SWB metrics are related to each other unconditionally, it will also tell us how likely it is that these different metrics are driven by some common forces. High correlation of SWB metrics (e.g., with a value close to 1) may indicate that it is very likely that some (unobserved) common factors are underlying their co-movement. If further analysis were interested in a more refined modelling approach to capture dependencies of the different SWB metrics via a multivariate modelling framework, a result of this kind may indicate the possibility to reduce the dimensions of the set of SWB metrics by summarising them into some common factors (see Ng (2015)).

3.2 Ordered probit

Due to the discrete nature of the SWB responses, it is sensible to use an ordinal discrete choice model to investigate the drivers of SWB. Discrete choice models are used in the literature relating to wellbeing (See for example, Akay et al. (2012)). We identify in panel B of Table A.2 those factors that may affect self-assessed SWB according to the literature, and we model their relationships using ordered probit models.

An ordered probit model is used to estimate relationships between an ordinal dependent variable (a variable that is categorical and ordered) and a set of independent variables. The GHQs ask about respondents' recent experience of different aspects of SWB. A respondent's self-assessed response can either be a report of (i.) lower (than usual) level of wellbeing (ii.) about the same (usual) level of wellbeing, or a report of (iii.) higher (than usual) level of wellbeing.[4] We denote a respondent's answer to SWB question k $(k = 1, \cdots, K; where\ K = 12)$ as j $(j = 0, 1, 2, respectively)$, and we also denote the number of respondents to the survey at wave $t$as N_t.

Suppose there is a continuous latent variable $y_{it}^{(k)*}$ that triggers respondent $i's$ categorical response to SWB question k in wave t $(t = 1, \cdots, 10)$ via the observation rule:

$$y_{it}^{(k)} = j \quad if\ \mu_{ij} < y_{it}^{(k)*} < \mu_{i(j+1)}, \qquad j = 0, 1, 2 \tag{3.2}$$

where $y_{it}^{(k)}$ is the observed categorical response. μ_{ij}' are the time-invariant and respondent-specific unknown thresholds to be estimated, and $\mu_{i0} = -\infty$, $\mu_{ij} \leq \mu_{i(j+1)}$, and $\mu_{i3} = \infty$.

The unobserved latent variable $y_{it}^{(k)*}$ is assumed to be related to a set of individual factors x_{it}, and regional factors z_{rt} (r denotes a region, $r = 1, 2, \ldots, 12$) in the following manner:

[4] Note that in some cases, the question asks if an individual has experienced e.g. loss of confidence or loss of sleep; in this case a report of "no loss" would correspond to a higher level of wellbeing in relation to a report indicating any "loss".

$$y_{it}^{(k)*} = \beta_i' x_{it} + \delta_i' z_{rt} + \varepsilon_{it} \tag{3.3}$$

ε_{it} is a respondent-specific error term that is assumed to be normally distributed with zero mean and unit variance. x_{it} does not contain a constant.

Given the standard normal assumption of ε_{it}, the conditional probabilities of observing wellbeing response $y_{it}^{(k)} = j$ at time t is given by $P_{jit}^{(k)} = P\left(y_{it}^{(k)} = j \,\middle|\, x_{it}, z_{rt}\right)$. The conditional probabilities of observing the three responses are:

$$P\left(y_{it}^{(k)} = 0 \mid x_{it}, z_{rt}\right) = P\left(y_{it}^{(k)*} \leq \mu_1 \mid x_{it}, z_{rt}\right) = \Phi(\mu_{i1} - \beta_i' x_{it} - \delta_i' z_{rt}) \tag{3.4}$$

$$\begin{aligned} P\left(y_{it}^{(k)} = 1 \mid x_{it}, z_{rt}\right) &= P\left(\mu_{i1} < y_{it}^{(k)*} \leq \mu_{i2} \mid x_{it}, z_{rt}\right) \\ &= \Phi(\mu_{i2} - \beta_i' x_{it} - \delta_i' z_{rt}) - \Phi(\mu_{i1} - \beta_i' x_{it} - \delta_i' z_{rt}) \end{aligned} \tag{3.5}$$

$$P\left(y_{it}^{(k)} = 2 \mid x_{it}, z_{rt}\right) = P\left(y_{it}^{(k)*} > \mu_{i2} \mid x_{it}, z_{rt}\right) = 1 - \Phi(\mu_{i2} - \beta_i' x_{it} - \delta_i' z_{rt}) \tag{3.6}$$

The parameters μ_{ij}'s, β_i's and δ_i's can be estimated using maximum likelihood. For each i, the log-likelihood function is given by:

$$\begin{aligned} l_i(\boldsymbol{\mu}, \boldsymbol{\beta}, \boldsymbol{\delta}) = {} & I\left[y_{it}^{(k)} = 0\right] ln[\Phi(\mu_{i1} - \beta_i' x_{it} - \delta_i' z_{rt})] \\ & + I\left[y_{it}^{(k)} = 1\right] ln[\Phi(\mu_{i2} - \beta_i' x_{it} - \delta_i' z_{rt}) - \Phi(\mu_{i1} - \beta_i' x_{it} - \delta_i' z_{rt})] \\ & + I\left[y_{it}^{(k)} = 2\right] ln[1 - \Phi(\mu_{i2} - \beta_i' x_{it} - \delta_i' z_{rt})] \end{aligned} \tag{3.7}$$

where $I[\cdot]$ is the indicator function.

When we investigate the drivers of SWB, we pool all respondents across the UK and across each UK region to estimate pooled national and regional ordered probit model as in equation 3.6 with the individual factors x_{it}. We also include dummy variables for regions and waves in these pooled regressions. We include in x_{it} those factors that capture demographic characteristics, household conditions, employment and income, caring responsibilities, and physical health. We also assume all aspects of SWB are affected by the same set of individual factors. When we adjust for heterogeneity,

we estimate the equation 3.6 with both x_{it} , and the regional factors z_t for each respondent in the balanced panel. We will discuss more about the adjustment for heterogeneity later in this section.

3.3 Constructing summary measures of SWB in the form of balance statistics

To construct wellbeing indicators, we quantify the qualitative individual-level responses on reported SWB by aggregating the proportion of reported positive and negative SWB experience and compute the balance of experience as a difference between the two. Balance statistics or Balance of Opinion are widely used as economic sentiment indicators that reflect current economic conditions in a timely manner. Similar to the socio-economic indicators, the micro-datasets underlying these types of indicators are usually qualitative survey responses. As Weale and Pesaran (2005) discuss, "the balance statistics, up to a scalar factor, provides an accurate measure of the average expected, or actual change in the variable in question if the percentage change of falls and rises reported by the respondents remain constant and of the same order of magnitudes for rises and falls over time".

Let $y_{i,t}^{(k)}$ denotes a response of respondent i to SWB metric k in wave t , where $k = 1, \cdots, 12$ and $t = 1, \cdots, 10$. $j = 0, 1, 2$ to denote negative, neutral (or no change) and positive responses, respectively. The proportions of positive $G_t^{(k)}$, neutral $E_t^{(k)}$ and negative $M_t^{(k)}$ responses are given by:

$$G_t^{(k)} = \frac{\sum_{i=1}^{N_t}(y_{it}^{(k)} = 2)}{N_t} \times 100$$

$$E_t^{(k)} = \frac{\sum_{i=1}^{N_t}(y_{it}^{(k)} = 1)}{N_t} \times 100$$

$$M_t^{(k)} = \frac{\sum_{i=1}^{N_t}(y_{it}^{(k)} = 0)}{N_t} \times 100$$

Where $\left(y_{it}^{(k)} = j\right)$ is one count of response j given by respondent i in wave t, and $\sum_{i=1}^{N_t}(y_{it}^{(k)} = 1)$ gives the total number of respondents who have given response j. Note that $G_t^{(k)} + E_t^{(k)} + M_t^{(k)} = 100$. So, the balance statistic of SWB metric k in wave t is computed as the difference between the proportion of reported positive experience and the proportion of reported negative experience.

$$B_t^{(k)} = G_t^{(k)} - M_t^{(k)} \tag{3.11}$$

Where $B_t^{(k)}$ denotes the value of the balance statistics of a SWB metric in wave t (See also DGECFIN, 2021 for discussion of balance statistics).

To summarise the sentiments of the twelve SWB measures, we compute a composite index. Existing studies that examine measures to summarise multiple SWB indicators or metrics, e.g., Michalos et al. (2011) and Boccard (2020), discuss the plausibility of assigning weights to SWB metrics. Both papers refer to Laplace's Principle of Insufficient Reason as argument in the absence of valid reasons to assign weights. The principle indicates how probabilities should be assigned when there are multiple events or outcomes. It states that when there is insufficient reason or absence of evidence to support that one outcome is more likely or should be ranked higher than the other possible outcomes, then all outcomes should be assigned equal probabilities. If we assign different weights to SWB metrics, we are making an implicit assumption that one metric is relatively more important than the others and ignore heterogeneity across individuals. Since we do not have any apparently good reason to believe that any SWB metrics are more important in determining overall wellbeing experience than the others, we assign equal weights to the twelve metrics.

We compute the composite index of SWB by first averaging standardised balance statistics of the twelve SWB metrics (i.e., with weight equals $\frac{1}{K}, where\ K = 12$). We then rescale this average series to an index value with mean equal to 100 and standard deviation equal to 10. The resulting composite index is regarded as an unadjusted composite measure of SWB as opposed to the adjusted composite measure of SWB in which we adjust for heterogeneity. We explain the adjustment in the next subsection.

3.3.1 An adjustment for heterogeneity

Most existing summary measures of wellbeing do not consider the relevance of individual-specific and regional factors in understanding individuals' SWB experiences. These tend to be simple aggregated measures of individual outcomes and offer limited insights into policy measures that may influence wellbeing. We suspect there is a certain level of heterogeneity among respondents' SWB experiences due to different individual characteristics and that there are likely to be some differences across UK

regions. Such individual and regional factors, e.g., regional disposable income, regional productivity, education, income and health, could be directly or indirectly influenced by policy. The existence of heterogeneity is an assumption we test by analysing the ordered probit estimation results. If such heterogeneity is proved to exist, then an appropriate method of aggregation would be one that considers the relevance of these differences to ensure the resulting summary measures are informative. *We aim* to create summary measures of SWB that accommodate heterogeneity across individuals' wellbeing experiences. One way of doing this is to give more weight to those respondents whose SWB outcomes are more closely associated with certain socio-economic factors. By doing so, we expect the SWB aggregates to better reflect the direct or indirect influence of policy via the correlation with the observables.

To adjust for heterogeneity, we first estimate the ordered probit model conditional on the individual and regional factors for each respondent in the balanced panel and retrieve the R^2 from each of these individual regressions. We then re-compute the balance statistics for each SWB where we assign larger weights to the respondents whose individual regressions have better model fit.

We include in equation (3.6) both the individual factors x_{it} and the regional factors z_{rt} and estimate it for each respondent in the balanced panel. z_{rt} contains measures of economic performance in region r where respondent *i* resides. In our analysis, we include the Gross Valued Added (GVA) per hour and Gross Disposable Household Income (GDHI) per head in z_t^r to capture regional productivity and regional economic welfare. From each respondent-level ordered probit model, we obtain a pseudo R^2 coefficient. We construct weights based on the pseudo R^2 coefficients obtained from all respondent-level models. This allows us to weight respondents according to the relationship between their wellbeing experience and their own individual circumstances and the economic condition in the region where they reside. R^2 is usually used to indicate goodness of fit, but it also reflects the amount of variation in the dependent variable, i.e., SWB metric in this case, explained by the set of covariates together. Therefore, these weights take into account the collective impact of x_{it} and z_{rt} on $y_{it}^{(k)*}$. We argue that heterogeneity exists when x_{it} and z_{rt} explain $y_{it}^{(k)*}$ differently across i, causing values of pseudo R^2 obtained from the ordered probit model vary across respondents. In the scenario when a SWB metric of a respondent is sensitive to x_{it} and z_{rt} collectively, we should expect the value of pseudo R^2 to be high. Small value of pseudo R^2 means SWB metric of a respondent cannot be explained much by x_{it} and z_{rt} collectively. It may imply that other factors that are not captured in x_{it} and z_{rt} could better explain $y_{it}^{(k)*}$, may it be some other observable or unobservable factors.

Ideally, we should keep the set of covariates included in x_{it} and z_{rt} constant across respondents, so that analysis among individuals is consistent and comparison across respondents is feasible. But we cannot rule out the fact that some respondents' SWB can be explained by the observables to different degrees. In such cases, we should expect the estimated coefficients of the covariates to vary across all respondent-level models.

In our analysis, we first investigate the level of heterogeneity by means of variations across the values of pseudo R^2 from respondent-level ordered probit models. This will let us evaluate whether adjusting for heterogeneity is sensible. If heterogeneity is found to be present, we adjust the balance statistics of SWB to accommodate this. We propose to aggregate survey results in this manner to allow for a degree of heterogeneity[5] and exploit individual information in inferring wellbeing movements. The weighted summary measure of SWB metric k is therefore given by the difference between the weighted proportion of the positive and the negative responses:

$$B_t^{Adj,(k)} = \left[\sum_{i=1}^{N_B} w_i^{(k)} \left(y_{it}^{(k)} = 2\right) \times 100\right] - \left[\sum_{i=1}^{N_B} w_i^{(k)} \left(y_{it}^{(k)} = 0\right) \times 100\right] \quad (3.12)$$

where N_B denotes the number of respondents in the balanced panel and $B_t^{Adj,(k)}$is the value of the adjusted balance statistics of SWB metric k in wave t. $w_i^{(k)}$ is the weight assigned to respondent i for metric $k$and it is the pseudo R^2 coefficient obtained from the respondent's ordered probit estimation. We rescale these such that the sum of all weights adds up to unity, i.e., $\sum_{i=1}^{N_B} w_i^{(k)} = 1$.

An alternative method of aggregation would be to allocate larger weights to those individuals for whom the ordered probit estimation yields a lower pseudo R^2. This alternative weighting strategy would instead give more weight to those individuals whose personal wellbeing may respond more to unobservable factors including both factors omitted in the ordered probit models and those unmeasurable factors that could affect SWB but cannot be easily captured. Both ways of aggregation are equally valid, the question is whether one would want to obtain a measure that is more closely related to measurable factors or rather a more subjective aspect of one's perception of SWB. We also compute the composite index of SWB using the adjusted balance statistics of the twelve SWB metrics in the same manner as explained earlier in this subsection. Another way is to assign more weight to individuals whose responses are less correlated with these factors. The resulting SWB aggregate is therefore one that is not correlated with these observable factors that could be addressed or

[5] Mitchell et al. (2012)

improved by current policy. Such a measure would capture movements in the part of SWB that is of more random nature.

4. Results

We apply the methods described in Section 3 to the UKHLS individual-level responses and present results for the UK overall and for UK regions to find answers for the research questions outlined in Section 1.

4.1 UK results

4.1.1 Polychoric correlation analysis

Following the method described in section 3.1 we compute pairwise polychoric correlations of the twelve SWB measures using UKHLS data pooled across the UK. The values of the estimated coefficients are reported in Table B.1 in Appendix B. Figure 4.1 shows the heatmap of these coefficients.

