Essays on Measuring Wellbeing

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Declaration

I, the author, confirm that this thesis is my own work. I am aware of the University's Guidance on the Use of Unfair Means. I hereby declare that except where specific reference is made to the work of others, the contents of this thesis are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. An early version of Study 1 has been published online in the Sheffield Economic Research Paper Series (SERPS No. 2019020). The shorter version of the same study is also available on the websites (limited access for members only) of Understanding Society (2019), The European Health Economics Association (2019) and the Health Economic Study Group - HESG (Winter 2020) as it was presented in the conferences organised by these organisations. In addition, a paper version of Study 2 has also been published online in the Sheffield Economic Research Paper Series (SERPS No. 2021007). Study 3 was presented in HESG Summer 2021 and a paper version of its is available for members on HESG website.

This thesis contains fewer than 97,000 words including appendices, bibliography, footnotes, tables and equations.

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Abstract

This thesis comprises three empirical studies that explore the topic of measuring wellbeing (WB). The thesis aims to make a link between subjective and objectives aspects of WB and to combine different life domains into a single-index measure.

The first chapter motivates the topic and explains the structure of the thesis. Following that, Study 1 examines the use of subjective wellbeing (SWB) to capture changes in individual WB and to compare WB across individuals. Based on the assumption that SWB is interpersonally comparable, this study is the first to investigate the effect of health, physical and mental impairment on SWB and focuses on hedonic adaptation using UK data. The findings suggest no evidence for adaptation to all three kinds of impairment at eight to nine years after onset. There appears to be no difference in hedonic adaptation to health, physical or mental impairment by gender.

In contrast, Study 2 critiques the key assumption of interpersonal comparability of SWB in Study 1 and argues that to make cross-individual WB comparisons, preferences over different life domains need to be considered. Using the same dataset as Study 1, this study computes 'equivalent income', a preference-based single-index multidimensional WB measure. Equivalent income for each individual is calculated using the estimated coefficients related to income, health and employment from life satisfaction regressions. The results indicate low degree of overlap between individuals with the lowest equivalent income and those that are worst-off identified by equivalised income and by life satisfaction.

As the analysis in Study 2 was based on data from actual choices, only results are observed but not the settings of choices from which a particular outcome was selected. To overcome this issue, Study 3 provides new insights into the computation of equivalent income using the stated preference approach, which could potentially reveal preferences that could not be observed through actual decisions. Individual WB was described using seven domains across income, health and non-health. Preference data were collected using a discrete choice experiment (DCE) from an online survey of the UK general public (N = 3362). The DCE design was based on D-efficient partial profiles, in which at least two out of the six categorical domains were always ties, with non-zero priors. Equivalent income for each survey respondent was calculated using the estimated sample preferences. Similar to Study 2, the findings in this study indicate some discrepancies between equivalent income and equivalised income in ranking individual WB. The results also confirm evidence for heterogeneous preferences across some subgroups.

Overall, the results from this thesis demonstrate that measuring and comparing WB should consider its complex, multidimensional nature, and that using different measures is likely to result in remarkably different rankings of individual's WB.

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Chapter 1

INTRODUCTION

1.1 Background and Motivation

Measuring wellbeing has been a long-standing interest of economists, psychologists, political scientists and policy-makers. The main interest is to compare the average welfare levels of people, for example, within individuals over different points in time given exposures to different life events. This thesis focuses on the subjective and the objective approaches to measuring wellbeing. The objective wellbeing approach focuses on observable components of a good life such as material resources (e.g. income or housing) and social attributes (e.g. educational achievements) (see Conceição and Bandura, 2008; Western and Tomaszewski, 2016). In contrast, the subjective wellbeing approach is interested in personal feelings and how people evaluate and perceive their lives to assess wellbeing (i.e. happiness and life satisfaction) (see Conceição and Bandura, 2008; Smith and Clay, 2010). An endeavour to make a link between objective and subjective aspects of wellbeing and to combine different life domains into a single-index measure of wellbeing forms the aim of this thesis.

In the past two decades, there has been a growing interest in wellbeing as a central goal for social policies together with the criticism that GDP and other monetary indicators do not reflect wellbeing sufficiently (see Fleurbaey, 2009; Sen, 1985, 1998). In addition, human wellbeing has gained more attention as a measure of economic performance and social progress (Stiglitz et al., 2009).

Subjective wellbeing (SWB) is related to human mental states as a combination of people's evaluations about their lives, both positive and negative, and their affective responses to their experiences (OECD, 2013). In recent years, SWB has been investigated with a focus based on self-reported information on how happy or satisfied people feel about their lives. Other measures such as the General Health Questionnaire – GHQ have also been used to capture individual SWB (Goldberg, 1972). These questions are often included in large-scale social surveys such as the Euro-Barometer Survey Series (Eurobarometer Data Service, nd.), the British Household Panel Survey (BHPS) (Institute for Social and Economic Research, nd.), the German Socio-Economic Panel (GSOEP) (European University Institute, nd.) and the UK Household Longitudinal Study (UKHLS; also known as Understanding Society) (Understanding Society, nd.). One important finding in this field is the importance of non-monetary determinants of SWB such as health and labour status (Stiglitz et al., 2009).

Some have assumed interpersonal comparability of SWB while others have not (see Decancq, Fleurbaey and Schokkaert, 2015*a*). On the one hand, SWB scores have been used to compare individual's wellbeing levels interpersonally. For example, using the data from the BHPS and GSOEP to compare the disabled and non-disabled, Oswald and Powdthavee (2008) found that being disabled is associated with a drop of nearly one point in life satisfaction measured on a 7-point scale compared to the level of non-disabled people. As SWB reflects the hedonic aspects of wellbeing and how people evaluate their lives, SWB levels tend to change, especially when there are shocks such as changes in marital status or employment. In recent years, changes in SWB following the onset of different life events such as marriage, divorce or unemployment have gained more and more interest among SWB researchers. SWB has been used to investigate adaptation to different events in life, for example, marriage, divorce, widowhood (see Lucas et al., 2003; Zimmermann and Easterlin, 2006), unemployment (Clark et al., 2008), childbirth (Clark and Georgellis, 2013), and onset of disability (see Pagan, 2010, 2012; Powdthavee, 2009). Most of the previous studies use life satisfaction as a measure of SWB to analyse adaptation. If one only considers objective measures of wellbeing when studying adaptation, they will more likely overlook unobserved aspects such as individual feeling or aspiration. In addition, in many cases, after a shock, the objective situation of an individual remains the same (e.g. an individual remains impaired after the onset of impairment) but they gradually feel better as they get used to the condition. This kind of adaptation is one of the interests of this thesis.

In contrast, some do not assume interpersonal comparability of levels of SWB. It is argued that such comparisons involve value judgements and aspirations which are unobservable and might not be the same across different people (Scanlon, 1991). In order to make comparisons, from this point of view, preferences over different life domains need to be considered. In this approach, a measure of wellbeing needs to consider multiple domains such as income and non-income (e.g. health, employment, housing, and feeling safe) (Capéau et al., 2020). Since many of these domains are largely abstract (e.g. loneliness and feeling safe) which denote quality or states and do not have a physical existence, income on its own would be a poor metric to capture wellbeing. This leads to a need for a measure that covers multiple domains of wellbeing. One approach to collapse multiple domains of life into a wellbeing measure is based on preferences over these life domains. In particular, a preference-based measure uses a set of preference weights on different life domains to generate the values of specific wellbeing states. The values from those different domains could be converted into an index number to compare across individuals. Such measure is equivalent income. Equivalent income, proposed in series of papers by Fleurbaey (2005, 2006, 2009); Fleurbaey and Gaulier (2009); Fleurbaey and Schokkaert (2011) and Decancq, Fleurbaey and Schokkaert (2015*a*), is the hypothetical income that, if combined with a bundle consisting of the other non-monetary life dimensions at the optimal levels (e.g. perfect health), would make an individual indifferent between that situation and his/her current situation.

The main objective of this thesis is to contribute to the understanding of different measures of wellbeing. One contribution of the thesis is the use of SWB measure to investigate changes in individual wellbeing when they become impaired and how such effect of impairment on individual wellbeing changes overtime as they remain impaired, as well as whether people adapt to their conditions. SWB (measured by life satisfaction) in this approach is assumed to be not only within-personally but also interpersonally comparable. Another contribution to the literature comes from contrasting equivalent income with other wellbeing measures such as life satisfaction and equivalised income. It has been achieved by discussing the computation of equivalent income and how this measure takes into account both monetary and non-monetary life domains and collapses them into a single-index measure that could be used to compare individual wellbeing. Using the worst-off group as an example in which equivalent income is used as a wellbeing measure to identify the worst-off in a society, the thesis compares and contrasts the individuals who are identified as the worst-off by life satisfaction, equivalised income and equivalent income. The analyses in this thesis aim to show the importance of non-income life domains to individual wellbeing and how to combine them with monetary domain to compute a multidimensional wellbeing measure. In addition, the worst-off example describes how different wellbeing measures may rank the same group of individuals at different positions regarding their wellbeing, rather than to imply that identifying the worst-off is the single aim and application of equivalent income in measuring wellbeing.

1.2 Aims and Research Questions

This topic of measuring wellbeing forms the focus of this thesis, which includes three main chapters that empirically examine different wellbeing measures using UK data.

The first empirical study (Chapter 2) uses life satisfaction, a SWB measure, as an interpersonally comparable measure to analyse how individual wellbeing changes when people experience impairment. This chapter aims to provide a view on SWB and hedonic adaptation in the context of impairment. Four main research questions in this chapter are:

(i) *Is impairment contemporaneously correlated with SWB?*

(ii) *Do people adapt to impairment over time?*

(iii) *Do the above effects differ between physical and mental impairment?*

(iv) *Is there heterogeneity regarding effects of impairment on life satisfaction and adaptation afterwards across the genders?*

The second empirical study – Chapter 3 discusses the framework of equivalent income. The main motivation stems from the need to combine both income and non-income domains into the measure of wellbeing and how that could be possible with the use of equivalent income. Following the theoretical framework, the chapter computes equivalent income using the UK household panel survey, which aims to *compute equivalent income using a subjective satisfaction regression when considering hedonic adaptation*. The second research objective of this study focuses on *the worst-off groups captured by different measures of wellbeing such as life satisfaction, equivalised income and equivalent income in the UK*. Firstly, equivalent income is computed at the individual level using estimated coefficients from a life satisfaction regression, and then the results are compared and contrasted with life satisfaction and equivalised income in capturing the worst-off groups in the society. By focusing on a subgroup at the bottom of the wellbeing spectrum, the analysis aims to examine differences in ranking of individuals when different measures of wellbeing are used. It is worth noting that the ranking of individual wellbeing can indeed be done across the whole population, although the study only uses a small group as an exercise. In addition, the analysis takes into account the effect of hedonic adaptation to impairment by controlling for changes in wellbeing related to ill-health. This chapter provides some insights towards the operationalisation of equivalent income using panel data when adaptation is taken into account.

Chapter 4 explores a different approach to obtain equivalent income beyond the use of SWB data. As this chapter (and also the thesis as a whole) only collected data from one wave survey, it is not possible to address adaptation in the analysis here. The two key objectives of this chapter are:

(i) *to operationalise equivalent income using the stated preference approach, through a DCE;* and

(ii) *to examine the distribution of equivalent income and other wellbeing indicators across the survey sample.*

To achieve the first aim of the chapter, a discrete choice experiment was carried out through an online survey to elicit public preferences over income and different non-income life domains. Data from the survey were analysed to estimate parameters that are then used to compute equivalent income at the individual level. To address the second research objective of this chapter, the analysis follows a similar approach to Chapter 3 which is comparing the worst-off groups identified by equivalised income and equivalent income, and examines the degree of overlap among those individuals identified as the worst-off by these two monetary-metric measures of wellbeing, and the overlap between equivalent income and two health-related domains. Furthermore, I focus on sub-group analyses to seek to understand how heterogeneous preferences across different sub-groups affect the levels of equivalent income when different individuals face the same situation.

Overall, this thesis builds on the understanding of individual wellbeing and different measures of wellbeing in several aspects. Firstly, it provides a picture on how individual wellbeing changes when there is a change in life such as becoming impaired and how the level of wellbeing changes as people remain in the same situation. Secondly, it brings into the discussion a critical view on the assumption of interpersonal comparability of SWB and the importance of different life domains to people's wellbeing. Thirdly, the thesis contributes to the literature on wellbeing by empirically estimating equivalent income using two approaches. The first approach is based on a life satisfaction regression using panel data and the other is from preference data collected from a discrete choice experiment.

1.3 Structure and Content of the Thesis

The thesis consists of three stand-alone empirical studies in Chapter 2, 3 and 4. These studies adopt micro-econometric techniques to analyse individual-level data to deepen our understanding of wellbeing and measuring wellbeing with a particular focus on UK data. The last chapter concludes the thesis. The three chapters constituting the main context of the thesis are briefly summarised below.

1.3.1 Overview of Chapter 2

Little work has examined hedonic adaptation to impairment, especially by looking at physical and mental impairment separately. This study is the first to investigate the effect of health impairment, and physical and mental impairment on SWB measured by life satisfaction while focusing on the phenomenon of hedonic adaptation and its heterogeneity across the gender groups. The study further controls for severity of impairment to understand how the process of adaptation might depend on the severity of impairment. Using a fixed effects (FE) lag model, this study analyses data from the UKHLS 2009-2020. As severity of impairment is likely to affect the adaptation process, the Main sample is further restricted to only those individuals whose impairment is associated with functional limitations in the past four weeks. Furthermore, the analysis compares males and females by running FE regressions separately for the two genders.

The results show that getting mental impairment is worse, in terms of life satisfaction, than getting physical impairment of the same severity. There is no evidence to confirm adaptation to any of health impairment, physical and mental impairment at eight to nine years after onset with or without controlling for severity. There appears to be no difference in hedonic adaptation to health impairment, physical impairment and mental impairment by gender.

By investigating how individual's life satisfaction level changes since the onset and during the period in which the individual remains impaired, a better understanding about whether people gradually revert back to the baseline of overall life satisfaction after some time since the onset and if there is heterogeneity in the effects of impairment and adaptation to impairment between males and females can be reached. Being the first study unpacking different types of impairment (i.e. physical impairment and mental impairment) while attempting to address the attrition in the panel using multiple imputations[1] as an extension of the main analysis, this study contributes to not only the adaptation literature but also the methodological development to obtain more robust and less biased conclusion when panel data are used.

As opposed to the assumption of interpersonal comparability of SWB in this study, the next empirical study argue that doubts have been raised about whether such comparisons of wellbeing are possible to make when SWB depends on people's feeling and judgement. Chapter 3 hence addresses this argument by investigating a different measure of wellbeing using the same dataset as Chapter 2.

[1]Multiple imputation consists of three phases (i) the imputation phase, (ii) the analysis phase, and (iii) the pooling phase (i.e. combining analysis results) (Harel and Zhou, 2007). First, data are prepared to have a suitable structure for the imputations. After the variables of interest are identified for the regression and auxiliary variables for the imputations, missing-data pattern is checked and variables are then registered either as imputed or regular. In the next step, the imputation method for multivariate imputations is chosen based on an arbitrary missing pattern that is a combination of any missing data patterns, and a mixed of different variable types. Different options are added to the multivariate imputations to address continuous, categorical, and binary variables (Penn, 2009; StataCorp LLC, 2021*a*). In the second phase (i.e. completed-data estimation stage), each complete dataset is analysed and regression models are estimated separately for each of them (Penn, 2009). The estimations of parameters from these separate regressions are then combined in the last phase to yield the final results using FE regression. In this analysis, 10 imputations are used. In the completed-data estimation step, the desired analysis, linear FE regression, is performed separately on each different dataset for which a different imputation procedure was used.

Overall, the results are not qualitatively different from those in the main analysis. There is no evidence to confirm adaptation to all kinds of impairment after eight to nine years since onset.

1.3.2 Overview of Chapter 3

Wellbeing cannot be captured solely by monetary aspects of life or material standards of living as non-material life domains, such as health or feeling safe, also play a crucial role in defining how people feel about their life. Household income would be a poor metric to measure individual wellbeing and evaluate policies, and a multidimensional wellbeing measure is needed. In order to consider multiple domains of people's life, the wellbeing measure needs to collapse various domains into a single index, which requires the information on preferences over these domains. Such measure, as introduced and computed in the second empirical study (Chapter 3), is equivalent income.

First, the study discusses the theoretical framework and the construction of equivalent income. Second, coefficients related to income and non-income life domains are estimated from a life satisfaction regression using the ordered logit FE modelling technique. These coefficients are then used to operationalise equivalent income at the individual level. One contribution from this chapter is that the analysis takes into account hedonic adaptation when computing of equivalent income[2].

The wellbeing ranking of the UKHLS respondents in terms of their equivalent income is compared against the ranking of their individual income (i.e. equivalised income) and that of their life satisfaction. The results confirm less than one fifth of the total observations of the worst-off captured by both measures are in the intersection between the bottom decile of equivalent income and the bottom decile of equivalised income. When comparing equivalent income and life satisfaction, the correlation between the ordering of respondents in the worst-off 25% (i.e. 25% of the sample with the lowest life satisfaction and the bottom 25% of the sample with the lowest equivalent income) is less than 50%. In addition, the findings conclude that across all measures (equivalent income, equivalised income and life satisfaction) and relevant life domains (health and unemployment), female respondents aged 40-50 with lower education, living with other people in an urban area, childless and not owning a home outright are identified as the worst-off. Regarding adaptation, the results in this chapter corroborate the finding in the previous chapter which confirms no adaptation to impairment after more than three years since onset. The predicted willingness to pay (WTP) for perfect health and for not being unemployed shows that WTP for perfect health accounts for a large proportion of individual income (accounting for more than 85% of equivalised income), while WTP for not being unemployed is quite low (at less than 5% of equivalised income).

[2]Decancq, Fleurbaey and Schokkaert (2015*b*) tested lagged variables for scaling factors but did not find significant results. Hence, the analysis in this paper excluded those variables and did not account for adaptation.

The analysis in this chapter uses data on actual events, which may limit the amount of information on preferences. In addition, with revealed preferences from actual choices, only the results are observed but not how the choices were set out for a particular outcome to be selected. One possible solution is to obtain equivalent income through stated preferences data. By collecting primary data through a survey, one could potentially include different life domains of interest and elicit preferences that may not be able to observed through actual choices. This approach is discussed in Chapter 4 (the third empirical study).

1.3.3 Overview of Chapter 4

This chapter elicits preferences of the general public to operationalise equivalent income. Preference data are collected using a discrete choice experiment (DCE). Individual wellbeing is described across seven domains: the Effects of Physical Health, the Effect of Mental Health, Loneliness, Employment, Household Income, Housing Quality, and Neighbourhood Safety. A D-efficient partial profiles design, in which at least two out of the six categorical domains were always ties, with non-zero priors, was used. An online survey of the UK general public using an internet panel was conducted. A total of 4536 individual attempted the survey, with 3362 providing valid data for analysis. DCE data were modelled using conditional logit regressions, of which all coefficients representing ordered levels of categorical domains are significant and have the expected sign. Following that, equivalent income for each survey respondent was calculated using the estimated preferences. Agreement across the ranking of respondents using predicted equivalent income and the ranking using equivalised household income was analysed. In addition, different checks are carried out to investigate the correlations between equivalent income and non-income life domains. Furthermore, the analysis focuses on sub-group analyses to seek to understand how heterogeneous preferences across different sub-groups affect the levels of equivalent income when different individuals face the same situation. Overall, the findings from this chapter provide insights into average preferences of the UK public across different wellbeing domains.

The thesis is summarised in the last chapter. Chapter 5 discusses cross-study links and characteristics of each empirical study in the overall picture of the whole thesis. In addition, this chapter encloses the thesis with a discussion on the implications and potential future research related to this thesis.

Chapter 2

Adaptation To Impairment - Evidence From the UK Household Longitudinal Study

2.1 Introduction

Wellbeing is generally considered as a description of human being's state of life (McGillivray and Clarke, 2006). Measuring wellbeing has been a long-standing interest of economists, psychologists, political scientists and policy-makers. The main interest is to compare the average welfare levels of people, for example, within individuals over different points in time given exposures to different life events.

Recent studies have supported subjective wellbeing (SWB) as a meaningful measure of individual wellbeing when applied to policy-relevant research topics. For instance, Kahneman and Deaton (2010) use data collected in the Gallup-Healthways wellbeing Index to report an analysis of the impact of income and income-normalised effects on SWB. In addition, SWB measures have been used as indicators to monitor the populations and inform policies (see OECD, 2013; ONS, 2011).

In recent years, SWB has been investigated using happiness data[1], based on self-reported information on how satisfied people feel about their lives. Such a question is often included in large-scale social surveys like the Euro-Barometer Survey Series, the British Household Panel Survey (BHPS) or the German Socio-Economic Panel (GSOEP). For example, using the data from the Euro-Barometer, Di Tella et al. (2001) explore the impact of inflation and unemployment on happiness; and Clark and Georgellis (2013) study the effects of different

[1]"An advantage of happiness data is that they require only a minimum of information processing and understanding; instead they rely only on introspection of one's level of wellbeing."(MacCulloch, 2016, p 2)

life events (marriage, divorce, widowhood, unemployment, and a birth of a child) on SWB in Germany to investigate how people's happiness levels react to those changes and whether SWB levels return to their baseline levels over time.

This study is the first to investigate in an integrated framework the effects of impairment and different types of impairment on individuals' SWB and whether there are heterogeneous effects of impairment across gender. Using data from all of the latest ten waves of the UKHLS 2009 - 2020, the study presents econometric evidence from FE lag models on whether people adapt to different types of impairment. The remainder of the chapter is organised as follows. The next section summarises previous work in the literature. Following that, Section 2.3 and 2.4 explain the data and methods used. The empirical results are presented in Section 2.5. Section 2.6 performs different robustness checks. The chapter is concluded with some discussion in Section 2.7.

2.1.1 Motivation

Impairment is a part of human life that almost anyone will temporarily or permanently suffer at some point in their lives, as it is often related to ageing. In 2012, over 11 million people in Britain living with long-term disability, impairment or sickness, which accounts for around 18% of the whole population (DWP, 2014).

While a number of studies analyse the effects of different life and labour events including disability and ill-health on individual SWB, fewer studies analyse onset of impairment that can potentially influence individuals' lives in both the short-term and long-term (see Emerson et al., 2014; Freedman et al., 2012; Pagan, 2011; Santilli et al., 2014). Especially, when looking for evidence of adaptation to health conditions, impairment and disability, there are only a handful of existing studies, for example, Oswald and Powdthavee (2008), Powdthavee (2009), Pagan (2010), Pagan (2012), McNamee and Mendolia (2014), Cubí-Mollá et al. (2017), and de Hond et al. (2019).

'Hedonic adaptation' is the term used to refer to the psychological process where individuals react to changes in life circumstances (e.g., unemployment), become accustomed to those positive or negative changes, and return to their baseline levels of happiness while the situation remains unchanged (e.g., the individual remains unemployed) (see Frederick and Loewenstein, 1999; Lucas, 2007*a*). This implies a disagreement between an objective measure of wellbeing (e.g. employment status) and subjective measure of wellbeing (e.g. satisfaction with life). If the situation changes, for example, the unemployed is offered a job, "a brand-new adaptation process will unfold" under the employed situation (Lyubomirsky, 2011, p. 200). The literature on hedonic adaptation to ill-health is not very large, and as we see below, the evidence is also mixed.

Furthermore, most of the studies in the field of hedonic adaptation and ill-health look at impairment and disability in general (see Pagan, 2010, 2012) and many categorise disability in terms of severity (moderate/mild disability and severe conditions), without distinguishing between different kinds of impairment and disability (see Oswald and Powdthavee, 2008; Pagan, 2010; Powdthavee, 2009). To the best of my knowledge, there are no studies that analyse physical and mental impairment and their heterogeneous effects on SWB and adaptation process.

This study will assess changes in SWB following onset of impairment. In line with previous studies on adaptation to impairment and disability (see Oswald and Powdthavee, 2008; Pagan, 2010, 2012; Powdthavee, 2009), panel data are utilised. One advantage of panel data is that because they follow the same individuals over time, they allow the analysis of the trend of an individual's SWB following impairment. Secondly, large scale survey of a representative sample (e.g. household panel data) include many variables on socio-economic factors such as the pre-impairment years. In addition, using data from a nationally representative panel survey could also avoid biased results from the possibility of characteristics included in the surveys due to the recruitment strategy in which the purposes of the study may be exposed to participants and influence their responses (e.g. trial data (Anusic et al., 2014)).

2.1.2 Purpose of the Study

The main objective of this study is to analyse SWB of individuals when they acquire physical or mental impairment and how this changes over time as they remain impaired. In other words, this study examines changes in SWB measured by life satisfaction before, at and after onset of impairment both permanently and temporarily.

The medical literature usually distinguishes and separately studies physical and mental health (see Hussein et al., 1998; Treloar, 1999; Winter et al., 2008). Other disciplines such as politics and psychology also follow this pattern (see Gross and Hahn, 2004; Merikangas et al., 2007). In addition, many large surveys include composite indicators of health made up of these two dimensions: physical functioning and emotional health. For example, the BHPS, GSOEP and UKHLS include the physical and mental component summary scores of the 36-Item Short Form Health Survey (SF-36) and SF-12 (a shorter version of SF-36) to measure functional health-related quality of life. The former contains 36 questions covering eight domains of health status[2]. The SF-12 is a 12-item sub-set derived from the SF-36,

[2]Physical functioning (10 items); Social functioning (two items); Role limitations due to physical problems (four items); Role limitations due to emotional problems (three items); Mental health (five items); Energy/vitality (four items), Pain (two items), General health perception (five items)(Jenkinson et al., 1997)

which is further grouped into the Physical Component Summary Score (PCS) and Mental Health Component Summary Score (MCS) (see Andersen et al., 2007; Booker and Sacker, 2011; Gao et al., 2004; Jenkinson et al., 1997).

There are four main research questions in this study:

(i) Is impairment contemporaneously correlated with SWB?

(ii) Do people adapt to impairment over time?

(iii) Do the above effects differ between physical impairment and mental impairment?

(iv) Is there heterogeneity regarding effects of impairment on life satisfaction and adaptation afterwards across the genders?

The first question focuses on the effect of impairment on SWB measured by life satisfaction while the second question follows up that effect and concerns whether the wellbeing effect of impairment depends on the time that the individual has spent being impaired. Specifically, the question seeks evidence on whether SWB recovers over time since onset. Similar questions have been covered in earlier work with a focus on disability and health states (see Cubí-Mollá et al., 2017; Lucas, 2007*a*; Oswald and Powdthavee, 2008; Pagan, 2012; Powdthavee, 2009). Regression analysis will clarify the effect of being impaired for, for example, one, two, three and up to nine years. From the estimated coefficients in the regressions, the trend of changes in SWB since onset of impairment will be analysed to conclude whether or not evidence for adaptation is confirmed.

The third question distinguishes between physical and mental problems, which is a distinction that has not been addressed in previous studies. Physical impairment and mental impairment are different in nature in which physical impairment is related to the body while mental impairment is a condition of the mind (Kendell, 2001). As mental impairment is a condition in which a part of the human mind is impaired or does not properly function, it might affect an individual's ability to assess life, their aspirations and expectations directly, which potentially has an impact on life satisfaction. In other words, mental impairment might have a more direct influence on subjective wellbeing than physical impairment. Some studies in health suggest that people report differently when it comes to physical health and mental health, with a clear difference among people living with disabilities (Schwartz et al., 2007). Although the heterogenous effects of physical and mental impairment have not been researched in SWB, the literature in health suggests that this might be relevant to SWB. Therefore, the analysis in this chapter focuses on examining whether people react differently to physical impairment as opposed to mental impairment and whether they adapt to different types of impairment at a different rate. To answer this question, regression models will be run separately for sub-group of observations with onset of physical impairment and mental impairment and results will then be compared across groups and models.

Lastly, the study will contribute to fill a gap in the literature by testing for heterogeneity by gender regarding whether there are different effects of impairment on life satisfaction and whether males and females adapt to impairment differently over time. There has been a long-standing discussion on gender differences in subjective wellbeing. The findings from “The Paradox of Declining Female Happiness" by Stevenson and Wolfers (2009) confirm a fall in historical happiness levels of women compared to men, controlling for various aspects such as age, race and socio-economic characteristics, between 1972 and 2006 despite the improvement in economic and social progress for women during this period. This result has been confirmed in different measures of subjective wellbeing, across different datasets from various industrialized countries. A study by Plagnol and Easterlin (2008) concludes that heterogeneity in aspirations, expectations and attainments between males and females play an important role in the differences in overall wellbeing (i.e. happiness) between the two genders. Uppal (2005) finds evidence for differences in job satisfaction across the genders with and without disabilities. In addition, there has been evidence for heterogeneity in how men and women react to different life events resulting in different adaptation rates (Clark and Georgellis, 2013; Clark et al., 2001). With a focus on specific illnesses, Binder and Coad (2013) examine how changes in different (objective) health conditions affect individual subjective wellbeing in the UK and confirm that there are tendencies that the effect of illnesses and adaptation may vary across health impairments. Therefore, the analysis in this chapter aimed to examine whether heterogeneous adaptation to general health impairment, physical impairment and mental impairment exists between males and females.

In sum, this chapter will make four contributions to the literature. Firstly, by categorising impairment into physical and mental impairment, the analysis in this study is the first of its kind that tests for the effects of different types of impairment and seeks to determine if differences exist in wellbeing trends and adaptation to impairment between these two types. Secondly, the study takes into account heterogeneous effects of impairment across gender, which could affect their adaptation to impairment. The last contribution is that the paper contributes to the wellbeing literature by analysing the association between impairment and individuals' SWB using a fairly new longitudinal survey, the UKHLS (2009 – 2020). By examining impairment and adaptation, the chapter contributes to the literature of adaptation which currently heavily focuses on disability and health states. Besides, the chapter makes an attempt to take into account the potential problems related to attritions (i.e. dropping out from a panel study) and examines the potential differences between the results from the original data and the attrition-corrected data using a statistical technique called multiple imputation, which will be discussed further in an extension in Appendix A. Although attrition is not a new topic when considering panel data, the issues have not been regularly addressed in adaptation studies; an exception is Cubí-Mollá et al. (2017), which uses inverse probability weight (IPW).

2.2 Literature Review

This section will discuss the literature on SWB and adaptation to different life events and ill-health. The main focus of this section is to review what has been investigated and how, to identify any gaps in the current literature.

In adaptation research, one fundamental distinction lies between a process perspective and an outcome perspective of psychological adaptation. The process view's focal point is the dynamic psychological changes in intra-individuals that are triggered by substantial events (Schilling et al., 2011). The outcome perspective, which is the approach of this chapter, is interested in different measures of wellbeing, mostly SWB such as life satisfaction or happiness as indicators. Regarding adaptation to health problems, impairment and disability, there are different types, such as behavioural adaptation or hedonic adaptation. An example of the former is where somebody who used to enjoy music becomes deaf and following this he/she learns to paint, which possibly improves his/her life satisfaction. This change in behaviour is not of this study's interest. The latter assumes the situation and behaviours after the change in life remain the same but wellbeing changes, or in other words, people adapt (Lyubomirsky, 2011). This chapter looks at hedonic adaptation measured through SWB. It is worth to emphasise that these above-mentioned types of adaptation are distinct concepts, however, (a) actual data to distinguish between them are currently not available, and (b) in reality multiple kinds of adaptation can co-exist over time.

A related concept is that of response shift consisting of three constituents: re-prioritisation, re-conceptualisation and scale calibration. The theory is based on a change in the scale to measure variables of interest, which is SWB in this chapter, or the shift happens when individuals re-conceptualise or re-define the dimensions of interest through a different meaning or interpretation (Howard et al., 2011). The main different between hedonic adaptation and response shift is that in hedonic adaptation, the SWB scale is assumed not to change, but over time, people get used to the situation which also remains the same. Although in theory, there is a meaningful distinction in definitions of adaptation and scale calibration (i.e. changes in scale interpretation of quality of life overtime (de Hond et al., 2019; Ubel et al., 2010)), it is not possible to distinguish the two processes in practice.

Although the primary focus of this study is on the microeconomics literature, various recent papers in psychology have used the same large-scale panel datasets as economists and in some cases similar analytical techniques. In order to investigate these cross-disciplinary overlaps, the review will focus on the nature of the data (i.e. panel data) and analyses rather than the distinction based on the disciplines.

The literature review in this chapter will focus on three main parts (1) SWB and hedonic adaptation; (2) adaptation to different life events; and (3) adaptation to ill-health. Regarding the last two, a part of the literature explores both adaptation and anticipation or lead effects on SWB. Anticipation implies the effects of future events on the current level of SWB. The detail is explained in Section 2.2.3.

2.2.1 SWB and Hedonic Adaptation

Adaptation has been a long-standing interest among psychologists and economists. In a classical study on adaptation, Schkade and Kahneman (1998) argue that adaptation occurs when humans gradually pay less attention to their new circumstance over time. Brickman et al. (1978) show evidence for higher levels of happiness within paraplegic accident patients compared to what have been expected given their conditions. Another example is the finding by Kahneman et al. (2006) that spinal-cord injury patients initially spend much time thinking about their new circumstances and health problems, but eventually, their attention is withdrawn from that situation. Instead, they start spending more time on other daily issues and activities such as having meals or watching TV. Nevertheless, the reduction of attention varies in their extent and speed, from experience to experience (see Dolan and Kahneman, 2008; Wilson and Gilbert, 2008).

Like all other adaptation processes such as sensory adaptation, hedonic adaptation, according to Frederick and Loewenstein (1999), abates the emotional reactions over time. It is important to distinguish hedonic adaptation to a 'stimulus' (that stimulus has to be constant or repeated) from the effects caused by changes in the intensity of the stimulus itself over time. For example, if a paralysed woman becomes able to walk again after a period of physiotherapy and this boosts her happiness levels, this is not hedonic adaptation because her impairment or the stimulus has changed. The mechanism of adaptation assures that extra attention is drawn to flows (changes) and not to levels (stocks) (Lucas, 2007*b*; Lyubomirsky, 2011). This process is argued to enable humans to "discriminate between more and less significant stimuli"[3] (Lyubomirsky, 2011, p. 220).

Likening hedonic adaptation to a human's sensory system's adjustment to changes in the amount of light, Rayo and Becker (2007) set out a model explaining how individuals' emotional responses could be designed to behave in a similar way. The sensory adaptation mechanically and automatically reduces human's sensitivity to a constant stimulus, which

[3] For example, significant stimuli could be "new events that offer new information" and less significant stimuli could be "past events that should fade into the background" (Lyubomirsky, 2011, p. 220)

results in a shift of attention to other things in the environment rather than focusing on one same stimulus. Similarly, human's feeling also continuously "reverts to its long-term level" (Rayo and Becker, 2007, p. 302).

In contrast, the 'set-point' theory argues that the fundamental characteristic of hedonic adaptation is the happiness set-points endowed with humans and that this reaction is not similar to the adaptation in the human sensory system (Powdthavee, 2009). Using an AREA model (Attend – React – Explain – Adapt), Wilson & Gilbert (2005), cited by Powdthavee (2009), argue that adaptation stems from the fact that human beings need to make sense of all the stimuli in their lives. This theory, suggests that individuals initially react to shocks, but quickly return to the baseline level of wellbeing (Brickman and Campbell, 1971). In this view, hedonic adaptation involves explanation and is not mechanical and automatic as in sensory adaptation. However, the set-point theory fails to explain why adaptation process is different in different life events since this theory supports the idea that individuals fully adapt to life events.

Both of these two theories attempt to explain hedonic adaptation in the sense that humans respond to changes in life but then gradually return to the stable level. Both theories are based on the explanation that intense sensations require lots of energy and the gradual shift of attention away from a new event helps individuals to be aware of later changes and make better choices in life (see Frederick and Loewenstein, 1999; Rayo and Becker, 2007).

Turning to the empirical literature, much of the earlier empirical research relies on cross-sectional data (see Veenhoven and Ehrhardt, 1995). The main disadvantage of cross-sectional data is that the cross-sectional data has just one wave, which makes it hard to explore the adaptation process. Due to the lack of information on previous life satisfaction levels, these data from cross-sectional surveys make it difficult to investigate changes in SWB following onset of impairment and disability and to estimate their long-term effects on wellbeing. Therefore, the review here will only focus on panel data analyses to provide evidence of adaptation.

In most of the studies, SWB is measured by life satisfaction, but other measures such as the General Health Questionnaire – GHQ[4] have also been used. The responses to GHQ-12 are reported on a four-point scale of frequency of individuals' feeling compared to his/her usual state: "Not at all", "No more than usual", "Rather more than usual", and "Much more than usual" (Goldberg, 1972). The GHQ-12 and the Caseness GHQ score are widely considered

[4]GHQ are self-reported sets of questions on respondents recent conditions including ability to concentrate; lost much sleep over worry; feeling to be playing a useful part in things; feeling capable of making decisions; feeling constantly under strain; feeling unable to overcome difficulties; being able to enjoy normal activities; being able to face up problems; feeling unhappy and depressed; being losing confidence; being thinking of themselves as worthless; and being feeling reasonably happy (Goldberg and Williams, 1988).

as robust indicators of the individuals' psychological state (Clark, 2016). These measures have been used in some studies to capture adaptation to life events (see Clark and Georgellis, 2013). However, there is some correlation between psychological distress and mental health.

All of the studies reviewed in Section 2.2.2 and 2.2.3 of this chapter defines adaptation as the process where SWB recovers to its pre-event (i.e. impairment in this study) level while the the event remains in place, thus, individuals recovering from impairment are excluded from the analyses.

2.2.2 Adaptation to different life events

In two classic studies on adaptation, the authors find that people may experience significant effects of life events such as marriage, divorce or unemployment, over time, they adapt to not only negative but also extremely positive changes in life circumstances (see Brickman and Campbell, 1971; Brickman et al., 1978). This part of the literature review examines what have been researched in adaptation to life events. The details are summarised in Table A.1 in Appendices.

Investigating the psychological effects of past unemployment on SWB measured by life satisfaction, Clark et al. (2001) use 11 waves of the GSOEP data (1984-1994) with a focus on respondents aged between 25 and 55 years old in 1984. Past unemployment in this study is measured by the ratio between the number of months being unemployed and the number of months active in the labour market, over the past three years. Using an ordered probit model and a FE logit model (on a binary life satisfaction measure), Clark and his colleagues find that both current unemployment and past unemployment experience are associated with lower levels of life satisfaction. The results also show that the negative effects of current unemployment are the strongest for those being jobless for the first time and is weaker for those who have experienced unemployment in the past. In other words, the study shows evidence for adaptation to unemployment over time.

Clark (2006) analyses unemployment duration in relation with self-reported happiness in Europe in the 1990's using the GSOEP (1984-1998), BHPS (1996 - 1999) and the European Community Household Panel – ECHP (1994 - 1997). The results from ordered probit and FE logit regressions show little evidence of adaptation to unemployment after two years or more being jobless. The panel analysis reveals that the degree of negative effects of unemployment on life satisfaction is stable with little or almost no adaptation regardless of the duration (i.e. less than a year, one to two years or two or more years).

Other papers have examined adaptation to changes in marital status including marriage, divorce, and widowhood. Lucas et al. (2003) employ Multilevel Models or Hierarchical Linear modelling techniques (HLM) to test for reaction and adaptation to marriage and widowhood after at least two years since the events using the GSOEP wave 1-15. Using HLM allows to estimate within-subject impacts of marital events and adaptation to those changes and between-subjects effects (i.e. whether subject-level variables such as genders, age and initial level of wellbeing moderate these influences) simultaneously. Adaptation is confirmed to occur and complete in the case of marriage but can be partial for widowhood. Re-analysing the data with four additional waves using the same technique, Lucas and Clark (2006) test for adaptation after controlling for the effect of pre-marriage cohabitation as anticipation. With the new control of cohabiting prior to marriage, the results show full adaptation on average for both marriage and widowhood. It is sensible to see that changes in marital status are life events that are more likely to be anticipated than others (i.e. impairment or disability), so including anticipation effect makes sense.

In contrast, Zimmermann and Easterlin (2006) find no adaptation after more than two years of marriage and divorce in Germany using GSOEP (1984 – 2004). Employing hierarchical linear modelling, their model consists of an intercept reflecting average life satisfaction in the baseline period, which consists at least one year before marriage. The cohabitation term refers those who cohabit before marriage, which captures the average difference in the baseline between those participated in a cohabiting union and who did not. The second term captures "reaction" to marriage and measures the mean difference in life satisfaction between the baseline and the first year of marriage and an immediately following year. Adaptation is captured by the difference between the baseline value and SWB in the second year after marriage and all subsequent years of marriage. The analysis excludes first-time marriages ending in divorce within two years, those dissolved by the death of a spouse, and first-time marriages (first-time marriages that do not last more than two years) of those foreign-born whose spouse is living in abroad.

Using the same technique to analyse the GSOEP, Lucas (2005) concludes that divorce is associated with lower levels of SWB and there is partial adaptation to marital dissolution in the 18-year panel data. By contrast, Gardner and Oswald (2006) find evidence for complete adaptation to divorce in BHPS data. This study uses both life satisfaction and GHQ scores as the measures of SWB and both measures show similar results.

The literature also explores both adaptation and anticipation to various life events. Clark et al. (2008) propose lag and lead models to test whether individuals return to the initial levels of life satisfaction after some life and labour market events in the GSOEP (1984-2003). Individual FE regressions are used to analyse lead and lag effects separately for both men and women. It is noted that the "anticipation" in this context is captured by leads variables referring to future events (e.g. becoming unemployed in the next two to three years). For lead effects or anticipation, four dummies are used in the model for experiencing life events within the next year, in the next one to two years, in two to three following years and three to four following years. Hence, this term predicts, for example, an individual will enter unemployment within the next two years reporting significantly lower levels of satisfaction with life if lead variables of within the next one year, two years and three years are negative and significant. One expected problem mentioned in the paper is whether the results capture the “selection effect", for example, inherently happy people are more likely to get married. FE regression is utilised to capture any positive or negative effects of these lead variables which pick up anticipation rather than selection because FE controls for time invariant unobserved heterogeneity. In order to examine whether past experience affects SWB, six dummies were generated for six groups of lags including within one year, one to two years, two to three years and up to five or more years. Adaptation is confirmed if SWB levels revert to just-before-event levels rather than pre-anticipation level because anticipation and adaptation are examined in two separate models. The results show evidence for complete adaptation and anticipation effects in marital transitions including marriage, divorce, and widowhood. However, there is little evidence of adaptation to unemployment. By contrast, lay-offs have no long-lasting effects on either men or women. The result also shows that there is no adaptation to the birth of a child. This life event is difficult to say that the ‘situation’ remains the same as the challenges of parenting change quite rapidly from birth to some years after that (i.e. when the child is 5-6 years old and started to attend primary school). Therefore, there should be an assumption that the situation or life condition of “a birth of a child" remains within the research period, which was not mentioned in the article.

In a later study in 2013, Clark and Georgellis examine adaptation and anticipation in 18 waves of the BHPS. Following the methodology in Clark et al. (2008), however, this study employs both leads and lags in a contemporaneous model in which both adaptation and anticipation (all lead and lag variables) are included in one model for each event. In general, there is evidence for both anticipation and adaptation to all major events including marriage, divorce, widowhood, birth of a child, and unemployment. In this study, the baseline level is the level of SWB prior-to anticipation both anticipation and adaptation are included in one model. Therefore, adaptation is confirmed if wellbeing levels revert pre-anticipation level rather than just-before-event levels. In addition, the BHPS data also allow the researchers to compare the results of a single-item measure of SWB (life satisfaction) with a multiple-item mental functioning (the GHQ-12) using the Caseness version of GHQ. The findings conclude that the GHQ shows qualitatively very similar results to those from the analysis using life satisfaction regarding adaptation and anticipation.

In summary, the literature focusing on adaptation to different life events takes advantage of panel data to investigate in changes in SWB levels prior to, during and after the events happen. Different models have been utilised to examine hedonic adaptation, and in some studies, anticipation. The findings indicate that different measures of SWB do not result in qualitative difference in adaptation and anticipation conclusions. However, the conclusions are different across changes in several life events.

2.2.3 Adaptation to Ill-health

Much of the earlier literature on the impact of health-related events on individual wellbeing investigates the negative effects of specific diseases and health conditions. Some studies examine functional adaptations such as Bhatt et al. (2019) and Verstraten et al. (2005), and psychological adaptation such as Bergeron and Wanet-Defalque (2013) and Wang (2018). However, these are not of interest to this chapter which focuses on adaptation related to SWB. This section, therefore, will review relevant studies in hedonic adaptation related to individual SWB with a predominant interest in those studies using relevant techniques that are employed in the main analysis of this chapter. With regards to SWB adaptation to impairment and disability, the popular methodologies that have been used are hierarchical and non-linear modelling techniques, random effects (RE) and fixed effect (FE) models.

The two main studies using Hierarchical Linear (HL) and Non-linear Modelling techniques are Lucas (2007*b*) and Boyce and Wood (2011). Analysing waves 1-19 of the GSOEP and waves 1-12 of the BHPS, Lucas (2007*b*) investigates the trend of SWB before and after onset of disability. In the GSOEP, the information for disability is captured through the question on whether respondents had been “officially certified as having a reduced capacity to work or being severely handicapped", while in the BHPS, disability is measured by whether participants were registered as disabled. The analyses include only individuals who remain disabled for at least three years after onset of disability in order to focus on long-term disabilities. Multilevel models are employed in which level-1 (within-person level) includes five parameters: overall intercept, a parameter capturing changes from the baseline within two years immediately before onset of disability (capturing the average decrease in SWB in two years prior-onset), a parameter that reflects the average drop in SWB during the period of disability (the first year of disability) compared to the baseline, and two parameters for linear and quadratic changes in wellbeing following onset of disability. The pre-disability baseline level of satisfaction is captured by the estimation of the overall intercept. In some of the models, parameters reflecting income and employment status are included to test whether within-person effects of changes in income and occupation status mediate the effect of disability onset (i.e. if the lower level of satisfaction following onset of disability was due to changes in income or employment status). In level 2 (person-level), respondents’ sex and age at onset, average income across sample changes, and extent of disability are added as moderators of the parameters in level 1. The results reveal that long-lasting lower SWB levels measured by life satisfaction and distress levels are associated with onset of disability. Lucas (2007*b*) finds that there is no evidence for adaptation when examining life satisfaction, and some evidence for partial adaptation over at least three years after onset when SWB is measured by psychological distress. Later, Anusic et al. (2014) replicate this study on the Swiss Household Panel (SHP). They find similar results compared to Lucas (2007*b*) using GSOEP and BHPS.

Using the same techniques and disability measure in the GSOEP (2004-2009), Boyce and Wood (2011) focus on whether pre-disability personality determines if individuals would adapt to disability. Including only participants who became disabled, level 1 involves parameters reflecting: life satisfaction level in 2004 (pre-disability level), number of years being disabled (from zero to four years) at each time point and personal specific characteristics. In order to investigate the roles of individual heterogeneity and pre-disability personality on adaptation, level 2 adds interaction terms between personality traits (Big Five personality measures)[5], years being disabled in both linear and quadratic terms, and demographic controls. In line with previous studies, Boyce and Wood (2011) find that life satisfaction generally decreases following onset of disability, and subsequently, there is evidence for some adaptation after four years after onset. The authors' findings also indicate that personality prior to disability may influence individuals' adaptation to disability. In particular, there is evidence for swift and complete adaptation for agreeable individuals after four years following the initial onset of disability, while SWB of disagreeable people tend to become worse over time after onset.

Another strand of studies on adaptation of wellbeing measures to impairment and disability apply FE models (see Oswald and Powdthavee, 2008; Pagan, 2010, 2012; Powdthavee, 2009). Using the same source of data as Lucas (2007*b*), Oswald and Powdthavee (2008) explore the relationship between disability and life satisfaction in the UK (and in Germany as a check) using RE and FE models. Unlike the study by Lucas (2007*b*), which defines 'disability' as 'being registered as a disabled person', in this study the information for disability in BHPS is extracted from a labour related question *"What describes your current situation?"* of which one of the options is *"long-term sick or disabled"*. In order to test for both immediate and long-run effects of disability on life satisfaction, the authors create a variable reflecting 'the ratio of time spent disabled' together with a dummy for disability (=1 if the respondent is disabled in year t and =0 otherwise). The former variable takes values between 0 and 1: it is 0 if no disability in the previous three years, 1/3 if disabled for one out

[5]A set of questions are asked regarding the five core traits of human personality including extraversion, emotional stability, agreeableness, openness to experience, and conscientiousness (Caliendo et al., 2014)

of previous three years, 2/3 if disabled for two out of previous three years and 1 if disabled for three previous years. In their models, the immediate impact of disability is determined solely by the coefficient for the dummy variable of disability, while the long-run effect is the sum of the coefficients related to disability, the ratio of time spent disabled and interaction terms between them. In addition, Oswald and Powdthavee use the degree of disability determined by how much a respondent is hindered from daily activities due to their disabilities. The disabled population is divided into two groups (severe disability and moderate disability), which experience different degrees of partial adaptation.

In comparison with the study by Lucas (2007*b*), Oswald and Powdthavee (2008) use updated the datasets[6], utilise different definitions of disability and different estimation technique[7]. The findings in Oswald and Powdthavee (2008) are not in line with the results from the previous study by Lucas (2007*b*). Instead, Oswald and Powdthavee find evidence for partial hedonic adaptation of approximately 30% and 50% for severe disability and moderate disability, respectively. These findings are also corroborated when the data from GSOEP (1984-2003) are analysed as a check. The authors also do the same for lags of six years and the results are similar.

Pagan (2010) investigates the association between onset of disability and life satisfaction using the GSOEP (1984-2006) with a focus on working-age males aged 21-58 years old. This study uses a measure of disability based on work-limitation, in which an individual is considered disabled if he has a “degree officially registered disability" of at least 53% or has “a health satisfaction level of at most 2" in the 0 to 10 range (Pagan, 2010, p. 474). Adopting the methodology proposed by Clark et al. (2008), the author analyses the degree of adaptation and anticipation of individuals to disability. FE models for adaptation (lag effects) and anticipation (lead effects) are estimated separately using a set of eight dummy variables for lags (being disabled within one year and up to seven or more years) and four dummy variables for leads (disabled within the next year and up to disabled in the next three to four years). In this case, lag coefficients are comparable across studies that do not use lead variables since the two sets of variables of leads and lags are estimated in two separate models. Following the common results in this field, Pagan (2010) also confirms significant negative effects of disability on life satisfaction. In addition, he finds evidence for full adaptation to onset of disability after six or more years that an individual remains disabled. He also highlights that life satisfaction anticipates disability onset in the future.

Following the same methodology developed by Clark et al. (2008), Powdthavee (2009) looks for adaptation and anticipation to disability in the UK using BHPS waves 6-10 and

[6]Oswald and Powdthavee (2008) use GSOEP 1984-2003 and BHPS 1996-2004 while Lucas (2007*b*) uses GSOEP 1984-2002 and BHPS 1991-2002

[7]While Lucas (2007*b*) uses multilevel models, Oswald and Powdthavee (2008) use FE and RE models

waves 12-15 (wave 11 is omitted from the analysis due to the absence of the set of satisfaction questions). In this study, he categorises the disabled population based on the severity of the condition using the same definition for 'Severe Disability' and 'Moderate Disability' (in this study he calls this 'Mild Disability') in Oswald and Powdthavee (2008). He tests whether SWB levels revert to just-before-onset levels rather than pre-anticipation levels. In addition to investigating the lag and lead effects of disability, the author explores the impacts of disability on satisfaction across different life domains such as satisfaction with health or social life. In the lead and lag models, the results reveal that disability, regardless of severity, is associated with a significant reduction in life satisfaction scores and also confirm anticipation effects. Furthermore, the most detrimental impact of disability is on satisfaction with health, while the impacts on satisfaction with social life, income, the use of leisure time, housing and partners are less strong. The effect is positive but insignificant in the case of satisfaction with the amount of leisure time. Overall, hedonic adaptation to mild disability regarding satisfaction with housing, partner, social life, and use of leisure time is full within two years, except for health and income domains, which need three years to complete. Severely disabled people, however, experience a decline in SWB and do not adapt after four years following onset. Regarding lead effects, the results are similar regardless of severity. There is evidence for anticipation in some domains, but the strongest lead effects are also in the health domain.

Applying the same approach on a sample of German working-age males (aged 21-58), Pagan (2012) analyses lag and lead effects of disability on satisfaction with life and five domains including health, household income, housing, job, and leisure. In order to test for adaptation, eight lag dummies are included from within in one year to seven or more years of disability. Lead effects are estimated through a set of four dummies variables which are 'disabled within the next year' up to 'disabled three to four years hence'. The main findings show evidence for full adaptation to disability after five years when using life satisfaction as the SWB measure, which is in accordance with Pagan (2010). It is worth noting here that within the first three years following onset, adaptation to disability is not confirmed. Also, it is evident that individuals completely adapt to disability in terms of satisfaction with household income and housing (after five years) and leisure (after three years). However, in the other domains of satisfaction, there is only evidence for partial adaptation of 40% and 50% for satisfaction with health and job satisfaction, respectively. Regarding anticipation, there is no evidence to support lead effects in satisfaction with household income and leisure, whereas other domains and overall life satisfaction show evidence for anticipation to future disability.

Having reviewed the literature, there are two things to note. First, there is overlap regarding data and techniques used in adaptation to impairment and disability studies in psychology and economics. Second, there are some studies only checking for adaptation while the others test for both adaptation and anticipation to impairment and disability.

It is noted that while using the same datasets, the contrast between the results of the above-discussed studies including Lucas (2007*b*) and Oswald and Powdthavee (2008) probably stems from the use of different analytical techniques. Oswald and Powdthavee (2008) utilise the FE approach, which removes the assumed stable personality traits. By contrast, Lucas (2007*b*) employs the hierarchical linear (HL) approach, which assumes no correlations between explanatory or independent variables and the individual FE. It can be explained that the fundamental answer for the mixed results between studies that use these two methods lies on the associations between (1) persistent personal factors and self-reported satisfaction levels (i.e. extraverts tend to rate higher life satisfaction scores) and (2) personality traits and susceptibility to disability (i.e. extraverts are more likely to choose activities that may lead to injuries and accidents). As the HL approach assumes zero correlation between explanatory or independent variables and the individual FE, if these two associations exist, then that would mean the assumption of HL does not hold. In contrast, the FE approach completely removes the assumed stable personal factors (e.g. personality traits) and controls for any such associations to prevent their bias on the influences of impairment and disability on SWB. Given this, using FE can be expected to avoid overestimation of the real effects of impairment and disability on individual SWB and the degree of adaptation to impairment and disability.

A study by McNamee and Mendolia (2014) analyses the effect of chronic pain on life satisfaction (on a scale from 1 to 10) and adaptation to chronic pain after three years along with a calculation of compensating income variation among people suffering from chronic pain. The study uses the first ten waves of the Australian panel - Household, Income and Labour Dynamics of Australia Survey (HILDA) and employs linear ordinary least squares (OLS) and ordered logit models with an extension using RE and FE models. The measure of pain in McNamee and Mendolia (2014) is derived from a question in which individuals are asked if they have any long term health conditions where chronic pain is listed as one of the possible alternatives to select. One sensitivity check uses a question related to the severity of pain in the last four weeks (i.e. categories include: no pain at all; very mild; mild; moderate; severe; very severe), which establishes the robustness of the results of the main analysis. The findings confirm a large, negative and significant impact of chronic pain on life satisfaction. In addition, McNamee and Mendolia (2014) find a slightly stronger negative effect on men's life satisfaction compared to women. The adaptation analysis in this study follows the approach in Oswald and Powdthavee (2008) to examine adaptation up to three years since onset of the health condition. The results confirm evidence of partial adaptation at 24%. In addition, McNamee and Mendolia (2014) investigate the compensating income associated with chronic pain for the whole HILDA sample and estimate an average of AUS$730 per day for people living with chronic pain.

In addition to impairment, disability and pain, functional limitations and physical health issues are also of interest in the adaptation literature. A paper by de Hond et al. (2019) studies adaptation to functional limitations using the Survey of Health, Ageing and Retirement in Europe (SHARE). The study focuses on individuals who developed physical health problems during the span between 2004 and 2015 (i.e. five waves of the panel). de Hond et al. (2019) also examine the correlation between time since the onset of functional limitations and self-perceived health using a FE ordered logit model. The measure of functional limitations is based on the validated IADL scale that includes a wide range of limitations that occur frequently among the elderly. The scale is used for instrumental activities of daily living. The three main explanatory variables related to functional limitations in the analysis are an indicator of 'having at least one IADL limitation', 'the number of IADL limitations' (from one to nine) and 'duration since the onset of these limitations'. The findings confirm evidence for full adaptation in life satisfaction after more than five years since onset of the IADL limitations in the elderly population. Some evidence for adaptation to self-assessed health is confirmed but not complete within the studied period of 12 years (2004 - 2015).

As mentioned earlier in the introduction, although panel data have been widely used in the adaptation literature, few studies have addressed the problem related to attrition and missing data. An exception is the study by Cubí-Mollá et al. (2017), who examines adaptation to health states using four waves of the British Cohort Study (BCS70). Employing a distinct approach compared to most of other previous studies which uses only lags of ill-health, Cubí-Mollá et al. (2017) hypothesise a positive relationship between the duration of illness and the likelihood of reporting better health. The study uses a dynamic ordered probit model controlling for health state dependence (i.e. lag of self-reported health) to examine the effect of the presence of a long-term illness and time since diagnosis on individual subjective self-assessed health. Self-assessed health is regressed against a lag of the same latent variable at one year before the diagnosis to capture between-period state dependence, duration of health state since onset and individual characteristics such as education and marital status. One contribution of this paper is the use of inverse probability weight (IPW) suggested by Wooldridge (2002) to correct the model from attrition problems. Applying correcting weights calculated from the propensity to respond in each wave, the study acknowledges the problems related to non-response. The findings confirm that despite a negative impact of having long-standing illness, a positive and significant impact of time since diagnosis on self-assessed health, or in other words, the longer the individuals experience a chronic health condition, the more likely they are are to report better health. The authors conclude supports evidence for adaptation which happens over relatively duration over 20 years. The sub-sample analysis on disease-specific impact provides some evidence on the existence of adaptation, but results are diverse and statistically significant only for some conditions.

It is worth noting that most of the studies in the UK using BHPS and categorising impairment and disability using the set of hindrance questions. This chapter, however, does not include BHPS but only uses data from the UKHLS (see Section 2.3.2 for more detail). The reason is because the set of hindrance questions was changed in wave 9 and wave 14[8], which makes the measure of severity of disability and impairment less attractive for comparison over time (see Oswald and Powdthavee, 2008; Powdthavee, 2009).

In summary, previous studies confirm an unequivocal negative relationship between ill-health and individual SWB. However, the evidence for adaptation is still mixed between no adaptation, partial adaptation and complete adaptation depending on which data are used, the length of the panel datasets, the techniques used and the measures that capture SWB. In general, most studies find evidence of adaptation to health problems, impairment and disability after a relatively long time. Also, to my knowledge, most studies divide ill-health based on the severity of the condition, while there is no work that addresses the differences in effects and adaptation between physical and mental impairment. The summary of the literature review on Adaptation to ill-health is presented in Table A.2.

2.3 Data

2.3.1 Definitions and interpretation of measurements

Impairment and types

In 'United Nations the first fifty year', impairment is defined as "any loss or abnormality of psychological, physiological, or anatomical structure or function (Meisler, 1995). Impairment, in many cases, results in disability and handicap (Barbotte et al., 2001). As specified in the Equality Act 2010, an impairment could be the result of a medical condition but does not have to be diagnosed (GOV.UK, 2010).

In this study, 'Health impairment' refers to the condition of individuals who self-report long-term sickness, impairment or disability. 'Physical impairment' is used when someone reports that he or she has a long-term illness or impairment and their physical health condi-

[8] In wave 9 and wave 14, the set of hindrance questions (wHLSF3A, wHLSF3B, wHLSF3C, wHLSF3D, wHLSF3E, wHLSF3F, wHLSF3G, wHLSF3H, wHLSF3I, and wHLSF3J) is different from the one in other waves (wHLLT, wHLLTA, wHLLTB, wHLLTC, wHLLTD, and wHLLTE). See questionnaire in the BHPS for more details.

tions limit their formal work and daily activities. Similarly, 'Mental impairment' is defined as having long-standing illness, impairment or disability and mental health issues hindering work and daily life.

Onset of impairment

Onset of impairment is simply a term capturing the experience of becoming impaired. Regarding adaptation, observations from individuals with onset of impairment provide more meaningful information than those with an ongoing impairment, as it is possible to track them before, at and after the becoming impaired. The latter group, on the other hand, provides no information prior to the onset of impairment or the duration since onset, so they may have already adapted to their impairment, but this is unobservable.

Adaptation to impairment

For the purpose of this chapter, adaptation to impairment is understood as the hedonic adaptation process. Adaptation is captured by changes in SWB measured by life satisfaction and overtime they go back to their baseline levels of life satisfaction before onset.

It is noted that the recovery from the impairment is conceptually not adaptation as one cannot observe the two separately. Therefore, observations with recovery from impairment are not included in the analysis. Where an individual experiences more than one episode of impairment, each is treated as separate incidents.

2.3.2 Dataset

The data used in the empirical analysis are drawn from the UKHLS (Understanding Society), which is carried out by the Institute for Social and Economic Research (ISER), at the University of Essex.

As a successor to the British Household Panel Survey (BHPS), a multi-topic household survey from 1991 to 2009, the UKHLS involves more than 6000 participants from the British Household Panel survey who would like to join this new survey (Understanding Society, nd.). The UKHLS is the largest British longitudinal household panel covering a wide range of subjects including health, occupation, education, income, aspects of personal and social lives. The UKHLS follows around 40,000 households in the UK and contains more than 80,000 adult individuals in the entire sample of the unbalanced panel from 2009 to 2020 (Understanding Society, nd.).

This chapter uses all latest ten waves currently available of the UKHLS, covering the period 2009 – 2020. In all these rounds, a life satisfaction question was included. The study employs the adult survey of the UKHLS, which is for those individuals in the sampled households who are 16 years old or older. It is emphasised that (a) the chapter uses observations from only those individuals who at some point report having an impairment, and amongst these, (b) the analysis is restricted to those for whom there is at least one observation prior to onset. Furthermore, the Main sample is then restricted to only those individuals who report at least one health dimension being affected to better understand the effect of impairment on wellbeing as severity of impairment is likely to affect adaptation. An extension to the main analysis is a sub-sample analysis which focuses only on people who experienced a drop in the level of life satisfaction at the beginning of onset of impairment in order to better understand the effects of being impaired on wellbeing as the trend in wellbeing can be traced back to prior-onset[9].

For the purposes of this study, the UKHLS is the most suited in spite of being a shorter panel compared to other datasets such as the BHPS. Firstly, the UKHLS is designed with a specific question in the Disability Module on whether or not the respondent has a long-term illness, impairment or disability. The BHPS, on the other hand, does not have a separate question referring to long-term illness, impairment or disability. The information about ill-health in previous studies was extracted from labour status question[10]. Using the labour status question to derive impairment/ disability status can have possible limitations. For example, respondents who are impaired or disabled but are employed or belong to other categories (i.e. retired) may not report themselves as having a long-term sickness or disability (see Table A.3 for cross-tab between the number of observations captured by the two above-mentioned questions in UKHLS 2009-2020). Secondly, unlike the BHPS, there are two questions in the UKHLS, taken from the Self-Completion SF-12 Module[11], that capture the effects of physical and mental health problems hindering daily activities and formal work respectively. The description of variables used in this study is reported in Table A.4 in Appendix A.[12]

2.3.3 The Dependent Variable

Following the literature in which most research has used a single item measure of SWB (e.g. overall life satisfaction) (see Addabbo et al., 2015; Boyce and Wood, 2011; Lucas, 2007*b*; Oswald and Powdthavee, 2008; Pagan, 2010; Powdthavee, 2009), this study uses overall life satisfaction as the main measure of individual SWB.

The satisfaction questions in the UKHLS are asked in the Self-Completion Satisfaction Module in which overall life satisfaction is drawn from the question: *"How dissatisfied or*

[9]More details on how these sub-samples are created are in Section 2.4.4

[10]"Which best describes your current situation? [...] long-term sickness or disability" (ISER, n.d.)

[11]The 12-item Short Form Health Survey (SF-12) measures self-rated general health as well as physical and mental functioning (Ware et al., 2001).

[12]It is noted that there are some outliers of real household income per capital (i.e. very low or extremely high values), which results in minimum value of Ln of income is negative while the maximum value is more than 10. This issue, however, does not affect the final results qualitatively.

satisfied are you with your life overall?". The question is asked on a scale of one to seven, where one is 'Completely Dissatisfied' and seven is 'Completely Satisfied'.

Figure A.1 in Appendix A shows the distribution of life satisfaction for the Main sample. The distribution is negatively skewed, to the left. The average level of life satisfaction of the whole population is 5.78 while the mode is '6' (with a frequency of almost 45%). The data indicate that individuals who never report being impaired in the UKHLS report statistically significantly higher levels of average satisfaction compared to people who experienced onset of impairment at some point in their lives, at 5.38 and 5.17 respectively (see Figure A.2 in Appendix A).

The distribution of life satisfaction in the UKHLS 2009 – 2020 for male and female respondents is presented in Table A.5 in Appendix A. The distribution of life satisfaction is quite similar between male and female respondents with approximately 45% reporting six out of seven.On average, men reported slightly higher levels of life satisfaction (at 5.18) than women (at 5.17), which is not statistically significantly different.

Regarding life satisfaction by age, the group of 16-26 year olds, and 57-67 year olds have similar distributions, which is quite close to the total population[13]. The distribution for the oldest group is the most skewed (see Figure A.3 in Appendix A).

2.3.4 Key Independent variables

This section describes the variables that are used to define physical and mental impairment and the main explanatory variables in the analysis (duration of impairment captured by lags).

The chapter draws on four survey questions asked in all rounds of the UKHLS to define impairment and the two types of impairment. These are:

(i) *"Do you have any long-standing physical or mental impairment, illness or disability? By 'long-standing' we mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months." (Yes/No)*

(ii) *"During the past four weeks, how much of the time were you limited in the kind of work or other regular daily activities you do as a result of your physical health?"* (Physical health limits amount of work)

(iii) *"During the past four weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?"* (Mental health means accomplished less). Options of questions (ii) and (iii) are: (1) All of the time; (2) Most of the time; (3) Some of the time; (4) A little of the time; and (5) None of the time. The first four options are

[13] Age groups: 16-26; 27-37; 38-47; 48-56; 57-67; 68+ are divided by sextiles

grouped as “Yes, physical/mental health limits amount of work" and the last one is “No, physical/mental health does not limit amount of work".

(iv) *“Do you have any health problems or disabilities that mean you have substantial difficulties with any of the following areas of your life? Please select all of the answers that apply to you."* (The full list of answers are in section A.8, Appendix A).

The first question is from the Disability Module and the two latter are from the Self-Completion SF-12 Module in the survey. As was mentioned in Section 2.3.2 above, the definition of impairment in this study is based on different questions from those used in previous studies using the BHPS (see Oswald and Powdthavee, 2008; Powdthavee, 2009). In the BHPS the variable identifying impaired and disabled people is embedded in a question on the respondent’s labour market status[14]. Using the answer to this question to capture impairment and disability implies equating impairment and disability with inability to work, and therefore, does not account for individuals who have a chronic health problem but are in work or are retired. Indeed, from 2009 to 2020, there are 152,541 person-year observations of impairment or disability based on the first question (from the Disability Module), while only 15,913 person-years are defined as ‘long-term sick or disabled’ based on the labour status question. (See Table A.3 in Appendix A for a cross-table between these two variables.)

One empirical category that is used is “long-standing impaired and physical health limits amount of work", which is denoted as Physical impairment (related to question (ii) above). The definition of “physical impairment" is answering ‘yes’ to question (i) and all of the time in question (ii). The other is “long-standing impaired and mental health limits amount of work", and I term this category Mental impairment (related to question (i) and (iii) above). The cross-table between Physical impairment and Mental impairment is reported in Table A.6 in Appendix A. It is noted that question (ii) and (iii) are not consecutive to the first question, hence, the analysis does not distinguish between temporary (e.g. in the past month) and long-term impairment. To be exact, the chapter focuses solely on individuals who are healthy and then become ill or impaired, either permanently or temporarily.

It is often believed that mental health is associated with SWB (see Clark and Georgellis, 2013; Stephens, 1988), which in this study, is measured by life satisfaction. Therefore, it is important to note that the correlations between life satisfaction and mental impairment as well as the duration of mental impairment are negative as expected but not particularly high (absolute coefficient is < 0.3) (see Table A.7 in Appendix A).

[14]Respondents are asked to select one of the options for this question: self-employed, in paid employment (full or part-time), unemployed, retired, on maternity leave, looking after family or home, full-time student, long-term sick or disabled, on a government training scheme, unpaid worker in family business, and doing something else

The last question (iv), which is a consecutive question of question (i), is used to control for severity of impairment. Using the set of answers from this question, the Main sample is restricted to only those that chose at least one of the answer. In the whole sample, almost 40% (49,343 observations) who reported long-standing sickness, impairment or disability did not report any affected dimensions.

The whole UKHLS sample includes 152,574 observations of impairment in which 92,788 observations (29,038 respondents) have an ongoing impairment[15], of which 15,510 observations (1,551 individuals) report impairment for all ten years of the panel. The figures for physical impairment are 52,295 observations (18,918 individuals) with ongoing impairment and of which 5,040 observations (504 individuals) are with ten years being physically impaired.

For mental impairment, the figures are 34,003 observations (14,812 individuals) for the first category (i.e. ongoing impairment) from which 2,100 observations (210 individuals) have always reported mentally impaired for 10 waves. These ongoing observations are not included in the main analysis since they do not provide information about transitions into impairment, and therefore, it is impossible to check how their SWB changes following the onset.

In the unbalanced panel, there are 22,525 individuals who at some point have an onset of impairment (i.e. adding up to 127,629 person-year observations). Among those observations, 89,638 person-year observations (16,408 individuals) are physically impaired and 85,741 person-year observations (16,032 individuals) are mentally impaired. It is noted that not all of these observations are contemporaneous since these individuals can move in and out of impairment. In order to check that the results are not being driven by attrition, the model is re-estimated on a smaller balanced panel. In the balanced panel, there is a significant fall in the total number of person-year observations to only 52,720 observations (5,272 individuals) of impairment. The figures for physical impairment and mental impairment drop to 42,770 person-year observations (4,277 individuals) and 38,990 person-year observations (3,899 individuals) respectively (see Section 2.4.5 for more details on the balanced panel).

2.3.5 Control Variables

The analysis uses a set of control variables which are standard in the current literature. The descriptive statistics are reported in Table A.10, in Appendix A.

The literature on the differences in individual SWB between genders shows mixed results. There is often a difference in levels of SWB between male and female respondents. For

[15]Ongoing impairment is where a respondent continues reporting impairment from the earliest wave of the panel. Therefore, there is no way to track the first experience with impairment of those people.

example, women often tend to report higher levels of satisfaction and happiness than men (see Alesina et al., 2004; Di Tella et al., 2001; Eichhorn, 2012). Female respondents, in contrast, report lower GHQ scores (Clark and Oswald, 1994) compared to their male counterparts. However, there are few studies that find no significant gender variation in wellbeing (see Frey and Stutzer, 2000; Gardner and Oswald, 2006; Louis and Zhao, 2002). The mixed results suggest that the correlation between sex and wellbeing may depend on the situations where individuals are in as well as other aspects of life. It is worth noting that in some cases, the gender effect may disappear, such as for individuals who are hindered from work and daily activities due to health problems (Oswald and Powdthavee, 2008) or those providing informal care for others (Van Den Berg and Ferrer-i Carbonell, 2007).

The literature typically finds a ‘U-shaped’ relationship between age and SWB (see Blanchflower and Oswald, 2004; Clark, 2003; Clark and Oswald, 2006; Frey and Stutzer, 2002; Van Landeghem, 2012). In particular, previous studies employ both age and age-squared to capture the age effect on SWB (see Blanchflower and Oswald, 2008; Frijters and Beatton, 2012; Oswald and Powdthavee, 2008; Pagan, 2010). On the other hand, many studies use age groups to control for this effect (see Clark et al., 2008; Pagan, 2012; Powdthavee, 2009). In this analysis, age groups (27-37, 38-47, 48-56, 57-67, 68 and above) are included in the estimations with 16-26 being the omitted category.

Previous studies in marital status and SWB show that individuals who have a partner (whether married or cohabiting) report higher levels of wellbeing than single people (see Bridges and Disney, 2010; Clark et al., 2008; Clark and Georgellis, 2013; Dolan et al., 2008; Lucas and Clark, 2006; Lucas et al., 2003). Divorce and widowhood are both associated with lower levels of wellbeing in many existing studies (see Clark et al., 2008; Clark and Georgellis, 2013; Lucas, 2005; Zimmermann and Easterlin, 2006). In the analysis in this study, marital status is represented using the following categories: single, married, cohabit, widowed, divorced and separated, with the second group being omitted.

Existing literature on employment status and SWB indicates that the levels of SWB are lower for unemployed respondents compared to those who are employed (see Clark, 2006; Clark et al., 2008; Clark and Georgellis, 2013; Clark et al., 2001). Employment status in this analysis is conveyed through a set of dichotomous variables which are: employed (including self-employed), unemployed, retired and not active in labour market, with ‘employed’ being the omitted category.

Regarding education, different variables are used in the literature. Some studies employ the number of years of education (see Clark et al., 2008; Pagan, 2010, 2012), while the others use educational levels (see Clark and Georgellis, 2013; Oswald and Powdthavee, 2008; Powdthavee, 2009). Education in this chapter is measured by individuals’ current status of highest educational or vocational qualification in the past wave. There are three categories in the analysis including A-levels, University and the omitted category is for those who have no formal qualification or have acquired qualifications lower than or not included in the above.

Other variables used in all regressions are household income per capita[16], number of dependent children aged < 16 years old in the household (categories: no child - omitted, one, two , three or more children), household size (categories: single-person household - omitted, two-, three-, four-, five plus-person households), whether the respondents and/or their partners owned their home outright. The first three variables are used in many studies, for example, Clark et al. (2008), Oswald and Powdthavee (2008), Powdthavee (2009), Pagan (2010), and Pagan (2012), while the last one is less widely used (see Oswald and Powdthavee, 2008). Regional and wave dummies are also included in the analysis so as to account for regional and time effects.

2.4 Methodology

2.4.1 The regression model

While in psychology, life satisfaction scores are usually considered cardinal (see Ng, 1997; Schwarz, 1995), economists often treat SWB measures as ordinal where SWB is used as proxy utility (see Ferrer-i Carbonell and Frijters, 2004; van Praag, 1991). In this study, I treated the answers to the question of satisfaction as cardinal constructs in all regression models, because (1) the interpretation is simpler compared to ordinality, and (2) the estimation results are not influenced substantively by the assumption of cardinality or ordinality of the satisfaction scores (see Clark et al., 2008; Clark and Georgellis, 2013; Ferrer-i Carbonell and Frijters, 2004). This assumption is also in accordance with previous studies in impairment, disability and life satisfaction (see Oswald and Powdthavee, 2008; Pagan, 2010, 2012; Powdthavee, 2009).