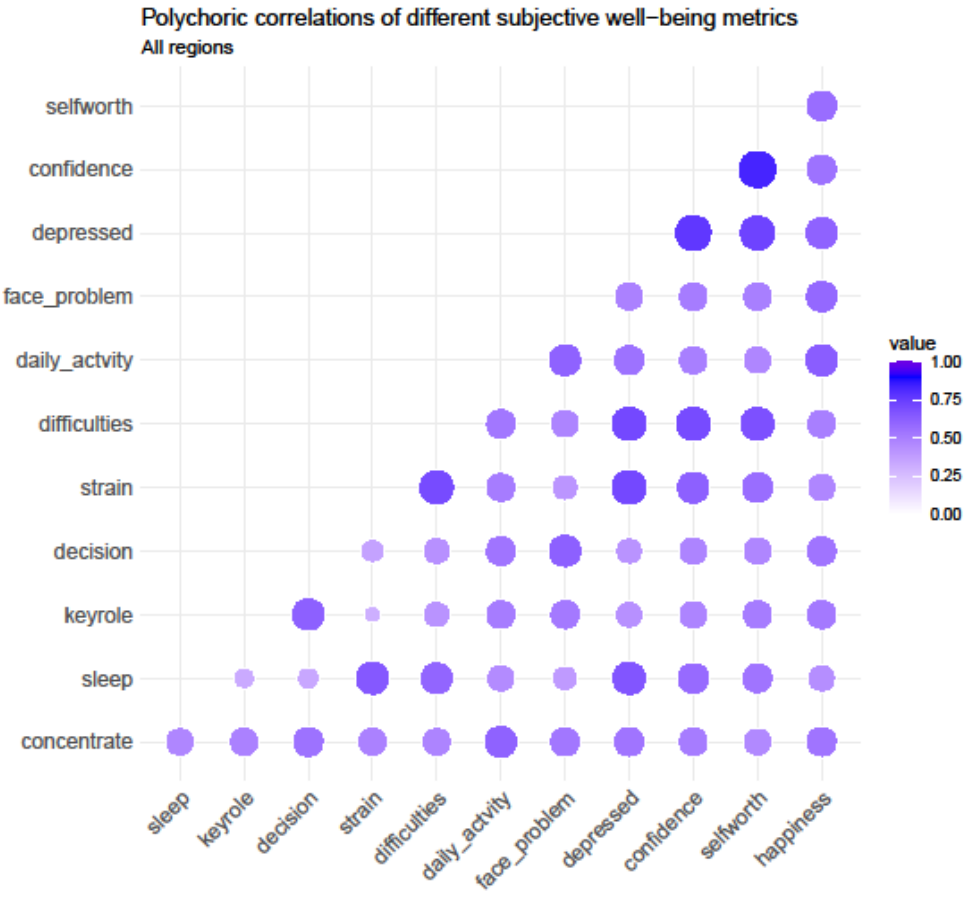
The values of the estimated coefficients range between 0.31 to 0.83, with an average polychoric correlation of 0.54. One's feeling of confidence appears to have the highest correlation with one's feeling of self-worth (correlation ρ = 0.83). One's feeling of depressed or unhappy appears to be highly correlated with a few other SWB measures such as one's feeling of being under strain (ρ = 0.71), one's ability to overcome difficulties (ρ = 0.71), one's feeling of confidence (ρ = 0.77), and one's feeling of self-worth (ρ = 0.73). One's feeling of under strain is also quite highly correlated with one's ability to overcome difficulties (ρ = 0.70) and one's feeling of depressed or unhappy (ρ = 0.71). We also find that pairwise correlations of one's feeling of playing a key role are quite low with one's feeling of under strain (ρ = 0.31), and one's sleeplessness (ρ = 0.33).

Table B.1 also reports the average correlations (column mean) of each SWB measure with the other eleven measures. One's feeling of depression or unhappiness and one's feeling of confidence have the highest average correlations with the rest of the eleven SWB measures, with average correlations of 0.6 and 0.59, respectively. While one's feeling of playing a key role appears to have the lowest overall correlation with the other eleven aspects of SWB.

General happiness has an average correlation of 0.54 on average with the rest of SWB measures. This finding is somewhat surprising. If we believe all the different aspects of SWB constitute to so-called general happiness, and therefore could be summarised by an unobserved common factor driving general happiness, then we should expect the correlation of general happiness with the other eleven SWB aspects to be higher. However, the values of the coefficients in Table B.1 show that while there are correlations between one's general happiness and the other aspects of SWB, these correlations are not high.

Our findings suggest a couple of important implications: (1) Any survey that aims to use a consensus of happiness as a measure of one's SWB could risk missing important aspects, and therefore may not provide a complete measurement. (2) These aspects of SWB could be driven by different individual factors in different ways. It is important to look at how each aspect of SWB is affected by and related to a common set of individual factors. It prompts us to examine these relationships using ordered probit models.

Figure 4.1 Heatmap of polychoric correlations of subjective wellbeing measures: UK (unbalanced panel)



4.1.2 Pooled (national) ordered probit analysis

In this section we report the results of the ordered probit regressions for the UK as a whole[6]. We estimate separate models for each of the SWB outcome variables. In each case we estimate a pooled regression, where we control for region fixed effects, as well as time (wave) fixed effects. In the regressions we include a range of individual socio-demographic factors, that according to the literature, potentially explain SWB outcomes. All effects are contemporaneous as we do not exploit lagged effects in these specifications.

[6] This modelling strategy is similar to the one in Blackaby et al (2012).

While the coefficients of an ordered probit estimation provide useful information on the sign of the covariates, we can derive a more intuitive interpretation of the magnitudes using marginal effects (which tell us by how much the probability of observing a particular outcome changes when we change the value of a regressor, holding the values of other regressors constant at a particular value (mean)). We show here the marginal effects of reporting the highest level of SWB. Tables 4.1 and 4.2 below present the results of the twelve ordered probit regressions. First, we look whether gender plays a role in explaining SWB outcomes. Compared to women, we find that men are more likely to score more highly for all twelve SWB variables[7]. This result may seem surprising and is not necessarily consistent with some prior findings. Across the different SWB variables there are some differences worth highlighting. The results show that men are more likely to score higher in most SWB variables: *sleepq, undstrain, confidence.* But the difference between men and women is the smallest in overall *happiness* and ability to play a *keyrole.* The marginal effects indicate that men are between 1% and 9% more likely to report the highest levels of SWB compared to women, depending on the SWB measure. The largest advantage relative to women is found for *confidence* and *ability to make decisions.*

Being married or in a partnership increases the likelihood of scoring high for most SWB variables (compared to being single or never married). Exceptions to this result are: *sleepq*, and *undstrain*. The latter results suggest being married/in a partnership is associated with a higher probability of reporting loss of sleep and being constantly under strain. Being divorced decreases the likelihood of scoring high in all SWB variables. These coefficients are always statistically significant for the whole sample. Being a widow or widower however yields more mixed results. The marginal effects show that overall divorced and separated people are up to 5% less likely to report the highest level of wellbeing, compared to the never married/single category. The effect is stronger for *sleep, depressed* and *undstrain*.

We then analyse whether there is any statistical relationship between education attained and SWB. We find that having a degree is generally associated with a higher probability of a lower score across the SWB variables. This finding appears to be true for nearly all the SWB variables, except one: *keyrole.* Respondents with higher education are more likely to score higher in the feeling of playing a useful role.

For the relationship between ethnicity and SWB, we find that respondents from a Black ethnic background are generally more likely to score high in the majority of SWB metrics. The results for

[7] This is true when pooling the individual observations across all regions, as well as when conducting the analyses region by region.

other ethnic groups yield mixed results. However, we can see that being Asian or Asian British is associated with a higher probability of more positive SWB outcomes. They are less likely to feel depressed or unhappy, more capable of making decisions, less likely to feel under strain and feel more capable to overcome difficulties. Being a migrant is associated with a higher SWB. This is the case for almost all the SWB categories, but there are two exceptions: the *ability to face problems* and to *overcome difficulties*, where differences are not statistically significant. In general, differences are not too large in magnitude between migrants and non-migrants.

We then look at age and wellbeing outcomes. Older respondents are more likely to score highly on a number of SWB metrics: they are more likely to concentrate, they show a higher ability to overcome difficulties, and feel more confident. They are also less likely to report problems with sleep, and to feel under strain and depressed. But as they age, respondents are also less likely to feel they can play a useful role, capable of making decisions, and face problems, as well as enjoy day-to-day activities. In terms of magnitudes for these SWB outcomes we see that these are small for each additional year of age, as shown by the marginal effects. The likelihood of reporting the highest levels of SWB for each additional year (of age) is at most 0.2% lower. Non-linearities may play a role in explaining the relationship between age and SWB as suggested by some papers (Kaptein et al. (2016)). Surprisingly, having a job is associated with scoring lower in terms of many of the SWB variables. This is however not the case in the following variables: *keyrole, confidence, selfworth.* So having a job increases the likelihood of feeling useful, better confidence levels and feelings of *selfworth*.

In relation to total income earned, we find generally that higher levels of income are associated with higher levels of SWB, although for some of the SWB variables, the coefficients are not statistically significant. There is only one variable for which higher income is associated with less probability of reporting good SWB. This is the case for the variable: *undstrain*. This indicates those respondents on higher incomes are more likely to be constantly under strain.

We investigate whether there is a statistically significant relationship between the type of accommodation/housing and wellbeing. We find that respondents that own their house outright are more likely to have higher wellbeing scores. This is in comparison to those respondents who have a mortgage, pay rent, are in shared ownership or living in local authority housing. The relationship between living in large households (4+ people) and SWB outcomes is mixed. In some SWB dimensions, those living in large households are more likely to have higher SWB (*concentrate, sleep, undstrain*), and in others, lower SWB (*enjdayact, depressed, confidence*).

Being a carer is associated with higher probability of reporting lower SWB generally. This is the case in particular when care responsibility is greater (at least 20 hours a week of caring responsibilities). In

the case of other more specific caring responsibilities, such as being responsible for children under 16, the results are mixed. We find that those being responsible for children under 16 are more likely to score high in several SWB variables. These are: *sleep*, *undstrain, overdiff, depressed*. In contrast, they are less likely to report higher SWB in the rest of the SWB outcomes.

We also check whether there is any relationship between living in an urban area *vs*. rural area, and subjective wellbeing. The regression results mostly show that respondents that live in urban areas are more likely to report lower wellbeing. This is observed for several of the SWB dimensions, but in some cases the results are not statistically significant. The differences in marginal effects are however small. People living in urban areas are less likely to be reporting high SWB outcomes in *sleep* (0.8% less likely) and *feeling depressed* (1.5% less likely).

Finally, we look at the relationship with physical health, one of the key drivers the SWB literature suggests affects SWB outcomes. We find that the relationship between (self-reported) health and SWB is the strongest of all metrics considered. The effects are statistically significant for all metrics. As one would expect, the effects are particularly strong for those reporting excellent or very good health (as opposed to just good health), relative to those in poor health. The marginal coefficients show that those with excellent health are up to 30% more likely to report the highest level of SWB compared to those that report poor health. Those with excellent health seem to be almost 20% more likely to report the highest levels of *happiness*. Health seems to be the most important determinant for SWB variables such as ability to *sleep, overcoming difficulties,* feeling *undstrain.*

We show that in general terms, self-reported health is the individual factor most strongly related to SWB. This is true for all SWB dimensions considered here. Other factors that seem to determine SWB are gender, race, income and marital status, but the latter show more variation across SWB dimensions. In Section 4.2 we highlight some of the main differences that we have observed across regions.

Table 4.1 Marginal effects of reporting highest levels of SWB in ordered probit regressions, Subjective Wellbeing variables (1) to (6): UK (unbalanced panel)

	(1)	(2)	(3)	(4)	(5)	(6)
Highest levels of SWB (1)	*concentrate*	*sleepq*	*keyrole*	*decicapa*	*undstrain*	*overdiffic*
Men	0.0132***	0.106***	0.00708***	0.00708***	0.0563***	0.0435***
	(0.000606)	(0.00280)	(0.00107)	(0.00107)	(0.00235)	(0.00272)
Married	0.00141*	-0.0140***	0.00946***	0.00946***	-0.00961***	0.0228***
	(0.000795)	(0.00358)	(0.00142)	(0.00142)	(0.00298)	(0.00345)
Divorced/separated	-0.00482***	-0.0494***	-0.00473**	-0.00473**	-0.0390***	-0.0274***
	(0.00107)	(0.00479)	(0.00193)	(0.00193)	(0.00400)	(0.00466)
Widow	-0.00141	0.00387	-0.00410*	-0.00410*	0.00307	0.00122
	(0.00133)	(0.00642)	(0.00241)	(0.00241)	(0.00542)	(0.00621)
GCSE/A-level/other	-0.000824	-0.0122***	-0.000625	-0.000625	-0.0205***	-0.00191
	(0.000882)	(0.00423)	(0.00152)	(0.00152)	(0.00354)	(0.00397)
Degree	-0.00303***	-0.0301***	0.00583***	0.00583***	-0.0645***	-0.0185***
	(0.000955)	(0.00455)	(0.00167)	(0.00167)	(0.00381)	(0.00430)
White	0.00684	0.0229	-0.00169	-0.00169	-0.00109	0.0565***
	(0.00470)	(0.0211)	(0.00918)	(0.00918)	(0.0165)	(0.0183)
Mixed race	0.00677	-0.00624	-0.00260	-0.00260	-0.0173	0.0366*
	(0.00521)	(0.0230)	(0.0100)	(0.0100)	(0.0182)	(0.0203)
Asian/Asian British	0.0144***	0.0115	-0.00604	-0.00604	0.0474***	0.0326*
	(0.00477)	(0.0212)	(0.00921)	(0.00921)	(0.0167)	(0.0184)
Black	0.0194***	0.0523**	0.0161*	0.0161*	0.0403**	0.0687***
	(0.00494)	(0.0218)	(0.00947)	(0.00947)	(0.0172)	(0.0190)
Arabic	0.000701	-0.0435	-0.0190	-0.0190	-0.00831	0.00356
	(0.00753)	(0.0307)	(0.0134)	(0.0134)	(0.0235)	(0.0264)
Migrant	0.00658***	0.00711	0.00393**	0.00393**	0.0198***	0.00276
	(0.00109)	(0.00465)	(0.00189)	(0.00189)	(0.00387)	(0.00446)
Age	0.000111***	0.00227***	-0.000439***	-0.000439***	0.00266***	0.00215***
	(2.66e-05)	(0.000121)	(4.79e-05)	(4.79e-05)	(0.000101)	(0.000116)
Job	-0.00133*	-0.0289***	0.0126***	0.0126***	-0.0571***	-0.0240***
	(0.000739)	(0.00337)	(0.00133)	(0.00133)	(0.00288)	(0.00331)
Ln(Income)	0.000191	0.000236	0.00550***	0.00550***	-0.00420***	0.00882***
	(0.000252)	(0.00104)	(0.000456)	(0.000456)	(0.000906)	(0.00104)
Urban	-0.00145**	-0.00832***	-0.00257**	-0.00257**	-0.00313	-0.00644**
	(0.000623)	(0.00307)	(0.00111)	(0.00111)	(0.00255)	(0.00298)
Shared ownership	-0.0152***	-0.0954***	-0.0177**	-0.0177**	-0.0947***	-0.110***
	(0.00440)	(0.0163)	(0.00793)	(0.00793)	(0.0151)	(0.0164)
Mortgage	-0.00501***	-0.0289***	-0.00681***	-0.00681***	-0.0494***	-0.0394***
	(0.000694)	(0.00323)	(0.00124)	(0.00124)	(0.00270)	(0.00315)
Rented accommodation	-0.00410***	-0.0461***	-0.0123***	-0.0123***	-0.0414***	-0.0588***
	(0.000871)	(0.00391)	(0.00156)	(0.00156)	(0.00331)	(0.00378)
Local authority	-0.00529***	-0.0543***	-0.0217***	-0.0217***	-0.0304***	-0.0608***
	(0.00110)	(0.00482)	(0.00192)	(0.00192)	(0.00406)	(0.00459)

4+ people household size	0.00129	0.00555	-0.000782	-0.000782	0.00278	-0.00575
	(0.000894)	(0.00376)	(0.00154)	(0.00154)	(0.00315)	(0.00361)
Carer	-0.00203	-0.0201***	-0.00790**	-0.00790**	-0.0107*	-0.0173**
	(0.00178)	(0.00759)	(0.00332)	(0.00332)	(0.00642)	(0.00768)
Careload light	-0.00257	-0.0263***	0.0116***	0.0116***	-0.0294***	-0.00709
	(0.00168)	(0.00713)	(0.00313)	(0.00313)	(0.00605)	(0.00724)
Careload heavy	-0.0140***	-0.0872***	0.0106***	0.0106***	-0.109***	-0.0766***
	(0.00203)	(0.00857)	(0.00379)	(0.00379)	(0.00723)	(0.00860)
Responsible for under 16	-0.00295***	0.0140***	-0.00204	-0.00204	0.00428	0.00178
	(0.000840)	(0.00359)	(0.00145)	(0.00145)	(0.00301)	(0.00352)
Health Fair/good	0.0670***	0.214***	0.131***	0.131***	0.216***	0.291***
	(0.00125)	(0.00473)	(0.00219)	(0.00219)	(0.00399)	(0.00440)
Health Excellent/very good	0.102***	0.361***	0.180***	0.180***	0.349***	0.459***
	(0.00144)	(0.00489)	(0.00232)	(0.00232)	(0.00417)	(0.00451)
Observations	312,409	312,409	312,409	312,409	312,409	312,409