This chapter does not investigate the anticipation effects of impairment due to two reasons. First, anticipation is relevant in the analysis of changes in SWB from different life events as that can be anticipated such as marriage, divorce, or loss of jobs (see Clark et al., 2008; Clark and Georgellis, 2013). Regarding impairment, if it is the result of deteriorating chronic illness, it is anticipated. However, it is not always predictable if impairment is a result of accidents[17]. Therefore, anticipation or lead effect is not of interest in this study. Second, due

[16]A calculated gross measure of monthly household income as the sum of personal monthly income of all household members. This number was then accounted for CPI to get real household monthly income and then divided by household size for capita value.

[17]There is no question in this dataset to track whether impairment or disability is the result of accidents.

to the relatively short panel used (ten years only) compared to other existing studies (e.g. 24 years in Pagan (2012)), it is not practically possible to include both lag and lead effects in the study. Having both anticipation and adaptation in one model will result in a very small sample, for example, if this analysis has lags up to five years and leads up to three years, only observations in 2015, 2016 and 2017 can be examined. However, a sensitivity check which is performed using lead effects is discussed in *Sections A.9.1* and *2.6*. Comparing studies on only lag effects and those including both leads and lags, the main different is the SWB baseline which is pre-onset level in model with lags and pre-anticipation level in model with leads. Specifically, the baseline pre-anticipation level is more likely to be higher than pre-onset (without anticipation) level. Therefore, it would be expected to see less adaptation evidence in models with both lead and lag effects.

In this study, FE lag models are employed to analyse the effects of impairment on SWB and to explore whether individuals adapt to impairment (see Pagan, 2012; Powdthavee, 2009)[18]. While the OLS approach completely ignores individual-specific effects, the RE model assumes zero correlations between explanatory variables and the individual fixed effects. The main advantage of employing the FE model over these two approaches is that the FE approach completely removes the fixed characteristics or stable personal factors (e.g. personality traits) to prevent their biases. By doing so, FE approach could possibly avoid overestimating the real effects of impairment on individual SWB and probably the degree of adaptation to impairment. As a robustness check, RE and OLS approaches are applied to the Main sample.

Applying the FE estimator and following Clark et al. (2008), both contemporaneous effects of impairment and adaptation to impairment are modelled by estimating a regression of the form:

$$Y_{it} = \alpha_i + \sum_{l=1}^{L} \beta_l C_{lit} + \sum_{m=1}^{M} \gamma_m H_{mit} + \varepsilon_{it} \tag{2.1}$$

The dependent variable, Y_{it} refers to SWB measured by life satisfaction. Equation (2.1) includes characteristics varying across both time and individuals estimated by coefficients β and γ, respectively. C_{lit} is a vector of standard controls (personal and household controls) which are usually used in most of the existing studies on wellbeing (see Clark and Georgellis, 2013; Cubí-Mollá et al., 2017; McNamee and Mendolia, 2014; Oswald and Powdthavee, 2008; Pagan, 2010, 2012; Powdthavee, 2009) and L is the total number of controls. The C_{lit} vector includes dummies for marital and labour force status, levels of education, the

[18]Due to the specification of FE models that omit time-invariant variables, sex is excluded from the main analysis. However, it is included in all the RE and ordinary least squares (OLS) models in *Section 2.6* for a robustness check in this chapter.

number of children in the household, and age groups, monthly household income per capita (in logarithm), and a full set of 12 regional dummies and ten year dummies. H_{mit} captures the duration of impairment and M is the total number of dummies capturing these durations. β_0 is the constant.

In this study, the above equation is analysed separately for health impairment, physical impairment and mental impairment. Following Powdthavee (2009), in order to analyse adaptation, the impaired at time t are divided into nine groups: those who have become impaired within one year, one to two years, two to three years, and up to eight to nine years. These nine groups are captured by nine dummies H_{1it}, H_{2it} and up to H_{9it} to reflect the duration of the current impairment episode. In particular, H_{1it} is a dummy for onset, H_{2it} is for an ongoing spell between one and two years, H_{3it} is for an ongoing spell between two and three years, and up to H_{9it} is for ongoing spells of eight and nine years. γ_1 to γ_9 are their respective coefficients. The distribution of the duration of impairment is in Table A.8 in Appendix A.

If one becomes impaired in time period t, H_{1it} equals to one, and all the other H-dummies equal to zero. If one becomes impaired in $t-1$ and if one is still impaired in t, then $H_{2it} = 1$. If one is impaired for two to three years, that individual is impaired in time periods t, $t-1$ and $t-2$ ($t-2$ is onset point in this case), then $H_{3it} = 1$ and so on. If an individual has more than one episode of impairment, then the next onset is also captured as $H_{1it} = 1$.

Applying the methodology in Clark et al. (2008) to test for adaptation, the baseline in the main analysis is the SWB level before onset of impairment. It is expected that there is a large negative and significant effect of H_{1it}, which would indicate a decrease in SWB within the year of becoming impaired. If there is no adaptation to impairment and the level of SWB remains steadily low while the individual is impaired, then all of the γ would take approximately the same negative value. According to Clark et al. (2008), if there is adaptation over time, later γ will show less impact (i.e. less negative effect) – individuals returning from impairment. Partial adaptation is defined as the process satisfying two conditions: (1) the last γ is significantly different from zero and shows less effect than the first one ($\gamma_{9it} < 0$ and $\gamma_{9it} > \gamma_{1it}$) and (2) the coefficient related to the longest duration (eight to nine years) is significantly different from the one related to onset (Clark and Georgellis, 2013). The reason for the second condition is that, although the coefficients of later lags may become less negative, the changes could be very small or they may not be statistically different from the coefficient related to onset. This practically does not mean “partial" adaptation since SWB would not on average change significantly from the year of onset . If there is full adaptation, the coefficients of longer durations (later values of γ) would be insignificant and statistically different from the previous significant coefficients, implying that over time, the impairment will cease to have any negative effect on life satisfaction (e.g. a non-significant γ_{4it} that is statistically different from γ_{3it} implies full adaptation after four years).

It is important to note that there are different trajectory types describing the dynamics of impairment. Trajectories here are determined based on whether an individual is impaired ($H_{it} = 1$) or non-impaired ($H_{it} = 0$) over the ten years of the panel (e.g. individuals who have a single long consecutive spell of impairment may have trajectories such as 0111111111 or 0011111111, where 0 represents not being impaired and 1 represents being impaired). Following the approaches of Gardiner and Hills (1999), Burkhauser and Daly (1996) and Burchardt (2000), the trajectory types of impairment were defined based on the distribution of the duration of episodes and the repetition of spells for impairment and both types of impairment (e.g. 000111000000 is short consecutive, and 0001010100 is short repeated). Table A.9 in Appendix A describes the frequencies of the different impairment trajectories. If an individual who was already impaired at their first interview in the panel recovers and then experiences further episodes of impairment, the second episode onwards are included in the analysis (e.g. a respondent with the trajectory '1110111' is included in the model for the episode starting at wave 5). It is worth acknowledging there is measurement error caused by the timing of interview dates. Although trajectory, for example, 0011110 will be treated as one long episode of impairment, this may include somebody who moves in and out of impairment and experiences multiple episodes of short-term impairment but being impaired at four consecutive interview dates. Similarly, 0000000 will be treated as never impaired, but may include somebody who experiences multiple episodes of severe impairment or severe illness between interview dates.

2.4.2 Controlling for severity of impairment

In the baseline analysis (i.e. Main sample), all individuals who report the onset of impairment are analysed. The process of adaptation might depend on severity. Therefore, to further understand how impairment affects individual SWB and whether adaptation happens as people remain impaired, I restricted the Main sample to those individuals whose impairment is associated with functional limitations by excluding those who do not report any functional dimensions affected by the impairment (i.e. using question (iv) discussion in Section 2.3.4). This restriction reduces the sample size by almost 40% and only 79,009 observations are included in the model for Health impairment. The number of observations in the regressions for Physical impairment and Mental impairment after controlling for severity are 59,135 and 58,613 respectively.

2.4.3 Gender subgroups

The Main sample (i.e. not controlled for severity) is further analysed to understand heterogeneity in impairment effects and adaptation regarding gender. The reason for not using the severity-controlled sample is practically due to a small sample after excluding individuals who do not report any affected functional limitations. As in these sub-group analyses, the whole sample is divided into different groups, the sample size is expected to further reduced, which may lead to insufficient sample size for the analysis if using the controlled sample. The model using function (2.1) is run again for each gender separately.

2.4.4 An extension: Sub-samples estimation

In order to further understand adaptation to impairment using life satisfaction as a measure of SWB (the second research question), the Main sample, which includes observations with pre-onset information, is restricted to only those individuals who reported a drop in the level of life satisfaction at the onset of impairment. The main reason behind this is because if reported life satisfaction does not go down, there is no scope to capture adaptation to impairment. However, life satisfaction is known to be a random variable that probably fluctuates over time even if objectively little happens in people's lives. By selecting subgroups that report a drop in life satisfaction at time t, regression to mean might pay a role in the trend that respondents bounce back after an initial decline in life satisfaction at the onset of impairment. In practice, adaptation and regression to mean could not be distinguished. Therefore, this approach is only considered as an extension of a sub-sample analysis rather than the main analysis.

The two sub-samples of impairment are further restricted from the Main sample to include those reported a drop in life satisfaction at the beginning of onset of impairment as follows:

(i) *Sub-sample 1*: includes all individuals who report a reduction in life satisfaction levels at onset of impairment compared to one year before.

However, there are respondents who had missing values of life satisfaction one year before onset of impairment but reported a drop in life satisfaction at onset compared to the average level of all years before that. Sub-sample 2 is created to include those individuals.

(ii) *Sub-sample 2*: consists of all respondents who report a reduction in life satisfaction levels at the onset of impairment compared to their own average level of satisfaction with life of all years before becoming impaired.

Section A.2 in Appendix A summarises the number of observations in Main sample and two Sub-samples each for health impairment, physical impairment and mental impairment. The majority of those who report an impairment do not report a drop in life satisfaction at the year of onset. There are two possible reasons, (1) one point decrease in life satisfaction is too crude (e.g. A person who felt and reported life satisfaction of 5 prior to impairment may feel around 4.6 in post-impairment stage, so she also reported 5, which shows no change in SWB), and (2) individuals may not feel less satisfied (e.g. A person who feels and reports life satisfaction of 5 in both prior and post-impairment stages).

In Sub-sample 1, 80,628 observations for health impairment are excluded due to missing value of one-year-pre-onset life satisfaction, while the corresponding figures for physical impairment and mental impairment are 47,217 and 42,666 respectively.

Although Sub-sample 2 includes some of the observations that are excluded in Sub-sample 1, there are still many missing values in this sub-sample. In the Main sample, item non-response for life satisfaction is 70,955 for those with a health impairment, 40,452 observations for those with a physical impairment, and 35,830 observations for those with a mental impairment. These excluded observations are the result of missing the average value of satisfaction in all years before onset[19].

For comparative purposes, Figures A.4, A.5 and A.6 display the dynamic effects of health impairment, physical and mental impairment on life satisfaction in the Main sample and Sub-samples 1 and 2. In all the graphs, the average value is the raw mean life satisfaction prior to onset of the impairment for relevant sub-samples.

Different regressions are run using the Main sample and two sub-samples. With the full set of controls, regression 1 tests the effect of health impairment on life satisfaction in the Main sample, while regressions 2 and 3 capture this effect in Sub-sample 1 and Sub-sample 2 respectively.

Regression 4 examines the wellbeing trend in the case of physical impairment in the Main sample, in comparison with the results from a similar regression on Sub-sample 1 (Regression 5) and Sub-sample 2 (Regression 6).

Regression 7 tests for the association between mental impairment and life satisfaction in the Main sample. The results are then compared to those from the regressions in Sub-sample 1 (Regression 8) and Sub-sample 2 (Regression 9) with individuals experiencing a reduction in SWB at onset.

2.4.5 Robustness Checks

A number of checks are carried out to test for the robustness of the main results using data from the Main sample of each impairment category.

[19]Note that these above-mentioned figures regarding missing values and number of observations are related to life satisfaction. However, when running regressions on these sub-samples, some further exclusion in the number of observations are from missing values in other variables.

As mentioned in Section 2.3.4, in the main analysis, an individual is categorised as having a “physical/mental impairment" if he/she is impaired and his/her answer for the question of ‘how frequently physical/mental health problems limit work or other daily activities’ is one of the options including (1) All of the time; (2) Most of the time; (3) Some of the time; (4) A little of the time. Otherwise, if the answer is (5) None of the time, the individual is grouped as ‘not physically/mentally impaired’. One obvious robustness check is to recode the binary variables capturing physical and mental impairment using a different threshold, for example, by taking the first three options as impaired and the other two as not impaired.

The second robustness check is to use a balanced panel to ensure that the results in the unbalanced panel (the main analysis) are not driven by respondents in the panel for only a short time. Hence, in this test, only individuals who had participated in all ten waves of the UKHLS are included in the analysis (denoted as BL1). In addition, to test for the effects of long consecutive impairment (e.g. 0111111) on an individual’s SWB, a conditional balanced panel on impairment trajectory is created by including observations of those individuals who have at least one year of not being impaired and report being impaired for three consecutive years after onset. The conditional balanced panel presented here is somewhat different from the conventional balanced panel operationalised in econometrics (i.e. the previously-mentioned balanced panel in this section) in that each individual not only needs to be observed in every year of the panel but also needs to satisfy the impairment conditions mentioned above (denoted as BL2).

In the third check using the Main sample, OLS and RE estimations are employed to analyse the Main sample to test whether the relationships between the duration of impairment and life satisfaction are maintained across different econometric techniques.

In addition, some further sensitivity checks are carried out. For example, the vector of controls is gradually extended across the models to check whether the result is driven by different explanatory variables and controls. First, three FE models are run, regressing life satisfaction on health impairment, physical impairment and mental impairment, respectively. The first regression has just the impairment dummy (with an intercept). Then the second regression replaces the impairment dummy with the impairment lag dummies for being impaired within one year, for one to two years, for two to three years and for up to eight to nine years. Next, all individual controls (age, marital status, employment status, and highest educational qualification) are included. After that, household controls such as monthly household income per capita, household size, home ownership, and the number of children are added to the regression. In the next step, 12 regional dummies are included and finally, wave dummies are added. The simpler regressions could be run on larger samples which include those observations that are missing the subsequent explanatory variables, but instead, all regressions are run on the same sample as the regression with full set of controls. This makes the results across the regressions in this check more comparable as they are run on the same sample. Being inspired by Powdthavee (2009) and Clark and Georgellis (2013), another check is to include lead effect of being impaired within the next year and in one to two years in the model. In this case, the number of lags of impairment (i.e. H_{mit}) are reduced accordingly. In the models including the lead effect of becoming impaired within the next years, only eight lag dummies are included in the regressions. Extending this to one to two years reduces one more lag variable and the regressions include lags of being impaired for up to six to seven years. Including lead effects in the model changes the baseline from pre-onset levels to pre-anticipation levels. This test aims to check if anticipation effects are significant when considering impairment effects on life satisfaction and if adaptation conclusions remains robust.

2.5 Results

2.5.1 Main results (Main sample and severity-controlled sample)

Health impairment and wellbeing

In Models 1 and 2, health impairment shows negative effects on life satisfaction over time, which is expressed by significant negative coefficients related to ‘lags’ of health impairment (see Table 2.1 for estimations of main variables and full regression results in Table A.11 in Appendix A). In Model 1 (Main sample), after a drop by around 0.104 point in life satisfaction on a scale of one to seven at onset of health impairment (p-value < 0.001), life satisfaction further decreases as impairment remains. Generally, all of the coefficients related to longer durations imply more impact (i.e. more negative effect) than the one at onset. In other words, there is evidence for reinforcement of impairment effect on SWB and no evidence of adaptation to health impairment.

In model controlled for severity of health impairment (Model 2), the effects of health impairment are more noticeable, which are shown by more negative and significant coefficients related to all lag dummies in the model. In line with the Main sample, there is no evidence for adaptation to health impairment after eight to nine years since onset in the analysis focusing on individuals who reported functional limitations associated with their reported impairment.

Physical impairment and wellbeing

An examination of the effects of physical impairment on life satisfaction in the Main sample and the severity-controlled sample shows expected results (see Table 2.1 for estimations of main variables and full regression results in Table A.11). The Main sample is tested in Model 3, in which the negative effect of physical impairment on SWB is confirmed as all coefficients related to lags of physical impairment from one year to nine years are negative and significant at 0.1% - 5%. After the first drop in life satisfaction at onset ($\gamma_1 = 0.181, p-value = 0.001$), levels of satisfaction with life overall show a downward slope with an increasing decrement. Therefore, no evidence of adaptation to physical impairment is confirmed in the Main sample after eight to nine years following onset.

The severity-controlled model (Model 4 in Table 2.1) follows a similar trend in which the parameters related to duration of physical impairment fluctuate overtime but remain negative and significant after eight to nine years since onset. Hence, no evidence for adaptation is found for this sub-sample.

Mental impairment and wellbeing

The results for mental impairment are similar (see Table 2.1 for estimations of main variables and full regression results in Table A.11). All of the coefficients related to the duration of mental impairment (from γ_1 to γ_9) are negative and significant at at least 0.1%. Model 5 (Main sample) shows a smaller drop in life satisfaction following onset of mental impairment when compared with the results for Model 6 (severity controlled sample). After this small drop, satisfaction levels continue decreasing and remain low after eight to nine years of impairment. The coefficient reflecting the longest duration of mental impairment is significant and more negative than the onset coefficient ($\gamma_9 = -0.517$ versus $\gamma_1 = -0.310$ in Model 5 and $\gamma_9 = -0.538$ versus $\gamma_1 = -0.334$ in Model 6). Therefore, it is concluded that there is no evidence of adaptation to mental impairment in the Main sample and severity-controlled sample.

It is noted that among all of the models reported in Table 2.1, the coefficients related to the longest duration of impairment (i.e. the 8-9 years group) have more negative values than ones at onset. However, the F-tests for differences across coefficients confirm that the parameters related to the onset and being impaired for eight to nine years are not statistically different from each other.

Controls in the model

The results reported in the table A.11 in the Appendix A show that there are negative and significant effects of the younger and middle-aged groups on life satisfaction, while the effect related to the older age group is insignificant. This is possibly due to the FE estimation distorting the convex pattern or U-shape of age in wellbeing (Frijters and Beatton, 2012).

Household income has positive and significant effects on life satisfaction in all models, which is as expected since rising income, ceteris paribus, will lead to an increase in individuals' satisfaction level. This result is in accordance with the literature as the relationship has been highlighted by Clark and Oswald (2006), Blanchflower and Oswald (2008), Clark et al. (2008), Oswald and Powdthavee (2008), (Powdthavee, 2009), and Pagan (2010).

Regarding marital status, as observed in the literature, people who are married have higher wellbeing than those who are not (Bridges and Disney, 2010; Clark et al., 2008; Clark and Georgellis, 2013; Dolan et al., 2008). The results show that, in reference to married individuals, almost in all other groups, life satisfaction levels are significantly lower. The exception is insignificant effect of cohabiting on life satisfaction compared to the baseline of being married.

In reference to the employed, unemployment is associated with significantly lower overall life satisfaction in all models, which is consistent with the literature (Clark et al., 2008; Clark and Georgellis, 2013; Frey and Stutzer, 2002; Oswald and Powdthavee, 2008; Powdthavee, 2009; Winkelmann, 2005). This relationship is confirmed to be robust when the FE approach is used to control for individual heterogeneity in the model (Winkelmann, 2005). In all models, in comparison with those employed, the retired are more satisfied while people who are not active in the labour market (e.g. on maternity leave, students, in a government training scheme, so on) are less satisfied with their life overall.

People with university degree are less satisfied with life compared to those with no formal qualification, while the effect of holding A-level or equivalent degrees is negative but insignificant. Home ownership has a positive and significant effect on life satisfaction across all models.

Regarding the number of dependent children and household size in most models, there is no statistically significant effects on life satisfaction (i.e. coefficients related to these variables are mostly insignificant). The exception are the positive and significant coefficients related to having three or more dependent children, which is consistent across all six regressions.

The post-estimation coefficient plots on the main effects (i.e. durations of impairment) are presented in Figures A.7, A.8 and A.9 in Appendix A.

Table 2.1 The effects of Health/ Physical/ Mental impairment on life satisfaction - Main Sample and Severity-controlled Sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
· Onset of impairment	-0.104***	-0.145***	-0.181***	-0.220***	-0.310***	-0.334***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
· Impairment: 1-2 years	-0.141***	-0.222***	-0.235***	-0.284***	-0.420***	-0.443***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
· Impairment: 2-3 years	-0.121***	-0.184***	-0.224***	-0.248***	-0.379***	-0.388***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
· Impairment: 3-4 years	-0.129***	-0.176***	-0.216***	-0.228***	-0.398***	-0.410***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
· Impairment: 4-5 years	-0.135***	-0.174***	-0.255***	-0.295***	-0.376***	-0.374***
	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
· Impairment: 5-6 years	-0.153***	-0.173***	-0.275***	-0.323***	-0.422***	-0.424***
	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)
· Impairment: 6-7 years	-0.161**	-0.208***	-0.269***	-0.276***	-0.447***	-0.469***
	(0.05)	(0.06)	(0.07)	(0.07)	(0.09)	(0.10)
· Impairment: 7-8 years	-0.196**	-0.215*	-0.203*	-0.216*	-0.398***	-0.377**
	(0.07)	(0.08)	(0.09)	(0.10)	(0.12)	(0.13)
· Impairment: 8-9 years	-0.195+	-0.234+	-0.273+	-0.272+	-0.517**	-0.538**
	(0.11)	(0.13)	(0.14)	(0.15)	(0.18)	(0.19)
Constant	5.268***	5.201***	5.309***	5.226***	5.159***	5.003***
	(0.19)	(0.23)	(0.21)	(0.26)	(0.22)	(0.27)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Wave & Region	Yes	Yes	Yes	Yes	Yes	Yes
Observations	110,191	80,355	87,044	62,378	83,106	61,819

Standard errors in parentheses.. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UKHLS 2009-2020

Note: Health impairment: Model 1-Main Sample, Model 2-Severity-controlled Sample. Physical impairment: Model 3-Main Sample, Model 4-Severity-controlled Sample. Mental impairment: Model 5-Main Sample, Model 6-Severity-controlled Sample

2.5.2 Genders, impairment and adaptation

The heterogeneous effects across the sexes are investigated by running separate models for male and female respondents for health impairment, physical impairment and mental impairment, using the Main sample.

Regarding health impairment, it is clear from Table 2.2 for estimations of main variables and full regression results in Table A.12 in Appendix A that male respondents experience weaker effects of health impairment on life satisfaction. For most of the duration of health impairment (except for being impaired for two to three years, six to seven years and seven to eight years), the coefficients for men are less negative and significantly different from those for women. However, there is no evidence for adaptation to health impairment for both men and women after eight to nine years since onset.

In the case of physical impairment, there is little evidence for heterogeneity between male and female respondents. The effects of the onset of physical impairment and being impaired between one and seven years are not different between men and women as the tests for statistical differences between corresponding coefficients reject the null hypotheses. The coefficient related to last lag of physical impairment (γ_9) for male respondents is insignificant but not statistically different from the previous coefficients (γ_8) and one at onset (γ_1). Likewise, female respondents continue experiencing negative and significant impact of physical impairment at longer duration. Both genders do not adapt after nine years since onset (see Table 2.2 for estimations of main variables and full regression results in Table A.12 in Appendix A for more details).

The models for mental impairment show that mental impairment is associated with lower levels of life satisfaction for both males and females even though this effect is more negative and significant for women, except for duration between six to seven years and eight to nine years (see Table 2.2 for estimations of main variables and full regression results in Table A.12 in Appendix A). Following onset, overall satisfaction with life reported by both male and female respondents remains low, which indicates no evidence that they adapt to mental impairment after eight to nine years following onset.

Table 2.2 The effects of Health/ Physical/ Mental impairment on life satisfaction – Genders

	MALE-H	FEMALE-H	MALE-P	FEMALE-P	MALE-M	FEMALE-M
· Onset of impairment	-0.090***	-0.114***	-0.182***	-0.179***	-0.289***	-0.323***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
· Impairment: 1-2 years	-0.117***	-0.160***	-0.234***	-0.235***	-0.404***	-0.430***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
· Impairment: 2-3 years	-0.160**	-0.153***	-0.245***	-0.208***	-0.352***	-0.393***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
· Impairment: 3-4 years	-0.075*	-0.167***	-0.219***	-0.213***	-0.318***	-0.443***
	(0.04)	(0.03)	(0.05)	(0.04)	(0.06)	(0.04)
· Impairment: 4-5 years	-0.114*	-0.152***	-0.328***	-0.205***	-0.368***	-0.385***
	(0.05)	(0.04)	(0.06)	(0.05)	(0.08)	(0.06)
· Impairment: 5-6 years	-0.121*	-0.180***	-0.225**	-0.316***	-0.409***	-0.429***
	(0.06)	(0.05)	(0.08)	(0.07)	(0.11)	(0.08)
· Impairment: 6-7 years	-0.184***	-0.142***	-0.335**	-0.234**	-0.613***	-0.384***
	(0.07)	(0.07)	(0.10)	(0.08)	(0.15)	(0.10)
· Impairment: 7-8 years	-0.199*	-0.199*	-0.254+	-0.179	-0.208	-0.482***
	(0.10)	(0.09)	(0.14)	(0.12)	(0.22)	(0.14)
· Impairment: 8-9 years	-0.106	-0.248+	-0.057	-0.388*	-0.774*	-0.468*
	(0.16)	(0.14)	(0.24)	(0.18)	(0.39)	(0.21)
Constant	5.548***	5.084***	5.763***	4.991***	5.596***	4.985***
	(0.30)	(0.25)	(0.30)	(0.30)	(0.36)	(0.29)
Standard Controls	Yes	Yes	Yes	Yes	Yes	yes
Wave and Regional dummies	Yes	Yes	yes	Yes	Yes	yes
Observations	47,980	62,210	36,624	50,420	33,732	49,374

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UK longitudinal study: 2009-2020

Note: Health impairment: MALE-H and FEMALE-H;

Physical impairment: MALE-P and FEMALE-P;

Mental impairment MALE-M and FEMALE-M.

2.5.3 Extension: Main sample and sub-samples

The combined results of regressions using Main sample and two Sub-samples for health impairment, physical impairment and mental impairment are reported in Table 2.3 below and in Tables A.13, A.14 and A.15 in Appendix A. The post-estimation coefficients plots for these models are presented in Figures A.10, A.11 and A.12 in Appendix A.

In Table 2.3, the Main samples are Regression 1 (REG 1 - health impairment), Regression 4 (REG 4 - physical impairment) and Regression 7 (REG 7 - mental impairment). Regrading the effect of health impairment, in Regression 2 (Sub-sample 1, those with reduced life satisfaction at onset compared to T = -1), after a large drop at onset, the levels of life satisfaction increase slightly after one to two years of being impaired but then stabilise. Comparing the coefficients related to impairment onset ($\gamma_1 = -1.163, p-value < 0.001$) and the longest duration (being impaired for eight to nine years, ($\gamma_9 = -0.108, p-value < 0.001$), the latter refers to a less negative impact. There are significant differences between the coefficients related to onset and being impaired for eight to nine years in this model. This implies there is evidence for partial adaptation to health impairment of around 34% after eight to nine years. In Regression 3 (Sub-sample 2, those with reduced life satisfaction at onset compared to T < 0), at onset $\gamma_1 = -0.791$, implying a drop in life satisfaction related to the starting point of impairment. The effect of health impairment gets less negative in longer duration, an eventually become insignificant after five to six years. The coefficients related to lags between six and nine years are insignificant and statistically different from those parameters in previous lags. Therefore, there is evidence for full adaptation after five to six years since onset in this sub-sample.

The results for physical impairment in the Main sample (REG 4), becoming physically impaired is associated with lower levels of SWB in Regression 5 (REG 5 - Sub-sample 1) and Regression 6 (REG 6 - Sub-sample 2). After a large drop in SWB at onset, in both sub-samples, the parameters related to lags of physical impairment fluctuate but remain negative over time. In REG 5, the tests for statistical differences across coefficients related to lags one to two years up to seven to eight years do not confirm the differences. At year eight to nine since onset, the coefficient gets worse than that at onset ($\gamma_9 = -1.433, P-value < 0.001$), which leads to the conclusion of no adaptation in Sub-sample 1 of physical impairment. In REG 6, after some ups and downs, the parameters related to the effects of physical impairment over the years remain negative but smaller magnitude. At eight to nine years of having physical impairment, people seem to experience less negative effects on their life satisfaction than the impact of onset. The coefficient related to the longest duration is statistically different from those previous ones including one at onset. Hence, there is evidence for partial adaptation at 22% in Sub-sample 2.

Regarding mental impairment, in Sub-sample 1 (REG 8), there is no evidence for adaptation as the coefficients related to later lags remain negative with an increasing magnitude. In contrast, in Sub-sample 2, the later lags are associated with significant but less negative coefficients (e.g. γ_8 and γ_9 are just more than a half of γ_1 in absolute terms, and the two coefficients significantly different from γ_1 at the 5% significance level). This is evident that SWB partially adapts to a mental impairment over time and that mentally impaired individuals gradually regain just less than half of the initial loss in life satisfaction after eight to nine years since onset (at around 37%).

Table 2.3 The effects of Health/ Physical/ Mental impairment on life satisfaction - Main Sample and Sub-sample Estimations

	REG 1	REG 2	REG 3	REG 4	REG 5	REG 6	REG 7	REG 8	REG 9
· Onset of impairment	-0.104***	-1.163***	-0.791***	-0.181***	-1.174***	-0.819***	-0.310***	-1.252***	-0.931***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
· Impairment: 1-2 years	-0.141***	-0.729***	-0.329***	-0.235***	-0.833***	-0.424***	-0.420***	-0.997***	-0.631***
	(0.01)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)
· Impairment: 2-3 years	-0.121***	-0.748***	-0.245***	-0.224***	-0.801***	-0.359***	-0.379***	-0.981***	-0.548***
	(0.02)	(0.04)	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)
· Impairment: 3-4 years	-0.129***	-0.752***	-0.216***	-0.216***	-0.817***	-0.311***	-0.398***	-1.062***	-0.571***
	(0.02)	(0.05)	(0.04)	(0.03)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)
· Impairment: 4-5 years	-0.135***	-0.886***	-0.212***	-0.255***	-0.949***	-0.318***	-0.376***	-1.065***	-0.475***
	(0.03)	(0.06)	(0.05)	(0.04)	(0.07)	(0.06)	(0.05)	(0.07)	(0.06)
· Impairment: 5-6 years	-0.153***	-0.883***	-0.229***	-0.275***	-0.867***	-0.173*	-0.422***	-1.070***	-0.470***
	(0.04)	(0.08)	(0.06)	(0.05)	(0.08)	(0.08)	(0.06)	(0.10)	(0.09)
· Impairment: 6-7 years	-0.161**	-0.812***	0.031	-0.269***	-1.047***	-0.266**	-0.447***	-1.267***	-0.518***
	(0.05)	(0.10)	(0.09)	(0.07)	(0.11)	(0.10)	(0.09)	(0.13)	(0.13)
· Impairment: 7-8 years	-0.196**	-0.962***	-0.163	-0.203*	-0.909***	-0.079	-0.398***	-1.202***	-0.498**
	(0.07)	(0.14)	(0.13)	(0.09)	(0.16)	(0.15)	(0.12)	(0.18)	(0.18)
· Impairment: 8-9 years	-0.195+	-1.108***	-0.280	-0.273+	-1.433***	-0.638**	-0.517**	-1.312***	-0.582*
	(0.11)	(0.22)	(0.21)	(0.14)	(0.23)	(0.23)	(0.18)	(0.29)	(0.28)
Constant	5.268***	4.681***	4.871***	5.309***	5.362***	5.596***	5.159***	4.624***	4.827***
	(0.19)	(0.35)	(0.30)	(0.21)	(0.37)	(0.30)	(0.22)	(0.38)	(0.32)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wave & Region	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	110,191	31,968	42,851	87,044	30,073	38,439	83,106	32,248	40,566

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UKHLS 2009-2020

Note: Health impairment: REG 1-Main Sample, REG 2-Sub-sample 1 , REG 3-Sub-sample 2

Physical impairment: REG 4-Main Sample, REG 5-Sub-sample 1 , REG 6-Sub-sample 2

Mental impairment: REG 7-Main Sample, REG 8-Sub-sample 1 , REG 9-Sub-sample 2

2.6 Robustness Checks

2.6.1 Frequency of physical and mental impairment

This section discusses the results from the same model specifications as those used in the main analysis. The difference here is the coding of the two variables for physical and mental impairment. This robustness check changes the threshold to group individuals in either of the groups including physical/mental impairment and not physical/mental impairment (see *Section 2.4.5*).

The results are consistent with those in the main analysis. There are some small differences in the magnitudes of the coefficients for lags of physical impairment and mental impairment (see Table A.16 in Appendix A). However, the qualitative findings of the effects of being physically impaired and mentally impaired on SWB and adaptation to impairment remain unchanged. Although mental impairment shows more negative impacts on SWB than physical impairment, there is no evidence for adaptation to both types of impairment after eight to nine years following onset. It is noted that although in the results for robustness check of physical impairment [PI (cutoff) column] and mental impairment [MI (cutoff) column] the last lag coefficients (γ_9) are insignificant, they are not statistically different from the earlier lag coefficients, which provides no evidence for adaptation to physical impairment and mental impairment after eight to nine years since onset.

2.6.2 Individual Fixed Effects Model – Balanced Panel Estimations

As discussed in the Methodology section, two approaches to check robustness in a balanced panel are applied in this chapter. The first approach is to include only those individuals who has responded in all ten waves (denoted as BL1 in Table A.17 in Appendix A). Overall, the effects of health impairment, physical impairment and mental impairment at each duration of impairment seem to be less negative in the balanced panel compared to the unbalanced panel. The coefficients across the two panels are not statistically different from each other. This check confirms consistent results of the main analysis.

In the second approach, the conditional balanced panel presented as BL2 in Table A.17 in Appendix A includes observations of those individuals who are impaired for at least three years continuously, preceded by non-impairment. The conditional balanced samples are about one order of magnitude smaller than the unbalanced samples regarding sample sizes. An examination of the effects of health impairment, physical impairment and mental impairment on life satisfaction in the conditional balanced panel shows that the patterns found in the unbalanced panel are confirmed in the conditional balanced panel. There is no evidence of adaptation after eight to nine years from onset of impairment.

2.6.3 OLS – RE – FE

In addition to the FE models, pooled ordinary least squared (OLS) and RE estimations (RE) are also employed to analyse the Main sample (see Table A.18, A.19, and A.20 in Appendix A for full results).

The sign and significance of coefficients capturing the effects of health impairment, physical impairment and mental impairment on SWB are consistent across the different estimation methods employed. However, regarding magnitude, all coefficients related to lags of impairment are the most negative in the OLS estimation while the results in the FE models are the least negative. Nevertheless, the overall trend of changes in levels of life satisfaction is similar across different techniques, which shows no evidence for either partial or complete adaptation to health impairment, physical impairment and mental impairment during the studied period.

2.6.4 Further Robustness checks

In order to test whether the results are robust, different controls are added to the models for health impairment, physical impairment and mental impairment, using the Main sample.

The results from all models for health impairment, physical impairment and mental impairment show that all coefficients related to lags are negative and significant. In addition, in all models across all types of impairment, the coefficients related to the longest duration since onset (being impaired for eight to nine years) implies more negative impact than those related to onset, which confirms robust results of the main analysis. The detailed regression results are reported in Table A.21, Table A.22 and Table A.23 in Appendix A.

2.6.5 Adding lead effects

Another robustness test follows Powdthavee (2009) and Clark and Georgellis (2013) to include lead effects of impairment within next year and in one to two years. In the models with one lead effect for health impairment, the lead effect of being impaired within the next year is confirmed to be negative and significant. When adding second lead effect, the lead effects of being impaired within the next year and in one to two years are insignificant, which means there is no evidence for anticipation for health impairment in the sample. As expected, the results of these regressions are similar to those in the main analysis, which shows no evidence for adaptation to health impairment. It is noted that the main difference between the main analysis and these lead effects models are (1) durations of impairment is shorter in the lead models, and (2) the baseline SWB is pre-anticipation level rather than pre-onset level.

The results remain robust for physical impairment. In the lead regression that includes only “having physical impairment within the next year" , lead effect or anticipation effect is confirmed, which suggests that people already reported lower levels of life satisfaction before onset of impairment. However, when including lead of one to two years pre-onset, coefficients related to both lead effects become insignificant.

Similarly, regarding mental impairment, the lead effects of having mental impairment within the next year is negative and significant at 5% in the regression that only includes one lead variable. Adding the second lead variable (i.e. “having mental impairment in one to two years") results in the first lead effect remains significant while the second lead effect is negative but insignificant. Overall, in both lead models, there is no evidence for adaptation to mental impairment, which is in line with the main analysis. Overall, lead effects of “being impaired within the next year" in the regressions for physical impairment and mental impairment are significant but the effects are rather smaller than the effects of onset (i.e. one order of magnitude smaller).

2.7 Discussion and Conclusion

This study has examined the relationship between impairment and life satisfaction using the ten latest waves of the UKHLS (2009 - 2020). The analysis utilises FE lag models following Clark et al. (2008) to estimate effects of impairment and adaptation to impairment. This chapter also contributes to the literature by exploring, for the first time, the onset of and adaptation to different types of impairment, by distinguishing between physical impairment and mental impairment, rather than by categorising health problems by severity (e.g. moderate, mild and severe conditions). Using recent data, the analysis shows that both physical impairment and mental impairment are associated with a low level of life satisfaction, and that getting mental impairment is worse, in terms of life satisfaction, than getting physical impairment of the same severity. No evidence for adaptation is found after eight to nine years since onset of either physical impairment or mental impairment. These findings contribute a different perspective to the literature as it seems that eight to nine years since onset is not long enough to observe adaptation.

Furthermore, the study tests for the effects of impairment and adaptation by gender. Female respondents appear to generally experience more negative impacts of health impairment and mental impairment on SWB compared to their male counterparts. In the case of physical impairment, there is no evidence for heterogeneous effects of impairment on men and women. Both men and women do not adapt to all types of impairment within eight to nine years since onset.

It is worth noting that the study further generated two sub-samples to further investigate the effects of onset of impairment of SWB. The Main sample was restricted to those who reported a drop in the level of life satisfaction at onset of impairment. About half of the observations in the Main sample did not report a decrease in life satisfaction at onset. The results from the sub-samples confirm some evidence for partial adaptation to health impairment and mental impairment but not to physical impairment.

In previous studies exploring UK data, the measures of illness (e.g. disability, impairment) were from an option of 'long-term sickness or disabled' in a question related to current labour status (see Oswald and Powdthavee, 2008; Powdthavee, 2009). As the labour status question does not include people in work, retirement or in full-time education who classify themselves as having long-term health problems, the data extracted from this question capture fewer observations of ill-health than the derivation of impairment in this chapter. In this analysis, information on long-standing sickness, impairment and disability is extracted from a specific question on health and disability which capture not only individuals with impairment and not active in the labour market but also those who are in the labour market. In addition, there is a current policy trend to increase the labour market participation rate (see ONS, 2019*b*) by reducing the inactivity rate among impaired and disabled people by providing support to individuals with health problems. The aims of this policy are to reduce hindrance and to help people to re-enter the labour market even if their disability and impairment status remain. This may lead to even fewer observations with 'long-term sickness or disability' from the current-labour-status question to include in the analysis compared to number of observations derived from the disability question. Therefore, the measure of impairment in this chapter is arguably better in capturing individuals with ill-health.

The differences in results of this chapter compared to some previous studies such as Pagan (2010) and Pagan (2012), which confirm adaptation to disability after six or more years since onset, could stem from the differences in the measures of ill-health and data used. While Oswald and Powdthavee (2008) and Powdthavee (2009) find some evidence for adaptation after nine years, the measures of ill-health and categories of health problems used in their studies are different from those used in this chapter. On the other hand, Cubí-Mollá et al. (2017) conclude that it may take up to 20 years before there are significant signs of adaptation to ill-health. The findings from this chapter potentially collaborate the results of Cubí-Mollá et al. (2017).

Despite several contributions, there are still opportunities for further research. The time dimension of the data utilised in this chapter is short compared to other panels used in previous studies and might not be long enough to confirm adaptation. This issue leaves more room for future research on the variation in self-reported life satisfaction before, at and after onset of impairment, which requires a longer panel. In addition to the relative shortness of the panel, the number of observations of those with long-term impairment is relatively small. This may lead to the lack of power in these longer impairment duration variables. On the other hand, it is not practically possible to distinguish between the lack of power and the potential issue that those with long-term impairment become increasingly heterogeneous.

As this chapter has confirmed significant effects of impairment on individual's life satisfaction and found some evidence for adaptation to impairment in some groups, in the next chapter, these aspects will be included in the life satisfaction regression using the same dataset to derive the information on equivalent income, a measure of wellbeing that will consider both income and non-income life domains. The focus of these two chapters is contrasting life satisfaction and equivalent income to examine how different approach to measuring wellbeing could lead to different ranking orders of individuals in terms of their wellbeing.

Chapter 3

Preferences and Equivalent income in the UK

3.1 Introduction

Wellbeing has been recognised as a combination of multiple life domains and in recent years, and the use of multidimensional wellbeing measure has gained prominence in policy-related research with a number of measures that have been proposed (see Aaberge and Brandolini, 2015; Fleurbaey and Blanchet, 2013; Ledić and Rubil, 2016, for more discussion). In addition to monetary aspect, wellbeing measures should consider the impacts of non-monetary life domains as parts of wellbeing (Decancq et al., 2017, 2016; Fleurbaey, 2009). Reflecting this multi-dimensional approach of wellbeing, the OECD's Better Life Initiative identifies three pillars of wellbeing, which are 'material conditions' (or economic wellbeing, referring to material living conditions), 'quality of life' (combining the set of individual's non-monetary aspects that affect opportunities that people have in life), and 'sustainability' (i.e. related to the impact of current actions and policies on the socio-economic and natural systems, and how these assets would be transmitted to the future) (OECD, 2011*a*). In the OECD's framework, wellbeing is a combination of income and wealth and 10 non-income domains including jobs and earnings, housing, health, work–life balance, education, social connections, civic engagement; environmental conditions, personal security, and subjective wellbeing (Durand, 2015). However, the literature has not been much concerned with how such wellbeing measure could be obtained to reflect both income and non-income aspects of people's lives, and capture opinions on what a good life is (Fleurbaey and Blanchet, 2013).

In addition, the distrust of the practical benefit of solely-income-based wellbeing measure has been pointed out in many recent studies (more detailed discussions are in Decancq and

Neumann, 2014; Fleurbaey, 2009; Fleurbaey and Gaulier, 2009; Ledić and Rubil, 2016). The use of individual income alone as a wellbeing measure is criticised to be a too narrow information basis to compare individual wellbeing (see Stiglitz et al., 2009, for an extensive survey). The argument against income as a wellbeing measure criticises the assumption that all individuals with the same equivalised income level are equally well-off, regardless of their non-monetary domains of life such as health, educational achievements, or labour market status (Decancq and Neumann, 2014). This argument is backed by a well-documented literature on wellbeing that confirms the importance of non-monetary life domains which may not be directly bought with money (see Benjamin et al., 2012; Clark, 2016; Graham, 2016). As individual income does not capture sufficient information to compare wellbeing across individuals (Defloor et al., 2017), including other domains that extend beyond income could provide more information to a wellbeing measure. One possible approach would be to collapse a multidimensional measure into a single index (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq and Neumann, 2014; Decancq and Schokkaert, 2016*a*; Fleurbaey and Gaulier, 2009; Kuklys, 2005; Sen, 1980, 1985; Stiglitz et al., 2009).

A variety of methods have been proposed to collapse a multidimensional measure into a single index that takes into consideration heterogeneous preferences and that can be used for interpersonal wellbeing comparison. This chapter follows one of the approaches in the literature that captures the information on preferences based on the concept of SWB, or 'experienced' utility as opposed to 'decision utility'[1] (Decancq, Fleurbaey and Schokkaert, 2015*b*). This approach aims to estimate willingness to pay (WTP) for goods that cannot be bought in the market through analysing their impacts on SWB (see Clark and Oswald, 2002; Decancq, Fleurbaey and Schokkaert, 2015*b*; van Praag and Ferrer-i Carbonell, 2007). This chapter reports on the computation of a so-called 'equivalent income', proposed in a series of papers by Fleurbaey (2005, 2006, 2009) and Fleurbaey and Gaulier (2009), which is a wellbeing measure that aggregates across several life domains and takes into account inter-individual preference heterogeneity across life domains. In the analysis, equivalent income is obtained using a satisfaction regression. The life satisfaction regression in this chapter controls for hedonic adaptation, which has not been done in the literature[2]. Controlling for hedonic adaptation is essential when SWB (i.e. life satisfaction in this study) is used as an independent variable to estimate relevant parameters for equivalent income computation (see Clark and Georgellis, 2013; Lucas, 2005; Powdthavee, 2009, for further discussion on

[1]Decision utilities are derived from observed decisions while experienced utilities are the "rewards" that people realise about the decisions they made at the endpoint of the decision process (Carter and McBride, 2013; Robson and Samuelson, 2011).

[2]Adaptation was briefly mentioned in Decancq, Fleurbaey and Schokkaert (2015*b*) as the authors tested lagged variables for scaling factors but did not find significant results. Hence, the analysis in this paper excluded those variables and did not account for adaptation.

evidence for the impacts of different life events on SWB and hedonic adaptation). Following that, the chapter will investigate in an integrated framework the differences in wellbeing ranking of individuals, depending on whether wellbeing is captured by individual income (i.e. equivalised household income) or by equivalent income or by life satisfaction. Using data from the latest ten waves of the UK Household Longitudinal Study (UKHLS) 2009 - 2020, the study presents econometric evidence from ordered logit fixed effects (FE) models on the effects of income and non-income domains on life satisfaction. The estimated coefficients from the regressions will then be used to compute equivalent income.

The remainder of the chapter is organised as follows. Section 3.2 introduces the concept and framework of Equivalent Income. Following that, Section 3.3 summarises empirical literature review. Section 3.4 and 3.5 explain the data and methodology used. The empirical results are presented in Section 3.6. Section 3.7 performs different robustness checks. Section 3.8 contains discussion and conclusion.

3.1.1 Motivation

The emergence of multidimensional wellbeing measures in research and policies has led to an increase in interest in many life domains which could be summarised using equivalent income (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017; Decancq and Neumann, 2014; Decancq and Schokkaert, 2016*a*; Decancq et al., 2016; Defloor et al., 2017; Fleurbaey et al., 2013; Ledić and Rubil, 2016; Petrillo, 2018). Recent studies have looked into data from different countries including Germany (Decancq and Neumann, 2014), Belgium (Defloor et al., 2017; Schokkaert et al., 2011), France (Fleurbaey et al., 2013), Russia (Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017), Colombia (Decancq et al., 2016), and so on. Others aim to rank wellbeing in various regions and areas, such as among 24 OECD countries (Fleurbaey and Gaulier, 2009) or European nations (Decancq and Schokkaert, 2016*a*; Jara and Schokkaert, 2017; Ledić and Rubil, 2016; Petrillo, 2018). However, very few studies have been carried out using UK data. Despite the fact that the UKHLS is a representative dataset providing rich information regarding SWB as well as different life aspects, no study has attempted to compute equivalent income using this dataset.

This chapter adapts equivalent income as a multidimensional single-index measure of wellbeing into UK data. The analysis aims to compare and contrast individual income and life satisfaction with regard to equivalent income when ranking individuals in the society. One illustration is a comparison in the portraits of the worst-off captured by different wellbeing measures. It is noted that detecting the worst-off group is neither the only application of equivalent income nor the main objective of this wellbeing measure. The exercise in this chapter is done for an illustrative purpose only.

3.1.2 Purpose of the Study

The main objective of this study is to compute equivalent income through the marginal rate of substitution between income and non-income life domains along a SWB contour using UK data. The computed results will then be compared with equivalised income and life satisfaction to examine if different worst-off groups are captured by different wellbeing measures.

There are two main research questions in this study:

(i) How to compute equivalent income using a subjective satisfaction regression and marginal rates of substitution between income and non-income life domains when considering hedonic adaptation?

(ii) Is the group of the worst-off captured by equivalent income in the UK different from one identified by equivalised income and life satisfaction?

The first question focuses on computation of equivalent income using secondary data from a panel survey. The computation of equivalent income using SWB data has been studied in earlier work such as Decancq, Fleurbaey and Schokkaert (2015*b*); Decancq and Neumann (2014); Decancq and Schokkaert (2016*a*); Decancq et al. (2016); Defloor et al. (2017); Fleurbaey (2009); Fleurbaey and Gaulier (2009); Ledić and Rubil (2016) and Decancq et al. (2017). Through a satisfaction regression, estimated relevant coefficients will be used to compute willingness to pay for the 'best' levels non-income life domains and equivalent income. However, to the best of my knowledge, none of the existing studies has taken into account the effects of hedonic adaptation. This chapter will incorporate the effects of hedonic adaptation to impairment in the analysis[3]. The second research question follows up the previous results and examines the overlap in ranking individual wellbeing using equivalent income in comparison with other wellbeing measures. The analysis uses a small subgroup of the worst-off as an example for this investigation. To do so, the worst-off individuals will be identified by each wellbeing measure of interest and then compared across them (i.e. comparison of the worst-off groups identified by equivalent income and equivalised income and by equivalent income and life satisfaction).

In sum, this chapter will make three contributions to the literature. Firstly, the analysis takes into account the effect of hedonic adaptation on aspirations and changes in subjective SWB levels. Despite an extensive literature investigating empirical computations and applications of equivalent income, no empirical studies to date has explored the effect of hedonic adaptation in general and adaptation to impairment in particular in this context. Evidence of hedonic adaptation has been confirmed regarding the impacts of different life events on SWB (see Boyce and Wood, 2011; Clark and Georgellis, 2013; Lucas, 2005; Powdthavee,

[3] A more complete discussion on hedonic adaptation to impairment is the focus of Chapter 2.

2009). Adapting to changes in life is reflected on the levels of SWB reverting back to the baseline (Bottan and Truglia, 2011). Therefore, theoretically, controlling for hedonic adaptation is essential when SWB is used as an independent variable to estimate relevant parameters for equivalent income computation. To examine how hedonic adaptation may affect individuals' evaluations, this study controls for lags of impairment by including a set of dummies capturing impairment durations. This set of dummies is adopted from the analysis in the second chapter[4]. Secondly, by comparing equivalised income and life satisfaction with equivalent income, the study contributes to strengthen the evidence that wellbeing measures matter when comparing individuals' wellbeing. If ranking by equivalised income and by life satisfaction and ranking by equivalent income largely disagree, this would highlight that collapsing the outcomes across multiple domains of wellbeing into one number would lead to a different view and focus of public policies when ranking people's wellbeing. Lastly, the chapter contributes to the wellbeing literature by computing equivalent income and the trade-off between income and non-income life domains using the UKHLS 2009 – 2020.

3.2 Income-based wellbeing measures (Framework)

3.2.1 Equivalised income

Let us consider individual income as a sole measure of wellbeing and an interpersonally comparable measure. Therefore, the wellbeing level of an individual 'i' at time t is captured by:

$$WB_{it} = Y_{it} \tag{3.1}$$

In the literature, disposable income (i.e. income after benefits received and taxes deducted) has become a standard measure in European countries, especially in poverty and inequality studies (see Decancq and Neumann, 2014). Theoretically, income used as an individual wellbeing measure should be individual income. However, income information is mostly collected at the household level in many large-scale surveys (Luttmer, 2005). In order to derive the individual level of income from household level data, two assumptions need to be made. Firstly, pooling household income accounts for how income is distributed within a household. Another assumption is that income can be commonly used by all family members, which creates advantages of living together as a result of economies of scale (see

[4]There are potential different life events and adaptation to control in the panel data analysis. However, due to practical reasons and the balance between including too many variables and maintaining the power of the main effects, this chapter only takes into account adaptation to health impairment as an example

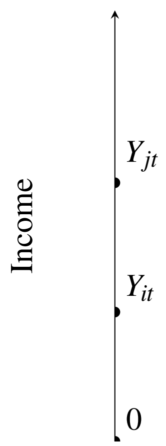

Fig. 3.1 Considering income solely when comparing individual wellbeing

Decancq and Neumann, 2014, for more discussion). Empirically, the use of equivalence scale has become standard to compute individual income from household income (OECD, 2008). While the household income level does not reflect individual need, per capita income assumes identical need across all household members. In contrast, equivalence scale can be applied to distinguish the difference between children and adults in the family (i.e. children need less) while taking into account economies of scale in which two or more people can share resources within a household[5].

When considering only income information to compare individual wellbeing, we assume that two individuals '*i*' and '*j*' with information on equivalised income have homogeneous preferences. If income is the only metric for this comparison as depicted in Figure 3.1, one can conclude that individual j is better off than individual i as j has higher income than i ($Y_{jt} > Y_{it}$).

It is noted that the above example is a very plain case as using income solely as an inter-personal comparable wellbeing measure assumes that (i) everything which matters to wellbeing can be bought; (ii) everyone with the same income level or broadly with the same material resources is considered equally well-off or equally badly-off; and (iii) Y is permanent income. Such strong assumptions do not seem to be realistic as they imply that all the other life domains have no relations with individual wellbeing which is considered to combine multi-domains of one's life. Indeed, empirical evidence has shown that different non-monetary life aspects and events have significant effects on individual wellbeing (see

[5]The income term used in this chapter is equivalised income, which is computed by using household disposable income divided by the OECD-modified equivalence scale as applied by household composition. The first adult is equivalent to 1.0. Additional adult or a child aged 14 and over in the household accounts for 0.5 each. A child aged between 0 and 13 years old contribute to the household composition by 0.3 (OECD, n.d).

Clark et al., 2008; Clark and Georgellis, 2013; Clark et al., 2001; Oswald and Powdthavee, 2008; Pagan, 2010, 2012).

3.2.2 Equivalent Income

The equivalent income approach is a method that combines different life domains into one money-metric wellbeing measure. This section will explain the framework on how this measure is obtained using household panel data.

As a multidimensional measure, equivalent income combines both income and non-income domains. Expanding from the example in Section 3.2.1, let us relax the above-mentioned assumption and add information on a non-income aspect, such as health (see Fleurbaey et al., 2009; Schokkaert et al., 2011, for more discussion on having more than one domain in wellbeing and preferences). Adding information on health and indifference curves to this example allows individuals to trade-off between different life domains. Considering individual i with health condition H_{it} and individual j with health condition H_{jt}, their indifference curves are shown in Figure 3.2 and Figure 3.3.

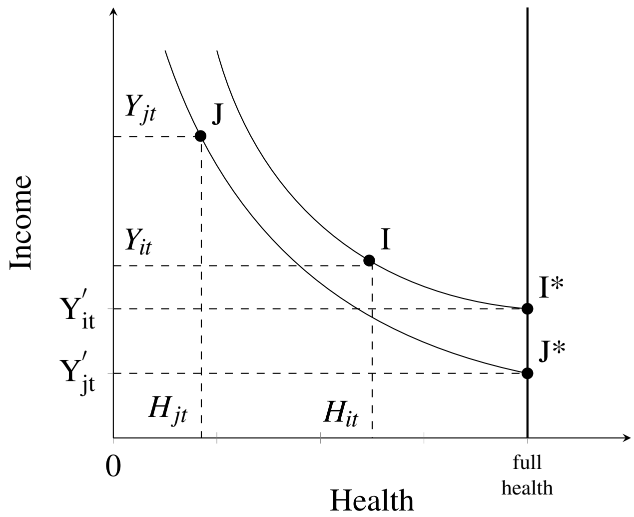

Fig. 3.2 Same preferences across individuals

Figure 3.2 describes a scenario with an assumption that both individuals agree on preference between income and health. Individual i is considered to be better off than individual j as i is on a higher indifference curve than j. It is quite straightforward to compare individuals with same preferences in this case. However, the assumption of the same preferences across individuals is strong and not always realistic. If we allow heterogeneity in preferences (i.e. the two individuals have different preferences), it means that individuals' indifference curves (ICs) will have to intersect (e.g. Figure 3.3). In this case, there is no clear dominance, even if

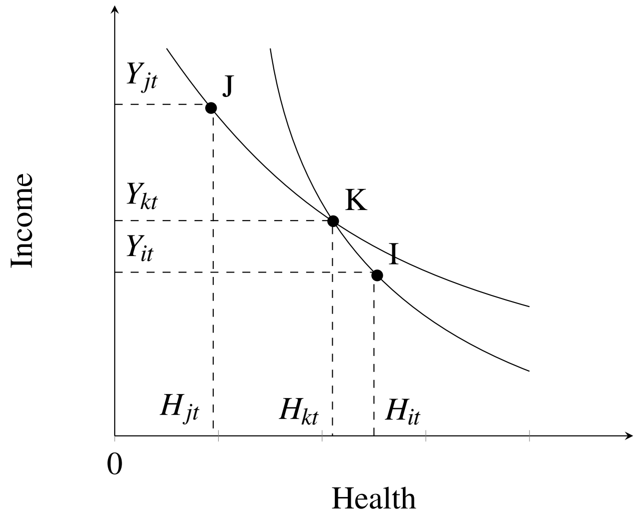

Fig. 3.3 Heterogeneity in preferences across individuals

individuals i and j are in the same life situation ‘K’ (i.e. the intersection point at which both individuals have same income and health levels), individual wellbeing is still not comparable between i and j as they have different preferences. The indifference curve of individual i is steeper than individual j’s, which implies that health is more important to individual i than it is for j. In both Figure 3.2 and 3.3, there is no clear dominance as individual j has higher income ($Y_{jt} > Y_{it}$) while individual i has better health ($H_{it} > H_{jt}$).

Comparing wellbeing between two people with two different life domains is complex. Once way to simplify the comparison is to keep one of the domain as a reference (i.e. keep one domain the same across individuals) and compare the other. For example, if both individuals have the same level of health, the other aspect (i.e. income) can be adjusted along their own indifference curves so that each individual is indifferent between their own original situation and their new situation. Hence, wellbeing comparisons can then be based on their positions on the other aspect (Decancq, Fleurbaey and Schokkaert, 2015*b*). However, keeping same the health condition as poor health for both individuals and allowing one to have a slightly higher income may not provide the obvious conclusion that, for example, the wealthier individual is better off than the poorer counterpart who has the same poor health condition. If the richer person cares about their poor health and the poorer person does not mind the same poor health, the richer’s wellbeing may not be as good as her/his poorer counterpart. In contrast, if both individuals have perfect health (denoted by H^*), which is assumed to be preferred by all individuals and the health domain cannot get better than the ‘perfect’ level, wellbeing comparison between the two individuals i and j can now be solely in terms of their income levels (see Decancq, Fleurbaey and Schokkaert, 2015*b*, for a detailed discussion). In other word, the wellbeing comparison is now based on an approach that

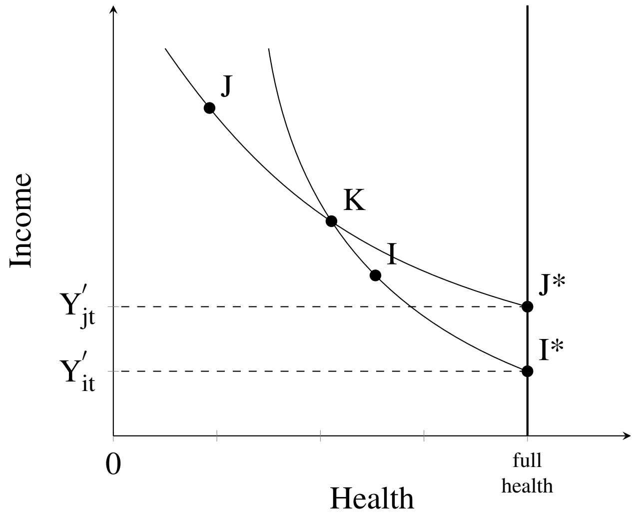

Fig. 3.4 Heterogeneity in preferences and Equivalent income

keeps health, a non-monetary life domain, at optimal level and compares individuals based on income domain (Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq and Neumann, 2014; Decancq and Schokkaert, 2016*a*).

From Figure 3.4, the current life situation of individual *i* at point '*I*' gives her the same level of wellbeing compared to a hypothetical situation 'I^*' (i.e. I^* combines full health and income $\mathrm{Y}'_{\mathrm{it}}$) as they are on the same indifference curve. Similarly, individual *j* indifferences between his current life situation '*J*' and the hypothetical situation 'J^*' at full health and income $\mathrm{Y}'_{\mathrm{jt}}$. As discussed before, it is reasonable to rank I^* and J^* on the basis of income solely. Therefore, individual *i* in situation '*I*' is worst-off than individual *j* in situation '*J*' as the hypothetical income $\mathrm{Y}'_{\mathrm{it}}$ is lower than $\mathrm{Y}'_{\mathrm{jt}}$. Such a hypothetical income is equivalent income[6].

Equivalent income (EI) is the hypothetical income level that, if combined with a bundle of relevant non-monetary life domains at the optimal levels (e.g. perfect health), would make an individual indifferent between that scenario and his or her current situation (Decancq, Fleurbaey and Schokkaert, 2015*b*).

In short, taking into account heterogeneity in preferences, when allowing the non-monetary life domains to be optimal, interpersonal comparison of wellbeing can be done by comparing only monetary or income domain. It is assumed that at full health H^*, individual *i* is equally satisfied with her current life situation '*I*' and life scenario 'I^*' while individual *j* is indifferent between his actual life scenario '*J*' and the hypothetical one, 'J^*'. In this case, comparing individual wellbeing between individual *i* and individual *j* by ranking

[6] An example of a comparison between a richer individual who cares more about health than the poorer, as opposed to the example used in Figure 3.3 and 3.4 is explained in Appendix B

their current life situation '*I*' and '*J*' can be done by ranking 'I^*' and 'J^*' on the basis of equivalent income $\mathrm{Y}_{\mathrm{it}}^{'}$ and $\mathrm{Y}_{\mathrm{jt}}^{'}$. In particular, if $\mathrm{Y}_{\mathrm{jt}}^{'} > \mathrm{Y}_{\mathrm{it}}^{'}$ (i.e. equivalent income), individual *i* is worse-off.

3.2.3 Equivalent Income and Marginal rate of substitution

The computation of equivalent income in this context is based on the assumption that people's preferences are consistent with their evaluation of overall life satisfaction (denoted as LS_{it}) (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Schokkaert et al., 2011). The expression of an individual's life satisfaction over different life domains is based on the comparisons with reference scenarios which can be expectations or aspirations, or the best or the worst possible situations, or other people's situations such as someone in one's family or one's friends and so on (Decancq, Fleurbaey and Schokkaert, 2015*b*; Schokkaert et al., 2011). Those comparisons may vary across individuals or within an individual over time. Theoretically, as defined, scaling factors related to those characteristics, besides life domains, that change the calibration of satisfaction scores but not direct object to preferences (Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2016). In other words, scaling factors include those aspects that only have impact on the cardinal characteristics of preferences but not the ordinalisation. However, it is not very straightforward to distinguish life domains and scaling factors empirically as some scaling factors of one person may actually be direct objects or be considered as life domains for the others[7].

When people optimise between their income and non-income life domains, marginal rate of substitution (MRS) in this context is the rate at which an individual gives up some amount of his or her income in exchange for an improvement in the levels of non-monetary life domains while maintaining the same level of satisfaction. In order to compute equivalent income using life satisfaction function, let us specify the life satisfaction function as:

$$LS_{it} = f(Y_{it}, D_{it}, s_{it}) \tag{3.2}$$

in which Y_{it} captures income of an individual i at time t. D_{it} represent non-income life domains (e.g. health and employment status) and s_{it} consists of scaling factors.

In Figure 3.5, A is the current situation of individual i with income Y_{it} and other non-income domains captured by D_{it}. Applying the concept of equivalent income discussed in Section 3.2.2, A^* is the hypothetical situation in which individual i has optimal non-income life domains D^* and equivalent income $\mathrm{Y}_{\mathrm{it}}^{'}$.

[7]The discussion on the empirical application of life domains and scaling factors can be found in Decancq, Fleurbaey and Schokkaert (2015*b*).

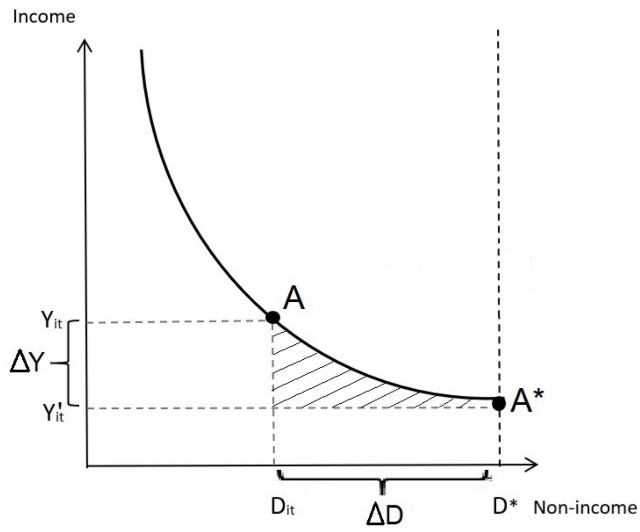

Fig. 3.5 Indifference curve between income and non-income domains

The process of computing equivalent income is divided into two steps. Firstly, the optimal outcome levels of non-income life domains are determined as D^*. An important assumption here is that D^* captures optimal or reference values of all domains which are set at the same maximal value of each life aspects for all individuals (see Decancq et al., 2017, for more detailed discussion)[8]. Then, based on the definition of equivalent income, the life satisfaction level given by equation (3.2) is equalised with life satisfaction level attained when individuals experience optimal values of non-income domains combined with equivalent income[9].

As individual i is indifferent between situation A and A^*, they are depicted as two points on the same indifference curve. The differences between actual income is denoted as ΔY and difference between the current versus optimal non-income domains are denoted as ΔD. Applying the concept of marginal utility (MU), a change in utility when income (Y) changes by one unit is captured as a change in utility

$$MU(Y) = \frac{\partial LS}{\partial Y} \tag{3.3}$$

And the change in other domains (D) is captured by:

$$MU(D) = \frac{\partial LS}{\partial D} \tag{3.4}$$

[8] More details of the optimal value will be discussed in the empirical models in Section 3.5.2

[9] The details of the calculation of equivalent income using estimated coefficients from the regression will be discussed in the Methodology section.

MRS is the rate at which if an individual gives up some amount of one “good" (e.g income) in exchange for another “good", they will maintain the same level of utility, MRS is theoretically computed as:

$$\mathrm{MRS}_{\mathrm{Y}}^{D} = \frac{MU(D)}{MU(Y)} = \frac{\partial D}{\partial Y} \tag{3.5}$$

This study uses the natural logarithm of income, hence, $\frac{\partial D}{\partial Y}$ is constant as the relationship between log of income $ln(Y)$ and non-income domains D will become linear. Assuming the difference between current non-income domains and the best level is ΔD, the total willingness to pay (WTP) to achieve the best level of non-income domains is:

$$WTP = \mathrm{MRS}_{\mathrm{Y}}^{D}.\Delta D = \frac{\partial D}{\partial Y}.\Delta D \tag{3.6}$$

Equivalent income is the difference between individual i’s actual income and i’s WTP to achieve the optimal level of non-income life domains, which can be computed as:

$$\mathrm{Y}_{\mathrm{it}}^{'} = \mathrm{Y}_{\mathrm{it}} - WTP = \mathrm{Y}_{\mathrm{it}} - (\mathrm{MRS}_{\mathrm{Y}}^{D}.\Delta D) = \mathrm{Y}_{\mathrm{it}} - (\frac{\partial D}{\partial Y}.\Delta D) \tag{3.7}$$

3.3 Literature Review

The concept of money-metric utility captured by an index number that represents individual preferences while being expressed in quantity (or monetary) units was introduced by Samuelson (1974) and Samuelson and Swamy (1974) and later the expression of money-metric utility was proposed to be ‘equivalent income’ by King (1983). Following the equivalence approach, Fleurbaey and Gaulier (2009) and Fleurbaey (2011) introduce a simple generalisation of this idea to encompass all relevant non-monetary life domains.[10]

The concept of creating an inclusive wellbeing measure that represents both monetary and non-monetary aspects is not a novel idea itself. However, it is not until early 2000s that this concept, with a strong focus on preferences, started drawing much attention, especially, regarding different approaches to obtain such a measure. This chapter follows a strand in the literature which is discussed in a series of papers by Fleurbaey (2005, 2006, 2009) and Fleurbaey and Gaulier (2009). In this branch of the literature, SWB data is utilised to derive equivalent income from relevant estimated coefficients from life satisfaction function.

[10] A similar generalisation was studied by Hammond (1994) in relation to the cost-benefit analysis of environmental externalities.

This section will focus on the empirical literature on the computation of equivalent income[11] using subjective wellbeing functions (e.g. satisfaction function). The literature review will be divided based on the two main research focuses including computing equivalent income for cross-country comparisons and the use of equivalent income as an interpersonal comparable wellbeing measure within a country. The main aim of this section is to review what has been investigated and to identify any gaps in the current literature.

3.3.1 Equivalent income in cross-country comparison

The first branch of the literature includes multi-country analyses. These studies use cross-country data to compare social welfare, and inequality in some research using different measures of wellbeing. One of the measures is equivalent income computed as a multi-dimensional measure that collapses both income and non-income life domains. These studies started by computing equivalent income at the individual level and then transformed that data to the societal level for international comparisons and inequality analyses. This could be done either through log transformation (Jones and Klenow, 2016) or through averaging method taking into account inequality (see Decancq and Schokkaert, 2016*a*; Ledić and Rubil, 2016) and decomposing inequality in equivalent income (Ledić and Rubil, 2020). In most of these studies, GDP per capita is used as a comparator to equivalent income in ranking countries.

The first study to discuss is Fleurbaey and Gaulier (2009), which applies the concept of equivalent income to compute a measure of living standards for cross country comparisons and empirically compares among 24 OECD countries for the year 2004. Besides GDP per capita, other aspects includes leisure, healthy life expectancy, risk of unemployment and household demographies and inequalities. The study calculates predicted willingness to pay (WTP) for each non-monetary domain and applies an average marginal WTP to approximate the average WTP for the population. It is worth noting here that even though in theory equivalent income is computed to respect individual preferences, practical applications need some approximations due to data limitations that preventing the computation of equivalent income using the individual preferences. It is argued that the marginal WTP for a unit improvement in non-income life domains from the current situation is over the whole population rather than over each single indifference curve. The results highlight some interesting changes in rankings of the 24 OECD countries when using equivalent income, compared to those using HDI and GDP using cumulative corrections. Overall, the results indicate that the ranking of countries using equivalent income depends on which non-income

[11] In some studies, 'equivalent consumption' is calculated from the same concept with equivalent income (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017).

factors considered in the life satisfaction regression or which non-income domains included in the computation of equivalent income.

A later study by Decancq and Schokkaert (2016*a*) (pg 21) also criticise the use of only income growth as “a too narrow-sighted measure of changes in wellbeing" to compare the growth of wellbeing across countries. The study discusses the concept of ‘equivalent incomes’ and illustrates the computation using the European Social Survey (ESS) for the years 2008 and 2010. The authors argue that different weighting schemes based on individual preferences should be applied when constructing an index of social wellbeing as individuals may have different ideas and preferences towards various life aspects. In addition, according to their view, it is necessary to capture cumulative deprivation[12] in the computation of such a synthetic wellbeing index. These data can be summarised in an individual-level matrix, which can be aggregated for the values of each domain and combined with the information about the distribution of these aspects. The study applies ordered logit estimation on life satisfaction and proposes a combination of household income per capita and four non-income domains including self-assessed health, (un)employment status, leisure and social interaction and physical and economic security. Decancq and Schokkaert (2016*a*) find that using different wellbeing measures leads to dissimilar conclusions for the worst-off and social progress in the EU. The findings highlight that the introduction of inequality aversion, results in a remarkably diversifying perspective on wellbeing progress among European nations. In particular, high educated individuals, especially women, experience more positive effect of income compared to their counterparts who are low- and middle-educated. Health seems to be more important to older and lower educated European citizens. Men tend to care more about (un)employment status and safety than women[13]. Regarding progress in social welfare, the results are based on the changes in social welfare calculated by aggregating results of individual wellbeing in each country using the parameter of equality aversion. The changes in social welfare given by income and equivalent income (i.e. yearly growth rates) between 2008 and 2010 are compared across countries. Using equivalent income compared to average income, results in the very top and bottom ranks are not very different. However, the most significant differences between the two rankings are the changes in ranking in the middle positions such as Germany, the Netherlands and Denmark. When using equivalent income,

[12]In the Statistical Release of the English Indices of Deprivation in September 2019, deprivation is broadly defined as a wide range of people’s living conditions. The reports stated that “people may be considered to be living in poverty if they lack the financial resources to meet their needs whereas people can be regarded as deprived if they lack any kind of resources not just income."(Ministry of Housing, Communities & Local Government, 2020).

[13]The result about safety is quite surprising, which could possibly be resulted from the use of “safety" variable (i.e. measuring the feelings of unsafely). The authors suggest in the case that these “feelings" are heterogeneous between males and females, the estimated coefficient might be influenced.

the relative importance of different non-income domains is revealed. Among all aspects, health, measured by self-assessed health, shows the largest effect on equivalent income and gets large weight on preferences as many survey participants have suffered from health issues, especially in the East European countries and, surprisingly in more developed countries like Germany and the Netherlands. Coming next in the rank is social interaction aspect, with Greece and Hungary to be disadvantageous while the quality of this domain is reasonably good in Denmark, the Netherlands, Spain, and Norway. Unemployment and feelings of safety seem to be less important among these considered domains in this study. Especially, unemployment shows only minor effect on wellbeing in average as this matter is more likely to affect only the jobless sub-group. One important finding in Decancq and Schokkaert (2016*a*) lies in the comparison in the inequality among European countries between the use of equivalent incomes and traditional income inequality. Overall inequality seems to be increased when considered cumulative deprivation in multiple domains, which results in shifts in the relative ranking positions among countries when comparing the figures across income and equivalent income.