Table 4.2 Marginal effects of reporting highest levels of SWB in ordered probit regressions, Subjective Wellbeing variables (7) to (12): UK (unbalanced panel)

Highest levels of SWB	(7) *Enjdayact*	(8) *faceprob*	(9) *depressed*	(10) *confidence*	(11) *selfworth*	(12) *happiness*
Men	0.0111***	0.0143***	0.0549***	0.0913***	0.0453***	0.0130***
	(0.000729)	(0.000889)	(0.00284)	(0.00304)	(0.00303)	(0.00118)
Married	0.000593	-0.000972	0.0210***	0.0363***	0.0326***	0.00211
	(0.000972)	(0.00119)	(0.00358)	(0.00383)	(0.00386)	(0.00160)
Divorced/separated	-0.00654***	-0.00726***	-0.0435***	-0.0168***	-0.0227***	-0.0115***
	(0.00130)	(0.00163)	(0.00480)	(0.00514)	(0.00508)	(0.00217)
Widow	0.000787	0.00143	-0.0151**	0.0108	0.0140**	0.00260
	(0.00164)	(0.00201)	(0.00664)	(0.00703)	(0.00693)	(0.00260)
GCSE/A-level/other	-0.00261**	-0.00299**	-0.0111***	-0.00536	0.00453	-0.00889***
	(0.00106)	(0.00130)	(0.00431)	(0.00456)	(0.00436)	(0.00165)
Degree	-0.00566***	-0.00190	-0.0322***	-0.0252***	0.00686	-0.00997***
	(0.00116)	(0.00141)	(0.00462)	(0.00492)	(0.00476)	(0.00181)
White	-0.000486	-0.00643	0.0497***	0.00326	0.00630	-0.00175
	(0.00664)	(0.00837)	(0.0187)	(0.0208)	(0.0218)	(0.00996)
Mixed race	-0.00218	-0.000153	0.0306	0.00284	0.0131	-0.00207
	(0.00717)	(0.00913)	(0.0206)	(0.0230)	(0.0240)	(0.0110)
Asian/Asian British	0.00677	-0.00236	0.0576***	0.0144	-0.0106	0.00939
	(0.00669)	(0.00842)	(0.0188)	(0.0209)	(0.0219)	(0.01000)
Black	0.00917	0.0219**	0.0903***	0.0741***	0.0782***	0.0258**
	(0.00686)	(0.00865)	(0.0194)	(0.0216)	(0.0225)	(0.0103)
Arabic	-0.00952	0.00135	0.000840	-0.00700	-0.0387	-0.00418
	(0.00946)	(0.0122)	(0.0274)	(0.0312)	(0.0311)	(0.0144)
Migrant	0.00496***	0.000621	0.0165***	0.0336***	0.0170***	0.00988***
	(0.00132)	(0.00163)	(0.00460)	(0.00503)	(0.00503)	(0.00210)
Age	-0.000289***	-0.000419***	-0.00287***	-0.00265***	-0.00256***	-0.000387***
	(3.30e-05)	(4.06e-05)	(0.000121)	(0.000129)	(0.000126)	(5.33e-05)
Job	-0.00224**	-0.00316***	-0.0214***	0.00248	0.00315	-0.00705***
	(0.000923)	(0.00113)	(0.00342)	(0.00364)	(0.00356)	(0.00148)
Ln(Income)	-0.00107***	0.000258	0.00672***	0.0123***	0.0153***	-5.97e-05
	(0.000311)	(0.000377)	(0.00104)	(0.00111)	(0.00105)	(0.000505)
Urban	-0.00133*	-0.00174*	-0.0150***	-0.00808**	-8.30e-05	-0.00298**
	(0.000757)	(0.000907)	(0.00311)	(0.00334)	(0.00333)	(0.00124)
Shared ownership	-0.0127**	-0.0128*	-0.0997***	-0.101***	-0.0933***	-0.0230**
	(0.00517)	(0.00657)	(0.0182)	(0.0185)	(0.0187)	(0.00913)
Mortgage	-0.00617***	-0.00573***	-0.0408***	-0.0308***	-0.0140***	-0.00953***
	(0.000848)	(0.00102)	(0.00325)	(0.00351)	(0.00350)	(0.00137)
Rented accommodation	-0.00652***	-0.00714***	-0.0537***	-0.0446***	-0.0531***	-0.00892***
	(0.00107)	(0.00133)	(0.00392)	(0.00422)	(0.00409)	(0.00174)
Local authority	-0.00720***	-0.0102***	-0.0639***	-0.0482***	-0.0745***	-0.0159***

	(0.00135)	(0.00165)	(0.00486)	(0.00520)	(0.00485)	(0.00216)
4+ people household size	0.00182*	-0.000724	0.00613*	0.00561	-0.00869**	-0.00112
	(0.00108)	(0.00133)	(0.00371)	(0.00403)	(0.00394)	(0.00174)
Carer	-0.000809	-0.00179	-0.0142*	-0.00865	-0.00483	-0.00409
	(0.00217)	(0.00278)	(0.00768)	(0.00820)	(0.00803)	(0.00358)
Careload light	-0.00506**	-0.00246	-0.0197***	-0.0103	-0.00610	-0.00688**
	(0.00204)	(0.00263)	(0.00725)	(0.00771)	(0.00756)	(0.00337)
Careload heavy	-0.0247***	-0.0128***	-0.0921***	-0.0451***	-0.0433***	-0.0316***
	(0.00248)	(0.00318)	(0.00854)	(0.00918)	(0.00895)	(0.00408)
Responsible for under 16	-0.00117	-0.00389***	0.00773**	-0.00641*	0.000649	-0.00499***
	(0.00101)	(0.00126)	(0.00359)	(0.00384)	(0.00382)	(0.00168)
Health Fair/good	0.104***	0.0858***	0.263***	0.275***	0.242***	0.116***
	(0.00157)	(0.00181)	(0.00464)	(0.00483)	(0.00432)	(0.00237)
Health Excellent/very good	0.150***	0.124***	0.437***	0.453***	0.395***	0.176***
	(0.00177)	(0.00194)	(0.00476)	(0.00494)	(0.00449)	(0.00252)
Observations	312,409	312,409	312,409	312,409	312,409	312,409

4.1.3 Composite measures of SWB

As a first step to understand how the trend of the overall SWB experience changes across time at both the national and regional level, we compute the balance statistics of SWB experiences. Using the method described in section 3.3, we first derive summary measures of SWB without applying any weights. We then move on to apply weights that account for heterogeneity in terms of how respondents' SWB experiences are related to their own personal circumstances and regional economic conditions. We produce separate composite indices using the unadjusted and the adjusted balance statistics of SWB.

For the unadjusted analysis, we examine trends and patterns of SWB experience across metrics and across waves reflected by both the balanced and unbalanced panel of respondents at the national level. In contrast, for the adjusted analysis, we examine the trends and patterns of SWB experience across metrics and across waves as reflected by the balanced panel of respondents and at the national level only. This is because weights are obtained from ordered probit models of respondents who responded to the survey in all ten waves.

4.1.3.1 Unadjusted balance statistics of SWB metrics

From the unbalanced panel of individuals

Following the method described in section 3.3, we first compute unweighted balance statistics of the twelve SWB metrics across the UK and compare their trends and patterns across waves and metrics using observations from an unbalanced panel of respondents. Figure 4.1 shows the plots of the balances of the twelve SWB measures across waves. Positive values of balance statistics indicate that the overall reporting of positive experience outweighs overall reporting of negative experience of SWB, while negative values indicate that the overall reporting of negative experience outweighs overall reporting of positive experience.

We observe a consistent overall negative experience that outweighs overall positive experience in *"concentration", "playing a useful role", "enjoy day-to-day activities", "ability to face problems", "capable of making decisions"* and *"general happiness"* in all waves. The same applies to *"capable of making decisions"*, except in wave one. However, we observe a consistent overall positive experience that outweighs overall negative experience in the *"loss of sleep", "constantly under strain", "problem overcoming difficulties", "unhappy or depressed", "losing confidence", "believe worthless"* in all waves.

Table 4.1 reports the balance statistics of the twelve SWB measures, their mean across waves and their standard deviation, as well as the mean of the balance statistics across all twelve SWB measures in each wave. We observe large differences in the share of reported positive and negative experience for some SWB measures. Such differences appear to be most substantial *in "believe worthless"* with on average about 60 percentage points difference. There is at least 20 or more percentage points difference in the share of reported positive and negative experience in *"losing confidence*", *"problem overcoming difficulties", "loss of sleep", "unhappy or depressed".* Contrary to the above, the difference in the share of positive and negative experience in *"capable of making decisions"* and *"general happiness"* are not large, on average only 2 and 3 percentage points.

To aid comparison, we standardise the balance statistics of each SWB aspects to have mean 0 and standard deviation 1. Figure 4.2 shows the plots of the standardised balances of the twelve SWB measures across waves. The plots show the same patterns as those in Figure 4.1. The balance statistics of the twelve SWB measures shows different trends over time, indicating different tendencies of reporting positive and negative experience among the twelve SWB aspects over time.

There are some similarities among the balance statistics of SWB measures in terms of trend and patterns. First, *"concentration", "playing a useful role", "capable of making decisions", "ability to face problem", and "general happiness"* follow very similar movement over time. There was a drop in their

values between wave one and two, and between wave seven to wave ten. This implies an increase in the report of negative experience in these SWB aspects in that second period.

The balance statistics of *"enjoy day-to-day activities", "problem overcoming difficulties", "unhappy or depresses", "losing confidence", "believe worthless"* also follow very similar movement over time. There was a drop in their values between wave one and two and wave six to wave 10, except for *"problem overcoming difficulties"* whose value increased between wave one and two. This implies an increase in the report of negative experience in these aspects of SWB in that second period. We also observe an increase in their values between wave two and three and between wave five and six, indicating an increase in the report of positive experience in these aspects of SWB in these two periods.

To obtain a view of how the overall SWB in the UK changes over time, we summarise the balance statistics of the twelve SWB metrics using a composite index as described in section 3.3. Column N of Table 4.1 gives the values of the composite index across waves. Figure 4.3 shows the plot of this composite measure over all waves. The overall sentiment of SWB fluctuates over time. We observe three periods of fall in the overall sentiment of SWB: wave one and two, wave four and five, and from wave six onwards. There are also two periods of increase in overall sentiment of SWB: between wave two and wave four, and between wave five and six. Overall sentiment reaches its highest in wave six, then followed by a consistent fall and reach its lowest point in wave ten.

Figure 4.1. Balance statistics of SWB measures (unadjusted): UK (unbalanced panel)

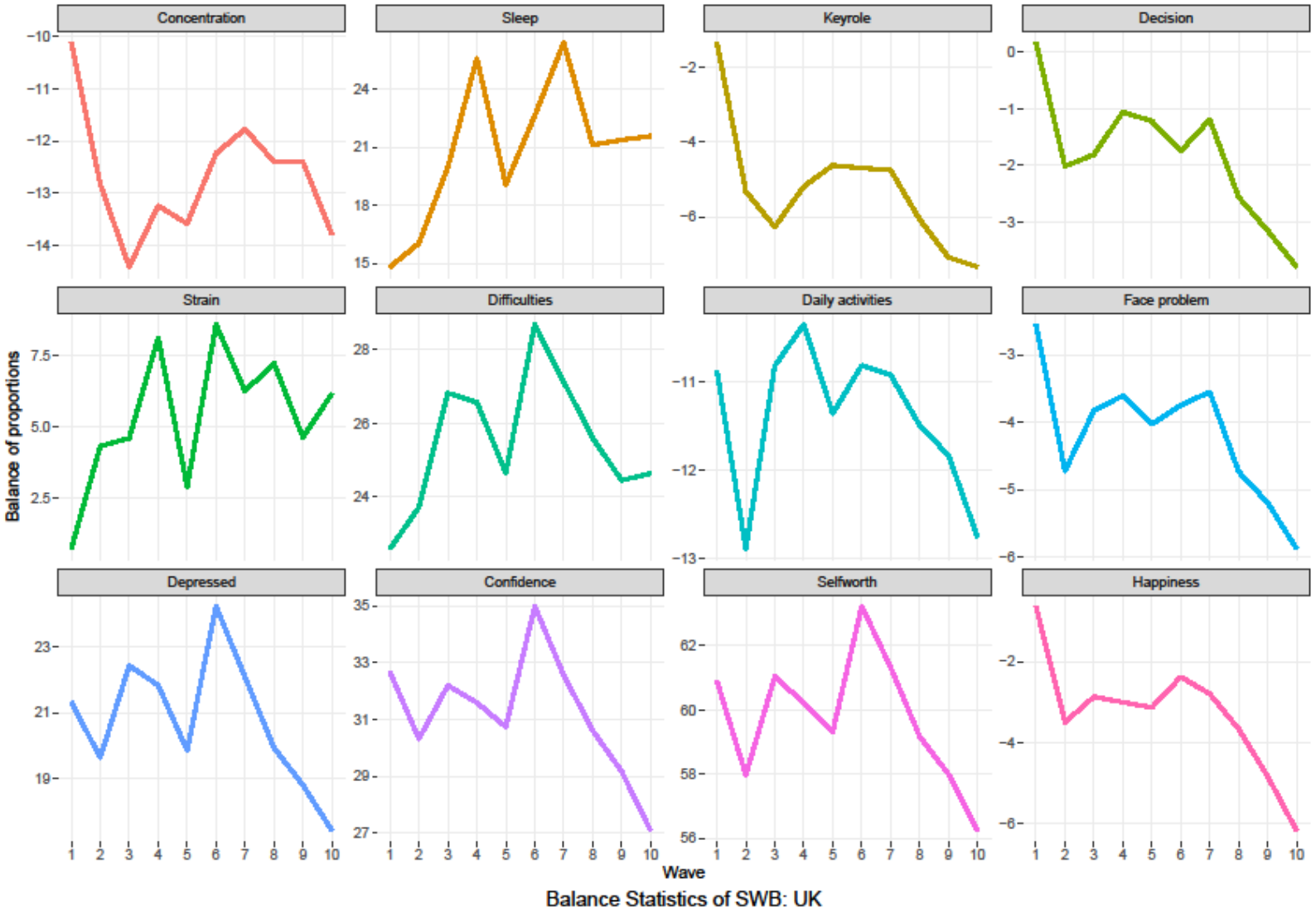


Table 4.1: Balance statistics (unadjusted) of SWB: UK (unbalanced panel)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
wave	concentrate	sleep	keyrole	decision	strain	difficulties	daily activities	face problem	depressed	confidence	selfworth	happiness	Mean of Balances across SWB measures	Composite index of SWB
1	-10.117	14.816	-1.346	0.173	0.710	22.588	-10.871	-2.552	21.322	32.669	60.900	-0.628	10.639	108.169
2	-12.823	16.033	-5.328	-2.017	4.310	23.714	-12.892	-4.719	19.637	30.322	57.972	-3.497	9.226	91.192
3	-14.407	19.982	-6.270	-1.811	4.594	26.823	-10.814	-3.830	22.416	32.194	61.036	-2.868	10.587	101.785
4	-13.238	25.601	-5.191	-1.058	8.120	26.576	-10.344	-3.606	21.827	31.594	60.215	-3.003	11.458	107.616
5	-13.578	19.079	-4.627	-1.216	2.886	24.654	-11.356	-4.031	19.857	30.741	59.323	-3.133	9.883	97.211
6	-12.236	22.637	-4.698	-1.747	8.587	28.693	-10.810	-3.749	24.212	34.979	63.225	-2.375	12.227	113.716
7	-11.772	26.408	-4.755	-1.191	6.245	27.133	-10.918	-3.551	22.073	32.559	61.328	-2.795	11.730	109.738
8	-12.394	21.124	-6.071	-2.564	7.226	25.604	-11.490	-4.732	19.936	30.616	59.176	-3.666	10.230	97.768
9	-12.401	21.380	-7.086	-3.156	4.622	24.449	-11.831	-5.192	18.808	29.177	57.994	-4.840	9.327	90.209
10	-13.784	21.573	-7.340	-3.798	6.157	24.638	-12.759	-5.873	17.435	27.099	56.242	-6.179	8.617	82.596
mean	-12.675	20.863	-5.271	-1.838	5.346	25.487	-11.409	-4.184	20.752	31.195	59.741	-3.298	10.392	100.000
s.d.	1.206	3.667	1.688	1.136	2.425	1.826	0.856	0.954	1.985	2.152	2.023	1.468	1.170	10.000