A study by Ledić and Rubil (2016) also examines the differences in cross-country wellbeing comparisons using various wellbeing measures in European countries. Using data from the European Quality of Life Survey (EQLS) for 2007 and 2011, the study computes the respective means, inequality and social welfare levels using individual income and equivalent income. Similar to the study by Decancq and Schokkaert (2016*a*), in order to obtain equivalent income, besides disposable household income per adult equivalent, unemployment and self-assessed health are included. Besides that, other relevant non-monetary life domains combined in the study are housing quality, crime and environment quality. The findings show striking discrepancies in cross-country comparisons of equality in social welfare between those two money-metric wellbeing measures. However, the efficiency aspects (i.e. the average levels comparisons) or the ranking order of countries by the mean equivalent income is in accordance with those based on mean income. When mean equivalent income is considered, it accounts less than a half of average income in both 2007 and 2011 for all countries. This implies that WTP for the optimal non-income life domains adds up to more than half of mean income, in which the majority of the difference is the shortfall of health domain from ‘perfect health’ level. Despite that consistent ranking of countries using mean levels is found between income and equivalent incomes, the ranking by growth rates is substantially different. Inequality level calculated by equivalent income is significantly higher than income inequality. Regarding social welfare, the findings indicate that the cross-country disparity in equivalent income-based social welfare is affected more by variation in average levels of non-income aspects than by changes in mean income and income inequality. By contrast, the diversifications in the traditional income-based social welfare levels across countries are mostly driven by the variation in average income and a less noticeable contribution of income inequality. Therefore, combining non-income domains rather than exclusively focussing on income would potentially account for more than half of the cross-country variation social welfare.

Despite the fact that both studies by Decancq and Schokkaert (2016*a*) and Ledić and Rubil (2016) apply an ordered logit model and treat life satisfaction as ordinal, there are some noticeable differences across the two studies. While Decancq and Schokkaert (2016*a*) capture decreasing returns of each non-income domain using Box-Cox transformation, Ledić and Rubil (2016) treat domains as categorical variables and generate categorical dummies for each of the levels. Besides, the most striking difference is that the former study includes interaction terms between some life domains and individual characteristics to capture sub-group heterogeneous preferences, whereas the latter study treat preferences as common to all individuals. In this respect, the way that Ledić and Rubil (2016) obtain equivalent income deviates from the original motivation of equivalent income (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Fleurbaey, 2005, 2006; Fleurbaey et al., 2008).

Focusing on consumption as a proxy of income, Jones and Klenow (2016) compute a welfare metric using an expected utility framework that combines leisure, mortality and inequality for multi-country comparisons. The study explores both micro data from household surveys and cross-country macro data. The analyses focuses on the differences in welfare comparisons across countries when using GDP per capita and when using consumption-equivalent welfare measure. The findings show high correlation between the average equivalent consumption level and GDP per person despite substantial deviations between these two indicators. In particular, compared to the use of GDP per capita, using consumption-equivalent welfare measure for cross-country comparisons implies a smaller dispersion of welfare among developed countries such as France or the US, but much larger gaps when comparing between developed and developing countries (e.g. Latin America, Southern Asia, and sub-Saharan Africa). The main drivers of this result is poor mortality and extreme inequality.

In a recent study, Ledić and Rubil (2020) expanded the previous research in Ledić and Rubil (2016) with the same focus on cross-country welfare comparisons among 27 EU members over 2007 - 2011 and using the same dataset, the European Quality of Life Survey. Other similarities across these two studies including income domain computed using disposable household income per adult equivalent; five non-income domains including unemployment, general health, housing quality, crime and environmental quality, and same set of scaling factors. Therefore, the construct of equivalent income at the individual levels is the same across the two studies. In addition, Ledić and Rubil (2020) include some decompositions to calculate wellbeing inequality in different counter-factual distributions including the respective contributions of equivalent income inequality in income and non-income aspects, cross-country variation of social welfare and finally combining the above-mentioned two decompositions to analyse cross-country variation in equivalent income-based social welfare regarding contribution of income and non-income domains. The results, overall, are in line with previous research, which highlight the difference between equivalent income and income as cross-country welfare measures. Ranking countries based on growth rates of income versus equivalent income shows substantial disagreements while the ranking based on mean values of the two measures is very similar. Using equivalent income shows higher inequality across countries, and rankings of EU member states by both equivalent income inequality level. These changes over time are noticeably different from the conclusions by income. The decomposition results indicate the importance of non-income domains' contributions to equivalent income and equivalent income inequality, which strengthens the argument that the cross-country variation in equivalent income-based social welfare is deemed to be sensitive to changes in non-income domains.

3.3.2 The use of equivalent income in single-country analyses

Another branch of the empirical literature in equivalent income focuses on computing a wellbeing measure for individual comparisons within a certain country. The studies included in this section exploit household datasets to construct equivalent income using (equivalised) disposable household income (see Decancq and Neumann, 2014; Decancq et al., 2016; Defloor et al., 2017; Jara and Schokkaert, 2017) or expenditure per consumption unit (Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017). In these works, monetary and non-monetary domains are used as covariates in SWB regressions (e.g. mostly life satisfaction) to estimate the coefficients which are then used to compute equivalent income. Some of these studies compare the characteristics of the worst-off identified by equivalent income with those identified by other wellbeing measures such as life satisfaction, income or some objective measures. One point to note here is the differences in the data used across these studies. Although they all exploit micro-data, some papers construct equivalent income using single year data (see Decancq and Neumann, 2014; Decancq et al., 2016; Jara and Schokkaert, 2017; Schokkaert et al., 2011) while the others focus their analyses on a period of time (i.e. using panel data) (examples including Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017; Defloor et al., 2017; Fleurbaey et al., 2009).

The first study to discuss is by Schokkaert et al. (2011), which aims to measure job quality for policy evaluation. The study first sets out a conceptual framework on using subjective satisfaction to capture preferences and compute equivalent income. Then, empirical illustration is carried out through the application of the framework on the data from SONAR, a Flemish survey database with the birth cohort 1978, using an ordered logit model. The regression is estimated with job satisfaction (i.e. 1-5 ordinal scale) as a dependent variables. The job related aspects included are net monthly wage in full-time equivalent and a list of non-income domains such as subjective job characteristics[14] and objective job characteristics[15]. In addition, some interaction terms between the above mentioned domains and individual characteristics[16] are also treated as regressors. The results are compared with subjective job satisfaction, an (equal-weights) objective indicator[17], and an (average preference) objective indicator[18]. The findings indicate that the choice of specific wellbeing measures is important for policy evaluation. When considering job quality for school-leavers in Flanders, there are significant differences across the discussed wellbeing indicators. Using subjective satisfaction with job results in a rather small weight assigned to objective job characteristics, hence over-links the issue of low job quality with higher-educated individuals. This finding could be explained in the regression results in which higher educated workers are less satisfied with their jobs, ceteris paribus. Hence, not correcting for these differences in aspirations could lead to overestimations. The objective indicator based on the average levels of individual preferences is more similar with equivalent income than the (equal-weights) objective indicator[19].

Later studies extend the scale of the research rather than focusing on one certain aspect when obtain equivalent income. For instance, the working paper Fleurbaey et al. (2009) and the publication version Decancq, Fleurbaey and Schokkaert (2015*b*) explore the application of the framework of equivalent income using the Russia Longitudinal Monitoring Survey (RLMS-HSE), a panel from 1995 to 2003. This study employs an ordered logit fixed effects model to analyse the data while controlling for unobserved heterogeneity in the satisfaction regression. An important note from this research is that it derives the monetary metric of

[14]Physical demanding/ dangerous/ dirty job, Job that is a challenge and worth the effort, Job with a lot of pressure of time, Job with a lot of repetition, Job in collaboration with others, Job with results and possibilities to reveal capabilities, and Job with a lot of autonomy to decide.

[15]Dummies including company size larger than 50 employees, temporary contract, learning new skills during the first job and working in sector education.

[16]Successful school years (>12 years old), Mother's education low, Search time, Locus internal, Motivation to work from material aspects.

[17]A simple average of the normalized values of income and non-income job related domains, which equals to (value - min).(max - min), in which max and min are values of the best performers and the worst performers in each domain.

[18]This measure is calculated with respect to constant reference aspiration levels between jobs (average level) and does not correct for differences in aspirations. The constant reference aspiration levels in comparing between jobs is considered as a simple level shift, hence, this objective measure is irrelevant to preferences and has no impact on the relative job rankings.

[19]This measure is considered as an objective summary index constructed by applying uniform or equal weights which are simple average of normalised values of wages and other job domains.

wellbeing measure using consumption (i.e. expenditure per consumption unit as a proxy of income). Decancq, Fleurbaey and Schokkaert (2015*b*) argue that it is notably challenging to measure income in Russia due to its large informal economy during the studied period. In addition, spending can be used as a proxy of permanent income, which is the main component to compute a monetary wellbeing measure that respect preferences. Other non-consumption life domains considered to affect wellbeing in this study include self-assessed health, (un)employment status, housing quality and experiencing wage arrears[20]. The study only includes some interaction terms (which are significant at least 10%), between life domains and individual characteristics to account for heterogeneous preferences among sub-groups[21]. The results are in accordance with other studies in the literature, which indicate that the picture of wellbeing captured by equivalent income is dissimilar when compared with other alternative indicators such as material consumption, objective wellbeing measure[22] or life satisfaction. Using Spearman rank correlation test, Decancq, Fleurbaey and Schokkaert (2015*b*) confirm the highest correlation level is between equivalent income and the objective measure (i.e. $\rho = 0.64$), while low coefficients of only 0.48 and 0.25 are found between equivalent income and expenditure per consumption and between equivalent income and subjective satisfaction respectively.

In a later study, the same group of authors extend their research using the RLMS-HSE data in the period 1995 - 2005 (Decancq et al., 2017)[23]. The results from equivalent income calculation are used to decompose wellbeing inequality in four components to analyse wellbeing inequality in various counter-factual distributions. These distributions are constructed by 'neutralising' different sources of wellbeing inequality by decomposing the inequality in equivalent incomes into four components.

The first component accounts for the correction between wellbeing outcomes and evaluations/ preferences. It is indicated from the finding that neutralising the correlation between preferences and outcomes (i.e. preferences-first decomposition) would lead to a decreasing effect on inequality level. The second one respects heterogeneous preferences (i.e. preferences-second decomposition), which also results in a negative impact on wellbeing

[20]This variable captures the phenomenon that wages were delayed to pay, which was common in Russia during the studied period.

[21]Those interactions are: Young (dummy for age < 40) # Health, Young # Expenditure, Male # Health, Male # Unemployed, Rural # Health, Rural # House, Minority # Health, Minority # Expenditure, High education # House, High education # Unemployed, and High education # Wage arrears.

[22]This measure includes four domains: expenditure, health, housing and unemployment, of which each domain is normalised by (value - min)/(max - min) using values from the best performers (maximum value) and the worst performers (minimum value).

[23]The set of interactions included in this study slightly differs from the study in 2015. They include Rural # Expenditures, Higher-educated # Expenditures, Young # Health, Male # Health, Rural # House, Higher-educated # House, Young # Unemployed, Male # Unemployed, Higher-educated # Unemployed.

inequality. The third term of the decomposition focuses on the correlation among different outcome domains (i.e. preferences-third decomposition), which is based on an assumption of fixed preferences. The results indicate that the higher the correlation between outcome domains is, the higher the inequality becomes. The forth term considers inequality within each of the outcome aspects, which poses the largest influence of inequality in expenditure and health aspects on the overall level of inequality in the society. To progress further in the investigation of the contribution of heterogeneity in preferences in inequality, the study then focuses on between-within sub-group[24] decomposition. The results confirm the importance of preference heterogeneity in wellbeing inequality measure. It is noted that the results in this study would be specific in the case of Russia and may not hold if a similar research is carried out using a different dataset else where[25].

Using German data, Decancq and Neumann (2014) discuss five operational measures of wellbeing and the information required in each measure. Exploiting data from the German Socio-Economic Panel (GSOEP) in 2010, the study illustrates how to compute equivalent income using estimated relevant coefficients from an ordered logit life satisfaction regression. Main variables in the regression are three life domains including monthly household equivalised disposable income, objective health index and labour market status as well as interactions of income with binary indicators of socio-demographic characteristics to capture sub-group preferences (e.g. income # having partner, income # male and income # non-midlife[26]). A list of controls are also involved to account for the effects of individual characteristics such as education, age and personal traits. The computed values of equivalent income are then compared with four other alternative wellbeing measures including income, a composite wellbeing index[27], subjective wellbeing (i.e. overall life satisfaction in a 1-10 scale) and a measure based on individual von Neumann-Morgenstern (vNM) utility function[28]. The study focuses on the bottom distribution of each measure of wellbeing to compare the characteristics of the worst-off groups captured by different indicators and

[24] 16 reference sub-groups are partitioned using socio-demographic characteristics: gender, higher education, living in rural area, older than 40 years old.

[25] See Ledić and Rubil (2020), which was discussed in Section 3.3.1 for the application of decomposition method in cross-country analyses.

[26] This group includes individuals belonging to age-group 45-60 years old.

[27] An index that aggregates different life aspects using an equal weight scheme and sets the parameter capturing the degree of substitutability between domains equal 1. Hence, this measure allows a simple additive aggregation and perfect substitutability between transformed outcomes. It is, therefore, considered as an un-weighted average of the standardised outcomes in all domains.

[28] The vNM utility function takes into account risk attitude, which requires data on individual preferences over lotteries of vectors of life domains. The whole sample is classified into two groups of risk neutral or risk averse using the median of the risk attitude variable as a threshold. The ordinal preferences of the risk neutral respondents are the same as those in the computation of the equivalent income. The risk averse group is captured through a concave Box-Cox transformation.

examines the degree of overlap across them. The findings confirm different populations identified as the worst-off depending on the choice of wellbeing indicators. In particular, using income solely tends to pick up the profile of low-educated, unemployed citizens who are living without a partner as the badly-off. The composite wellbeing index also has the lowest distribution including the jobless group as unemployment amounts a relative large weight in this indicator. Life satisfaction, on the other hand, seems to captures individuals with more negative attitude toward themselves, which results in low satisfaction scores. Taking into account heterogeneous preferences, equivalent income is mostly affected by health aspects, which leads to an over-representation of unhealthy community such as pensioners and the disabled among the worst-off. Similar, the bottom group portrayed by the vNM utility has similar characteristics as those identified by equivalent income but is more risk seeking. Regarding the overlap across the five discussed wellbeing measures, the results show very low degree of overlap as expected from the portraits of the worst-off, ranging between 9% and less than 0.9% when including from two to five indicators. In addition, Decancq and Neumann (2014) report predicted WTP for health aspect ranging between € 1,300/month (income) to more than € 5,700/month (vNM and equivalent income) to go from current health to 'perfect' health. The figures for not being unemployed is noticeably lower, only between € 100/month in the full sample and up to € 1,050/month when considering the composite index of wellbeing. The differences between WTP for health and unemployment could partly stem from the binary nature of the unemployment domain while health domain has more than two levels. The authors stress that higher the WTP might mean respondents are about the relevant non-income domains but also implies that with higher WTP, the more the individual suffers from imperfect non-income domains according to his or her opinion about a good life.

In a later study by Decancq et al. (2016), equivalent income is computed in the context focusing on multidimensional poverty in Colombia using Colombian Encuesta National de Calidad de Vida (ECV) dataset for the year 2008. Equivalent income is derived from the information on material living standards (i.e. income), self-assessed health, education[29], housing[30], unemployment[31] and functioning security[32]. With a focus on the comparison between the two sub-groups living in rural and urban areas, the ordered logit regression includes interactions between each of the functioning variable and a dummy for 'rural area'. The results are then compared and contrasted among four alternative common wellbeing

[29] A categorical variable taking 0 for no formal education, 1 for primary education, 2 for secondary level and 3 for tertiary education.

[30] Measured by logarithm of imputed rent on different objective housing related characteristics.

[31] A binary variable takes 1 for being unemployed.

[32] A binary variable captures if an individual is covered by health insurance or not.

measures in Colombia including income, SWB measured by life satisfaction, the Colombian Multidimensional Poverty Index (CMPI) and the SIBEN index. Decancq et al. (2016) implement the Spearman rank correlation test to examine the correlation between the five wellbeing measures used in the study. The test reveals the lowest correlation between equivalent income and life satisfaction while the highest relation is confirmed between income and equivalent income. In addition, 10% of the bottom distribution which identifies the worst-off groups by each measure is identified to examine the overlap degree across measures. It is confirmed that different wellbeing measures of choice portrait non-homogeneous worst-off individuals. In particular, the highest overlap is at 5.3% between income and equivalent income, whereas any other pair of measures only coincide between 1% and 4%. The extent of overlap when considering three measures ranges between 1.5% and slightly higher than 2%.

A more recent study in Belgium by Defloor et al. (2017) obtain equivalent income using an application of OLS approach in the LEVO questionnaire in 2011 - 2013. The study investigates the computation of equivalent income using family income, health, education, social life, employment status and living in a pleasant environment as relevant life domains. In addition, different interactions between those functioning variables and individual characteristics[33] and personality traits[34] are added into the regressions. It is noted that the study computes equivalent incomes using three different SWB indicators, which are 'life satisfaction', 'happiness' and 'valuable' (i.e. the extent to which respondents consider their lives as valuable to themselves). The results of obtained equivalent incomes using these indicators are highly correlated, which are shown by high Spearman rank correlation coefficients of more than 0.8 in all pairwise ranking. The figures for correlation between equivalent income and SWB indicators are low, which are in line with previous studies such as Decancq et al. (2016). The findings indicate that different groups of worst-off might be identified by equivalent income when different SWB indicators are used to obtain this money-metric measure. In particular, men seem to be considered as badly-off when equivalent income is calculated using life satisfaction and feeling valuable. Individuals who have children are less likely to be identify in the 10% bottom distribution of equivalent income based on happiness.

A study by Jara and Schokkaert (2017) explores the effect of potential policy reforms on the income distributions using different wellbeing concepts including equivalent income. Using 2013 EU-SILC data for Sweden and employing the microsimulation model EUROMOD, the EU-wide tax-benefit microsimulation model, Jara and Schokkaert (2017) include equiv-

[33]Dummies for Female, Having children, Religious, Relationship, Age-18, and Age squared/1000.

[34]The personality traits include: Attitude, Altruistic, Solicitous, and Expectant. The variables are computed through a factor analysis using a set of 12 questions related to how respondents face the world. These factors are then included in the OLS regression directly as dummies and within interactions with wellbeing domains.

alised household disposable income and other non-income domains such as health, being unemployed and housing quality in the life satisfaction[35] regressions to estimate coefficients which are then used to compute equivalent income. To account for subgroup differences in preferences, interaction between the non-income life domains and dummies for personal characteristics (e.g. being male, having a higher education degree and being aged 40 or more) are included in the regressions. It is noted that the paper employs the information about self-rated affects or emotions available in EU-SILC 2013[36] as a proxy of personality traits to control for individual-specific time-invariant characteristics since the analysis only able to use a single cross-section of the data due to the availability of information on life satisfaction. In addition, the authors analyse the indirect effects of potential policy changes via their effects on health by simulating four counter-factual scenarios related to hypothetical policy reforms (e.g. additional social assistance payment, increase in child benefit, additional payment of housing allowance for pensioners and improvement in housing quality). The effects of these hypothetical reforms are examined through the average impacts on the beneficiaries (i.e. relative comparisons between additional tax payment of 25% and additional benefit received), and then broadened the scope over the whole population. The results indicate that policy reforms' impacts varies substantially depending on the wellbeing approaches used in the policy evaluation. In addition, the authors conclude that the use of equivalent income add more relevant information as a wellbeing measure and may benefit policy evaluations.

It can be concluded from the literature review that although there is an extensive literature in the computation of equivalent income using data from several countries, no studies have been published using UK household data. However, one study (Yang, 2018), while it does not obtain equivalent income, does apply the equivalence approach to obtain a multidimensional wellbeing index that has some similarities with HDI-type composite indices, which use only information about the attainments but not the preference relations, by integrating preferences between dimensions of wellbeing to assesses wellbeing and comparing wellbeing levels between individuals. The preference index is computed in two steps. Firstly, through a life satisfaction regression, indifference curves for the chosen wellbeing domains are estimated using relevant parameters from ordinal and interpersonally non-comparable information about preferences. Then, for each individual, the equivalent bundle is computed on the reference path which is located between the minimum and maximum attainment bundle in the potential attainment set of domains. This reference bundle makes the individual indifferent to her actual bundle of multidimensional well-being attainments (Yang, 2018). This is the preference index values, which can be used to rank the current situations of

[35]an 11-point scale ranging from 0 (“not satisfied at all") to 10 (“fully satisfied").

[36]This information indicates if respondents felt “very nervous", “down in the dumps", “calm and peaceful", and “downhearted or depressed" over the past four weeks using a 5-point scale measure.

various individuals who may have different preferences and different levels of attainment in wellbeing domains. These individual-level measures can be aggregated over the population.

Using all waves of the British Household Panel Survey (BHPS) to estimate heterogeneous preferences over different wellbeing dimensions, the analysis includes three life domains: equivalised (annual) household income, health[37] and education (i.e. measured by attainment in the education domain using an individual's highest qualification). The study applies the fixed effects ordered logit estimation developed by Ferrer-i Carbonell and Frijters (2004) to estimate the effect of those domains on overall life satisfaction, in which one regression only includes wellbeng domains and controls (i.e. homogeneous model) and one with wellbeing domains, controls and interactions between domains and a vector of dummy variables capturing scaling factors[38]. The relevant estimated parameters are then used to compute a preference-sensitive multidimensional index and compare with other wellbeing measures and HDI.

One finding from the regression is that income seems to have no statistically significant effect on subjective wellbeing among older individuals with lower education, whereas younger people tend to put more weight on health status than their older counterparts. To better explain the discrepancies between the preference index measure and other alternatives, several comparison tasks are carried out. The cross-tabulations of quintiles of the preference index and income implies little agreement between the two measures on the ranking of individuals bu different wellbeing measures. Contrasting the individual characteristics of the least-well-off by different measures of wellbeing indicates that disadvantages across income, health and subjective life satisfaction tend to be captured by the preference index and HDI approach. Income, on the other hand, tends not to identify those with poor health and low life satisfaction as the worst-off. The study concludes that the preference index would identify different worst-off groups in the society compared to the use of unidimensional measures such as life satisfaction and income.

3.4 Data

3.4.1 Dataset

The data used in the empirical analysis are drawn from Understanding Society - the UKHLS 2009 - 2020. This dataset was also used in the first study of this thesis, hence will only be

[37]This is a composite indicator derived using the predicted linear index from an ordered logit model of 'satisfaction with health'.

[38]A list of interactions is included in the regression: Young # income, Higher educated # income, Young # health, Unemployed # health, and Young # education, in which 'young' refers to 36 years old or less.

discussed briefly in this section[39]. With a total of 444,181 observations in the unbalanced panel, on average each individual appears in 5 waves.

The chapter will include three life domains: income, health and employment (i.e. economic activities), which are the most commonly used in the literature and are also frequently considered as objective policy outcomes. Except for income, which is a cardinal variable, the other aspects are treated as categorical. Details of each domain will be discussed below. The descriptive statistics of the data used in the analysis are reported in Table B.1 in Appendix B.

3.4.2 The Dependent Variable

In the empirical literature (see Decancq, Fleurbaey and Maniquet, 2015; Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017; Decancq and Neumann, 2014; Decancq and Schokkaert, 2016*a*; Decancq et al., 2016; Defloor et al., 2017; Ledić and Rubil, 2016), the most commonly used SWB measure is overall life satisfaction, which will be employed as the dependent variable in this chapter. Figure B.2 in Appendix B shows the distribution of life satisfaction in comparison with other wellbeing measures studied in this chapter. The distribution is negatively skewed, to the left (skewness = -1.076). The average level of life satisfaction of the whole population is 5.18 while the mode is '6' (with a frequency of 44.64%).

The distribution of life satisfaction in the UKHLS 2009 – 2020 for males and females is presented in Figure B.3 in Appendix B. On average, men reported slightly higher levels of life satisfaction (at 5.18) than women (at 5.17), which is not statistically significantly different from each other.

Regarding life satisfaction by age, the group of 16-32 year olds, 33-46 year olds and 47-61 year olds have similar distributions, which is quite close to the total population. The distribution for the oldest group is the most skewed to the left (see Figure B.4 in Appendix B).

3.4.3 Key Independent variables

This section describes the variables demonstrating different relevant life domains that may affect individual wellbeing, and a set of scaling factors used as controls.

As reported in Figure 3.6, the unbalanced panel of ten waves of UKHLS includes total 443,631 observations (86,948 individuals), of which 374,161 person-year observations (75,883 individuals) provide information on life satisfaction. However, the regressions

[39] Attrition was discussed in Chapter 2 with an additional analysis using multiple imputations reported in an Appendix. Therefore, this is not the main interest of neither Chapter nor this chapter.

are run on 369,915 observations when life domains alone are included in the models and the sample size significantly decreases to 173,731 (39,662 individuals) when all relevant interactions and controls are included. When restricted for balanced panel for one of the robustness checks, only 136,450 observations (13,645 individuals) remain in the panel, of which 126,947 person-year (13,621 individuals) observations have available data on life satisfaction. The regressions are then run on a rather small sample size of 67,189 observations (9,517 individuals).

Life Domains

Income

The income concept used in this study is attainment in the income domain measured by equivalised household income. The variable from the dataset is the net household monthly income, which summarises net monthly incomes from all members of the household including proxies and within household non-respondents (Gundi, 2017)[40]. Income levels from this variable is then equivalised using the OECD-modified equivalence scales, which is also provided within the UKHLS household database. The equivalised income values are adjusted for inflation using CPI data with base year 2009 (Data from ONS, 2019*a*). The study opts to use natural logarithm of real income as a common practice[41]. The mean values of real equivalised income is plotted in Figure B.5 in Appendix B.

Self-assessed Health

When considering non-income domains, health aspect is the first to include as the effect of health on individual wellbeing has been confirmed not only in the equivalent income literature but also the broader literature of wellbeing research (see Chakravarty and Lugo, 2019; Clark, 2016; Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq and Neumann, 2014; Fleurbaey, 2016*a*,*b*; Fleurbaey and Gaulier, 2009; Stiglitz et al., 2009). In this chapter, health is measured through ‘self-assessed health’ question (i.e. general self-assessment of an individual’s health or subjective health) as *“In general, would you say your health is...?"*. The answers are in five categories including *‘Excellent’, ‘Very good’, ‘Good’, ‘Fair’, and ‘Poor’*.

A different approach that is proposed by Van Doorslaer and Jones (2003) and applied in Decancq, Fleurbaey and Maniquet (2015) combines objective health and subjective health to compute a composite index of the health domain. In this approach, individual health is derived as a composite index using coefficients estimated from a regression using the

[40] Data adjusted for council tax liability and benefit is available only with the Understanding Society Special Licence.

[41] Equivalised income has a right skew (mean=1925.28, which is larger than median=1627.05), hence using log transformation would make the distribution of income more symmetric.

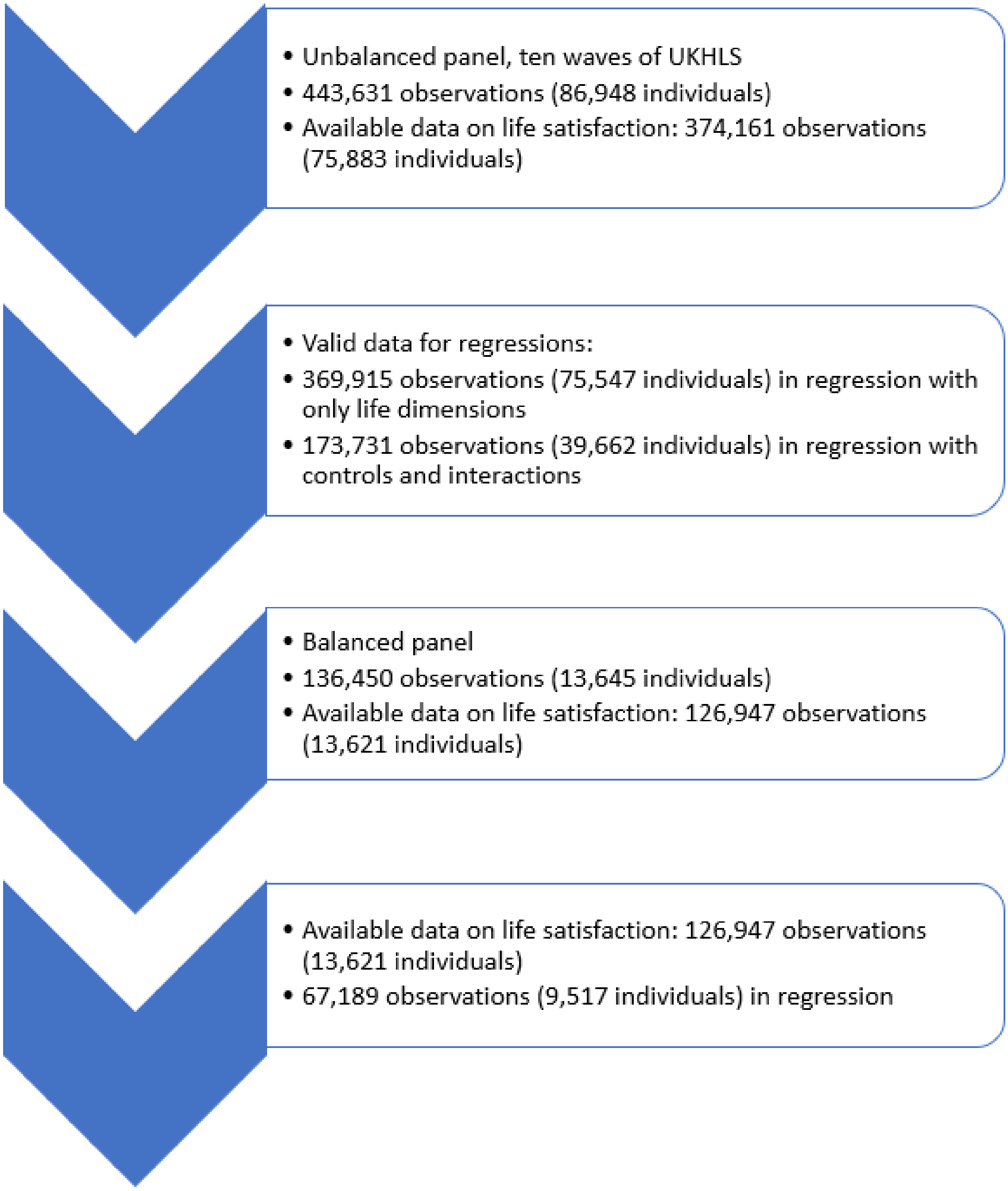

Fig. 3.6 Summary of the number of observations (individuals) in the whole sample and valid data for the analysis

self-assessed health as the dependent variable and objective health indicators (e.g. diabetes, heart attack, anaemia, hospitalization and recent operations) as explanatory variables.

In the UKHLS there is a set of variables capturing a series of health conditions (hcond) and whether respondents still have conditions (hconds). However, the two sets of variables do not capture exactly the same conditions and these variables change across waves and none was collected in wave 2. In addition, these objective health indicators only provide information on whether a respondent has certain health conditions rather than the severity or duration of their conditions. In contrast, the measurement (as opposed to the concept) of adaptation requires the condition or the impairment to be stable – otherwise, it would not be possible to conclude if the change in life satisfaction was caused by a change in the impairment or it was the results of adaptation. Therefore, these objective indicators were not used to compute individual health domain. Since hedonic adaptation is based on the assumption that the impairment remains stable over time (Frederick and Loewenstein, 1999), and if the condition is improved, there is no scope to examine hedonic adaptation. This raises questions regarding whether these objective health indicators might be too crude to explain self-reported health and whether they are relevant to the study of hedonic adaptation to ill health.

Given that life satisfaction and self-assessed health are both self-reported variables and possibly subject to the same set of personal reporting patterns that are unobserved, there may be concerns over spurious correlations where no causal relationship exists. However, as the analysis is based on an ordered logit FE approach, the model limits potential sources of bias due to time-invariant characteristics that influence both SA health and Life satisfaction (Collischon and Eberl, 2020).

The health domain in this study is treated as a categorical variable. From the original variable, three dummies are generated as ‘Excellent and Very good Health’ (i.e. grouping the first and second categories), ‘Good health’ and ‘Fair and Poor health’ (i.e. grouping the last two categories), of which the last dummy will be treated as the baseline in the model. There are two main practical reasons for grouping these categories. Firstly, a test for significant difference between categories shows that there is no statistically difference between ‘excellent’ and ‘very good’ health and between ‘fair’ and ‘poor’ health. Secondly, the distribution of ‘excellent health’, ‘fair health’ and ‘poor health’ are quite small compared to ‘very good health’ and ‘good health’, which in some models results in insignificant coefficients. By grouping the categories as discussed, the coefficients related to self-assessed health become more significant and meaningful. The distribution of self-assessment of health is reported in Figure B.2 in Appendix B . Regarding the distribution of health across waves, the majority of respondents report very good or good health in all waves. More than 30% state that they have very good health and between 25% and 30% report good health. The figure for poor health accounts for the lowest proportion in all waves, around 5%. The distribution of health is quite similar between male and female respondents. Regarding age, the youngest group (age 16-32) reports the highest proportions of excellent and very good health, whereas the rates for the same categories are the lowest in the oldest group compared to other age groups. The relative changes in health categories when people get older follow the trend that higher proportions of fair and poor health are reported among older respondents. Distribution of the Health domain is reported in Figures B.7, B.8 and B.9 in Appendix B.

(Un)employment

The second non-monetary domain is employment, which is also included in many previous studies such as Decancq, Fleurbaey and Schokkaert (2015*b*); Decancq et al. (2017); Decancq and Neumann (2014); Decancq and Schokkaert (2016*a*); Decancq et al. (2016); Defloor et al. (2017); Ledić and Rubil (2016) and Petrillo (2018). The variable is drawn from the question that asks respondents about their current economic activity *"What best describes (your) current employment situation?"*. The answers include 10 to 11 options[42], of which a set of dummies capturing whether an individual reported being 'employed', 'unemployed' (the baseline) or 'not active in labour market' is generated (see Figure B.2 in Appendix B for distribution of these three categories generated from the economic activities variable). Most of the categories grouped into "Not active in labour market" account for less than 10% of the total distribution, except for 'retired' at 23%. Based on this question, this chapter does not distinguish between short-term (i.e. the unemployed duration is within a year) and long-term unemployment (i.e. at least 12 months out of work). It is noted that in this demonstration, the group approach contrasts being involuntarily 'unemployed' versus 'employed' and 'not active in labour market' (i.e voluntarily unemployed). Previous research has shown a strong effect of unemployment relative to employment on individual wellbeing, such as Clark (2003, 2006); Clark and Oswald (1994); Di Tella et al. (2001); Lucas (2005) and Clark and Georgellis (2013), hence unemployment is here considered. Distinguishing between being 'unemployed' and 'inactive in labour market' would separate the effects of being voluntarily out of labour market in comparison to whose who want to work but cannot find a job (i.e. unemployment).

Scaling Factors

Demographic Characteristics

The UKHLS contains extensive information on individual characteristics. A set of variables that describe respondents' socio-demographic characteristics are included as scaling

[42] 1-Self employed, 2-In paid employment (full or part-time), 3-Unemployed, 4-Retired, 5-On maternity leave, 6-Looking after family or home, 7-Full-time student, 8-Long-term sick or disabled, 9-On a government training scheme, 10-Unpaid worker in family business, 11-Working in an apprenticeship (only starting from wave 3).

factors: age (i.e. included as *age*, age^2 and age^3), education (i.e. the highest qualification ever reported is used to generate a dummy for having university degree or higher education), marital status (i.e. categories: married or as married, single and others), owned home outright[43], household size (i.e. dummy capturing whether an individual is living with other people), having dependent children, living in rural area, and social status[44] (i.e. categories: higher social status, middle social status and lower social status). Similar variables have been used as standard controls in many studies using life satisfaction and happiness regressions (Clark, 2003; Clark and Georgellis, 2013; Decancq and Neumann, 2014; Di Tella et al., 2001, see)[45].

Hedonic Adaptation

In addition to the standard controls, a set of dummies capturing duration of impairment is included to account for hedonic adaptation to impairment[46]. As discussed in Section 3.2.3, scaling factors might change the cardinalisation of preferences as they reflect expectations and aspirations. Having health as a life domain and including adaptation to impairment as a scaling factor will theoretically help to capture any changes in the intercept of preferences (as opposed to changes in in gradient/ slope) due to adaptation and returning to the baseline of life satisfaction overtime after the onset of impairment. In Chapter 2, the results confirm that there is negative and significant effect om life satisfaction from the onset of impairment, that these can be present over different durations up to eight to nine years, and there is no significant evidence of complete adaptation within the duration of the data. In theory, controlling for adaptation to impairment is important as this may change the individual's aspiration and expectation. Given the analysis in Chapter 2 has found that the coefficients of all durations of impairment up to nine years since onset remain negative and significant, the parameters related to duration or lag of impairment account for a downward adjustment of life satisfaction when individuals suffer from impairment. This, as a result, will potentially lead to a higher preference weights on better health levels (i.e. excellent or very good health and good health) compared to the baseline of fair or poor health. If adaptation is not controlled for, the results would be biased. One difference in the set of lags (or duration) of impairment compared to Chapter 2 is that the set of lags here includes onset of impairment,

[43]The pooled data across all ten waves used in this study have 32.47% owning home outright, 37.91% on mortgage, 28.50% renting or part-renting part-owning, and 1.12% on other schemes. Grouping the latter three categories into "not owning home outright" as opposed to "owning home outright" is to capture the distinction in the financial condition between the two groups. Those who own home outright are more likely to have less burden from housing costs as they do not have to pay mortgage or rent.

[44]This variable is derived from the Registrar General's Social Class (SC) of current job.

[45]Most of these variables were discussed in more details in the Data section in Chapter 2.