Figure 4.2. Standardised Balance Statistics of SWB (unadjusted): UK (unbalanced panel)

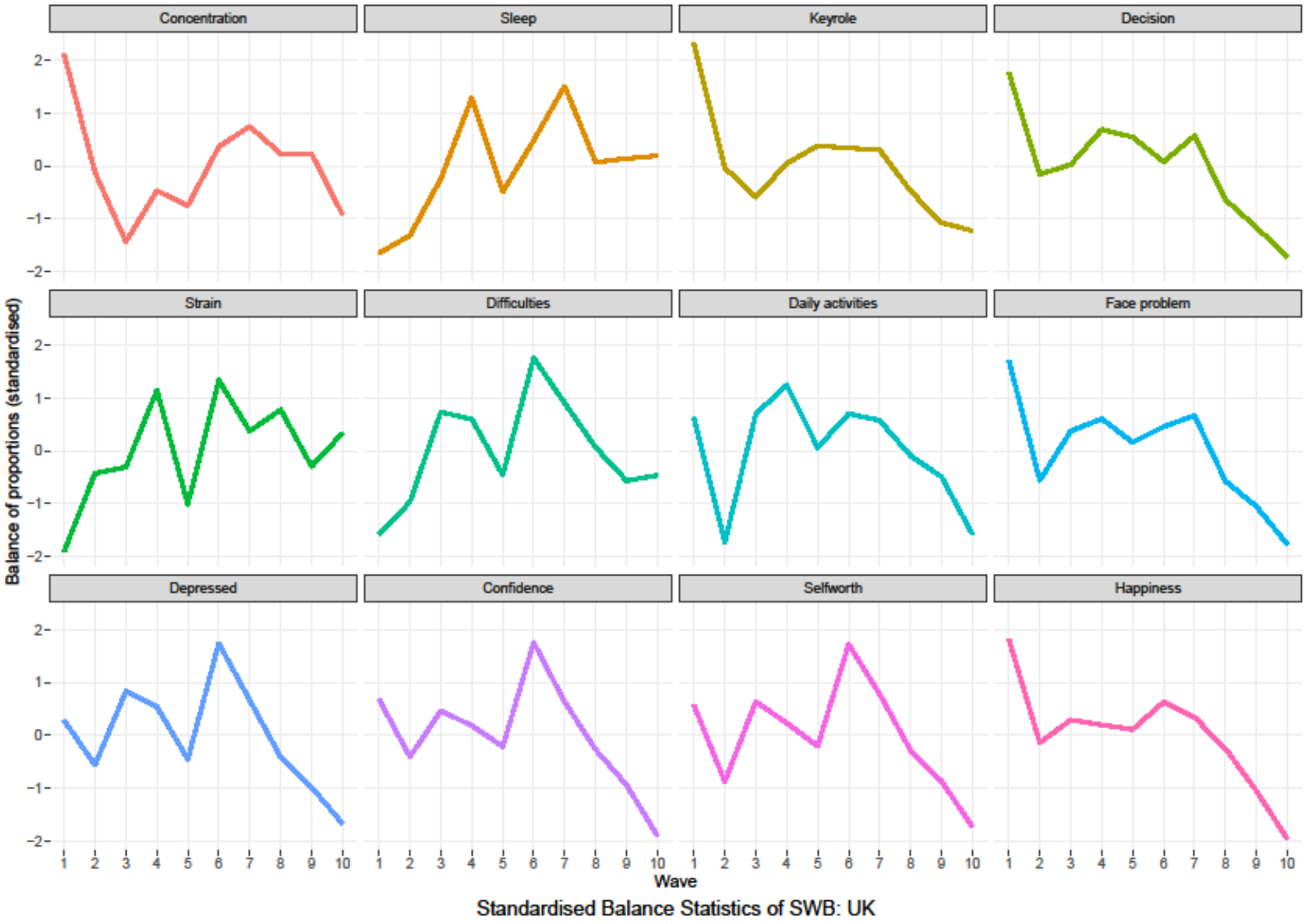
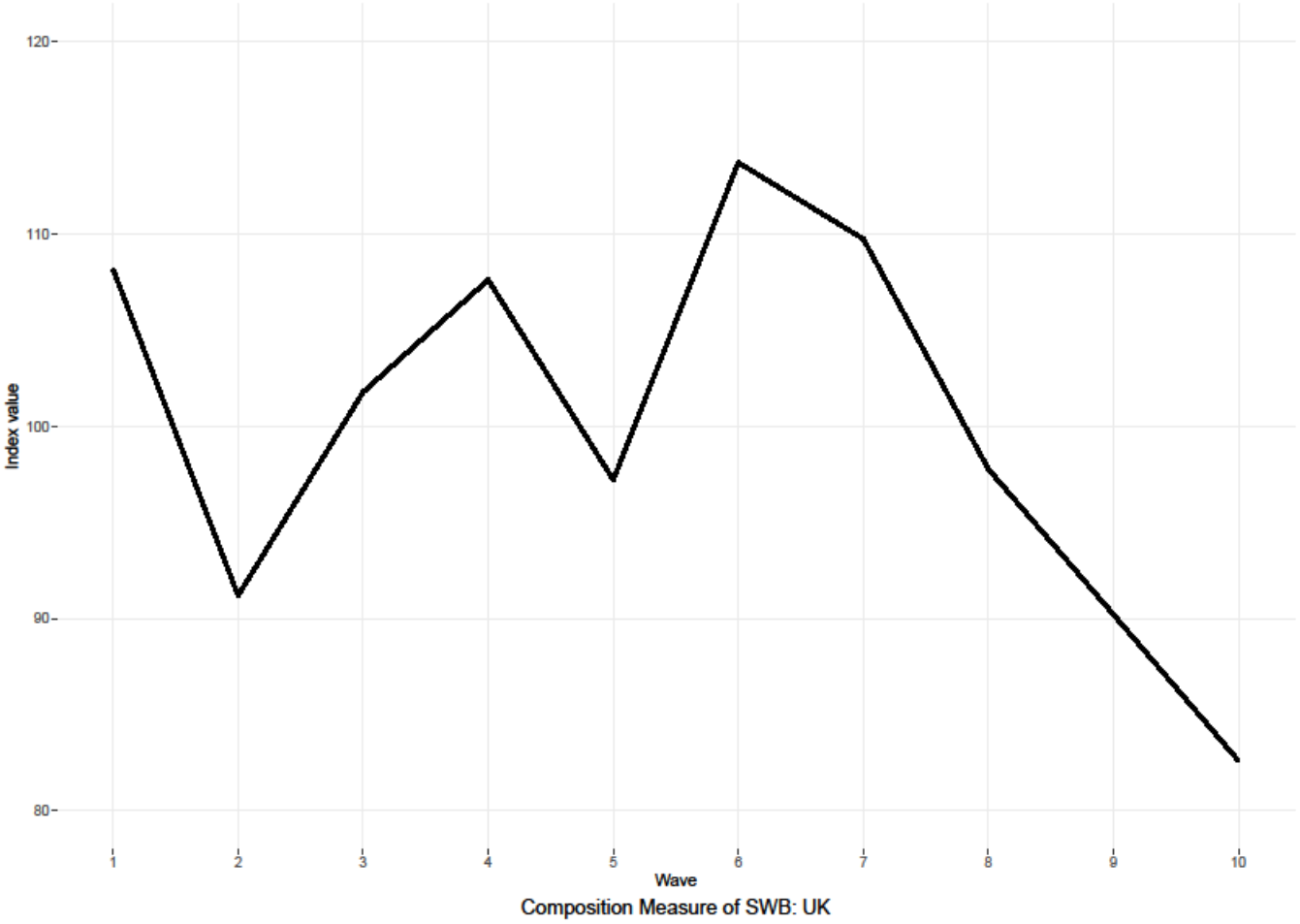


Figure 4.3. Composite Index of SWB (unadjusted): UK (unbalanced panel)



From the balanced panel of individuals

We also examine the trend of the sentiments of SWB, and their composite index computed using the balanced sample we later use to obtain results adjusted for heterogeneity. Comparing the results from the balanced panel with those presented above using the unbalanced panel gives us an idea of whether the sentiments of SWB of this subset of respondents are representative of the unbalanced UK panel.

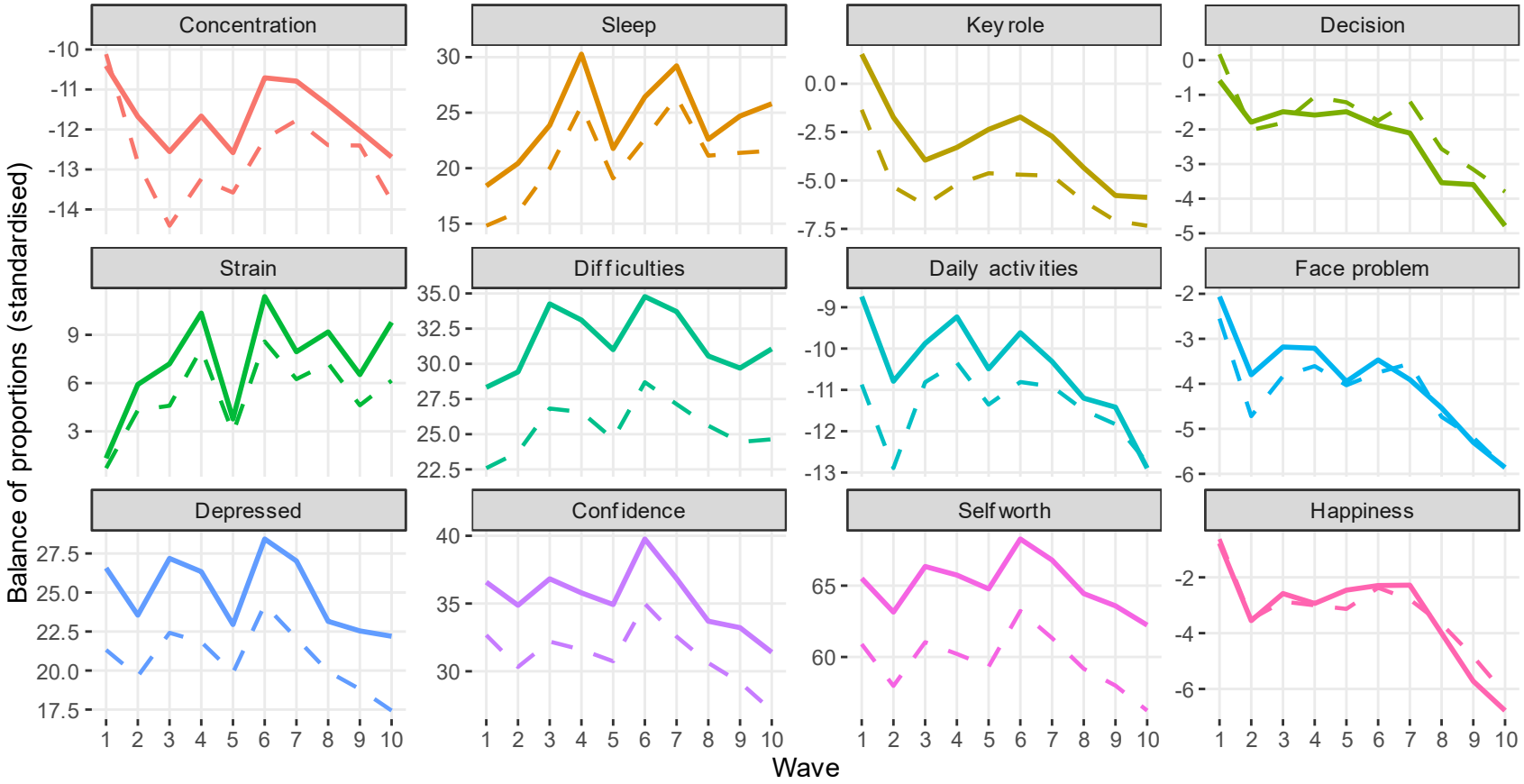
Figure 4.4 shows the plots of the time series of balance statistics for the twelve SWB metrics across waves using the balanced panel (solid lines) against those obtained using the unbalanced panel (dashed lines). The trends and patterns of the SWB sentiments in the balanced panel of respondents are consistent with the results of the unbalanced panel. There are some differences in the magnitudes between the sentiment in the balanced panel and unbalanced panel, but these differences are quite small in percentage points. For *"ability to face problems", "capable of making decisions"* and *"general*

happiness", the differences between the values of balance statistics computed using the balanced and from the unbalanced panels are in fact negligible in some waves.

Figure 4.5 plots the standardised balances of the twelve SWB metrics across waves using the balanced panel (solid lines) to aid comparison of trend and patterns among SWB metrics. We also benchmark with those computed using the unbalanced panel (dashed lines). As in the results obtained using the unbalanced panel, we find the sentiment of some SWB metrics follow similar pattern over time. The sentiment of *"playing a useful role", "capable of making decisions", "ability to face problem", and "general happiness"* follow very similar movement over time. While the sentiments of *"enjoy day-to-day activities", "problem overcoming difficulties", "unhappy or depresses", "losing confidence", "believe worthless"* also follow very similar movement over time. These findings are broadly in line with the results we obtained from using the unbalanced panel.

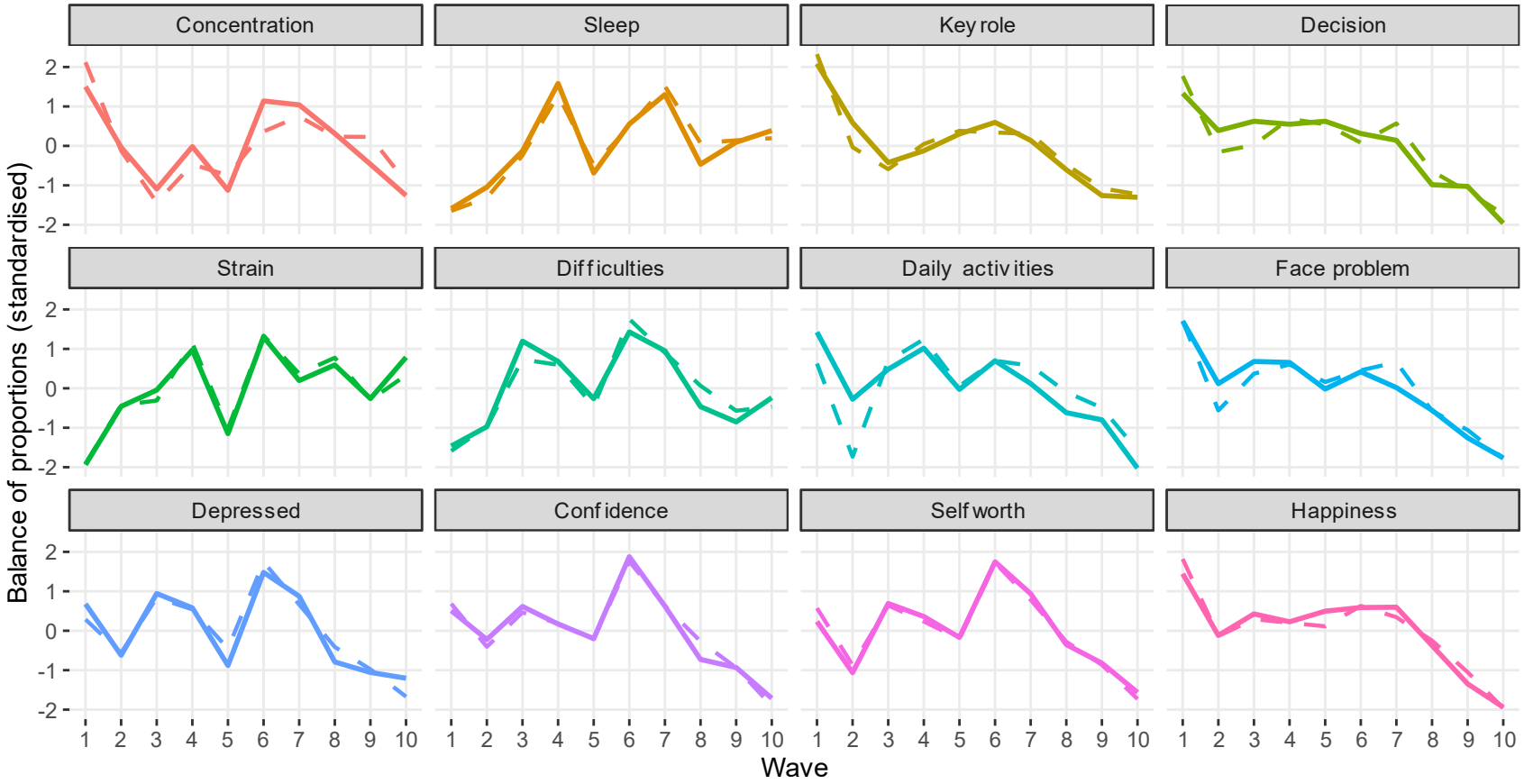
We also compute a composite index of SWB using the balance statistics obtained from the balanced panel. Column N in Table 4.2 gives the values of the composite index of SWB from the balanced panel across waves. Figure 4.6 plots the composite index from the balanced panel across waves (solid line) against that of the unbalanced panel (dashed line). Both series follows the same patterns over time, despite small differences in magnitude in some waves. The results we report in this subsection confirm that the sentiments of SWB from the balanced panel of respondents are representative of those from the unbalanced panel of respondents.