[46]The set of dummies for duration of impairment is constructed in the same way that it was done in Chapter 2.

being impaired for one to two years, two to three years and three years or longer (as opposed to the set of eight dummies capturing up to eight to nine years of being impaired since the onset in Chapter 2). The decision to include this set of lag dummies is based on practical reasons, which are: (1) the number of observations in later lags (i.e. longer than three years) are rather small, and (2) there is little to no statistical difference in the effects of being impaired for four, five and up to nine years compared to three years since onset.

The inclusion of adaptation to impairment in this chapter is for illustrative purpose only, rather than implying a focus on impairment. In the adaptation literature, adaptation is confirmed in many life events such as changes in marital status (e.g. divorce, marriage) or employment (see Clark et al., 2008; Clark and Georgellis, 2013, for more discussion). Similar approach could be taken to account for adaptation to particular life events.

3.5 Methodology and Empirical Models

3.5.1 Theoretical and ideal model specifications

This section will explain the econometric technique used in the regressions to estimate relevant coefficients that are used to construct equivalent income using the data from UKHLS 2009 - 2020. The econometric specification of life satisfaction equation in the above equation is then written as:

$$LS_{it} = \alpha_i + \mu_t + \beta_1 ln(Y_{it}) + \beta_2 lnY_{it}\#Z_{it} + \sum_{k=1}^{K} ({\gamma_1}^k D_{it} + {\gamma_2}^k Z_{it}\#D_{it}) + \delta C_{it} + \varepsilon_{it} \tag{3.8}$$

which can be simplified as:

$$LS_{it} = \alpha_i + \mu_t + (\beta_1 + \beta_2 Z_{it}) \cdot ln(Y_{it}) + \sum_{k=1}^{K} ({\gamma_1}^k + {\gamma_2}^k Z_{it}) \cdot D_{it} + \delta C_{it} + \varepsilon_{it} \tag{3.9}$$

in which Y_{it} captures income of an individual i at time t. D_{it} represents non-income life domains (e.g. health and employment status), Z_{it} are socio-demographic characteristics (e.g. education or social status) and C_{it} is a vector of standard controls (e.g. age, household size, etc.). β_1 and β_2 are coefficients capturing the effect of income and interactions between income and socio-demographic characteristics on life satisfaction, while ${\gamma_1}^k$ and ${\gamma_2}^k$ are coefficients related to k non-income domains and interactions between those and Z_{it}. Individual fixed effects and time trends are captured by α_i and μ_t. ε_{it} is the error term. The individual characteristics or scaling factor (s_{it}) may include both socio-demographic characteristics Z_{it}

and the standard controls C_{it}. The interaction effects between Z_{it} and relevant life domains are captured by the coefficients β_2 and $\gamma_2{}^k$ in equations (3.8) and (3.9), which have an impact on people's trade-off across various life aspects. The standard controls C_{it} may capture changes within individual and differences across individuals in aspirations and expectations that might affect life satisfaction levels even when preferences remain the same. In contrast, changes in so-called socio-demographic characteristics Z_{it} would change preferences. These effects are captured by the interactions between Z_{it} and life domains. The differences between Z_{it} and C_{it} are displayed in the computation of equivalent income in equations (3.10), (3.11), (3.12) and (3.13). In particular, Z_{it} is included in the equivalent income equation, whereas C_{it} is not.[47]

Based on the definition of equivalent income as the level of income combined with the optimal non-income life domains that would result in a bundle that an individual finds equally attractive as his or her current situation, the coefficients estimated from the life satisfaction regression expressed in function 3.9 can be expanded as:

$$\begin{aligned} LS_{it} &= \hat{\alpha}_i + \hat{\mu}_t + (\hat{\beta}_1 + \hat{\beta}_2 Z_{it}) \cdot ln(Y_{it}) + \sum_{k=1}^{K} (\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}) \cdot D_{\mathrm{it}} + \hat{\delta} C_{it} \\ &= \hat{\alpha}_i + \hat{\mu}_t + (\hat{\beta}_1 + \hat{\beta}_2 Z_{it}) \cdot ln(\mathrm{Y}'_{\mathrm{it}}) + \sum_{k=1}^{K} (\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}) \cdot \mathrm{D}^* + \hat{\delta} C_{it} \end{aligned} \tag{3.10}$$

in which D^* captures the optimal levels of non-income domains and $\mathrm{Y}'_{\mathrm{it}}$ is equivalent income. From the above functions equivalent income is calculated as:

$$(\hat{\beta}_1 + \hat{\beta}_2 Z_{it}) \cdot ln(\mathrm{Y}'_{\mathrm{it}}) = (\hat{\beta}_1 + \hat{\beta}_2 Z_{it}) \cdot ln(Y_{it}) + \sum_{k=1}^{K} (\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}) \cdot D_{\mathrm{it}} - \sum_{k=1}^{K} (\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}) \cdot \mathrm{D}^* \tag{3.11}$$

$$ln(\mathrm{Y}'_{\mathrm{it}}) = ln(Y_{it}) + \sum_{k=1}^{K} \left(\frac{\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}}{\hat{\beta}_1 + \hat{\beta}_2 Z_{it}} \right)' \cdot (D_{it} - \mathrm{D}^*) \tag{3.12}$$

which yields

[47]In practice, a backward and forward stepwise process was taken to decide which interactions between life domains and individual characteristics to include (i.e. $Z_{it} * D_{it}$ by eliminating those non-significant interactions gradually based on their p-values (i.e. keeping the most significant ones up to 5% significance). The other characteristics were included in the regressions as controls (i.e. C_{it}).

$$\mathrm{Y}_{\mathrm{it}}^{'} = Y_{it} \cdot exp\left[\sum_{k=1}^{K}\left(\frac{\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}}{\hat{\beta}_1 + \hat{\beta}_2 Z_{it}}\right)^{'} \cdot (D_{it} - \mathrm{D}^{*})\right] \tag{3.13}$$

The equation (3.13) is used to compute equivalent income when the data for a given income level and values of other non-income domains are available. Marginal rate of substitution $\mathrm{MRS}_{\mathrm{it}}^{YD}$ between income and non-income domains can be computed using the corresponding estimated coefficients as in equation (3.14). It is noted that $\mathrm{MRS}_{\mathrm{it}}^{Y\&D}$ is time and individual dependent, which is expressed by subscripts *it*. In other words, individuals with different income and/or different socio-demographic characteristics at different time might have different MRS.

$$\mathrm{MRS}_{\mathrm{it}}^{Y\&D} = Y_{it} \cdot \frac{\hat{\gamma}_1{}^k + \hat{\gamma}_2{}^k Z_{it}}{\hat{\beta}_1 + \hat{\beta}_2 Z_{it}} \tag{3.14}$$

Due to data limitation, only three domains are included in this chapter namely income (Y_{it}), health condition (H_{it}) and employment status (E_{it}). Theoretically, to account for individual heterogeneity of preferences, a possible approach could be to include all possible interactions between life domains and scaling factors (i.e. individual characteristics) (Decancq, Fleurbaey and Schokkaert, 2015*b*). With the empirical model in this chapter, there are many potential interactions between the three life domains and individual characteristics. Having too many interactions in a model is data-demanding given the high correlation between terms and increases the problem of driving out the main effects. Therefore, not all interaction terms are included in the empirical model. This results in only average preferences are estimated at the subgroup levels rather than at the individual levels.

In order to decide which interactions to take into consideration, stepwise procedures with backward and forward elimination are followed. The backward process started by running an ordered logit fixed-effects regression with a full set of possible interactions between functioning variables (i.e. life domains) and scaling factors. Then, an interaction or a group of interactions (e.g. Excellent/Very good Health × Rural and Good Health × Rural) are excluded based on the magnitude of related p-value. Those with largest p-values that imply insignificant effects are excluded successively until only interaction terms at 5% significant level are kept in the estimation. In addition, a forward procedure is carried out to test the final result using backward stepwise procedure. In the forward stepwise procedure, firstly, the regression will all possible interactions are estimated and p-values of those interactions are compared to decide which interactions to include first. In this case, a group of interactions with the lowest p-values in the full interactive regression (i.e. Excellent or very good health × Education and Good health × Education) is included first. Following that, those with the second lowest p-values (i.e. Employed × Living in rural area and Not active in labour market × Living in rural area) are added. However, the newly added interactions are insignificant. Hence, the final model only includes interactions between health and education. This result is consistent regardless of the types of procedure, whether forward or backward.

3.5.2 Empirical demonstration

Ordered Logit approach is chosen as the dependent variable, life satisfaction, is treated at an ordinal scale. Since many of the main variables in this chapter involve subjective scores (e.g. life satisfaction and self-assessed health), which might suffer from biases owing to unobserved heterogeneity or individual expectation and aspiration, the estimated parameters from the regression may be biased (see Defloor et al., 2017; Ferrer-i Carbonell and Frijters, 2004; Jara and Schokkaert, 2017, for more discussion). In this case, using panel data to control for the possibilities of correlated time-invariant unobserved heterogeneity could be a solution. Therefore, the UKHLS panel is utilised to model individual wellbeing through an Ordered Logit Fixed Effects approach using the 'Blow-up and Cluster' Stata program by Dickerson et al. (2014)[48]. Following the regressions, the estimated parameters of the model with interactions are then used to compute equivalent income.

The computed equivalent income is then compared with equivalised income and life satisfaction to examine the similarities and differences between these wellbeing measures as well as the degree of overlap of the worst-off identified by each pair of measures (equivalent income versus equivalised income; equivalent income versus life satisfaction). To examine the extent of consistency between equivalised income and equivalent income to identify the worst-off, the study compares the group at the lowest end of the distribution for each of these two measures. First, the least-well-off 10% based on equivalent income are identified for each wave. Next, the same number of observations with lowest levels of equivalised income is identified to check for the level of overlap between the two groups. Another check is cross-tabulation of quintiles of equivalised income and equivalent income in the whole panel and across waves.

In addition, to check for degree of overlap between life satisfaction and equivalent income, a tabulation between life satisfaction when life satisfaction equals one, two or three and the quartiles of equivalent income is carried out. Across all the waves and in the pooled data sample, the distribution of the three lowest levels of life satisfaction (i.e. life satisfaction between one and three) is between 23% and 28% of total number of observations of self-reported life satisfaction. Therefore, these groups of the least satisfied with life overall are

[48]The programming codes are included in section B.8 Appendix B.

compared with the quartile groups by equivalent income to analyse the correlation across these two measures of wellbeing.

Furthermore, the portraits of the worst-off by equivalised income, equivalent income, life satisfaction and relevant life domains are captured to examine the characteristics of the worst-off identified by each measure and life domain. To do so, the first step is to capture the group of all observations reporting life satisfaction of one as the reference group. The reason to use life satisfaction as the reference is (i) life satisfaction is a discrete measure; and (ii) the number of observations with life satisfaction equal one is the smallest number of the worst-off across all the other measures and life domains. Having the smallest number of observations as the reference group would mean that all the observations from other categorical life domains have the same (lowest) value (i.e. the worst-off in employment domain are those who are unemployed and those badly-off in health domain are fair and poor health). Secondly, the bottom groups identified by equivalised income and equivalent income are captured by restricting the group with the same number of observations in the reference group. As self-assessed health and unemployment are categorical variables and the number of observations at the bottom distribution is larger than the figure for the reference group, a random seed is included in the selection process to randomly capture the same number of observations identified as worst-off all domains across all waves.

Lastly, in order to understand further the correlation between equivalent income and equivalised income, life satisfaction and relevant life domains, Spearman Rank Correlation tests are carried out.

3.5.3 Robustness checks

A number of checks are carried out to test for the robustness of the main results. As mentioned in Section 3.4.3, income used in the main analysis is equivalised income at a given time point. One possible check is to use 3-year moving average income as an alternative of income. This check aims to account for fluctuations in income across waves, for example, an artist has a boost in income in one year when he sells some of his paintings. The average level of equivalised income is calculated by taking the mean of income at the individual level across three continuous years (i.e. average income in 2010 is calculated by taking the mean of income in 2009, 2010 and 2011) in order to account for some of the above-explained fluctuations. Doing so leads to a loss in the number of observations as the observations in the first year and last year an individual appears in the panel are excluded (see Figure B.5 in Appendix B for mean of equivalised income and average equivalised income over years). In this check, regressions are operated separately for equivalised income and average equivalised income using Ordered Logit RE (OLOGIT) and Ordered Logit FE (BUCOLOGIT). It is noted that all regressions are run on the same number of observations which is restricted to only those included in regressions using average income.

The second robustness check is to employ different techniques including Ordinary least squares (OLS), linear FE and OLOGIT to analyse the data so as to test whether the relationships between life domains and life satisfaction are maintained across different econometric approaches. Collischon and Eberl (2020) argue that both OLS and FE approaches are to estimate linear regressions. They are both known for 'simplicity' in using and interpreting, 'wide applicability' and 'efficient computation'. When comparing these two approaches, FE provides more advantages than OLS since FE models controls for time-invariant variables that may correlate with the treatment variables (i.e. avoiding treatment effect biases) or the outcomes of interest over time (Collischon and Eberl, 2020). OLOGIT (and other logistic models) are more suitable to estimate ordinal variables. However, the general OLOGIT used in the robustness check is a random effects approach, which assumes that individual-specific characteristics are uncorrelated with the outcome variables. This assumption is rather simplistic and in many cases does not hold, which is the main disadvantage of the random effect approach when comparing with the fixed effect approach (Schmidheiny and Basel, 2011). Due to the discussion above, these different regression techniques are only used as robustness checks to the main approach of ordered logit FE modelling. Similar to the first robustness check, all of these techniques are applied on the same sample to ensure that any potential differences across approaches come from different techniques rather than sample and sample size.

Lastly, the BUCOLOGIT regression is run in a balanced panel to ensure that the results in the unbalanced panel (the main analysis) are not driven by respondents in the panel for only a short time.

Since the main objective of this chapter is to estimate equivalent income using the parameters from the life satisfaction regressions, the coefficients from the regressions in the above-mentioned robustness checks are used to compute levels of equivalent income, which are then compared across the checks and with the main results.

3.6 Results

3.6.1 Regression results

Following the model specification given by equation (3.8), the estimation results are presented in Table 3.1. The first column shows the results of the regression including only equivalised income and non-income domains (i.e. no controls and no interactions). The second column reports the results of the same model specification but the sample is restricted to the specific sample as one with controls. The third column presents a model that includes all of the chosen life domains and standard controls but does not account for preference heterogeneity by subgroups. The next column includes all life domains and interactions but the set of controls does not account for adaptation. The last column extends the regression in the third column by adding interactions between life domains and scaling factors to represent a model that captures differences in preferences across sub-groups such as people with university degree.

In comparison with the baseline, the effects of all life domains are in line with the wellbeing literature using life satisfaction (see Dolan et al., 2008; Ledić and Rubil, 2016). Log of equivalised income has positive and significant effect at 0.1% on life satisfaction. The estimated coefficient of income is 0.051 in the unrestricted-sample simplest model (i.e. first column), which becomes quite close to the results in the regression with controls when the sample is restricted to the same as the regression with controls (second result column). The figures for income in the model with full controls, the model with controls but without adaptation and the full regression with controls and interactions are at 0.114, 0.112 and 0.113 respectively.

The positive sign related to coefficients of 'Excellent or very good health' and 'Good health' implies that compared to the baseline or reference group of 'Fair or poor health', better health states have positive impacts on individual wellbeing (i.e. positive corresponding coefficients significant at 0.1% in all regressions). In the full regression with interactions, having 'Excellent or very good health' compared to 'Fair or poor health' has a positive impact of a magnitude that is more than 11 times larger than the positive of doubling income (i.e. $0.890/0.078 \approx 11.4$)[49]. Having 'Good health' is almost twice less valuable for life satisfaction than having 'Excellent or very good health' (i.e. $0.890/0.504 \approx 1.77$), ceteris paribus. These results confirm the importance of health aspect in individual wellbeing measured by life satisfaction and reaffirm that this domain should be taken into account when measuring wellbeing. When comparing the results in the last two columns (i.e. model without controlling for adaptation to impairment versus model controlling for adaptation for impairment), both coefficients related to the health domain show similar results across models, although those in the model without adaptation are more positive.

Likewise, the strong positive impact of being 'Employed or self-employed' on life satisfaction is confirmed at 0.1% significant. The figures for the other regressions including one with controls and one with controls and interactions are 0.601 and 0.599 respectively.

[49] The difference between natural logarithm of double income and natural logarithm of income is $ln(2Y) - ln(Y) = ln(2) \approx 0.693$. Hence, increasing natural log of income by 0.693 is equivalent to doubling income, which is associated with a log-odds of life satisfaction by $0.693 \cdot 0.113 \approx 0.078$).

'Not active in labour market' also shows positive and significant effects at 0.1% on life satisfaction when compared to the baseline of unemployment. This effect is consistent across all regressions in Table 3.1. Rarely differences are observed between a model with and without adaptation regarding the effect of the Employment domain.

The interaction effects between self-assessed health and higher education highlight some interesting results, which are similar between the models presented in the last two columns. The positive and significant coefficients between 'Excellent or very good health' and 'Good health' with the dummy 'Higher education' show that life satisfaction of people with university degrees or equivalent is more influenced by given improvements in health condition compared to people with lower education levels, given the baseline consisting of people with fair and poor health and without university degree. In the last column when the interactions between health domain and higher education are included, the coefficient related to 'Education: University' becomes negative and significant. This coefficient captures the estimated effect (in the log odd ratio metric) of higher education (i.e. contrasting having a university degree and not holding a degree) conditional on 'having fair or poor health', which implies that for people with fair or poor health, having a university degree has a negative and significant effect on their life satisfaction.

The effects of the socio-demographic variables are generally as expected in a typical wellbeing regression using overall life satisfaction (Clark et al., 2008). In addition, the regressions control for adaptation to impairment with the set of dummies capturing the duration of impairment from the onset to three or more years remaining impaired. The set of dummies for duration of impairment have negative and significant coefficients between 0.1% and 5% significance. This set of dummies capture changes in life satisfaction related to the effects of and hedonic adaptation to impairment. There is no evidence to confirm complete adaptation to health impairment after three or more years since onset as all coefficients related to duration of impairment remain negative and significant. This result is in line with those found in Chapter 2. Controlling for adaptation to impairment in this chapter accounts for fluctuations in life satisfaction levels when individuals experience health conditions that might affect their aspiration and evaluation of overall life satisfaction.

Regrading the effect of age on life satisfaction, the U-shaped pattern is confirmed as the coefficient related to age is negative while one related to age squared is positive. In average, at the age of 53, life satisfaction is at its lowest level of 4.9 and started increasing again with age. This result is commonly found in the literature (see Blanchflower and Oswald, 2004; Clark, 2003; Clark and Oswald, 2006; Frey and Stutzer, 2002; Frijters and Beatton, 2012; Oswald and Powdthavee, 2008; Pagan, 2010; Van Landeghem, 2012). Keeping all other factors the same, being married or living together as married and being single both show a positive relationship with life satisfaction with significant coefficients at at least 5%. Higher education shows negative but insignificant effect on life satisfaction in the model without interactions. The effect becomes significant at 5% when interactions with health domains are included in the regression (see Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017; Yang, 2018, for discussion with similar results). Living in a rural area in comparison with urban lives is observed to be related to higher level of satisfaction with life, which is implied by a positive and significant coefficient of 0.099 and 0.101 in the regression including controls and one with controls and interactions. Owning a home outright is associated with a positive and significant effect on life satisfaction ($p\text{-value} < 0.05$). Other controls including living with other people (i.e. household size is larger than one), having children and having high or middle social status are insignificant.

To further examine any differences in the estimations with and without accounting for adaptation, the parameters reported in the last two columns in Table 3.1 are used to compute equivalent income in some hypothetical scenarios in Table 3.2 below.

Across all scenarios reported in the table above, the estimated equivalent income levels from the main analysis (i.e. accounting for adaptation) are higher than the figures for the model that does not control for adaptation. The relative differences (i.e. percentage-wise) are larger as the health domain gets worse. However, the differences in the estimated equivalent income in these examples are very small, which is possibly due to the finding that people do not fully adapt to impairment within the studied time frame (i.e. up to eight to nine years since onset).

Table 3.1 Ordered Logit FE models

	No controls	No controls (Restricted sample§)	With controls (C_{it})	With interactions (No adaptation)	With interactions ($C_{it}, Z_{it}\#D_{it}$)
Equivalised income	0.051***	0.122***	0.114***	0.112***	0.113***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Excellent or Very Good Health	0.999***	1.015***	0.994***	0.913***	0.890***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)
Good health	0.628***	0.589***	0.576***	0.519***	0.504***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Employed and self-employed	0.284***	0.588***	0.601***	0.599***	0.599***
	(0.03)	(0.13)	(0.13)	(0.13)	(0.13)
Not active in labour market	0.392***	0.681***	0.624***	0.621***	0.622***
	(0.03)	(0.14)	(0.14)	(0.14)	(0.14)
Year became disabled			-0.114***		-0.114***
			(0.02)		(0.02)
Disabled for 1-2 years			-0.161***		-0.160***
			(0.04)		(0.04)
Disabled for 2-3 years			-0.128*		-0.127*
			(0.05)		(0.05)
Disabled for 3 years or more			-0.157**		-0.155**
			(0.06)		(0.06)
Age			-0.071	-0.073	-0.074
			(0.05)	(0.05)	(0.05)
Age squared			0.002**	0.002**	0.002**
			(0.00)	(0.00)	(0.00)
Age cubic			-0.000	-0.000+	-0.000
			(0.00)	(0.00)	(0.00)
Married or as married			0.410***	0.409***	0.409***
			(0.05)	(0.05)	(0.05)
Single			0.113+	0.112+	0.111+
			(0.06)	(0.06)	(0.06)
Education: University			0.031	-0.188*	-0.187*
			(0.07)	(0.09)	(0.09)
Owned home outright			0.092*	0.094*	0.093*
			(0.04)	(0.04)	(0.04)
Living with others			-0.072	-0.073	-0.072
			(0.05)	(0.05)	(0.05)
Having children			0.038	0.038	0.038
			(0.03)	(0.03)	(0.03)
Rural			0.099+	0.103+	0.101+
			(0.06)	(0.06)	(0.06)
Higher social status			-0.003	-0.003	-0.003
			(0.04)	(0.04)	(0.04)
Middle social status			-0.010	-0.010	-0.010
			(0.04)	(0.04)	(0.04)
Wave dummies			Yes	Yes	Yes
Interaction terms					
Excl or V.G Health # University				0.267***	0.267***
				(0.06)	(0.06)
Good Health # University				0.190***	0.191***
				(0.05)	(0.05)
Pseudo R^2	0.0154	0.0154	0.0165	0.0164	0.0168
Log likelihood	-322674.73	-322674.73	-132843.51	-132862.79	-132814.30
Observations	173,731	173,731	173,731	173,731	173,731
Individuals	39,662	39,662	39,662	39,662	39,662

Standard errors in parentheses
Source: The Understanding Society - The UK longitudinal study: 2009-2020
$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Note: Baseline: having fair and poor health, being unemployed, not disabled, neither married nor single, having no university degree, not own home, living alone, having no dependent children, living in urban area and having lower social status
§: This regression is ran on the same sample in column 3 (i.e. model includes life domains and controls) but only include the effects of life domains

Table 3.2 Equivalent income estimated using coefficients in models with and without accounting for adaptation

	Equivalent income	
Scenarios*	**Model not accounting for adaptation**	**Main analysis accounting for adaptation**
The 'best' scenario (i.e. excellent or very good health, being employed) and having university degree	**£1,000.00**	**£1,000.00**
Good health, employed and having university degree	£32.85	£29.66
Good health, unemployed and no university degree	£0.16	£0.14
Good health, not active in labour market and having university degree	£20.55	£18.15
Fair or poor health, not active in labour market and no university degree	£0.47	£0.35

Note: * In all scenarios, equivalised income is at £1000.00/month
Equivalent income is calculated using estimated coefficients from the last two columns in Table 3.1

3.6.2 The extent of overlap between the individuals identified as the worst-off when using equivalised income and life satisfaction versus equivalent income

Firstly, all coefficients that determine preferences from the full regression are used to calculate equivalent income. From the data for equivalised income and the computed equivalent income, the groups at the bottom 10% are selected to compare the worst-off identified by these two measures. Table 3.3 presents the number of observations of the worst-off captured by at least one measure, by both measures and the degree of overlap between the individuals identified as the worst-off when using income-based measures (equivalised income vs. equivalent income). In the pooled sample, there are 36,639 observations (i.e. person-waves) in the lowest equivalent income decile (equivalent to the bottom 10% in this measure). From the data on equivalised income, 36,639 observations in the lowest income decile are identified to compare with those in the lowest equivalent income decile group. There are 64,201 observations that are in the lowest equivalised income or the lowest equivalent income decile groups (i.e. the third row of Table 3.3), while 9,077 of them are identified as the worst-off by both income-based measures (i.e. those both belong to the lowest income decile groups). This result implies a percentage overlap between the individuals identified as the worst-off between equivalent income and equivalised income of just above 14% when comparing the 10% bottom distribution. The results across ten waves vary slightly but keeps the same trend, which remain between 11% and up to almost 17%. Across-wave detailed results are reported in Table B.2 in Appendix B.

Table 3.3 The extent of overlap between the individuals identified as the worst-off by income-based wellbeing measures

	Overlap between EI and equivalised income Pooled data
10% lowest EI (no. of obs)	36,639
No. of worst-off captured by at least 1 measure	64,201
No. of worst-off captured by both measures	9,077
% overlap between EI and equivalised income	14.14

Source: Own calculations based on the Understanding Society - The UK longitudinal study: 2009 - 2020

The second check is based on cross-tabulation of each quintile of equivalised income across all quintiles of equivalent income in the whole panel and across waves. The dominators (i.e. 1.00) reflect the 100% degree of overlap if all the group of individuals ranked by equivalised income is the same as one ranked by equivalent income. Table 3.4 shows the result for the whole sample in which the highest percentage overlap between the two measures is at 61% and in the fifth quintile (i.e. the highest 20% of the distribution). In other words, 61% of those in the best quintile group for equivalent income are also in the best quintile group for equivalised income. The extent of overlap is lower, at about half size (e.g. around 30%) in the first and second quintiles, which are the worst-off among all quintile groups. The third and forth quintiles only contain an overlap of 16% and 19% respectively. The trend is similar across all waves when the cross-tabulation is carried out for each of the waves. Detailed results across waves are reported in Tables B.3 to B.12 in Appendix B.

Table 3.4 Cross-tabulation of Equivalised income and Equivalent income (Pooled data: 2009 - 2020)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.32	0.32	0.32	0.04	0.00	1.00
2	0.26	0.27	0.13	0.34	0.00	1.00
3	0.21	0.15	0.16	0.44	0.04	1.00
4	0.14	0.15	0.17	0.19	0.35	1.00
5	0.06	0.11	0.22	0.00	0.61	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

In addition, a tabulation between the quartiles of equivalent income and life satisfaction when life satisfaction equals one, two or three is carried out to check for degree of overlap between these two approaches. The results for pooled data (see Table 3.5) show that the degree of overlap between equivalent income and life satisfaction at the first quartile (i.e. the worst-off) is less than half (i.e. at 45.58%). The figures across waves range between 42% and 49% (Details are reported in Table B.13 in Appendix B). Given that the share of those with lowest life satisfaction is around one forth of the sample both across waves and in the pooled data, if there was full overlap between the worst-off in terms of equivalent income and the worst-off in terms of life satisfaction, the first quartile should be always 100% (or very close) while the others should be approximately 0%. In other words, if this was the case, the worst-off identified by equivalent income would be the same as those in life satisfaction.

Table 3.5 Cross-tabulation of Equivalent Income and Life satisfaction (Pooled data) 2009 - 2020

	Lowest life satisfaction: LS = 1 or 2 or 3
Quartiles of Equivalent Income	Full Sample
1	45.58
2	25.16
3	17.21
4	12.04
Total	100.00
Total no. of observations	93,532

Source: Calculations based on the UK household longitudinal study 2009 - 2020

In order to understand further the correlation between equivalent income and equivalised income, life satisfaction and relevant life domains, Spearman Rank Correlation tests are carried out and reported in Table 3.6.

The Spearman's rank correlation test determines statistical dependence between the ranking of two variables (i.e. life domains and equivalent income) of which direction of the relationship is assessed using a monotonic function[50]. Intuitively, the closer the absolute values of the Spearman's rank correlation coefficients (ρ) to 1.00, the more similar rank the two variables in the test have (i.e. perfect score of 1.00 means identical variable) (Fieller et al., 1957). The sign of ρ indicates the direction of the monotonic relationship between the two variables (i.e. positive values mean the variables have the same direction movement and negative values mean opposite directions) (Fieller et al., 1957; Lehman, 2005).

The results show that all of the pairwise Spearman Rank correlations are significant at 0.1% to 5% in pooled sample and across waves, which indicates that ρ is statistically different from 0. The level of significance of the Spearman's rank correlation coefficients does not provide information on how strong the correlation between the two variable is. However, the values of ρ implies whether the correlation between the two variables of interest happens by chance (e.g. a significance level of 5% means that 5% the relationship happens by chance) (Choi, 1977; Fieller et al., 1957).

The correlation is relatively low between equivalised income and equivalent income with the Spearman coefficient at 0.53. This highlights that a high income level does not guarantee a high level of wellbeing when taking into account other non-income life domains. Equivalent income shows even lower correlation with life satisfaction. The magnitude of

[50]Monotonic relationship reflects, for example, when variable X increases, variable Y also increases; or when variable X increases, variables Y decreases.

the Spearman Ranking coefficients is barely more than half of those between equivalent income and equivalised income. When comparing the correlation between life satisfaction and income-based wellbeing measures, the figure for the correlation with equivalent income (i.e. at 0.28) is higher than one related to equivalised income (i.e. at 0.12).

The figure for correlation between equivalent income and health shows a negative sign as the self-assessed health is coded as a 5-category variable ranging from '1' for excellent health to '5' for poor health. As the values of this variable increase, general health gets worse. The rank correlation between equivalent income and self-assessed health is the highest among all life domains, which reaffirms that equivalent income is considerably influenced by the health aspect ($\rho = -0.82$, of which the absolute value is relatively close to 1.00. The figures for correlation of equivalent income with employment, not being active in the labour market and unemployment are 0.33, -0.17 and -0.33 respectively. The results across waves are robust and similar to those in the pooled sample (More details across waves are reported in Table B.14 in Appendix B.).

Table 3.6 Spearman Rank Correlation Between Well-being measures and Life Domains

Domains/ WB measure	Equivalent income	Equivalised income	Life satisfaction	Self-assessed health	Employment	Not active in labour market
Equivalised income	0.53	1.00				
Life satisfaction	0.28	0.12	1.00			
Self-assessed health	-0.82	-0.19	-0.28	1.00		
Employment	0.33	0.42	-0.01	-0.22	1.00	
Not active in LM	-0.17	-0.32	0.06	0.21	-0.88	1.00
Unemployment	-0.33	-0.22	-0.10	0.04	-0.29	-0.20

Source: Calculations based on the UK household longitudinal study: 2009 - 2020

Key: WB, wellbeing; LM, labour market

3.6.3 Who are the worst-off?

In order to examine the characteristics of the worst-off identified by equivalised income, equivalent income, life satisfaction and relevant life domains, the portraits of the worst-off by each measure and life domains are captured and reported in Table 3.7 (for details across waves, see Table B.15 - Table B.24 in Appendix B). First the number of observations with life satisfaction equals 1 is identified as the reference sample for the worst-off. The reason for this selection is because of the relative number of observations of the worst-off captured by categorical variables such as life satisfaction, employment (labour market status) and health. Among those three, the number of the worst-off based on life satisfaction (i.e. life satisfaction at one) is the smallest. Based on the number of observations with life satisfaction of one, the same number of observations are identified as the worst-off by each domain and measure: those with fair or poor health, those with lowest income, those with lowest equivalent income and those who are unemployed.

Table 3.7 Average characteristics of the worst-off in pooled data: 2009 - 2020

	Full sample N = 173,731	Income N = 7,110	Equivalent income N = 7,110	Life satisfaction N = 7,110	Self-assessed health N = 7,110	Unemployment N = 7,110
Life satisfaction (mean between 1-7)	5.21	4.88	3.88	1.00	3.68	4.45
Equivalised income (£/month)	2,260.80	234.10	1,027.44	1,641.98	1,545.62	1,143.33
Average equivalised income (£/month)	2,280.52	807.74	1,202.22	1,694.51	1,584.05	1,291.17
Health aspect						
Self-assessed health (mean between 1-5)	2.35	2.70	4.20	3.28	5.00	2.83
Excellent and very good health (in %)	58.66	46.13	0.37	34.05	0.00	40.15
Good health (in %)	29.99	29.73	4.02	18.76	0.00	31.35
Fair and poor health (in %)	11.36	24.14	95.61	47.20	100.00	28.50
Having long-term impairment	24.32	33.07	69.74	54.15	93.68	35.12
Onset of impairment	7.96	8.56	12.97	8.25	6.91	8.91
Impaired for 1-2 years	3.10	3.12	6.50	4.01	4.69	3.90
Impaired for 2-3 years	1.59	1.68	3.74	2.03	3.18	1.93
Impaired for 3+ years	1.81	2.00	5.09	3.75	7.11	2.32
Employment aspect						
Employed (in %)	95.34	21.56	23.43	34.92	15.17	0.00
Unemployed (in %)	0.24	21.21	55.21	11.27	6.43	100.00
Not active in labour market (in %)	4.42	57.23	21.36	53.81	78.39	0.00
Marital status						
Married and as married (in %)	69.61	40.13	48.51	51.38	53.88	42.75
Single (in %)	21.45	40.64	30.61	26.87	16.55	46.67
Others (in %)	8.94	19.23	20.88	21.75	29.57	10.58
Age (mean)	42.90	44.59	45.78	49.19	58.00	37.38
Male	46.91	48.09	44.23	40.25	40.54	53.91
Education: University (in %)	45.65	26.70	55.05	21.64	19.00	23.07
Own home outright (in %)	21.19	29.16	21.44	27.97	32.60	15.40
Living with others (in %)	89.75	63.76	76.87	78.67	72.26	86.17
Having children (in %)	40.00	27.18	35.45	28.35	18.59	39.64
Living in rural area (in %)	24.27	16.08	17.48	21.43	20.44	14.53
Having high social status (in %)	43.19	27.56	38.86	28.42	33.61	21.71
Having middle social status (in %)	39.19	53.86	40.95	45.69	44.40	45.55
Having low social status (in %)	17.62	18.58	20.19	25.89	21.99	32.74
WTP for perfect health (£/month)	1,992.90	223.79	1,027.30	1,625.90	1,545.25	1,109.47
% of EI in income to achieve perfect health	11.85%	4.40%	0.01%	0.98%	0.02%	2.96%
WTP for being employed (£/month)	8.41	148.65	969.95	633.93	256.96	1,137.63
% of EI in income to achieve ‘employment’	99.63%	36.50%	5.60%	61.39%	83.37%	0.50%

Source: Own calculations based on the Understanding Society - The UK longitudinal study

Equivalent income and life satisfaction across all waves identify those worst-off including individuals who have fair or poor health and are long-term impaired, not active in labour market, are married or living as married and at the age almost 50 years old. Most of the worst-off are females who do not own a home outright. The majority of the least-well-off portrayed by these measures live with other people in urban area, have no children and belong to middle social status.

Interestingly, equivalised income and unemployment capture individuals with the best health level as the worst-off, which is similar to the descriptive statistics in the full sample. In contrast to the above-discussed measures, using equivalised income or unemployment as wellbeing measures results in the worst-off group who mostly are single.

Based on self-assessed health, the worst-off are those who have fair or poor health and the majority suffer from long-term impairment and are older than 50 years old. In line with the other measures, those badly-off identified by self-assessed health are mostly female and more likely to be married, living with other people and do not have children.

Overall, across all measures (equivalent income, equivalised income and life satisfaction) and relevant life domains (health and unemployment), it is observed that women (53% in the full sample, 52% in the worst-off identified by equivalised income, 56% by equivalent income, 60% by life satisfaction, 59% by self-assessed health and 46% by unemployment) at the aged 40-50 (35% in the full sample, 22% captured by equivalent income, 36% by equivalent income, 28% by life satisfaction, 23% by self-assessed health and 28% by unemployment), living with other people (full sample: 90%, equivalised income: 64%, equivalent income: 77%, life satisfaction: 79%, self-assessed health: 72% and unemployment: 86%) in urban area (the corresponding percentages are 76%, 84%, 83%, 79%, 80% and 85%), childless (60% in full sample, and the figures for the others with the same order in Table 3.7 are 73%, 65%, 72%, 81%, and 60%) and do not own home outright (79% in full sample, equivalised income: 71%, equivalent income: 79%, life satisfaction: 72%, self-assessed health: 67% and unemployment: 85%) are usually identified as the worst-off.

Another information reported in these tables is WTP for perfect health and for not being unemployed. These values are calculated separately for the worst-off across measures and life domains. It is clear that WTP for perfect health often accounts for a large proportion of individual income (accounting for more than 80% of equivalised income), which is consistent across all measures and waves. Hence, equivalent income to achieve perfect health as a proportion of equivalised income is quite small. This result is in line with many studies in the literature such as Decancq and Neumann (2014) and Ledić and Rubil (2016). By contrast, WTP for not being involuntarily unemployed is quite low (at less than 5% of equivalised income) compared to the figures for the health aspect. Similar results are also confirmed by the above-mentioned studies. This also means equivalent income in these cases accounts for larger proportion of equivalised income.

3.7 Robustness Checks

Regression results

In the first robustness check, the data are examined using both FE ordered logit (BUCOLOGIT) and RE ordered logit (OLOGIT) on regression using equivalised income at each point in time and using the 3-year moving average of equivalised income. The results are reported in Table B.25 in Appendix B. Overall, the results remain robust regardless of different income variables used.