Figure 4.4. Balance statistics of SWB measures (unadjusted): UK (Balanced panel)



Balance Statistics of SWB (unweighted):
Balanced panel (solid line) vs. Unbalanced Panel (dashed line), UK

Figure 4.5. Standardised Balance Statistics of SWB (unadjusted): UK (balanced panel)

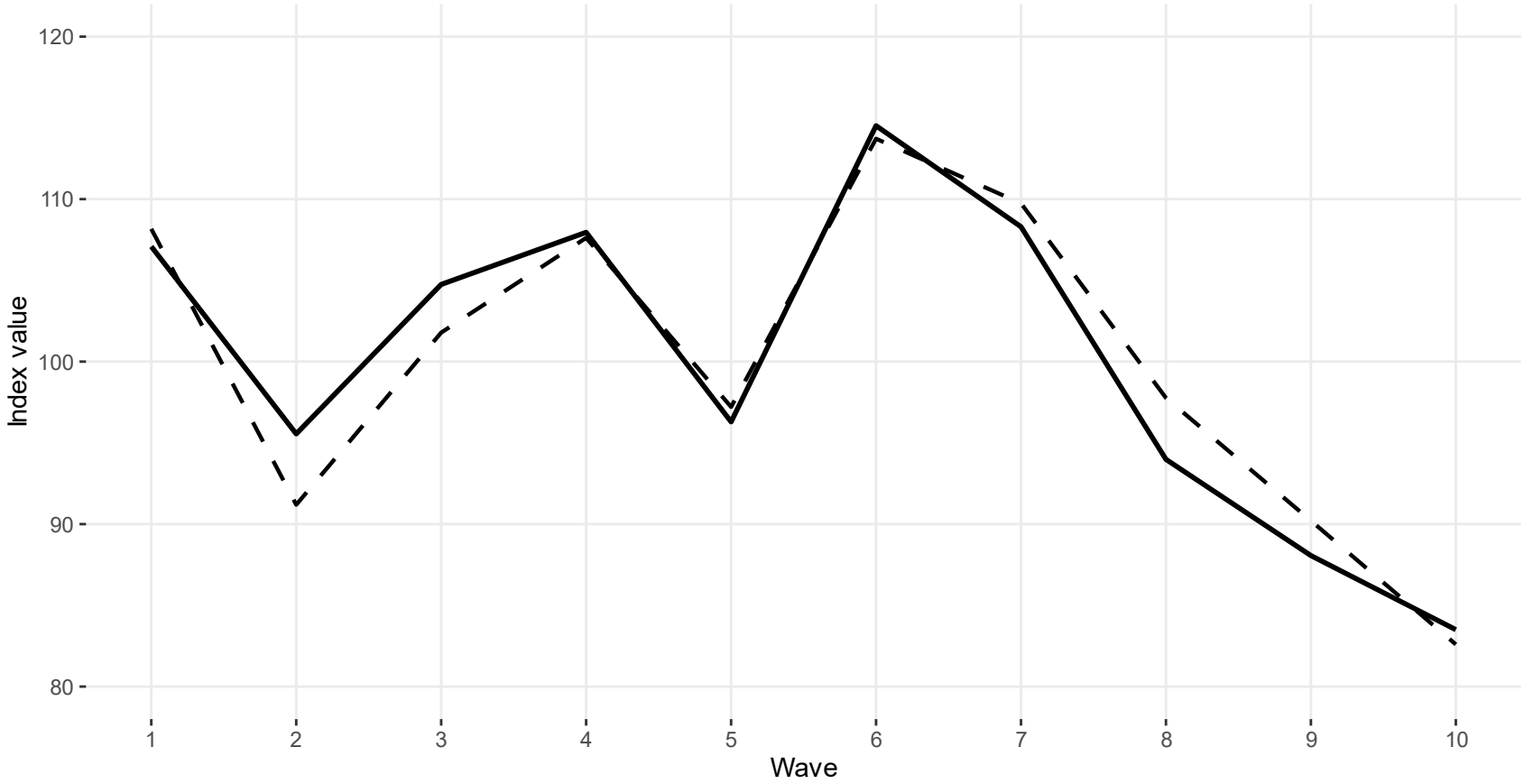


Standardised (unweighted) Balance Statistics of SWB :
Balanced panel (solid line) vs. Unbalanced Panel (dashed line), UK

Table 4.2 Balances of SWB measures (unadjusted): UK (balanced panel)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
wave	concentrate	sleep	keyrole	decision	strain	difficulties	daily activities	face problem	depressed	confidence	selfworth	happiness	Mean of Balances across SWB measures	Composite index of SWB
1	-10.408	18.399	1.530	-0.587	1.325	28.329	-8.742	-2.063	26.567	36.580	65.510	-0.779	12.972	107.085
2	-11.679	20.434	-1.735	-1.789	5.914	29.422	-10.791	-3.797	23.549	34.872	63.147	-3.551	12.000	95.552
3	-12.553	23.863	-3.948	-1.489	7.198	34.258	-9.876	-3.183	27.182	36.826	66.343	-2.582	13.503	104.749
4	-11.665	30.269	-3.292	-1.584	10.354	33.110	-9.234	-3.210	26.335	35.787	65.742	-2.937	14.140	107.955
5	-12.580	21.773	-2.363	-1.489	3.770	31.007	-10.490	-3.948	22.948	34.927	64.773	-2.459	12.156	96.294
6	-10.709	26.417	-1.721	-1.885	11.378	34.777	-9.616	-3.469	28.425	39.762	68.269	-2.295	14.944	114.517
7	-10.791	29.217	-2.718	-2.104	7.950	33.711	-10.313	-3.907	27.018	36.839	66.794	-2.281	14.118	108.298
8	-11.392	22.606	-4.344	-3.538	9.179	30.556	-11.201	-4.535	23.153	33.698	64.445	-4.002	12.052	93.984
9	-12.034	24.696	-5.778	-3.592	6.529	29.695	-11.419	-5.300	22.538	33.220	63.584	-5.723	11.368	88.064
10	-12.690	25.802	-5.874	-4.781	9.780	31.061	-12.894	-5.860	22.196	31.403	62.232	-6.775	11.133	83.502
mean	-11.650	24.348	-3.024	-2.284	7.338	31.593	-10.458	-3.927	24.991	35.391	65.084	-3.338	12.839	100.000
s.d.	0.826	3.740	2.186	1.273	3.104	2.228	1.204	1.093	2.320	2.329	1.823	1.772	1.295	10.000

Figure 4.6 Composite Index of SWB (unadjusted): UK (balanced panel)



Composite Measure of SWB (unweighted):
Balanced panel (solid line) vs. Unbalanced panel (dashed line), UK

4.1.3.2 Adjusting balance statistics of SWB metrics for heterogeneity

This subsection discusses findings on balance statistics of SWB and the composite index of SWB computed with adjustment to accommodate heterogeneity across individuals SWB responses to a range of observable factors. We demonstrate one way to obtain weights to adjust for heterogeneity when computing summary measures of SWB. We also discuss an alternative weighting scheme.

We experiment with a few parsimonious variations of the respondent-level ordered probit model as in equation (3.6) in which we have different individual factors in x_{it}, but restrict its dimension to a small number. That is, we only include a few numbers of individual factors in each variation, but we retain the same set of regional factors in z_{rt}. The ordered probit analysis presented in section 4.1.2 informs the choice of individual factors we should consider in our adjustment. We also include regional GVA per hour and regional GDHI per head in the respondent-level ordered probit. Evidence has shown that macroeconomic variables may be relevant in studies of wellbeing (see for example, Kaptein et al. (2016)). The results in this subsection are obtained using two versions of equation (3.6), both including regional factors – one in which x_{it} includes only 'personal income' (refer it as Model 1 hereafter), and one in which x_{it} includes only 'personal health' (refer it as Model 2 hereafter).

The decision to confine our analysis in this paper to small-scale ordered probit models rather than a large-scale one as used in section 4.1.2 is partly driven by our findings in section 4.1.2 and partly driven by concerns of result accuracy. We focus the individual factors in our models on two variables that emerge as key, from our own results and from previous literature. We also aim to minimise concerns to ensure no overfitting and poor model prediction. As we have only ten observations (waves) in the UKHLS data, we are restricted by the number of regressors we could include in the model to ensure estimation results are reliable. Future work that aims to use longitudinal wellbeing datasets that provide long time series of individuals should consider including more individual-specific factors in $\boldsymbol{x_i}$ to improve adjustment.

For each SWB metric k, we estimate equation (3.6) for each respondent i, where $i = 1, \dots, N_B$ and N_B denotes the number of respondents in the balanced panel who responded to all ten waves of UKHLS. There is therefore a total of $12 \times N_B$ ordered probit regressions. There are in total 7,321 respondents in the balanced panel. We notice that for some respondents, their ordered probit models cannot be estimated as their response to a certain SWB metric k appears to always be the same in all waves. It implies the pseudo R^2 coefficients of their ordered probit models to be zero. There are also cases which yield pseudo R^2 coefficients with value one. We exclude these two types of cases from our adjustment.

Adjusted balance statistics of SWB

Before we compute the adjusted balance statistics of SWB metrics using weights obtained from Model 1 and Model 2, we first look at the distribution of the pseudo R^2 coefficients obtained from the respondent-level ordered probit models for each metric to check for evidence of heterogeneity of individual's SWB responses to the set of observables included in the models. This provides an indication of whether an aggregation scheme designed to account for such heterogeneity is sensible. Close investigation reveals significant variation in the value of the pseudo R^2 coefficients across respondents, confirming the importance of adjusting summary measures to accommodate these differences.[8]

To compute balance statistics of SWB adjusted for heterogeneity, we use the pseudo R^2 coefficients from the N_B individual ordered probit models as weights using equation (3.6). Those respondents whose SWB is better explained by the observables, as reflected by larger values of pseudo R^2 coefficients, are given a larger weight in this aggregation. This weighting strategy is thus designed to give more weight to respondents for whom their wellbeing outcomes have a close link with the observables than to those whose experiences correspond only weakly or not at all.

Note that we observe respondents who appear to always respond with the same categorical answer to certain SWB measures no matter how the values of their individual factors and regional factors have changed over time. This causes the value of the pseudo R^2 in their ordered probit models to be zero. This indicates their experience in a particular aspect of wellbeing is orthogonal to the individual and regional conditions considered.[9] It means these respondents are assigned with zero weights in our aggregation, and they are naturally excluded in the aggregation to the overall SWB composite measure.

The adjusted balance statistics of SWB are computed using equation (3.12). We compare them with the unadjusted balance statistics presented in section 4.1.3.1. As in the unweighted analysis, we standardise the balance statistics to make them comparable. Figure 4.9 plots the standardised and

[8] We find the distribution of pseudo R^2 coefficients obtained from Model 1 (with personal income) centres around values between 0.28 and 0.30, but there is a long tail of values towards the right of the distribution, mainly between 0.3 and 0.6. The characteristics of the distribution of the pseudo R^2 coefficients from the respondent-level Model 2 (with person health) are consistent with those of Model 1.

[9] We notice the reason why certain respondents always give the same response can be ambiguous. One explanation could be that their SWB experience is truly orthogonal to any observables and unobservables. However, another explanation could be that the change in their experience is not significant enough to cross the threshold between categories, especially when there is a small number of categories. We are unable to distinguish between these two cases using our data.

adjusted balance statistics of the twelve SWB metrics we compute using weights obtained from Model 1 (with personal income, pink line) and Model 2 (personal health, blue line) against the unadjusted balance statistics (dashed line). Looking at the twelve SWB aspects separately, the overall trend of the two weighted series and the unweighted series appears very similar, despite some small differences in some waves. The trend and changes in the adjusted balanced statistics over time are mostly consistent with that of the unadjusted series.

We compute a composite index with mean 100 and standard deviation 10 using the adjusted balance statistics of SWB as in the previous subsection (we refer to this as the adjusted composite index hereafter). Figure 4.10 plots the adjusted composite index of SWB computed using weights from Model 1 (with personal income, pink line) and Model 2 (with personal health, blue link) against the unadjusted composite index (dashed line). The three series follow very similar trends. There is not much divergence of the two weighted series except at the beginning of the sample period. The annual dips are a little less intense in the two adjusted series as compared to the unadjusted series in the beginning and at the end of the sample period. There is a more rapid decline in the two weighted series in wave 8 and less rapid decline from wave 8 onwards.

Figures 4.9 and 4.10 appear to suggest that adjusting for heterogeneity using the current weighting scheme does not seem to offer much difference. However, there are two important caveats. First, we confine to just a few observables in the ordered probit models we use to obtain weights, especially individual specific factors, due to short time series of individuals. While personal health and personal income are two important factors that affect SWB in general, as also shown by our pooled regressions, we cannot rule out the fact that their significance could vary across respondents. Besides, for some respondents there could also be other factors or a combination of factors that are not included in our models that could (collectively) affect their SWB more than the combination of factors we included in our current weighting scheme. Secondly, as discussed in section 3.3.1, the current scheme allocates higher weights to the SWB responses given by those respondents whose SWB experiences are more highly correlated with the observables included in the ordered probit models. What we present above is one way to obtain weights to adjust for heterogeneity. An equally valid alternative is to allocate weights to SWB responses given by those respondents whose SWB are less correlated with the observables i.e., more correlated with those unobservable factors which are not captured in the models. These unobservable factors could be some omitted measurable factors or some other unmeasurable factors e.g., externalities, political climate, quality of institutions, pollution, or other environmental factors. Further work should explore the use of this alternative weighting scheme and compare how collective sentiments of SWB adjusted to accommodate heterogeneity differ when individual SWB responses are adjusted to unobservable factors. Should longer time series of

individuals be available, further work could also accommodate a wider range of individual factors in models that generate weights to improve adjustment.

Nevertheless, our empirical analysis in this paper shows an example of how one could obtain weights to establish summary measures of SWB experiences that account for their correlations with individual specific factors and macroeconomic conditions.

Figure 4.9. Standardised Balances of SWB measures (adjusted): UK (balanced panel)

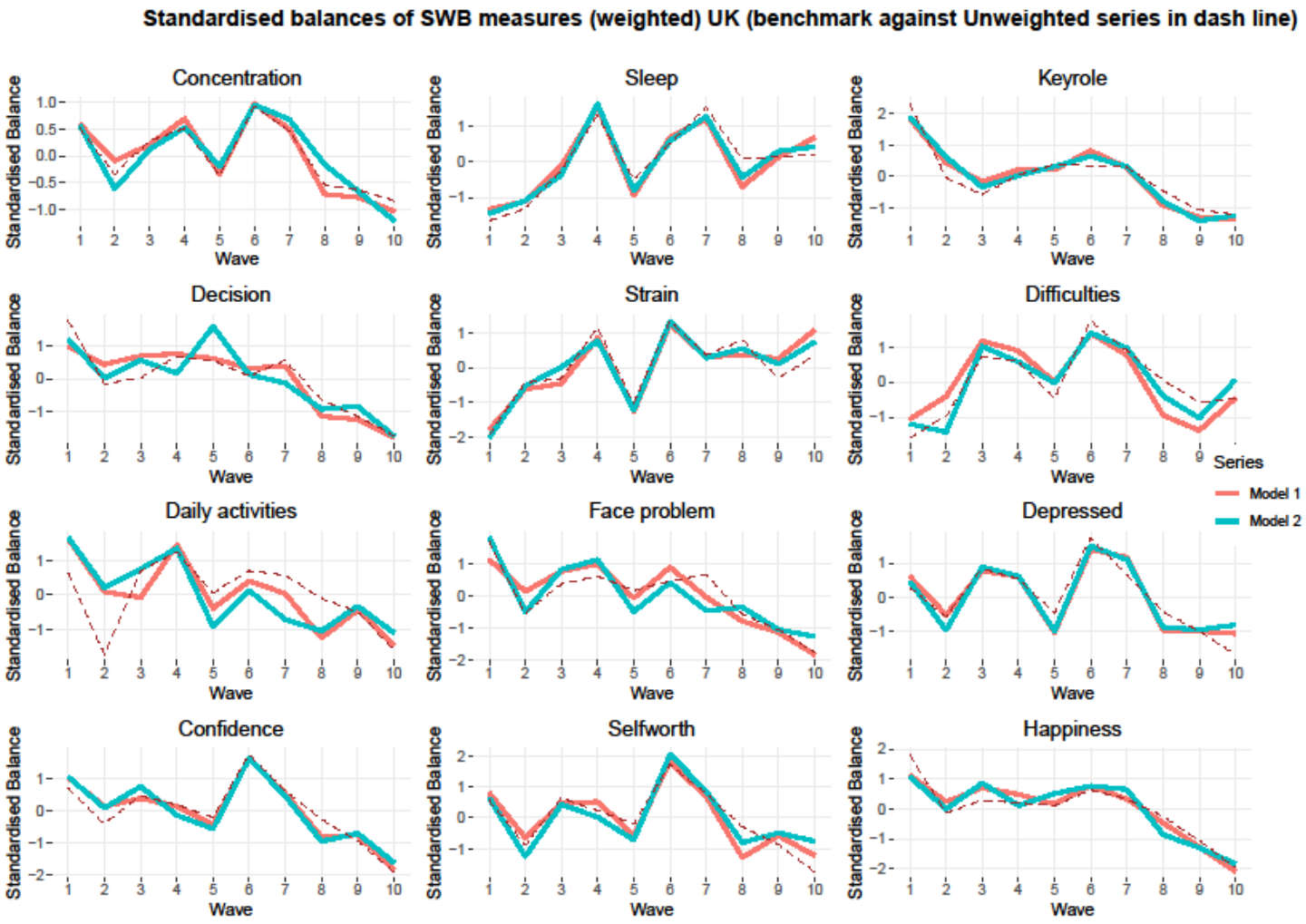
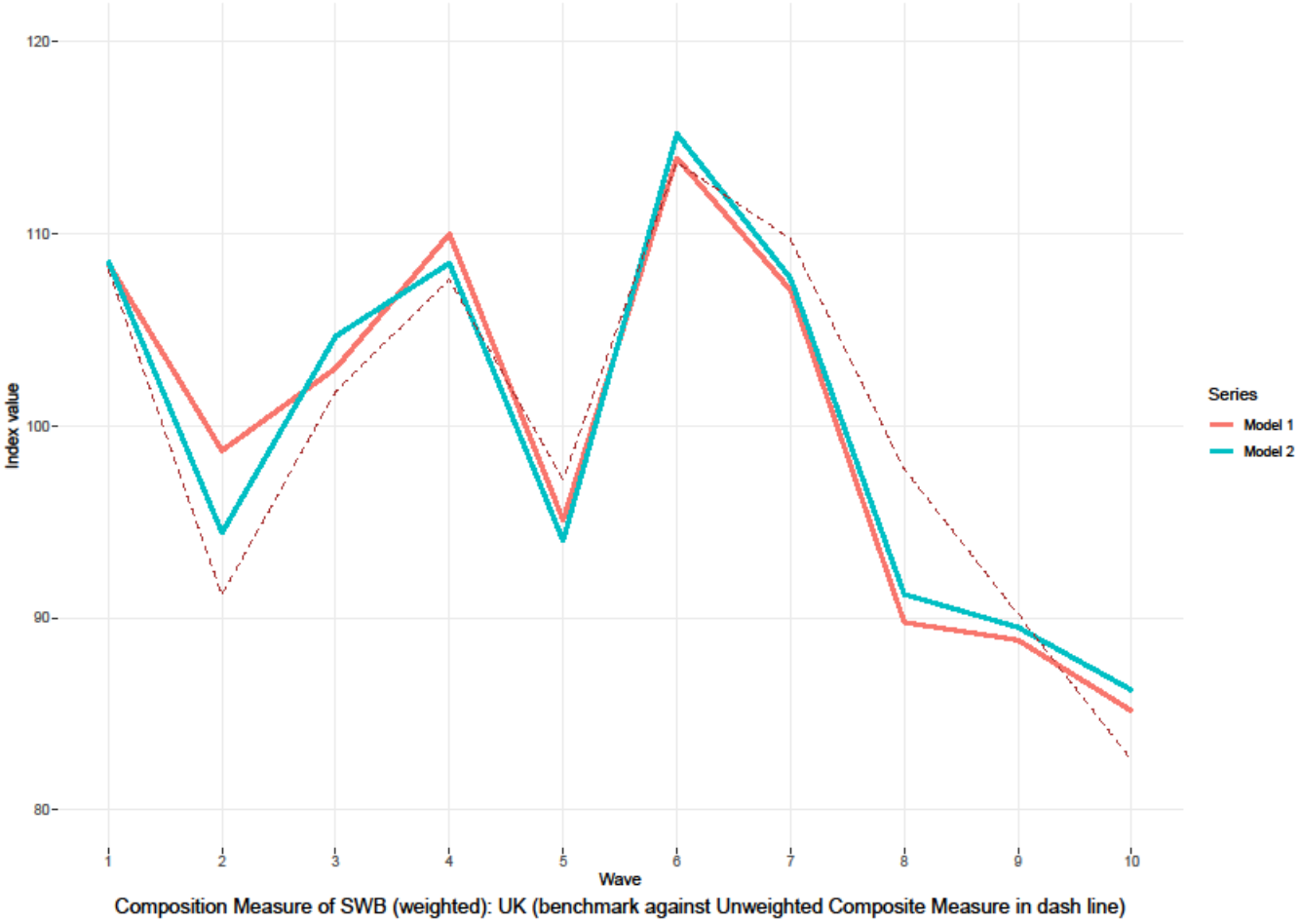


Figure 4.10. Composite Index of SWB (adjusted): UK (balanced panel)



4.2. UK regions

In this subsection we summarise the main results of our SWB analyses at a regional level based on the UK Government Office Regions (GOR). There are in total twelve GORs[10]: North-East, North-West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South-East, South-West, Wales, Scotland, Northern Ireland. This geographical classification is roughly equivalent to the International Territorial Level 1 (ITL 1) classification. As we have a large number of charts and tables for the regional analysis using the unbalanced sample, it is difficult to showcase all of them in this paper. We therefore discuss the main regional findings and compare them with the UK results in Section 4.1 in this subsection and present a selection of charts or tables for illustrative purposes

[10] There were nine Government Offices for the Regions (GOR) established across England in 1994 which became abolished in 2011. These are equivalent to the International Territory Level 1 regions.

wherever necessary. The full set of outputs from the UK regional analysis can be made available upon request.

One of the aims of the paper is to explore differences in SWB across the UK regions. While we could conduct the analysis using the balanced sample, we are somewhat restricted by the low regional sample sizes when we look at the regional subsamples. We therefore conduct regional analysis using the unbalanced sample pooled across each UK region only to offer some regional insights across the different SWB dimensions using the same methods applied to the pooled UK unbalanced sample.

We first examine the correlation across different SWB variables at the regional level and then estimate probit models region by region. We seek to identify factors that may affect differently SWB in different regions. We then turn our attention to computing (unadjusted) balance statistics, which summarise differences in SWB outcomes across the UK regions.

For pairwise polychoric correlations we find that the results are consistent with those in the UK sample. That is, in few cases the correlation takes values above 0.7. This shows that in the majority of cases the correlation across variables is not as high as one could have expected. This further justifies our decision to analyse each of the SWB metrics separately. Unconditional correlations between different SWB aspects do not vary much across regions, and thus the regional findings are consistent with the overall UK findings.

We then estimate the pooled ordered probit model on a regional basis (which can be made available upon request) and only discuss here the main results. First, we find statistical differences in the role of marital status in explaining SWB outcomes across regions. Looking at the region-by-region results, generally, we observe that being divorced or separated decreases the probability of scoring high in SWB. In contrast, being married or in partnership brings more mixed results in the probability of scoring higher in various measures of SWB. But in London in particular and also in Scotland, married/in partnership respondents are more likely to report positive SWB outcomes. Moreover, divorced or separated individuals in London do not necessarily report lower SWB, in contrast to what is observed in the majority of other regions. There are also two regions where being married is consistently associated with lower SWB; this is the case of Wales and Northern Ireland. And being divorced or separated is associated with a higher probability of reporting worse wellbeing outcomes in regions such as North-East and the North West.

Our regional analysis shows that it is mostly in London and the East of England where respondents of black ethnic background are more likely to report positive SWB (this was a result observed in the UK unbalanced sample). This is not the case for many of the other regions in the UK. Migrant status is not

a key determinant of subjective wellbeing in regions such as East Midlands, West Midlands, South West, Wales, Scotland and Northern Ireland. London and the West Midlands are the two regions where we observe a stronger relationship between income and better wellbeing.

In terms of education, generally, in most regions respondents with a degree are more likely to feel they can play a useful role. In the case of those with an intermediate level of education (e.g., GCSE/A-Level/other), the results for the likelihood of reporting higher SWB in relation to no education are less conclusive.

For the UK unbalanced sample, we showed that the variable most strongly correlated with SWB was health. Another key variable from the analysis of the literature is income (although we find generally less evidence of a strong effect on SWB). In tables B.2 and B.3 we show statistical differences across regions in relation to these two variables. There are differences across regions, but in most cases, these are not statistically significant.

Balance statistics of the UK regions

To draw some regional inferences, we then examine the balance statistics of SWB for the twelve regions using the unbalanced panel. First, looking at the balance statistics of SWB measures *"concentration", "playing a useful role", "capable of making decisions", "enjoy day-to-day activities", "ability to face problem", and "general happiness*", the share of negative experience has consistently outweighed the share of positive experience for SWB measures in North East, North West, West Midlands, East of England, South West, Wales, Scotland and Northern Ireland. We show a selection of regional charts for illustrative purposes (figures B.1-B-4).

The same applies to East Midlands and the Yorkshire and the Humber, except for the measure "*capable of making decisions*" where the shares of positive experience slightly outweigh negative experience in wave one.

In the South East, we observe a similar story for SWB measures *"concentration", "enjoy day-to-day activities", "ability to face problem", and "general happiness"* across all waves, but comparable shares of negative and positive experience in *"playing a useful role", "capable of making decisions"* except in wave one.

London displays a slightly different picture as compared to the other regions in these six SWB measures. While the reported share of negative experiences also outweighs that of the positive experience for *"concentration", "playing a useful role", "enjoy day-to-day activities"* in all waves as in other regions, respondents reported a positive balance in *"capable of making decisions"* in almost all waves. Only in wave ten when the positive and the negative share becomes comparable leading to a

close to zero value of the balance of proportions. Reported experience in *"general happiness"* in London is also a little different from other regions. Respondents reported an overall positive balance in wave one. In wave four and seven, the share of positive and negative experiences is comparable, reflected by close to zero values of the balance of proportions in these two waves. Overall negative balance of proportions is reported in all other waves.

For SWB measures *"loss of sleep", "constantly under strain", "problem overcoming difficulties", "unhappy or depresses", "losing confidence", "believe worthless",* the share of reported positive experience outweighs that of the negative experience across all twelve regions.

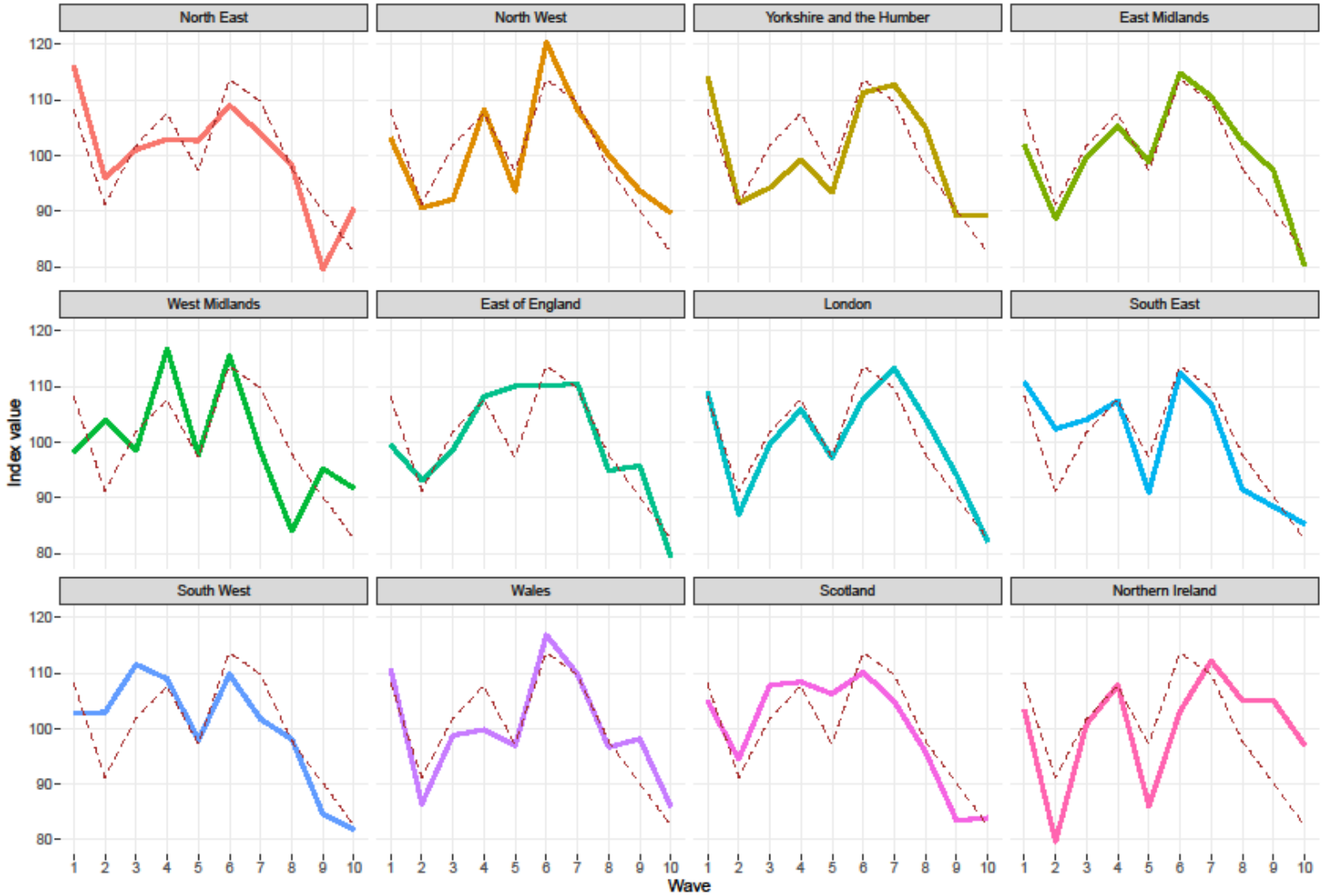
In terms of the (absolute) magnitude of the difference between the positive share and the negative share, our results show that the regional pictures are quite similar to the national picture. The most substantial difference in the opposite shares appears in *"believe worthless"* with differences ranging between 55 and 60 percentage points, followed by *"losing confidence"* with differences ranging between 27 and 34 percentage points. The difference in the share of positive and negative experiences in *"capable of making decisions"* appears to be the smallest as compared to all other SWB measures in all twelve regions, ranging between 1.4 to 3 percentage points.