In addition to the BUCOLOGIT, OLS and Ordered logit RE) are also employed to analyse the data (see Table B.26, Appendix B). Comparing across techniques regarding life domains (i.e. income, health and employment), the signs and significance of main variables remain robust regardless of the model used. When considering the interaction terms, only those analysed through the RE Ordered logit regression are insignificant. However, the sign of these parameters remain the same, which are all positive. Regarding the scaling factors, there are no noticeable changes in the coefficients related to an individual's socio-demographic characteristics. Across all other techniques, the parameters related to lags of impairment remain significant and negative, which is in line with the results of Chapter 2 (i.e. no evidence for complete adaptation in average).

In the third robustness check, restricting the unbalanced panel to generate a balanced panel leads to a decrease in the sample size by 2.6 times. While 173,731 observations are included in the unbalanced panel regression, only 67,189 observation-years are analysed in the balanced panel as some individuals were not involved in all ten waves of the UKHLS. Overall, the main results of the regression and the conclusion are robust (see Table B.27 Appendix B for detailed results).

Comparing equivalent income estimated across robustness checks

As the key output from the econometric modelling is equivalent income, an obvious robustness check is to compare the values of equivalent income computed from parameters estimated across the above-mentioned checks.

Table 3.8 presents some examples of estimated equivalent income as percentage of equivalised in come using parameters from the main analysis and those regressions from robustness checks. Overall, there is not much difference in the estimations of equivalent income across these regressions. The first scenario is when an individual's current situation is at optimal (i.e. having excellent or very good health and being employed or self-employed), hence, equivalent income equals to equivalised income. The next five scenarios are when the individual has at least one life domain not at optimal, which results in a lower equivalent income than equivalised income. The last scenario is when the individual has the 'worst' situation (i.e. having fair or poor health and being unemployed), which is shown by an equivalent income close to zero (equivalent to a range between 0.00001% and 0.09% as a percentage of equivalised income).

The closest estimations with the main analysis are those based on a linear FE regression. When comparing between the main analysis using FE ordered logit model and the OLS and OLOGIT, which do not control for unobserved heterogeneity, equivalent income seems to be over-estimated. Across all of the non-optimal scenarios, the estimated levels of equivalent income are higher in the random effects regressions compared to the main analysis and the linear FE regression.

When using average levels of equivalised income in BUCOLOGIT, the estimations of equivalent income are slightly higher but not much different from the main analysis. In contrast, the estimated levels of equivalent income from the unbalanced panel are much higher than those from the analysis, which could also be seen from the smaller magnitudes of relevant coefficients to the calculation which are estimated from the balanced panel compared to the unbalanced panel from the main analysis.

Table 3.8 Estimated equivalent income across robustness checks

Scenarios			**Equivalent income as % of equivalised income**					
Health	**Employment**	**Education**	**Main analysis $\mp$**	**BUCOLOGIT (Average Y_{it})$\star$**	**OLS §**	**OLOGIT §**	**Linear FE §**	**BUCOLOGIT Balanced panel #**
Excellent/ very good health	Employed or self-employed	University degree	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Good health	Employed or self-employed	University degree	1.68%	2.74%	6.92%	5.58%	2.53%	5.53%
Fair or poor health	Employed or self-employed	No university degree	0.04%	0.09%	0.30%	0.41%	0.02%	0.56%
Excellent/ very good health	Not active in labour market	No university degree	122.57%	131.06%	143.04%	159.66%	114.52%	103.77%
Excellent/ very good health	Unemployed	University degree	0.50%	2.04%	16.42%	23.71%	0.27%	12.96%
Good health	Unemployed	University degree	0.01%	0.06%	1.14%	1.32%	0.01%	0.72%
Fair or poor health	Unemployed	University degree	0.00%	0.00%	0.03%	0.09%	0.00%	0.01%

Note: $\mp$: Calculations are based on estimated parameters from column 5, Table 1.
$\star$: Calculations are based on estimated parameters from column 3, Table A25 Appendices.
§: Calculations are based on estimated parameters from column 2, 3, 4, Table A26 Appendices.
#: Calculations are based on estimated parameters from column 3, Table A27 Appendices.

3.8 Discussion and Conclusion

This chapter has explored the concept of equivalent income and computed this monetary metric using the UKHLS (2009 – 2020). Using the ordered logit FE model on a life satisfaction function against income and non-income life domains, the study has investigated the differences in wellbeing ranking between the individual income level (i.e. equivalised income) and equivalent income and between equivalent income and life satisfaction in the UK.

Theoretically, equivalent income is computed by collapsing income and all possible relevant non-income domains into a single-index measure. However, from a practical point of view, constructing equivalent income empirically using a SWB function, for instance life satisfaction, requires a lot from the data when including interaction effects to capture subgroup preferences. Therefore, this chapter opts to include only those interactions that are statistically significant at at least 5%. Including as many individually specific characteristics as possible to account for differences in individual situations is potentially desirable. Due to data limits, this cannot be done as expected in the theory. Empirically, including interactions and controls to capture the average preferences of socio-demographic sub-groups rather than individuals could provide a simplified procedure to capture preferences.

The effects of all life domains from the life satisfaction regressions show expected results which are in line with the wellbeing literature using life satisfaction. With the baseline of individuals who report fair or poor health, are unemployed and have no university degree, the positive and significant coefficients capturing the interaction effects between self-assessed health and higher education highlight that life satisfaction of people with university degrees or equivalent is more influenced by given improvements in health compared to those with lower education levels.

Following the regressions, equivalent income levels were computed using the estimated parameters. The values were then compared with other measures including household equivalised income and life satisfaction to analyse the extent of overlap in individuals identified as the worst-off using different measures of wellbeing. For both the comparisons between equivalent income and equivalised income and between equivalent income and life satisfaction, the degree of overlap is quite low, at 20% and under 50% respectively

It is noted that the range of overlap in individuals identified as the worst-off by equivalent income and equivalised income in this chapter is higher than the results reported in other studies (i.e. most at less than 10%) such as Decancq and Neumann (2014) using German data and the Colombian study (Decancq et al., 2016). This result might be due to the differences in the number of non-income life domains and specific domains included in the computation of equivalent income across studies. It is expected that the more non-income domains to include in the life satisfaction regression to estimate equivalent income, the lower the degree of overlap in the worst-off groups identified by equivalent income and equivalised income.

In addition, the chapter examines the characteristics of the worst-off identified by equivalised income, equivalent income, life satisfaction and relevant life domains and reports similarities and differences across these indicators. There are many discrepancies regarding who is identified as the badly-off based on different approaches. Overall, it seems that women at aged 40-50, living with other people in an urban area, childless and do not own a home outright are mainly identified as the worst-off.

The reported WTP for perfect health and for not being unemployed shows that WTP for perfect health often accounts for a large proportion of individual income (larger than 85%), which is consistent across all waves. This result is in line with many studies such as Decancq and Neumann (2014) and Ledić and Rubil (2016). By contrast, WTP for not being unemployed is quite low (at only about 5% of equivalised inome) compared to the figures for the health aspect. Similar results are also confirmed by the above-mentioned studies.

In sum, this chapter has made three contributions to the literature. Firstly, the analysis takes into account the effect of hedonic adaptation on aspirations through the inclusion of a set of controls for onset and the duration of impairment. Despite an extensive literature investigating empirical computation and application of equivalent income, no empirical study to date has examined the effect of hedonic adaptation in general and adaptation to impairment in particular in this context. Furthermore, the chapter compares equivalised income and equivalent income and equivalent income versus life satisfaction regarding the worst-off groups that these measures identify. The discrepancies in ranking by different wellbeing measures highlights that the use of different measures of wellbeing is likely to result in remarkably different rankings of individual's wellbeing. In addition, the findings indicate that collapsing the outcomes across multiple domains of wellbeing into one number would lead to a better and broader view and focus of public policies when considering the worst-off compared to using income alone. The last contribution is that the paper contributes to the wellbeing literature by being the first one to compute equivalent income using UK data.

There are still opportunities for further research. Regarding the econometric technique used in the analysis, the chapter used the 'Blow-up and Cluster' Stata programming (BUCO) by Dickerson et al. (2014) to estimate the ordered logit fixed effect models. As BUCO is a user-built program in Stata, it is not flexible when including tests and other additional functions for further analyses, such as estimation of marginal effects. In addition, the program does not allows for factor-variables and time series operators, many variables were manually generated in the models, which requires time and is prone to errors. In earlier 2021, Stata has released a new command 'FEOLOGIT' for estimating fixed effects ordered logit models.

Compared to the BUCO, this command allows for for flexibilities in testing and provides more post-estimation options. Given that this chapter was done using BUCO in 2018 and updated in 2020, it would be interesting for later studies to compare the results from these two techniques: the BUCO versus the FEOLOGIT.

In addition, the analyses in this chapter only include two non-income domains: health and unemployment, which results in a quite narrow-context measure of wellbeing. In addition, including hedonic adaptation to the computation of equivalent income in this chapter is currently just an example of the application using the set of lags of impairment. This issue leaves more room for future research to extend the list of relevant non-income domains and adaptation to different life events included in the computation of equivalent income. In addition, the computation of equivalent income in this chapter was done using survey data based on actual events and choices. A drawback of this kind of data is that they limit the amount of information on preferences as many alternatives may not be available in certain circumstances and the decisions made might not reveal a person's preferences in the presence of risks and uncertainty (Bann, 2002). One possible solution could be to obtain equivalent income through stated preference data in which different domains of interest can be included. This approach will be explained and discussed in the next chapter of this thesis.

Chapter 4

Eliciting public preferences across life domains to calculate equivalent income

4.1 Introduction

Wellbeing cannot be captured solely by monetary aspects of life or material standards of living (Stiglitz et al., 2009). Non-material life domains, such as health, job quality or feeling safe, also play a crucial role in defining what a good life is (Capéau et al., 2020; Fleurbaey, 2009; Stiglitz et al., 2009). Monetary and non-monetary life domains could influence the degree to which people feel about their lives or determine how satisfied they are. In other words, these factors may not only be correlated with individuals' subjective wellbeing (SWB) such as life satisfaction, but also determine people's overall opinion about their life. To combine both income and non-income domains, and collapse multiple domains of wellbeing into a single index number, 'equivalent income' is proposed in a series of papers by Fleurbaey (2005, 2006, 2009) and Fleurbaey and Gaulier (2009)[1]. This measure of wellbeing considers both material and non-material aspects of life, yet takes into account preferences on how important those different domains are to a good life.

In addition to the value added to the academic literature on measuring wellbeing, equivalent income also has potential contribution toward policy-relevant aspects. Public policies need to be evaluated across multiple domains of wellbeing, including, for example, health, employment, housing, and social capital. From that point, equivalent income could become a wellbeing measure to evaluate policies and inform policy-makers decisions. To do so, two key assumptions in evaluations are that social welfare is an aggregation of individual wellbeing, and that wellbeing is multidimensional. Multidimensional approaches to policies

[1] Detailed discussion can be found in Chapter 3

have been discussed in some research such as Adler and Dolan (2008); European Statistical System Committee (2011) and OECD (2011*b*).

There are different methods to operationalise equivalent income, of which the two methods discussed in this thesis are computing equivalent income from estimated parameters in a SWB function (e.g. a life satisfaction function)[2] and using the stated preference approach to derive preferences from choices made by individuals in hypothetical scenarios. This chapter reports an attempt to operationalise equivalent income based on the latter approach, which follows the early study by Fleurbaey et al. (2013). One of the popular methods used in this approach is the discrete choice experiment (DCE), a method that analyses ordinal preferences in cardinal terms. The technique has been applied extensively in transport research (Arencibia et al., 2015; Hole, 2005), environmental economics (Bateman et al., 2009; Brock et al., 2017) as well as health and healthcare-related topics (Bryan and Dolan, 2004; Hole, 2008; Promberger et al., 2012; Rowen et al., 2016; Shah et al., 2015).

DCEs include choices among several sets of alternatives which are defined by a given number of relevant attributes and corresponding attribute levels. Respondents make choices based on which they would prefer the most among each set of alternatives. The exercise is repeated with alternatives combining different levels of the attributes of interest. Researchers experimentally control the attribute levels and then quantify the effects of changes in levels of attributes on respondents' choices. The coefficients estimated from the data reflects preferences over different attributes. Preference weights derived from DCEs can be used to calculate willingness to pay (WTP) or the value that respondents are willing to sacrifice from one attribute to get more of the others (Hauber et al., 2016).

This chapter will operationalise equivalent income, a preference-based multidimensional wellbeing measure, based on stated preference data over experimental hypothetical scenarios. The detailed discussion on the framework and concept of equivalent income is presented in Chapter 3. The remainder of the chapter is followed by a literature review. Section 4.3 outlines the methods including the choice experiment design, survey set-up and econometric analyses. Data from the survey and the main results are discussed in Section 4.4 and Section 4.5. In addition to the main analysis, some subgroup analyses are presented in Section 4.6 to further examine equivalent income levels for different subgroups such as genders, age groups or people with different marital status. A brief report on robustness checks is in Section 4.7. Finally, Section 4.8 puts these findings in context and discusses limitations as well as suggestions for future research.

[2]This approach is discussed in Chapter 3.

4.1.1 Motivation

There is a shift in the focus of policies towards the incorporation of various non-monetary life domains, arising from the growing recognition of the importance of an inter-sectoral[3] and system-based approach[4] to public policy. Interventions need to consider multiple domains besides income such as health, employment, housing, and feeling safe (Capéau et al., 2020; Stiglitz et al., 2009). Since much of these are largely abstract (i.e many non-income life domains are not clearly visible while some are largely dependent on feelings and aspirations), household income on its own would be a poor metric to capture wellbeing, which leads to a need for a preference-based single-index measure that covers the multiple domains of wellbeing[5]. 'Equivalent income' is a preference-based monetary measure of wellbeing that adjusts income for non-income aspects of life, taking into account individuals' preferences on how important those different domains are to a good life (Fleurbaey, 2005, 2006, 2009; Fleurbaey and Gaulier, 2009; Fleurbaey and Schokkaert, 2011). Hence, equivalent income is a wellbeing measure that can be used to evaluate policies and inform policy-maker decisions.

This chapter endeavours to estimate equivalent income through a stated preference approach. The study uses a DCE through an online survey in the UK to collect data on preferences over different life domains and compute equivalent income. This approach is based on respondents' choices among alternative hypothetical scenarios. The choice data are modelled to estimate a utility function and to calculate preference weights of different life domains, WTP to achieve the best levels of non-income dimensions and equivalent income of the general public from the estimated coefficients. To contribute methodological and substantive understandings of values in individual decision making and public views on different policy outcomes, this research would potentially provide evidence of public preferences regarding necessary trade-offs between different policy outcomes in the UK.

4.1.2 Purpose of the Study

The main aim of this study is to operationalise a preference-based measure of multidimensional individual wellbeing – equivalent income – for the UK that can be used in the evaluation of public policy interventions with health and non-health benefits. Stated prefer-

[3]Inter-sectoral intervention is a term espoused by health-related agencies. These interventions aim to make changes in different systems or sectors to achieve a defined public health goal (Freudenberg, 2008)

[4]This is an approach that applied scientific insights to "understand the elements that influence health outcomes" (Kaplan et al., 2013)

[5]A preference-based wellbeing measure is a measure that is based on a set of preference weights to generate the value of wellbeing. This type of measure combines different domains that can be used to describe an individual's life. The values from those various domains could be converted into an index number using an algorithm from a survey on general public's preferences (Brazier et al., 2017)

ences of the UK general public over hypothetical scenarios are collected through an online survey using DCE. The estimated parameters are then used to calculate equivalent income for each respondent, which is compared with individual equivalised income to examine the discrepancies between the two measures. In addition, a preference ranking of the wellbeing domains is generated using the estimations from the econometric models. There are two objectives:

(i) to operationalise equivalent income using the stated preference approach, through a DCE; and

(ii) to examine the distribution of equivalent income and other wellbeing indicators across the survey sample.

The first objective focuses on an aspect that has not been explored much in the literature of equivalent income. The main studies that could be named from the literature that use the stated preference approach to estimate equivalent income are Abasolo et al. (2018); Fleurbaey et al. (2013) and Capéau et al. (2020). Among these, only Abasolo et al. (2018) reports on an attempt to operationalise equivalent income using a DCE, while the other studies directly ask respondents for their WTP. In a broader literature of estimating preferences and evaluating preference weights over different life domains, some recent studies also apply DCEs, such as Watson et al. (2019, 2008) and Decancq and Watson (2019). This chapter endeavours to use the DCE method to elicit preferences over different life domains and estimate implied WTP in monetary terms for the gains in non-income life domains. From this, the study expresses values of different non-income domains such as health or safety in monetary terms and obtain equivalent income as a multidimensional monetary measure of wellbeing. The second objective is to examine how the survey data capture income and other wellbeing indicators to compute equivalent income using parameters estimated from the data.

In sum, this chapter will make three main contributions to the literature. Firstly, by surveying the public using stated preferences approach through a DCE, the chapter contributes to the literature of equivalent income by testing and providing evidence on how to operationalise equivalent income using a DCE. The second point is the contribution to the methods literature, which is to illustrate how preference data from a DCE are used to estimate equivalent income as a measure of wellbeing. As the exercises are quite complex, it might need to consider many aspects such as the number of the tasks, wording and explanation to make it possible to run the survey online without the interviewer's or coordinator's presence. The chapter reports on the results of administering the DCE survey on an online platform considering the feedback from two pilots before launching the main survey. The last contribution lies in the inclusion of different non-income non-health domains in the DCE and the analyses. Eventhough including non-health non-income attributes (e.g. employment and housing quality) are not incommon in DCEs generally, most of the previous studies using the stated preference approach to obtain equivalent income mainly focus on health and do not include other aspects such as safety or housing quality. This chapter attempts to expand the range of life domains included in the calculation of equivalent income. These domains are policy-relevant and have been part of many projects aiming to improve living standards such as Centre for Progressive Policy and Thriving Places Index (2019) and The Greater Manchester Outcomes by Greater Manchester Combined Authority (The Greater Manchester Combined Authority, n.d). The contribution will potentially enable advisors to support policy makers with a more informed sense of likely public responses to changes in policies. The use of equivalent income could convert the effects of different social and public policies into a monetary metric.

4.2 Literature Review

Wellbeing is multidimensional; hence the measure of wellbeing needs to go beyond the traditional narrow focus on monetary aspects such as income and covers non-monetary aspects like health, employment, security and so on (Stiglitz et al., 2009). The Commission on the Measurement of Economic Performance and Social Progress – CMEPSP report by Stiglitz et al. (2009) suggests three approaches to multidimensional measures of wellbeing, which are (i) using indices of SWB (e.g. life satisfaction or happiness), (ii) the capability approach by Sen which focuses on possibilities and achievements (see Sen, 1993, 1998, for more discussion), and (iii) the equivalence approach combining both objective and subjective approaches (see Fleurbaey, 2011). The topic of this chapter will follow the last approach.

The equivalence approach uses a reference set of values to define life situations as a basis for interpersonal comparability (Fleurbaey, 2011). In particular, in this approach, the reference situation is 'equivalent' to the current situation if an individual finds it as good as her current situation. The worst-off in the society are the focus of this chapter to describe one application of equivalent income, which is similar to what was discussed in Chapter 3. They are then those whose equivalent situation is the worst in the reference set. Equivalent income is one of the approaches that is developed from the equivalence approach. Therefore, to compute equivalent income, one needs to define the reference set of situations in such a way that all non-monetary life domains are fixed at the optimal levels and only the monetary aspect (i.e. income) varies across situations. By doing so, equivalent income can be used to measure wellbeing by combining both monetary and non-monetary domains and describe it in a monetary metric (Fleurbaey, 2011). The details of the framework of equivalent income are discussed in Chapter 3.

One approach to compute equivalent income is to use relevant estimated parameters from a life satisfaction function using large scale datasets. This approach has become popular in the literature due to the availability of many panels and cross-sectional data with extensive information at both individual and household levels. Following the methods used in Decancq, Fleurbaey and Schokkaert (2015*b*); Decancq et al. (2017); Defloor et al. (2017); Fleurbaey and Gaulier (2009); Ledić and Rubil (2016, 2020), Chapter 3 has computed equivalent income using the UK Household Longitudinal Study data.

This chapter, however, applies the other approach which uses stated preference data to obtain equivalent income. This section will discuss some key papers and what has been done in the literature. The first study is an early attempt to carry out a pilot survey using the contingent valuation method to obtain equivalent income (Fleurbaey et al., 2013). The authors argue that it is not feasible to collect information on WTP and equivalent income for every individual in society. However, it could be possible and realistic to obtain data from a representative sample and calculate the average weights for different life domains. To demonstrate the concept and its application in practice, a pilot study using contingent valuation for health was carried out in 2007 in Marseilles, France. The sample included 542 respondents randomly selected in different areas in Marseilles for face-to-face interviews. Therefore, this sample is not a representative sample for France due to its small size, non-representative distributions of demographic characteristics and the fact that respondents were only from one city. The survey, however, does not aim to get a representative sample but to collect sufficient data with enough variation in health and income for modelling. Health is modelled using a vector of objective health characteristics captured by a list of diseases grouped by categories (e.g. respiratory diseases, cardiovascular diseases and so on) that the respondents might have experienced in the past 12 months. Another health-related aspect is the use of healthcare services in the past year. Once the respondents completed the income, health and socio-demographic questions, they were asked to think about a hypothetical scenario in which they could trade-off income for perfect health (i.e. no health problems). They were required to declare the income level (equivalent income) that they would be equally happy to have if no health problems had occurred. The answers were displayed by a payment card showing interval values between “€0" to “more than €1,500". Overall, more than 80% of the respondents indicated that they would give up some income for better health and provided their WTP for perfect health. Almost 10% of the respondents said that their concerns lied with different life domains while almost 8% declared that their income levels were already too low to trade off.

Fleurbaey et al. (2013) report a mean WTP for being in full health of €33 in the first quartile group for personal income, €48.1 in the second, €66.1 in the third and €150.2

in the fourth. The authors note that although mean WTP rises with personal income, the values increase less than proportionally with personal income. In addition, the estimated parameters from the data were used to map indifference curves between health (i.e. based on the number of diseases in the past 12 months) and personal income. The authors admitted that it was impossible to accurately estimate preferences for different subgroups based on socio-demographic characteristics as the sample size was too small. The last set of results from the pilot survey is the distributional weights computed based on equivalent income. Different weights based on different levels of personal income were obtained for three cases concerning health covering “no severe disease", “one severe disease" and “two severe diseases". The results indicate that distributional weights monotonically reduce in respect of health and personal income (Fleurbaey et al., 2013). Overall, the study attempted to determine equivalent income, with a focus on the health aspect, using the contingent valuation method, and discussed the challenges and limitations of the work.

A later study by Abasolo et al. (2018) is a working paper of a small-scale exploratory study of a convenience sample (n=52 for the quantitative analysis and n=17 for the qualitative sample/interviews), using a DCE to capture individual wellbeing. It is noted that in this study the authors use the term ‘equivalent consumption’ instead of ‘equivalent income’ as they argue that this term better represents “the person’s objective standards of living and access to material goods" (Abasolo et al., 2018, p.4). There are two versions of the survey, which aim to explore the application of equivalent consumption from the individual and societal perspectives, respectively. In this study, the concept of equivalent consumption is operationalised across five attributes from three domains: consumption (personal spending), health (physical function, pain and depression) and close relationships. Consumption is treated as a continuous attribute, whereas each of attributes in the health domain has three attribute levels and close relationships is a two-level attribute.

In the first approach using the contingent valuation, respondents were asked for their WTP to achieve the best combination of the non-monetary life domains. The data from their answers are then combined with the information on their current situation to calculate equivalent consumption at the individual level.

The second approach used a set of choice tasks combining different hypothetical scenarios (DCE) to indirectly obtain the level of equivalent consumption. The exercise included pairwise choice experiments using sequential ranking[6] to reduce the number of choice tasks each respondent needed to complete. The sequential raking exercises involved four hypothetical scenarios that were described by various combinations of attributes at different

[6]For a detailed discussion on this approach, see Louviere et al. (2008). In this study, the term used is “sequential best-worst scaling" or “best-worst questions".

levels. Respondents were asked to rank those four “lives" from the ‘best’ to the ‘worst’ (i.e. options to choose from: prefer the most, prefer the second, prefer the third, prefer the least) (Abasolo et al., 2018). The data from these choice tasks were then expanded into six implied pair-wise choice observations, which provided more observations than a binary choice experiment survey (Abasolo et al., 2018). The DCE was designed in Ngene based on D-efficiency, which were then adapted to make two versions, one for individual perspective and the other for societal perspective. The only difference between these two versions was the wording and perspective of the sequential ranking tasks. In the individual version, people were asked to rank scenarios from best to worst given that they might find themselves in the four given situations A to D. The social welfare versions asked respondents to rank similar scenarios that other people might live in keeping in mind that the role of the government was to re-distribute welfare benefits from the well-off to the badly-off.

The main survey includes two samples: the online survey sample without the researcher’s presence and the interview sample. There were 52 valid respondents from the online survey which were from staff working in administration and facilities at the University of Sheffield. These participants were randomly allocated to either the individual version or the societal version of the survey. Data from the survey were analysed through different methods. While data from the contingent valuation questions can be used directly to calculate equivalent consumption, data from the DCE were analysed using rank-ordered logit regressions to estimate relevant coefficients for computing equivalent consumption levels. It is noted from the paper that the analyses excluded all inconsistent choices. They were identified as internal inconsistency as respondents who did not report any health or relationship problems (i.e. optimal level of non-income domains) stated that the scenario in which their “current health and relationship problems went away", but their “spending was cut to half its current level" was “about the same / better off than now" (Abasolo et al., 2018). The interview sample includes 17 participants but only 16 of them completed all the ranking exercises.

The findings indicate that when pooling data across individuals, the model performed significantly better. However, by doing so, it is only feasible to estimate preferences across groups rather than individuals. The results from the interviews suggest that the choice tasks are to some extent complex and participants found it hard to interpret some elements of the exercises. Overall, Abasolo et al. (2018) have reported in detail how the contingent valuation and DCE approaches could be applied to compute equivalent consumption. The results from both quantitative and qualitative data have contributed not only to the methodologies but also to the practical aspects of the equivalent income literature.

Capéau et al. (2020) discuss individual wellbeing of Belgians and describe different life domains that determine wellbeing and their distribution. The authors propose a wellbeing measure – equivalent income – that considers the various domains of wellbeing and also takes into account individual heterogeneous preferences. Besides the theories and frameworks discussed in the book, Capéau et al. (2020) present a large-scale survey of the Belgian public, using the data from the MEqIn project that involves than 3000 adults from over 2000 Belgian families. The representative survey includes income, consumption and affordability, health, work status, housing, and time use. In addition, this survey includes modules related to respondents' WTP for the optimal levels of each life domain in the survey, which allows the calculation of equivalent income.

The next group of papers to be discussed in this section do not operationalise equivalent income but estimate preference weights and examine some heterogeneous preferences. Adler and Dolan (2008) introduce a "different lives" survey format to ask respondents to rank various hypothetical lives. The study reports a pilot survey conducted in London (N=40 students) and Philadelphia (N=32 students). The questionnaire's structure is similar to a time-to-trade-off (TTO) survey[7]. In this survey, there were four domains, where each had two levels: longevity (65 or 75), health ('able to move around freely' or 'hard to move around without assistance'), happiness (being in a good mood for 95% or 85% of the time), and income (£30,000 or £45,000 for the UK version and $100,000 or $300,000 for the US version). These attributes and attribute levels were used to generate 16 different lives. The data was then processed using a rank-ordered logistic model based on random utility theory. The regression results show all significant coefficients at 1%. Overall, for both samples, the coefficients on health account for the largest effect of all, which is followed by happiness. The estimated coefficient on income is larger than one on life expectancy for the UK respondents, while the US participants put more weight on longevity than on income. The pooled regression results agree with the ranking from the US sample. It is noted from Adler and Dolan (2008) that less than 10% of responses in the UK sample and less than 5% of responses in the US sample had inconsistent rankings (i.e. preferred a logically better state to a logically worst state). As the survey was piloted on two convenient but not representative samples, the authors did not draw any policy-related conclusions and emphasise that the work only aims to demonstrate the proposed method.

Benjamin et al. (2014) proposes a methodology for survey-based tracking of wellbeing which was conducted in the US with a valid online sample of 4,608 respondents who were asked to complete pairwise choice tasks on different bundles of life domains. The study compiles a list of 136 aspects of wellbeing including 113 'private-good' aspects (i.e. related to an individual's own wellbeing such as their own health) and 23 'public-good' aspects

[7] TTO tasks reflect the length of remaining longevity or life expectancy that an individual might be prepared to trade off to avoid being in a non-perfect health state (Brazier et al., 2017).

(i.e. related to the wellbeing of the whole society, for example, 'equality of opportunity in the country'). Of all 113 private-good domains, 108 are you-aspects, which are applicable to the respondents themselves but could be connected with everyone (e.g. own health). Five others are you-only-aspects, which could only affect the respondent but could not meaningfully concern other people at the same time (e.g., own social status). From these aspects, two versions of the survey were designed; one includes personal-choice scenarios and the other involves policy-vote scenarios. Each respondent was randomly allocated with 30 hypothetical choice tasks including 11 personal scenarios (i.e. opening clause: *"Imagine that you are making a personal decisions..."*), five policy-vote scenarios (i.e. opening clause: *"Imagine that you and everyone else in your nation are voting on a national policy issue..."*), and 14 additional exploratory versions of policy-vote scenarios (which were not analysed in this paper). The 'choice question' is designed to extract respondents' intensity of preference. There were two, three, four and six aspects (or rows) per scenario. For each aspect, respondents were given two options with relative rankings to choose from, each of which was on a three-level ranking of "much higher", "somewhat higher" and "slightly higher" than their current situation[8]. Respondents needed to choose between two options using a six-point scale ("much prefer option 1", "somewhat prefer option 1", "slightly prefer option 1", "slightly prefer option 2", "somewhat prefer option 2", and "much prefer option 2") (Benjamin et al., 2014).

The data from the survey were analysed using ordinary least square (OLS) regressions separately for the two versions of the survey. The dependent variable is the responses from the six-level scale in the choice questions, while the independent variables are the relative ratings of the aspects in the choice tables (Benjamin et al., 2014). The estimated coefficients from these models were then used to rank different life domains included in the survey. Overall, high marginal utility estimates on wellbeing measures are confirmed. The largest coefficients are found for "the overall wellbeing of you and your family" and "the happiness of your family". The parameters from the regression confirm lower ranking by individuals compared to domains such as health, family, value, security and having options (Benjamin et al., 2014). Regarding policy choices, some you-aspects remain at high ranks in this model as they are in the individual-perspective model, such as 'overall wellbeing of you and your family', 'health', 'personal value' and 'financial security'. Aspects related to avoiding abuse and having freedom account for more weights and are ranked higher in the policy model. Among the objective aspects, most of the standard and widely used macroeconomic indicators have a quite low rank, except for 'low employment'.

[8] The hypothetical situations were assumed to happen in the next four years but the effects would remain after that (Benjamin et al., 2014).

To further examine cross-group heterogeneity in preferences, the regressions were run for different subgroups including male versus female; people with income higher and lower than $ 50,000/per annum; political views: liberals, moderates, and conservatives; attending and not attending religious services at least monthly; and being younger or older than 45 years old. Generally, the rankings in personal scenarios in these subgroups are in line with the results of the whole sample. There is a general agreement across subgroups regarding the high ranking of aspects related to family, health and security, which highlights the importance of these aspects and suggests prioritising the measurements relevant to these aspects. Related to the policy context, it is suggested from the findings that freedom and capabilities are highly important.

Using a different approach to explore preferences, Balestra et al. (2018) analyse the preference weights estimated from the OECD Better Life Index (BLI) data to investigate components that form users' preferences (i.e. BLI users are individuals around the world who volunteer to take part in the OECD BLI survey) over the 11 wellbeing dimensions in the BLI and test for heterogeneity in preferences and in the impact of the levels of satisfaction on weights attached to corresponding dimensions. The authors argue that although the BLI measures the "absolute importance of life domains (i.e. expressed on a 0-5 scale)" (Balestra et al., 2018, p 914), the study uses relative weight[9] computed as a percentage of the total weights assigned. The authors argue that this approach can be "considered a way to try to account for possible cultural bias (e.g. the tendency that some cultures may have in systematically over- or under-inflating the importance of topics) and make cross-country comparisons meaningful" (Balestra et al., 2018, p 914). As the normalisation procedure of the BLI prohibits time-dependent comparison of wellbeing domains (i.e. cannot investigate whether preferences change over time), the analysis only uses responses submitted in 2014 as this year has the largest observations. The baseline OLS model examines the effects of gender[10], age groups[11] and geographical locations[12] on BLI relative weights. In addition, the model considers the average objective living conditions in each country which is captured by national performance over the set of BLI dimensions. Each of these objective parameters measures the impact of having the average level of a corresponding wellbeing outcomes (i.e. indicators that compose the BLI dimensions) proxied by the different BLI domains on BLI

[9]A relative weight is calculated as a percentage of the weight on a specific dimension on the total weights assigned to all dimensions (Balestra et al., 2018).

[10]Female is the omitted category while male is captured by a dummy variable.

[11]Four age groups includes: younger than 25 years old, 25-34 years old, 35-54 years old, and 55+ years old, of which the first category is the reference.

[12]The variable represents the world region of residence: Asia-Pacific, Europe, North America and South America, of which the last category is the reference.

weights (e.g. the variable reflecting the Health dimensions is obtained by the average score in life expectancy and self-reported health by country) Balestra et al. (2018).

The results find that most important aspects include health, education and life satisfaction. The analysis also indicate some heterogeneity in preferences across the gender, different age groups and regions. While male users allocate more weight to material aspects such as income or housing, their female counterparts are more interested in quality of life. The elderly attribute more weight to dimensions such as health, housing, environment, and civic engagement, whereas respondents younger than 35 years old care more about education, work-life balance, job, income and satisfaction. Balestra et al. (2018) also confirm some regional patterns in the importance of different wellbeing domains.

Extending from the first part of the study, Balestra et al. (2018) analyse the extended survey from the BLI with additional data on socio-demographics and dimension-specific satisfaction scores to explore a link between preferences and self-reported satisfaction levels. Following the same approach mentioned above to account for cultural diversity and for cross-country comparisons, relative satisfaction is used instead of absolute scores of self-reported satisfaction. The whole sample analysis is analysed using OLS, while the subgroup analyses are processed using a finite mixture model (FMM) proposed by Clark et al. (2015). The FMM approach models heterogeneity in the effects of self-reported satisfaction on weights attached to corresponding dimensions, whereby BLI users are probabilistically sorted into different classes. The findings agree with the results from the first part of the analysis while adding further evidence on preference heterogeneity across the subgroups.

Watson et al. (2019) discuss the domain weights used for the Index of Multiple Deprivation (IMD) and report a cross-method comparison among three main preference-based approaches to obtain weights for seven domains in the IMD (income, employment, health, education, housing and service, environment, and crime). The first method uses an individual's experience of social exclusion using results from a report by Dibben et al. (2007) that obtain domain weights using estimated parameters from the millennium poverty and social exclusion survey (PSE). The second approach is based on government spending with the assumptions that the population's preferences could have an impact on the government's policies and spending on social policies are associated with IMD domains. The corresponding weight for each IMD domain is then calculated based on the percentage of government's expenditure on that dimension using data for the financial year 2013/14 for each major central government department and local authority. The last approach is computing preference-weight from DCE data, of which the results were from Watson et al. (2008). The 2008 version is a working paper version reporting the results from DCE to derive preference-based weights for the IMD, which is similar to the main approach in this chapter. Two main assumptions in this survey are: (i) the state of deprivation can be described by the relevant domains, and (ii) one can infer the relative importance of these domains to individuals from their judgements if one multidimensional deprivation state is worse than another. The survey combines different pairwise hypothetical life scenarios defined by the seven IMD domains. Each attribute has two levels representing being deprived in the dimension or not, hence, there are 128 deprivation states. The choice tasks combine these states and 128 mirror-image alternatives of theirs, which were randomly divided into 16 pairs per respondent and in eight versions of the questionnaire. The total sample includes 251 completes from the general public, corresponding to a 25.1% response rate. The sample is not representative of England's population in terms of demographic characteristics such as age or sexes.

The results were analysed based on random utility theory and through a logistic regression model. As the sample under-represents those younger than 60 years old and people with no or 'O' level education qualification (or equivalent), both unweighted and weighted results based on population proportions in the 2001 census were reported. Overall, most domains show statistically significant effects on respondents' choices, which implies that people regard those with worse IDM should be higher priority to receive government support. The relative importance of the domains is stable when comparing the unweighted and weighted results even though there are slight changes in the magnitude of the coefficients. It is noted that as domains included in this context related to the measure of deprivation (as opposed to measure of welllbeing) have two levels (i.e. deprived or not deprived), the relative importance of these domains are at the lower end of wellbeing, which may not be the same across the entire spectrum of wellbeing. The domain ranking obtained from the survey results suggests a highest to lowest weight in the order of income, living environment, health and disability, education, skill and training, barriers to housing and services, crime, and employment.