We standardise the balance statistics of the SWB to make them comparable. A value below zero in a particular wave indicates the SWB in that wave is below the sample period average, and a value above zero indicates the SWB in that wave is above the sample period average. We observe some regional variations in each of the SWB measures in general, with some regions showing more similar patterns in the trend of some SWB measures than others.

The regional unadjusted composite measure

Figure 4.11 plots the composite measures of SWB, which are the rescaled average balances, by UK region against the UK composite measure (dashed lines). In general, the regional composite measures of SWB follows similar trend as the UK composite measure during the sample period. All regions experienced a drop in overall SWB in wave two except for West Midlands and South East. There is also a dip in overall SWB in wave five across all regions, except in the East of England. After then, we observe a drop in overall SWB in all regions from wave six onwards, except for East of England, London, and Northern Ireland, the decrease in overall SWB in these region does not start until wave seven. It means that the regional variations observed (see Figures B.1 to B.4 for illustration) do not translate into major regional differences when we aggregate across the twelve SWB measures.

Figure 4.11. Composite measure of SWB (rescaled average balances): UK regions (unbalanced panel)



Composition Measure of SWB: UK regions (benchmark against UK series in dash line)

5. Conclusion

This paper explores the use of individual level data on self-reported SWB experience available from the UKHLS to construct national and sub-national SWB measures for the UK. We investigate the drivers of SWB by means of discrete choice models, focusing on a set of individual factors that affect individuals' SWB as suggested by the existing literature. We create summary measures of SWB in the form of balance statistics with and without accommodating heterogeneity across individuals' wellbeing experiences.

Our study makes three main empirical contributions. First, we draw a consistent picture of changes in wellbeing over time by exploiting the longitudinal nature of the survey. We thus offer new evidence that cannot otherwise be revealed by looking at the annual snapshots produced by other types of surveys. Second, we provide a detailed breakdown of the trends by examining twelve aspects of SWB in different UK regions, with elements that are conventionally regarded as a direct measure of wellbeing (e.g. general happiness), and elements that directly reflect the state of wellbeing (e.g. sleep, confidence). Thereby, we provide a more complete picture of changes in wellbeing in the UK compared to most empirical studies. Third, we establish a method to quantify categorical SWB responses accounting for the impact of individual-specific and regional factors. The resulting summary measure, in the form of adjusted balance statistics, is therefore expected to be more informative than simple aggregation implied by most empirical studies.

Findings from the polychoric analysis confirms that wellbeing is a complex concept and cannot be easily summarized by considering just a few summary dimensions. We find that relationships between the different SWB variables appear similar across regions, but the extent to which some individual sociodemographic factors impact on SWB show some regional variations.

As found in previous studies, the relationship between physical health and subjective wellbeing is found to be robust across regions, in showing that healthier individuals are more likely to report higher levels of subjective wellbeing. Overall, we find that those that report excellent health are 30% more likely to experience the highest levels of SWB compared to those that report poor health. Econometric results also show that men appear to have higher levels of satisfaction in all SWB dimensions considered, a finding that is not consistent with some prior literature.

There are other results that are worth noting, and that may appear surprising. For instance, the role of income and education. We find that having a degree is not necessarily associated with higher levels of wellbeing, only in specific dimensions that more closely reflect work satisfaction. Results are similar

when looking at the job situation and income earned. The ambiguous nature of these relationships would benefit from further investigation and analysis.

We find overall decreasing levels of wellbeing in the UK since 2014 at the national level and in most regions. Although we do not observe a unique pattern of change across all aspects of SWB, there are similarities. For instance, we observe a declining trend for most aspects of SWB in recent years but the timing of when this started differs. Our research, however, does not investigate the reasons underlying a declining trend in SWB. For example, a recent study by Wallace et al. (2021) finds one of the factors that might explain the decline in wellbeing is a worsening in mental health due to loneliness and isolation.

This research is a thorough study of wellbeing in the UK. We provide a range of results that look at differences in aspects of SWB and in different regions, and how these change over time. Our findings should be informative for policymakers interested in understanding regional disparities in living standards, not only in terms economic welfare, but also in terms of personal wellbeing.

6. Avenues for further research

In this section, we discuss avenues for further work in light of the results described in this paper. Our weighted adjustment assumes all respondents are being affected by the same set of individual and regional factors and assigned weights to those whose SWB experiences are more correlated with these observables. Hence those whose SWB is less correlated with or orthogonal to these observables are given small or zero weights. To better understand our results or to improve our adjustment method, we could single out the respondents whose SWB has a weak relationship with the observables we are currently adjusting for. We could further investigate whether their SWB is more dependent on a different set of observables or their reported SWB is purely random. Comparing the balance statistics of these individuals with the ones whose SWB is more correlated with these set of observables would allow us to understand whether different methods of adjustment matter and whether the resulting composite measure shows different patterns.

For future work one could envisage extending the range of observable factors determining SWB in the weighted analysis and that could be uncorrelated with the variables included. Ultimately, we would aim to get a better picture of the extent to which adjustment based on a different set of observable characteristics affects the overall movement of SWB as reflected by the balance of experiences.

In this paper we have used a parsimonious specification to construct weights used for the computation of the balance of SWB experiences. This is dictated by the limited number of time periods available in the UKHLS sample. The decision to condition SWB measures on personal health and personal income in our weighted analysis has been motivated by the results in Section 4 and findings in existing literature. Looking ahead, we can think of broadening the list of explanatory variables in line with the ordered probit results, which showed us that individual influences on wellbeing may be wide-ranging. These could include variables such as marital status, gender and ethnicity. We acknowledge there could be a level of variation in the pseudo R^2 statistics across the individual ordered probit regressions estimated using the same set of regressors. However, for those who have a smaller value of the pseudo R^2 statistic their SWB could be dependent on a different set of characteristics. Similarly, we could extend the list of aggregate factors that can influence individuals' perceptions of wellbeing. Some examples are social capital and environmental factors.

These additional analyses would be facilitated by extending the data to include the British Household Panel Surveys (BHPS) to bring the total number of combined waves to twenty-eight (eighteen waves from BHPS and ten waves from UKHLS). We could then focus the analysis on just the BHPS cohort in the combined dataset. The downside of doing so is that the sample size will grow smaller over time. The reduction in sample size of the BHPS cohort is even more prevailing in the UKHLS data.

There would be a trade-off between time series information and cross-sectional information, but a larger time series would allow us to undertake a secular analysis of the drivers of SWB and exploit a larger number of variables when adjusting our composite measures of wellbeing. Future analysis focusing on the UKHLS sample could consider examining the differences in overall SWB experience, in terms of the balance of experiences, in different subgroups or combination of subgroups adjusting for effect due to personal income, personal health, and regional factors to further exploit individual heterogeneity.

Finally, we have not explored SWB during the pandemic, as our UKHLS analysis finishes in wave ten (which covers some responses from year 2020 for those interviews that could not be conducted during the intended fieldwork period). Further work could also explore these data to understand changes in SWB and in its determinants since the pandemic and whether these are likely to be transitory or of a more permanent nature.

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Appendix A

The UK Household Longitudinal Study

UKHLS is a survey with annual interviews. Households included in data collection in its first wave are visited each year. The survey collects information about changes to the individual and household circumstances. Data collection for each wave takes place over a twenty-four-month period. The sample of the study includes multiple components that cover different sub-groups over time and geography. These components include the General Population Sample (GPS), the Ethnic Minority Boost Sample (EMBS), the Immigrant and Ethnic Minority Boost Sample (IEMBS) and the British Household Panel Survey sample (BHPS).

In 2009, the UKHLS began with the GPS of 26,000 UK households and also included about 4,000 households in the EMBS chosen from areas of high ethnic minority concentration in 2009-10 where at least one member was from an ethnic minority group.[11] The sample from BHPS is added in wave 2, bringing about an additional 8,000 households to the UKHLS sample. IEMBS was added in wave 6 to include about 2,900 households chosen from areas with high ethnic minority concentration in 2015 where at least one member was born outside the UK, or from an ethnic minority group. Our analysis includes all these sub-groups to ensure our findings are representative over time, geography, and ethnicity.

[11] See screening questions in McFall, S., Nandi, A, & Platt, L., (2020), "Understanding Society: UK Household Longitudinal Study: User Guide to ethnicity and immigration research", Understanding Society. https://www.understandingsociety.ac.uk/sites/default/files/downloads/documentation/mainstage/user-guides/user-guide-ethnicity-immigration-research.pdf

There are three types of sample statuses in the UKHLS. They are the Original Sample Members (OSMs), the Temporary Sample Members (TSMs)[12], and Permanent Sample Members (PSMs)[13]. Among these three types of member statuses, we focus our analysis only on OSMs. OSM include: (1) All members of households included in GPS in wave 1 of UKHLS. (2) EMBS who are from a qualifying ethnic minority in wave 1 of UKHLS. (3) Household members who met the eligibility criteria included in the IEMBS in wave 6. (4) Any child born to an OSM mother after wave 1 and live with the mother at the survey wave following the child's birth. (5) BHPS OSMs: OSM in BHPS are those who were enumerated at the first wave of the BHPS samples[14] or those who were subsequently born to an OSM mother or father or both. All OSMs, regardless of age, are followed for interview and remain as eligible sample members as long as they are resident within the UK. Hence, they potentially remain as eligible sample members for the life of the UKHLS.

Table A.1. UKHLS General Health Questionnaire (GHQ) Subjective Wellbeing Questions

	Question text	Choices of response
A. Concentration	"Have you recently been able to concentrate on whatever you are doing?"	"Better than usual", "Same as usual", "Less than usual", "Much less than usual"
B. Loss of sleep	"Have you recently lost much sleep over worry?"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"
C. Playing a useful role	"Have you recently felt that you were playing a useful part in things"	"More so than usual", "Same as usual",

[12] TSMs include (1) Any household members eligible for inclusion in the EMBS in wave 1 who are not from a qualifying ethnic minority. (2) Any household members of IEMBS at wave 6 who are not from a qualifying minority or immigration background (i.e., non-ethnic minorities who were born in the UK). (3) Any new person living in an OSM or PSM household after wave 1, including any child born to an OSM father after wave 1 but not an OSM mother and living with the father (or any other OSM) at subsequent survey wave after the child's birth. A TSM remain eligible for interview as long as the person is in an OSM or PSM household. Those who are not living with an OSM or PSM household are not followed and becomes ineligible for interviews.

[13] PSMs includes any TSM father of an OSM child born after wave 1 and living with the child in the subsequent survey wave after the child's birth. PSMs remain eligible for interview for the life of the UKHLS. PSMs are followed for interviews after they no longer live with an OSM only for that reason that they could provide information for the analysis of the OSM.

[14] These include including wave 1 of the original BHPS sample, wave 9 of the BHPS Scotland and Wales boost samples, wave 11 for NI component.

	Question text	Choices of response
		"Less so than usual", "Much less than usual"
D. Capable of making decisions	"Have you recently felt capable of making decisions about things"	"More than usual", "Same as usual", "Less so than usual", "Much less capable"
E. Constantly under strain	"Have you recently felt constantly under strain"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"
F. Problem overcoming difficulties	"Have you recently felt you couldn't overcome your difficulties"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"
G. Enjoy day-to-day activities	"Have you recently been able to enjoy your normal day-to-day activities?"	"More than usual", "Same as usual", "Less than usual", "Much less than usual"
H. Ability to face problem	"Have you recently been able to face up to problems?"	"More so than usual", "Same as usual", "Less able than usual", "Much less able"
I: Unhappy or depressed	"Have you recently been feeling unhappy or depressed?"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"
J: Losing confidence	"Have you recently been losing confidence in yourself?"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"
K: Believe worthless	"Have you recently been thinking of yourself as a worthless person?"	"Not at all", "No more than usual", "Rather more than usual", "Much more than usual"

	Question text	Choices of response
L: General Happiness	"Have you recently been feeling reasonably happy, all things considered?"	"More so than usual", "About the same as usual", "Less so than usual", "Much less than usual"

Note: Source: *https://www.understandingsociety.ac.uk/documentation/mainstage/dataset-documentation. Note that invalid values in the responses are all omitted in the dataset for our analysis. These include "missing", "inapplicable", "proxy", "refusal" and "don't know".*

Table A.2. Individual-level SWB variables and individual factors

UKHLS variables	Description	Acronym in oprobit
Panel A: *GHQ Subjective Well-Being*		
Concentrate	less than usual, same as usual, better than usual	*concentrate*
Loss of sleep	loss more than usual, loss no more than usual, no loss at all	*sleepq*
Playing a useful role	less than usual, same as usual, more than usual	*keyrole*
Capable of making decisions	less capable than usual, same as usual, more capable than usual	*decicapa*
Constantly under strain	more under strain than usual, no more than usual, less under strain than usual	*undstrain*
Problem overcoming difficulties	more than usual, no more than usual, not at all	*overdiffic*
Enjoy day-to-day activities	less than usual, same as usual, more than usual	*enjdayact*
Ability to face problems	less able than usual, same as usual, more able than usual	*faceprob*
Unhappy or depressed	more than usual, not more than usual, not at all unhappy or depressed	*depressed*
Losing confidence	more loss than usual, no more loss than usual, no loss	*confidence*
Believe worthless	more than usual, about the same, not at all	*selfworth*
General happiness	less than usual, about the same, more than usual	*happiness*
Panel B: Individual Factors		
Demographic characteristics		
Men	Whether an individual is male or not	

UKHLS variables	Description	Acronym in oprobit
Age	Age as at date of interviewed (derived variable with date of birth and date of interview)	
Marital Status	Single/Never married, Married, Divorced/Separated, Widow	
Level of Education	No qualification, GCSE/A-level/Other, Degree/Other higher degree	
Ethnicity	White, Mixed, Asian/Asian British, Black, Arabic, Other	
Migrant	Whether an individual is a migrant (non-UK born first generation)	
Household condition		
Household size	Whether an individual is from a household size of 4+ or up to 4	
Housing ownership	Owned outright, Shared ownership, Mortgage, Rented accommodation, Local authority	
Responsibility for under 16	Whether an individual is responsible for aged under 16.	
Employment and Income		
Job	Whether an individual is in employment or not (in employment includes employed, self-employed, other job)	
Income (monthly)	Total monthly income (net). This includes income from the following sources: labour income, miscellaneous income, private benefit income, investment income, pension income, social benefit income.	
Caring responsibility		
Carer	Whether an individual has caring responsibility (inside or outside of household)	

UKHLS variables	Description	Acronym in oprobit
Care load	None, Light (i.e., less than 20 hours weekly), Heavy (i.e., at least 20 hours weekly)	
Personal health		
Physical health condition	Poor, Fair/Good, Excellent/Very good	
Geographic location		
Government Office Region	North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East, South West, Wales, Scotland, Northern Ireland	
Urban	Whether the address of an individual is in urban or not (Based on the ONS Rural and Urban Classification of Output Area 2001.Urban settlement has a population of 10,000 or more)	

Appendix B: Tables and graphs

Table B.1 Pairwise polychoric correlation coefficients of the subjective wellbeing measures – All Regions.

	concentrate	sleepq	keyrole	decision	strain	difficulties	daily-activities	face-problem	depressed	confid-ence	self-worth	happin-ess
concentrate		0.473	0.489	0.549	0.491	0.482	0.610	0.531	0.537	0.511	0.462	0.542
sleepq	0.473		0.330	0.344	0.652	0.598	0.448	0.387	0.661	0.585	0.545	0.437
keyrole	0.489	0.330		0.618	0.312	0.420	0.510	0.521	0.427	0.477	0.505	0.515
decision	0.549	0.344	0.618		0.360	0.433	0.537	0.624	0.423	0.478	0.466	0.541
strain	0.491	0.652	0.312	0.360		0.703	0.514	0.414	0.706	0.622	0.566	0.468
difficulties	0.482	0.598	0.420	0.433	0.703		0.526	0.485	0.715	0.697	0.677	0.501
daily-activities	0.610	0.448	0.510	0.537	0.514	0.526		0.612	0.550	0.503	0.474	0.633
face-problem	0.531	0.387	0.521	0.624	0.414	0.485	0.612		0.490	0.508	0.499	0.594
depressed	0.537	0.661	0.427	0.423	0.706	0.715	0.550	0.490		0.773	0.729	0.612
confidence	0.511	0.585	0.477	0.478	0.622	0.697	0.503	0.508	0.773		0.825	0.548
Self-worth	0.462	0.545	0.505	0.466	0.566	0.677	0.474	0.499	0.729	0.825		0.568
happiness	0.542	0.437	0.515	0.541	0.468	0.501	0.633	0.594	0.612	0.548	0.568	
column mean	0.516	0.496	0.466	0.488	0.528	0.567	0.538	0.515	0.602	0.593	0.574	0.542

Note: *Diagonal elements of one's are omitted*

Table B.2 Statistical test equality of coefficients across regions. Income variable.

Region	*concentrate*	*sleep*	*keyrole*	*decicapa*	*undstrain*	*overdiffic*	*enjdayact*	*faceprob*	*depressed*	*confidence*	*selfworth*	*happiness*
North West	0.24 (0.63)	0.08(0.78)	3.71(0.05)*	0.00(0.94)	1.21(0.27)	0.26(0.60)	1.46(0.22)	1.46(0.22)	0.14(0.70)	2.55(0.11)	2.74(0.09)*	0.00(0.94)
Yorkshire and Humber	0.02 (0.88)	0.52(0.47)	0.12(0.73)	0.40(0.52)	0.29(0.58)	0.45(0.50)	4.17(0.04)	0.62(0.42)	0.01(0.93)	0.05(0.82)	3.96(0.04)*	0.28(0.59)
East Midlands	0.42(0.53)	3.90(0.04)**	1.52(0.21)	1.56(0.21)	0.48(0.48)	0.06(0.80)	2.60(0.10)	1.51(0.21)	0.10(0.75)	0.08(0.78)	0.26(0.60)	0.08(0.77)
West Midlands	0.64(0.42)	2.93(0.08)	1.39(0.23)	1.14(0.28)	0.01(0.92)	0.99(0.31)	3.56(0.05)	5.15(0.02)	0.30(0.58)	2.47(0.11)	2.11(0.14)	0.93(0.33)
East of England	0.01(0.92)	0.29(0.59)	3.15(0.07)*	0.47(0.49)	1.25(0.26)	0.78(0.37)	1.07(0.30)	0.38(0.53)	0.34(0.56)	0.16(0.69)	0.75(0.38)	0.36(0.54)
London	0.52(0.47)	1.31(0.25)	1.27(0.25)	0.06(0.80)	0.36(0.55)	0.08(0.77)	1.45(0.22)	1.15(0.28)	0.36(0.54)	0.07(0.78)	0.10(0.55)	0.02(0.89)
South East	0.29(0.65)	0.43(0.51)	1.48(0.22)	0.87(0.35)	0.08(0.77)	2.54(0.11)	1.17(0.27)	1.56(0.21)	2.48(0.11)	1.02(0.31)	2.76(0.09)	0.33(0.56)
South West	0.33(0.56)	0.78(0.37)	0.92(0.33)	0.63(0.42)	2.23(0.13)	0.01(0.93)	1.92(0.16)	0.60(0.43)	0.48(0.49)	0.11(0.74)	0.25(0.62)	0.00(0.99)
Wales	0.13(0.71)	1.10(0.29)	3.70(0.05)*	0.97(0.32)	0.67(0.41)	3.09(0.08)*	0.12(0.72)	1.36(0.24)	0.29(0.59)	3.35(0.07)*	7.26(0.00)***	0.15(0.69)
Scotland	0.50(0.47)	1.73(0.18)	2.39(0.12)	0.33(0.56)	0.13(0.71)	0.41(0.52)	2.36(0.12)	1.59(0.20)	0.46(0.49)	0.69(0.40)	2.26(0.13)	0.00(0.99)
Northern Ireland	0.20(0.65)	0.84(0.36)	0.26(60)	0.55(0.45)	0.08(0.77)	0.02(0.88)	0.17(0.67)	0.04(0.84)	0.03(0.87)	1.60(0.20)	2.71(0.09)*	0.32(0.56)

Chi-squared statistic. Omitted region is North East.

Table B.3 Statistical test equality of coefficients across regions. Health variable (For category 'Probability of reporting highest SWB'.)

Region	*concentrate*	*sleep*	*keyrole*	*decicapa*	*undstrain*	*overdiffic*	*enjdayact*	*faceprob*	*depressed*	*confidence*	*selfworth*	*happiness*
North West	0.77(0.38)	0.02(0.88)	0.11(0.73)	1.09(0.29)	1.01(0.31)	4.33(0.03)**	1.46(0.22)	0.16(0.69)	0.37(0.54)	4.98(0.02)*	17.6(0.00)***	0.93(0.00)
Yorkshire and Humber	0.49(0.48)	0.02(0.88)	0.00(0.98)	0.05(0.82)	4.76(0.03)**	5.28(0.02)**	0.96(0.32)	0.81(0.36)	2.25(0.13)	3.06(0.08)	3.06(008)*	0.03(0.86)
East Midlands	0.02(0.88)	0.03(0.86)	0.28(0.55)	0.14(0.70)	2.81(0.09)	2.25(0.13)	0.00(0.97)	1.86(0.17)	0.90(0.34)	0.36(0.54)	4.15(0.04)**	0.18(0.66)
West Midlands	3.38(0.06)*	3.20(0.07)*	1.76(0.18)	0.21(0.64)	0.03(0.80)	0.02(0.90)	1.06(0.30)	0.35(0.55)	0.39(0.53)	0.12(0.75)	1.73(0.18)	0.24(0.61)
East of England	0.94(0.33)	0.71(0.40)	0.86(0.35)	1.48(0.22)	2.81(0.09)*	1.40(0.23)	0.29(0.59)	4.14(0.04)**	1.67(0.19)	6.61(0.01)**	12.42(0.00)***	0.34(0.55)
London	0.61(0.43)	3.58(0.05)*	2.36(0.12)	0.42(0.51)	0.27(0.66)	1.11(0.29)	4.91(0.03)	8.48(0.00)***	0.51(0.47)	3.53(0.06)*	17.81*(0.00)	0.02(0.89)
South East	5.00(0.03)**	13.73(0.00)***	0.97(0.32)	0.02(0.90)	8.47(0.00)	7.20(0.00)	0.23(0.63)	1.50(0.22)	3.04*0.08)	14.79(0.00)***	15.69(0.00)	0.01(0.92)
South West	0.01(0.92)	0.59(0.44)	0.41(0.51)	0.55(0.45)	0.00(0.94)	0.04(0.84)	0.45(0.50)	0.00(0.96)	1.41(0.23)	5.05(0.02)**	1.87(0.17)	0.02(0.89)
Wales	0.00(0.94)	2.60(0.10)	1.32(0.25)	1.62(0.20)	0.06(0.81)	0.08(0.77)	1.57(0.21)	0.85(0.35)	0.02(0.87)	0.04(0.83)	4.48(0.03)**	0.08(0.77)
Scotland	0.03(0.87)	0.07(0.79)	1.19(0.27)	0.32(0.57)	0.03(0.87)	0.11(0.73)	0.82(0.36)	0.43(0.51)	0.05(0.82)	0.34(0.56)	10.19(0.00)***	0.19(0.66)
Northern Ireland	5.04(0.02)***	5.99(0.01)	3.93(0.04)	1.82(0.17)	0.30(0.58)	0.67(0.41)	6.35(0.01)	3.88(0.04)	0.69(0.40)	1.22(0.26)	3.38(0.06)*	2.26(0.13)

Chi-squared statistic. Omitted region is North East.

Figure B.1. Balance statistics of SWB measures (unadjusted): North West

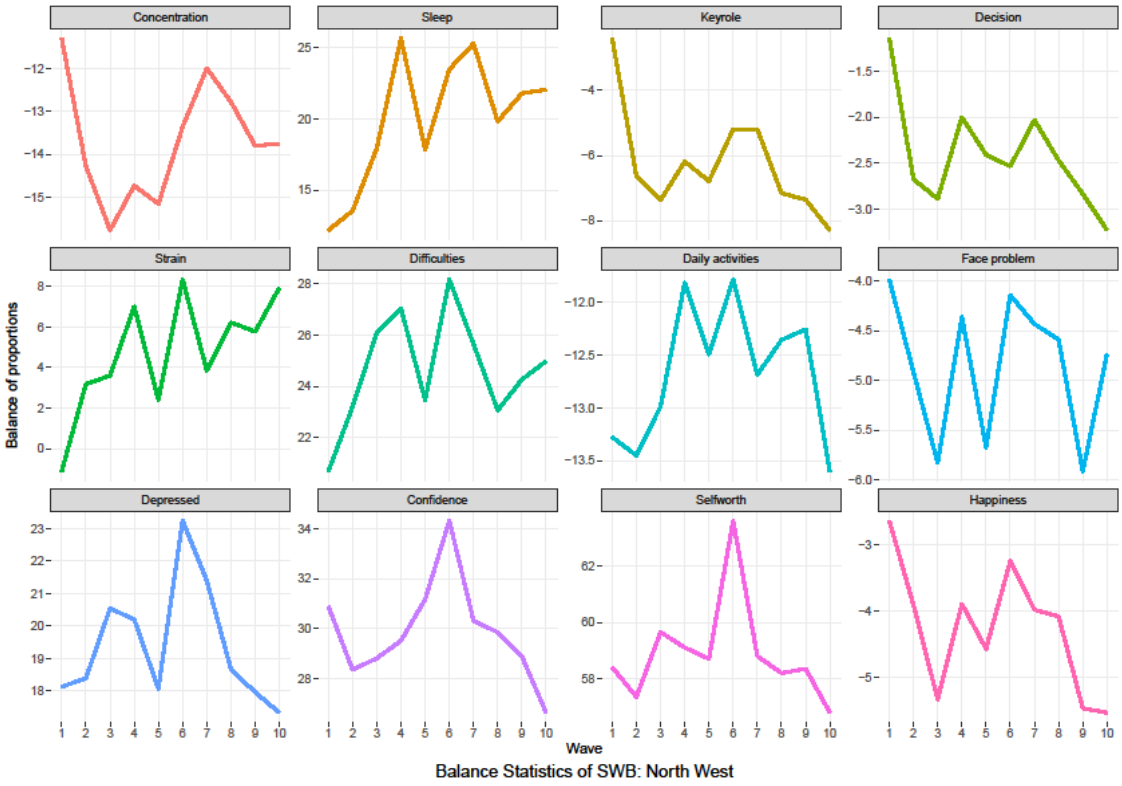

Figure B.2. Balance statistics of SWB measures (unadjusted): East Midlands

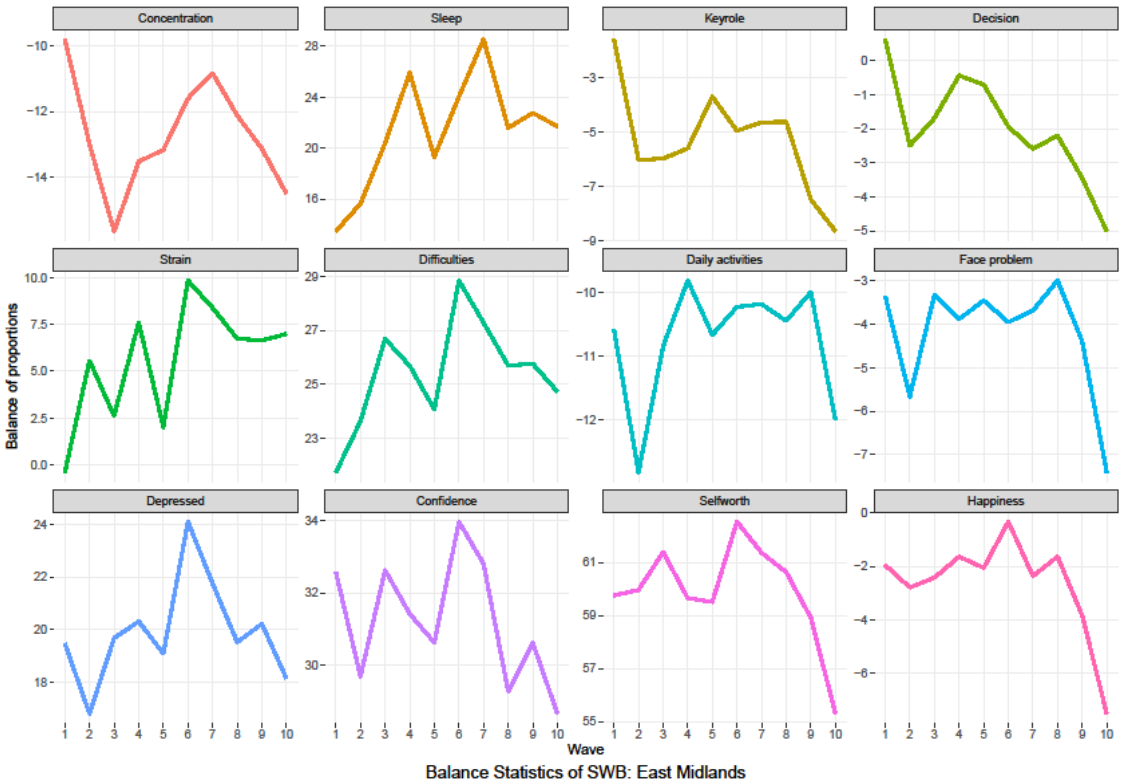

Figure B.3. Balance statistics of SWB measures (unadjusted): Sout East

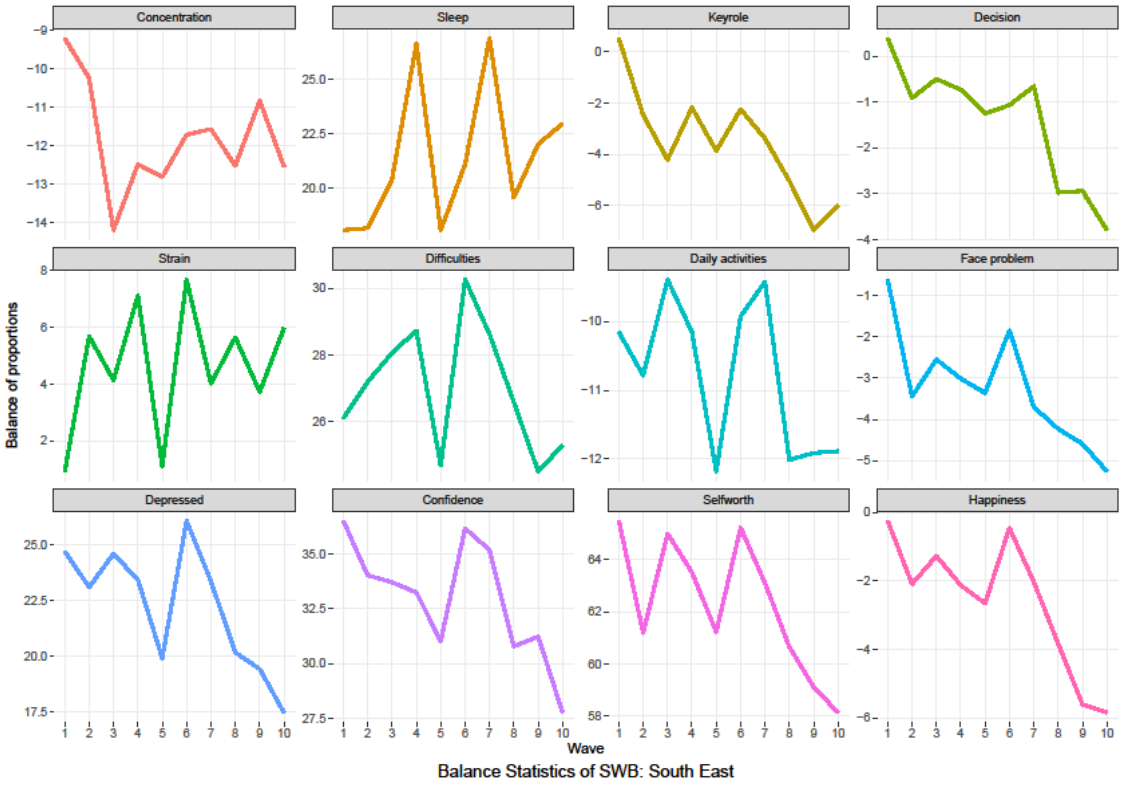

Figure B.4. Balance statistics of SWB measures (unadjusted): London