Applying a similar approach – DCE – Decancq and Watson (2019) elicit preferences over different life domains and obtain weights for the Human Development Index. The study reports the results from four experiments carried out on convenience samples (N=1022) including students majoring in Microeconomics in four countries Belgium, Colombia, Ethiopia and the US. All surveys were in paper-and-pencil format with English instructions, except for Belgium (in Dutch) and Colombia (in Spanish). There are three relevant life domains including income (in local currency and is converted to 2015 USD considering exchange rates on the interview dates), life expectancy (in years) and educational attainment (in years). Each attribute includes three levels that reflect the 20th, 50th and 80th percentile figures of the national distribution, which aims for cross-country comparability. As for income, the variable 'per capita monthly household disposable income' is used as a proxy of GDP per capita to avoid confusion for respondents. The survey includes 12 pairwise choice tasks, of which only nine pairs are from an efficient design. The other three pairs added at the 4th, 7th and 10th place in the sequence are used to test the transitivity of the preference of participants (For more details regarding transitivity test, see Decancq and Watson, 2019).

The estimated coefficients from the data from the four surveys show that most students from Belgium, Colombia and the US stated that the income domain was always considered. More than 60% of the Ethiopian and US sub-samples always considered the health domain, while the figures for Belgium and Colombia were about 50% of the respondents. The education domain was always considered in the choice tasks by around half of the participants in Colombia and Ethiopia. The data from the nine choice tasks from the efficient design were analysed through conditional logit models. Three models were conducted separately for each country-level data, which are (i) linear additive case like the old HDI specification (models fixing curvature parameter level at 1), (ii) a multiplicative case of the new HDI (setting curvature parameter level at 0), and (iii) using the model's best-fitting level of curvature parameter (Decancq and Watson, 2019). The estimated coefficients for each dimension from each model are then used to calculate weights across the three domains. The weighting schemes are different across countries. For example, income accounts for the highest weight in Belgium, both in a within-country across-domain comparison and a cross-country comparison, which was followed by the Colombian sub-sample. Data from Ethiopian and US samples place the lowest weights on income compared to their counterparts from other countries. From all sub-samples and models, the remaining weights are shared between health and education, of which the former domain has a higher weight than the latter. Furthermore, to examine whether there are heterogeneity regarding the weights on different domains within each sub-sample, the domain weights are compared across different subgroups within the largest sub-sample (Belgium, N=470). Comparing the subgroup with low self-reported subjective life expectancy and one with 'high life expectancy', the weight given to the health domain is larger in the former group. The authors stated that this finding could be explained from the experience of confronting health problems in the group of people with longevity. The group of students whose parents have not obtained a degree have placed lower weight on the education domain than those from higher education families.

WTP calculated for an annual increase in the non-monetary domains depends on the level of curvature parameters and corresponding weights. Overall, WTP levels for non-income domains are highest in the US whereas the Colombian and Ethiopian sub-samples appear to trade off much less income for the increase in health and education attainment domains. The last set of findings obtained from the data are related to testing assumptions about the curvature parameter and weighting scheme. The results reject the null hypothesis of equal weights across domains in all models. Regarding the aggregation of the domains, both hypotheses of additive aggregation and multiplicative aggregation are rejected in the Belgian sample. Likewise, an additive aggregation is not confirmed in the Ethiopian sub-sample. Decancq and Watson (2019) also reject the hypothesis of a multiplicative aggregation in the Colombian models.

After reviewing the relevant literature, it can be drawn from the review that despite extensive literature in the computation of equivalent income using life satisfaction regression (see Literature Review in Chapter 3 for more details), little work has been done using the stated preference approach. Among the three most relevant papers including Fleurbaey et al. (2013), Abasolo et al. (2018) and Capéau et al. (2020), Capéau et al. (2020) is the largest study with more than 3000 respondents and five life domains (income, consumption and affordability; health; work status; housing and time use). Fleurbaey et al. (2013) focused on health and healthcare (sample size of over 500), while Abasolo et al. (2018) used a convenient sample of 52 to examine consumption and non-income domains such as health (physical function, pain and depression) and close relationships. In addition, the study by Abasolo et al. (2018) employed methodological questions to identify internal inconsistency. In general, some room and opportunities for future work can be summarised regarding the inclusion of more non-health domains and expanding the sample size for a more representative sample and conclusive results.

Among those studies that used DCEs but did not compute equivalent income, there is potential use of the data to estimate coefficients that could be to compute equivalent income if the levels of life domains are larger than two. Having only two attribute levels (e.g. (Watson et al., 2019)) is too crude, especially when as it only capture the best and the worst level of each life domain. This chapter attempts to fill in some of the above-mentioned gaps of the literature.

4.3 Methodology

4.3.1 Ethical consideration

The study was approved by the responsible ethics committee at the Department of Economics, the University of Sheffield before the beginning of the data collection. The first ethics application was approved in February 2020. However, due to the first COVID-19 lockdown, some changes were made, and the second ethics application was submitted based on the first version with some changes related to the interviews for the Qualitative pilot. The second ethics application was approved in April 2020 by the Ethic Committee at the Department of Economics.

The research only involves adults aged 18 years old and above. All participants provided their explicit consent. Personal identifying data was not collected during both interviews and online surveys.

4.3.2 Random utility theory

Theoretically, some properties of the preferences including completeness, continuity and transitivity are based on the assumption of an individual's deterministic behaviours, which implies that an individual can make identical choices conditional on the same given information and circumstances. However, such an assumption may not be consistent in practice as indicated by Tversky (1969) that when facing repeated choices between alternatives, consumers choose one alternative in some instances but pick the counterpart option in others. A theory to explain observed inconsistent preferences is a probabilistic choice theory, which analyses choices by determining the probability of different outcomes from each individual given a particular scenario. According to Hess et al. (2018), the practical implementations of choice modelling, therefore, needs to acknowledge the existence of uncertainties by employing a paradigm that contains a random element for choices to be represented as a probabilistic phenomenon[13].

Such approach combining the concept of utility maximisation and a random element is generally referred to as random utility theory in which the utility of an individual related to a choice alternative is assumed to involve both deterministic and stochastic utility components (Timmermans, 2001). The random component represents uncertainties around an agent's utility that the analyst may not be fully aware of or understand when developing the model (Bierlaire, 1998).

According to choice theory and the principles of utility maximising behaviour, the conditional probability of choosing a choice alternative, given its attributes and individual's characteristics, is equal to the probability of the utility exceeding that of the rest of the alternatives within the choice set (see Block et al., 1960; Marschak, 1960, for more discussion). That probability is then written as:

$$P(i|C_a) = Pr(U_{ia} \geq U_{ja}), \forall j \neq i \in C_a \tag{4.1}$$

Where individual a has a utility associated with alternative i denoted as U_{ia} and a utility associated with alternative j denoted as U_{ja}. Choice set of individual a is denoted as C_a

[13]Hess et al. argued that in practice, "the analyst does not know all, or indeed perhaps most, of the relevant facts about the agent to be modelled, such as the agent's preferences, attitudes, income, exact location, etc. In particular, the process by which an agent makes choices is unknown to the analyst, and a paradigm such as utility maximisation is likely to be only an approximation to the real process used." (Hess et al., 2018, p.182).

and $P(i|C_a)$ captures the probability that alternative i is chosen over alternative j given that U_{ia} is at least equal or larger than U_{ja}. However, the utilities associated with different alternatives are known by the decision-makers rather than the analysts, or in other words, utilities are incompletely observed by the analyst as function V which in most cases is different from utility U. The most common and simplified representation for U_{ia} is based on a linear regression, which implies that the utility level includes two additive components: V_{ia} represents a deterministic component of the utility U_{ia} observed by the analyst, and ε_{ia} is the error term. U_{ia} combines the explanatory variables and the joint distribution of the random vector of error terms ε_{ia}.

$$U_{ia} = V_{ia} + \varepsilon_{ia} \tag{4.2}$$

The error term is assumed to have an independent and identical Gumbel (type 1 extreme value) distribution, which implies no correlation in the error term across different alternatives or across different choice sets (Vass et al., 2018). Another assumption is that systematic deviations in the mean error coming from all alternatives do not affect choices since, as defined in equation 4.1, the model outcome depends on utility differences (Vass et al., 2018).

One well-known model to analyse a choice experiment based on random utility theory is the conditional logit model developed by McFadden et al. (1973), which treats an individual's choice among other alternatives as a function of the characteristics of those alternatives, rather than or in addition to the individual's own characteristics (Hoffman and Duncan, 1988). The conditional logit model specifies the probability that an individual chooses alternative i as:

$$P(i|C_a) = \frac{e^{V_{ia}}}{\sum_{i=1}^{J} e^{V_{ja}}} \tag{4.3}$$

where J is the number of alternatives in each choice that an individual faces.

Care should be taken when interpreting the estimated probabilities as they are affected by a scale parameter λ, which is inversely related to the variance of the error term (Vass et al., 2018). In other words, the estimated preferences parameters are scaled by the scale parameter λ as such:

$$P(i|C_a) = \frac{e^{\lambda V_{ia}}}{\sum_{i=1}^{J} e^{\lambda V_{ja}}} \tag{4.4}$$

For each observed function V of an individual a and alternative i, V_{ia} is explained by a set of explanatory variables X as:

$$V_{ia} = \sum_{k=1}^{J} \beta_k X_{kia} \tag{4.5}$$

where K is the number of predictor variables, X_{kia} captures the value of k^{th} explanatory variables of alternative i and individual a. β_k is the preference parameter associated with the k^{th} explanatory variable or attribute. X_{kia} vary across individuals and alternatives. Substitute V_{ia} (similar derivation is applied on V_{ja}) into the probability function above, and we have:

$$P(i|C_a) = \frac{e^{\sum_{k=1}^{J} \lambda \beta_k X_{kia}}}{\sum_{i=1}^{J} e^{\sum_{k=1}^{J} \lambda \beta_k X_{kja}}} \tag{4.6}$$

Function 4.6 implies that the estimated parameters $\hat{\beta}$ from the model is unidentified as it is not possible to separate the scale parameter λ from the preference parameters β_k, and that the scaled preference parameters $\lambda \beta_k$ indicate the effects of observable variables relative to the unobservable components (i.e. the variance of the error term) (Vass et al., 2018).

4.3.3 Equivalent income and life domains

Equivalent income is defined as the hypothetical amount of individual income ($Y^{'}$) that, if combined with the best levels of non-income aspects (captured by vector X^{*}), is as good as the current situation (Fleurbaey, 2005; Fleurbaey and Schokkaert, 2011):

$$U(X,Y) \equiv U(X^{*},Y^{'}) \tag{4.7}$$

If an individual has the best level of all non-income domains ($X \sim X^{*}$), then equivalent income should be the same as this person's current income ($Y^{'} = Y$). On the other hand, if any of the non-income aspects are not at the best levels, the individual's equivalent income should be lower than the current income level. The difference between current income and equivalent income is individual WTP to achieve the best profile in non-income domains.

$$WTP = Y - Y^{'} \tag{4.8}$$

In this study, the concept of equivalent income is operationalised across six domains of wellbeing against equivalised household disposable income after housing costs. The wellbeing domains consist of the Effect of Physical Health, and the Effect of Mental Health, Loneliness, Employment, Housing Quality, and Neighbourhood Safety. These domains are policy-relevant and have been considered by many projects aiming to improve living standards such as Centre for Progressive Policy and Thriving Places Index (2019). The derivation of these seven domains and the levels of each is beyond the scope of this thesis and is reported elsewhere (Tsuchiya, A. and Wu, C. on behalf of the SIPHER Consortium, 2021).

Table 4.1 The attributes (life domains) and levels used in the choice experiments

Attributes	**Attribute levels**
Effect of Physical Health – Ph In the past 4 weeks, have you accomplished less than you would like with your work or other regular daily activities as a result of your physical health...	Five levels of frequency: **1. None of the time/** 2. Little of the time/ 3. Some of the time/ 4. Most of the time/ 5. All of the time
Effect of Mental Health – Mh In the past 4 weeks, have you accomplished less than you would like with your work or other regular daily activities as a result of your emotional problems (such as feeling depressed or anxious)...	Five levels of frequency: **1. None of the time/** 2. Little of the time/ 3. Some of the time/ 4. Most of the time/ 5. All of the time
Loneliness – L You feel lonely and left out from others. . .	Three levels of frequency **1. Hardly ever/** 2. Some of the time/ 3. Often
Household Disposable Income – I Monthly (or weekly) household income (i.e. income from wage, benefits, pensions, etc, deciles after deducting your tax, national insurance, any occupational pension contributions, and after deducting your rent, mortgage payments or other housing costs)	Continuous attribute with 5 levels of disposable income (40% - 60% - 80% - 100% - 120%) which are calculated using the mean of each decile group.
Employment – E § This is about your main daily activity. If you are currently on maternity/ parental/ sick or furlough leave, you count as being employed. (Please choose the option that best describes your main daily activity.)	Six (non-ordered) levels **1. FT employed** 2. PT employed 3. Job-seeking 4. FT education/ training/ apprenticeship 5. Taking care of a family member with chronic illness or disability 6. Not working
Housing Quality – H § Your home is in a reasonable state of repair, has reasonable facilities (cooking/washing) and provides reasonable warmth. . .	Three levels of quality **1. All true/** 2. Partly true/ 3. Not true
Neighbourhood Safety – S You are concerned about the safety of the neighbourhood you live in. . .	Three levels of frequency of feeling concerned **1. Hardly ever/** 2. Some of the time/ 3. Often

Note: Reference levels for the DCE models are in bold.
Disposable income (I) is equivalised by household size (denoted as Y) and measured either on a continuous scale or by means of deciles. The figures are displayed in both per month and per week. Only per month values are reported here.
§ Differences in these domains between DCE and self-reported questions are explained in the survey flow in Section 4.3.6

In the ***Household Disposable Income*** domain, there are five levels displayed in the choice tasks, calculated as 40%, 60%, 80%, 100% and 120% of a reference income. The reference level of income is the mean value for each of the deciles of household disposable income in wave 9 of the UKHLS (University of Essex and Institute for Social and Economic Research, 2020). To ensure that these amounts were something each respondent found relevant, ten different reference incomes were used depending on the respondent's self-reported household disposable income. An example of the 2nd decile is in Table 4.2 below.

Table 4.2 Example of Household Disposable Income domain (the 2nd decile)

	Range	**Mean**	**5 levels used in DCEs**				
	(used in background question)	(used as reference income for DCE)	*40%*	*60%*	*80%*	*100%*	*120%*
Per month	**£851 – £1,220**	**£1,040**	*£420*	*£620*	*£830*	*£1,040*	*£1,250*
Per week	**£211 – £300**	**£260**	*£100*	*£160*	*£210*	*£260*	*£310*

The range of disposable income shown (between £852 and £1,220 per month or between £211 and £300 per week) is one of ten ranges displayed to respondents before the DCE exercise, to report their household disposable income after housing costs. Based on the income range they report, each respondent is then allocated to the variant of DCE that uses the mean value of this income range in the UKHLS as the reference income (100%) and the five levels of disposable income relative to this (40%, 60%, etc) in the choice tasks.

Theoretically, there are many potential interactions between the seven life domains. However, having too many interactions in a model, especially with limited sample size, is data-demanding given the high correlation between terms and increases the problem of driving out the main effects. Therefore, not all possible interaction terms are included in the empirical model. As income and employment status are highly correlated, disentangling the relationship between the two domains through the interactions between income and employment would help to explain the effects of each domain on people's choices, and hence wellbeing (For more discussion on the effects on employment on wellbeing and also on the computation of equivalent income, see Clark and Oswald, 1994; Decancq, Fleurbaey and Schokkaert, 2015*b*; Decancq et al., 2017). The Utility function estimated from the DCE data is:

$$U_i = \beta_1 Ph + \beta_2 Mh + \beta_3 L + \beta_4 E + \beta_5 H + \beta_6 S + \gamma_1 lnY^i + \gamma_2 E\#lnY^i + \varepsilon_i \tag{4.9}$$

where most of the notations are the same as those in Table 4.1 and Y^i is the individually-equivalised disposable income (i.e. individual income). Household Disposable Income in the DCE (I) is treated as continuous and is equivalised for each respondent i using their household size data from the background question. Equivalised disposable income Y^i is calculated by dividing the household disposable income I in the DCE scenario with the square root of the respondent's own household size (OECD, n.d) and captured in natural logarithm form (lnY^i). Interactions between Employment and Disposable Income are included and denoted as $E\#lnY^i$. All the other explanatory variables are categorical. The set of relevant parameters are captured by the β and γ coefficients. ε_i is an error term.

With the exception of Employment (for which there is no logically determined ordering), since the best levels are used as the baseline for categorical variables, the β coefficients are expected to be negative and ordered. The γ coefficients are expected to be positive. Based on the estimated parameters from the regression, the preference rankings across non-income life domains are generated and compared across domains.

4.3.4 The calculation of equivalent income and willingness to pay

The modelling of the survey data is based on an assumption that the probability of a given life scenario being selected (more preferred) is a function of the utility associated with hypothetical observable aspects (i.e., the allocated levels of the seven attributes) and unobserved components. When choice data is from a two-alternative forced-choice experiment (i.e. life scenario A or B, with no indifference option), modelling using a limited dependent-variable model is the most common method (Hauber et al., 2016). This method is the most suitable for regression that includes a dummy dependent variable (i.e. the left-hand-side variable in the regression is whether an alternative is chosen – 1 or not chosen – 0 in the choice task). Hence, logit models are an appropriate analysis method (de Bekker-Grob et al., 2012; Hauber et al., 2016). In conditional logit models, the probability of choice among several alternatives is related to the characteristics of the attribute levels in each alternative. These attributes levels are elements that unitedly define the alternative scenarios in DCE. McFadden et al. (1973) show that conditional logit models are consistent with random utility theory. Therefore, the data from the DCE in this survey can be analysed using a conditional (fixed-effect) logit model. There are ten income variants in the main survey, which were pooled together in the analysis.

In the first stage, a conditional (fixed-effects) logit model was used to estimate preference parameters which are key to calculate equivalent income in the second stage. Let us use vector X^k to represent the five non-income non-employment domains that do not interact with income in the model ($k = Ph, Mh, L, S$ and H). Based on function (4.9) and the definition of equivalent income as the hypothetical amount of income combined with the optimal levels of non-income domains that is as good as the current situation Decancq, Fleurbaey and Schokkaert (2015*b*), for any combinations of seven life domains, we have:

$$\sum_{k=1}^{K} \hat{\beta} X^{k} + \hat{\beta}_4 E + \hat{\gamma}_1 lnY^{i} + \hat{\gamma}_2 E\#lnY^{i} \equiv \sum_{k=1}^{K} \hat{\beta} X^{*k} + \hat{\beta}_4 E^{*} + \hat{\gamma}_1 lnY^{i'} + \hat{\gamma}_2 E^{*}\#lnY^{i'} \quad (4.10)$$

X^{*k} captures the best levels of these five life domains and together with full-time employment E^* (selected based on a post-hoc empirical basis as the reference for the Employment domain) form the reference group in the model (i.e., baseline).

The analysis in this study assumes homogeneous reference values for all respondents. The Employment domain is categorical and not logically ordered and the reference value was chosen based on a pragmatic choice. The results overall confirm that full-time employment or self-employment is preferred outcome for the whole sample, although part-time employment or self-employment is not statistically different from full-time employment or self-employment.

However, the heterogeneous preferences across subgroups and equivalent income levels can be calculated by subgroups if they are relevant to the aims of the research. As the analysis is based on average preferences of subgroups, normative issues need to be carefully considered. For instance, women, on average, prefer 'part-time employment or self-employment' (i.e. positive and significant effect at 1%) while men are less likely to choose a scenario with this category (i.e. negative and significant at 10%). However, even within female subgroup, not every respondent prefers part-time employment over full-time employment.

As dummy coding is used in the analysis, for each domain, the model contains a vector of dummy variables such that each of the mutually exclusive categories (apart from the reference category) corresponds to a $0/1$ indicator. The reference values X^{*k} and E^* are, by definition, always 0 regardless of what attribute levels X and E are.

In the second stage, one can use the preference parameters to calculate equivalent income for each survey respondent, based on their household disposable income after housing costs, equivalised using their household size, and adjusting for their non-income data. By construction, the utility one would derive from equivalent income ($Y^{i'}$) combined with the reference categories of all non-income dimensions is equal to the utility derived from one's actual income (Y^i) combined with the categories of the non-income dimensions that apply to one's actual circumstances. Hence, equivalent income can be computed as:

$$\hat{\gamma}_1 lnY^{i'} \equiv \sum_{k=1}^{K} \hat{\beta} X^{k} + \hat{\gamma}_1 lnY^{i} + \hat{\beta}_4 E + \hat{\gamma}_2 E\#lnY^{i}$$

$$Y^{i'} = Y^{i\left(1+\frac{\hat{\gamma}_2}{\hat{\gamma}_1}E\right)} \cdot exp\left(\sum_{k=1}^{K}\left(\frac{\hat{\beta}}{\hat{\gamma}_1} \cdot X^k + \frac{\hat{\beta}_4}{\hat{\gamma}_1} \cdot E\right)\right) \tag{4.11}$$

The computed equivalent incomes are then compared with equivalised disposable income. This was done by firstly ordering all respondents by equivalised income and dividing them into quintile groups. Then, the process was repeated for equivalent income. Lastly, the sample was cross-tabulated across the two sets of quintile groups to examine those in the diagonal cells. This test aims to understand the extent to which those in each quintile group for actual equivalised disposable income are also in the same quintile group for equivalent income. In addition, equivalent income is compared with the Effect of Physical Health and the Effect of Mental Health to examine the similarities and differences between each of the two health-related domains and this single-index multidimensional wellbeing measure. To do so, a cross-tabulation of five levels of the Effects of Physical Health or the Effect of Mental with equivalent income is carried out.

To further understand one application of equivalent income which is to identify the worst-off group, comparisons between equivalent income as a wellbeing measure and life domains were carried out through a multi-stage process. First, those 10% of the sample with the lowest equivalent income were identified. Second, the same number of individuals with the lowest equivalised disposable income were identified. Third, in order to achieve the same for the non-income domains, which are categorical, the worst-off 10% were identified using random seeds set within Stata[14]. Finally, after having the worst-off 10% by different domains and measures, checks were carried out to examine the percentage overlap across different combinations of multiple domains. For example, it aimed to see what percentage of those worst-off identified by both equivalent income and loneliness or by equivalised disposable income, equivalent income, and housing quality. The higher the degree of overlap across domains and equivalent income, the more consistency in identification of the same worst-off group, which implies high level of agreement between these domains and wellbeing measure. Especially, when all domain are included in the test, the extent of overlap with equivalent income implies how much efficient that equivalent income captures the worst-off identified by different life domains.

One indirect application of equivalent income is the willingness to pay (WTP) to achieve the best profile in the non-income life domains. Some examples are presented to illustrate the calculation of the absolute values of WTP and the comparison of WTP to achieve the best levels of health and non-health domains.

[14]A random seed is a number with which Stata starts its algorithm to generate a sequence of random numbers. This is to ensure that every time the outcomes generated from the same seed(s) will be identical (StataCorp LLC, 2021*b*)

Furthermore, from the estimated regression parameters, marginal willingness to pay (MWTP) to move from a certain attribute level to the optimal attribute level is given by:

$$MWTP_{attribute} = \frac{\hat{\beta}_X}{\hat{\gamma}_1} \tag{4.12}$$

In which $\hat{\beta}_X$ captures the estimated coefficients for non-income domains and $\hat{\gamma}_1$ is the estimation of income's parameter. The MWTP reflects how much an individual is willing to pay to transform from a certain attribute level to the optimal level of non-income domains[15].

4.3.5 The DCE design

Given Equation (4.9) above, the number of parameters (denoted as K) capturing the main effects is 20; i.e. one for disposable income, five for employment, four four for the effect of physical health and the effect of mental health each, two for neighbourhood safety, housing quality and loneliness each. In addition, there are five parameters related to interactions, which add up to a total of 25 parameters. The number of minimum choice tasks S_{min} in a DCE is calculated using the number of parameters ($P = 25$) to estimate and the number of alternatives or choices (C, i.e. $C = 2$ for pairwise choice exercises) (ChoiceMetrics Pty Ltd., 2018):

$$S_{min} = \frac{P}{(C-1)} = \frac{25}{(2-1)} = 25 \tag{4.13}$$

The convention is to have twice as many as S_{min} or more. The design of the choice experiment, therefore, consists of 120 choice tasks divided into 12 blocks of ten choices each since it is not practically possible for a single respondent to complete 120 choice tasks at once. The utility function was estimated through two-forced-alternative pairwise choice experiments. The design assumes scale and preference homogeneity and is generated using Ngene based on D-efficiency (ChoiceMetrics Pty Ltd., 2018). In order to reduce the cognitive burden of the choice tasks on respondents, a Partial Profile Design (ChoiceMetrics Pty Ltd., 2018) was used, where, in each choice task, two out of the six non-income domains were forced to have the same level across the two alternatives (i.e. at least two ties in each choice task). In addition to the benefits that potentially reduce the burden on respondents, the partial profile design does not over-compromise D-efficiency as the full candidate profile (i.e. all possible combinations of choice tasks with a given number of ties, which is two ties in this design) is generated using the most efficient design originally from Ngene (ChoiceMetrics Pty Ltd., 2018). This full list is then evaluated in Ngene to generate a set of design with

[15]The results of MWTP will be presented in Appendix C

the lowest D-error. Depending on the number of attributes and attribute levels as well as the design of the partial profile (e.g. one, two or three ties), D-efficiency may reduce more or less (Kessels et al., 2012). In this design, D-error in the partial profile design is 0.155 when D-error in the initial design, which is used to create the full-profile design, is 0.134 (i.e. an increase of about 10% in D-error)[16]. The Disposable Income domain was designed not to be tied in any choice task. Income was treated as continuous, and in the design, the levels were treated as relative (proportions relative to the reference income level, rather than absolute amounts) so that the same choice design could be used in the different income level variants. The priors (i.e. initial estimates or beliefs of the parameter values) were obtained from the results of a quantitative pilot conducted online with a sample size of 100 (details are available in Section C.1.3 in Appendix C.).

In the DCE design, the Income domain represented income at the household level. However, since the estimations from the econometric model were used to compute equivalent income, which is based on an individual's preferences between income and non-income domains, income in the econometric model needed to be set at the individual level. In order to facilitate this, household income in the DCE was equivalised based on each respondent's household size. The square root scale method was used to take into account economies of scale in consumption, which adjusts for the differences in needs across different household sizes (OECD, 2008, 2011*b*). Details on income treatment are presented in Section C.2 Appendix C.

4.3.6 The pilots and the survey protocol

A qualitative pilot aimed to examine how respondents interpret the wording used in the survey and to obtain feedback on the length and difficulty of the survey. A small convenience sample ($N = 10$) was asked to complete the online survey while on a video interview with the author to check for comprehension. After the qualitative pilot, changes were made to the survey (details available in Section C.1.2 in Appendix C). The revised design was then fielded through a quantitative pilot with 100 respondents in August 2020 from the PureProfile internet panel. This pilot provided the priors of the parameters used in the final DCE design.

[16]A-error for the initial design is 10.903 and A-error for the partial-profile design is 6.628. S-estimates from Ngene designs imply the S-efficiency measure (sample size based) (ChoiceMetrics Pty Ltd., 2018). The S-estimate from the initial design is 13,001, which is the figure related to 'Job-seeking' category under Employment domain; the next largest required sample sizes are 2597 and 2056, which are related to 'full-time education' and the interaction between income and 'full-time education'. The figures for corresponding parameters in the partial design are 7191, 1627 and 1132, respectively. As the second largest required sample size from S-estimate for the partial-profile design is lower than the sample size of the survey from this chapter, it is possible to meaningfully estimate most of the parameters from the design.

The final survey has ten variants based on deciles of household income from the UKHLS wave 9. The design aims to ensure that the respondents can relate to the income levels in the DCE. To do so, two possible alternatives were considered: (a) to allocate respondents in different groups by their household size and present the income attribute in the DCE as household income for the corresponding household size, or (b) to divide respondents into groups based on their household income ranges so that respondents can relate to the income levels in the DCE. In both approaches, the analysis will need to equivalise the level of household income presented in the DCE scenarios using the household size information for each respondent.

The first approach requires specifying the levels of household income for each household size group and the DCE design would have different variants based on household sizes (i.e. in this chapter this would be five as there are five groups of household size: a single person, two, three, four people and five or more people[17]). To do so, first of all, the mean income for each household group was estimated from the UKHLS wave 9 data. After that, from these mean values, five levels of income were calculated to use in the DCE design as 40%, 60%, 80%, 100% and 120% of the mean. The disadvantage of this approach is that the range of actual income levels within each household size group could be very wide. For example, from the wave 9 UKHLS data, the single-person household group has a mean disposable income after housing costs of £1,411/month but the minimum value is £1 and the maximum value is £35,506/month[18]. In this case, the hypothetical income levels from the DCE choice tasks would be extremely unrealistic to many respondents, especially those at the top end bottom end of the income distribution.

Therefore, I opted for the second approach. In this approach, respondents are divided into 10 groups based on their self-reported household disposable income after housing costs. The reference values used in the survey are from the mean deciles of the household disposable income after housing costs in the UKHLS wave 9. Similar to the previous approach, from each of these mean values, five income levels are calculated to use in the choice tasks. By dividing respondents by self-reported income levels and into 10 groups, the income range within each income-decile group is not too large and the hypothetical income levels presented in the choice tasks are not too far from their actual conditions. In addition, when pooling data across the ten DCE variants, the differences between point income values are not too wide.

[17]The descriptive statistics on household size from the UKHLS wave 9 are: 27.23% single household, 33.61% 2-person household, 15.24% 3-person household, 15.42% 4-person household and 8.51% 5-or-more-person household. The figures for the survey data are quite similar, at 20.32%, 39.92%, 18.38%, 13.65% and 7.73% respectively.

[18]The income ranges for the 2-person household, 3-person household, 4-person household and 5+ person household are: £3/month - £105,758/month, £44/month - £73,180/month, £42/month - £79,667/month and £44/month - £35,428/month respectively.

For each of the ten variants, there are 12 blocks of ten choice tasks each. Respondents were allocated to one of the ten variants of the DCE based on their answers in the income question and then were randomly allocated to one of the 12 blocks. Those who did not answer the income question were allocated to the variant for the 4th decile.

After improving the design and presentation of the survey given the results from the pilots, the main survey was soft-launched for a week to collect a small sample of 5% of the whole sample in the main survey (168 responses) at the beginning of October 2020. After checking that all the functionalities of the survey were working, the main survey was launched to collect the rest of the sample in November 2020. The data from the soft launch was pooled with the data from the main launch for analysis.

Several actions were taken to ensure the validity of the results. First, the sample was limited to residents in the UK. Second, to restrain respondents from mindlessly skipping through the questions, forced answer settings were embedded in the survey. However, except for the choice experiment section, the option for 'I prefer not to answer' was included. In addition, total time completion was used as a condition to include valid responses.

The survey flow includes:

i. Survey information and consent

ii. Introduction of the domains

iii. Background questions related to the seven domains and other screening questions (i.e. gender)

iv. Practice questions for the choice tasks (three questions). Respondents have an option(s) to read the instructions in detail on how the tabular format of the DCE works during Practice 1 and 2.

v. The main DCE: ten variants based on deciles of household income from the UKHLS wave 9. There are 12 blocks of ten choice tasks in each of the variants.

vi. Feedback questions

vii. General questions (other self-reported questions)

viii. COVID19 questions

Before being presented with the main DCE choice tasks, respondents needed to complete the background questions (part iii) that covered the seven domains used in the DCE. This part aimed to help respondents to get accustomed to the domains while thinking about their current situation. There was also a question regarding household size. In addition, questions on gender and age were included to set up quotas for the survey.

As mentioned briefly in Table 4.1 before, there were some differences in the wording and categories used in the background questions and the DCE for the Housing Quality domain and the Employment domain. The ***Housing Quality*** domain has slightly different answers in the background question from the wording that appears in the choice tasks although they match in meaning. The answers given include “Yes to all of these/ Yes to one or more of these/ None of these/ I prefer not to answer". In the choice tasks, the categories are “All true/ Partly true/ Not true". Regarding the ***Employment*** domain, “not working" categories include ‘long-term sick or disabled’, ‘looking after the home and family’ and ‘retired’ which are separate categories in the employment self-reported background question. Having an attribute with too many levels requires a very large sample size, hence, the number of levels in the Employment attribute was reduced to six by grouping those three above-mention categories as “not working". The remaining six categories are the most policy-relevant.

After completing the background questions, respondents were directed to the practice questions. There were three practice questions with increasing difficulty levels. In Practice 1, respondents were introduced to the tabular format of the DCE with a question and three options to choose from as shown in the below example.

Practice 1: Please imagine a year of your life, to take place in the next three to five years. If a year of your life in the near future could be like A or B, which would you prefer?

Everything that is not mentioned is the same for A and B. **After one year, you will return to your normal life.**

Domain	Life scenario A	Life scenario B
You accomplish less because of physical health:	Some of the time	Some of the time
You accomplish less because of emotional problems:	All of the time	All of the time
You feel lonely and isolated from others:	Often	Often
Disposable income of your household is:	£1,730/month or £430/week	£1,390/month or £350/week
Your employment situation is:	Job-seeking	Job-seeking
Your home is in a reasonable state of repair, has reasonable facilities (cooking/washing) and provides reasonable warmth:	All true	Partly true
You are concerned about the safety of the neighbourhood you live in:	All of the time	All of the time

I prefer...

☐ Life scenario A

☐ Life scenario B

☐ I am not sure how this table works - I want more explanation

This practice question has a dominant choice, in which *“most of the domains in the life scenario A are the same as those in life scenario B, and scenario A has higher income and better housing condition."* When respondents were about to choose Life scenario B, a pop-up message as above was shown to ask if they were sure they would like to choose life scenario B. If they still chose B, they would be redirected to a screen in which they had an explanation of why A was better than B and were given a chance to re-do the question or to get a further explanation of how the tabular format of the choice task worked. If the respondents chose the last option in Practice 1, they would be redirected to further explanation of how the tabular format worked. Practice 2 also gave participants an option to go back to the explanation of the tabular format. In this question, the difficulty of the choice task was enhanced by showing fewer same aspects between scenarios A and B. The last practice question had only three ties (i.e. three same domains) and the others were different, but neither scenario was dominant over the other. Practice 3 was closer to the difficulty level of the actual choice tasks which usually has only two ties across seven domains. After completing the practice questions, respondents were directed to the main choice task exercise section (v) with a message that *“There are no right or wrong answers"*.

Once respondents completed the choice tasks, they were presented with a feedback section where they could give both positive and negative feedback related to their experience doing the DCE. Following that, respondents needed to answer questions about their demographics before completing the last part of the survey related to the respondent's experience and understanding of COVID-19 (not used in this thesis).

4.3.7 Subgroup analyses and robustness checks

In addition to the main analysis using the whole sample, subgroup analyses were carried out to understand heterogeneity in preferences. It has been observed that there is heterogeneity in preferences across groups such as gender (Decancq and Schokkaert, 2016*b*; Jones and Schurer, 2011), age groups (Tangian, 2005), marital status (Decancq and Neumann, 2014) or educational levels[19] (Schokkaert et al., 2011). The chapter examines preferences across subgroups by comparing the predicted levels of equivalent income rather than comparing the estimated coefficients since DCE coefficients are on a latent scale and cannot be compared directly across models. As explained in the random utility theory section, the coefficient estimates from DCE models combine preference heterogeneity captured by preference parameters β_k and error variance or scale heterogeneity captured by the scale parameter λ. Without disentangling the two, which is empirically challenging, interpreting the regression coefficients for preference heterogeneity will lead to a biased conclusion (Wright et al., 2018). By contrast, equivalent income computed from the coefficients are on an absolute scale, which by-passes the issue of scale heterogeneity and can be directly compared across subgroups. Therefore, the subgroup analyses are based on comparing equivalent income levels for set scenarios across different groups. Besides the levels of equivalent income, the result will report 95% confidence interval (CI) for each point estimate to examine the overlap between these CI ranges.

The first analysis is a comparison between male and female subgroups. Two regressions using the model specifications that include interactions between income and employment were estimated each for males and females. The parameters from these models were used to compute equivalent income for hypothetical situations which were then compared across subgroups. Further potential subgroups are different age groups, marital status groups, educational level groups and groups based on having or not having dependent children, as there is evidence confirmed from the literature for heterogeneity in preferences in these groups.

[19] The previous chapter in this thesis also confirms some differences in preferences between people with different educational levels, i.e. with versus without a degree.

Furthermore, robustness checks were carried out. The first check excludes respondents who took more than an hour to submit the survey. This was done by checking the total time to complete the survey and excluding those who took more than four times the average survey completion time of the sample. This check aims to eliminate respondents who might be either mindless or simply just left the survey for hours. The second check excludes those who might not have understood the choice tasks based on their written feedback and tickbox comments. This group includes respondents who chose *“Not sure about my answers"* in the feedback section and those who stated in the comment box that they did not understand the tasks or were not sure how to answer, or those who had issues with competing the survey using a smart-phone[20].

4.4 Data

4.4.1 Description of the survey and survey completion

The main survey was held on Qualtrics over ten days at the beginning of November 2020, for general public respondents recruited from PureProfile panel. Respondents who spent less than 30% of the average time completion (i.e. five minutes) on the survey were excluded from the analysis.

Among 4536 participants, about 88%, equivalent to 3970 respondents, submitted their responses. However, only 3373 data points are valid, and 347 points are invalid due to gender-quota full (7.65% of total submissions), speeders (i.e., those who completed the survey in five minutes or less, at 5.51%), and dropping out (6.72%). Among those who dropped out, 9.84% stopped while doing or after finishing the practice questions and 1.97% stopped while doing the DCE. Among those 3373 valid responses, 2865 participants (approximately 85%) completed the survey in less than 30 minutes. If excluding outliers who completed the survey in more than 30 minutes, the average time completion was 13.19 minutes. Including those completing in less than 40 minutes, the figure was slightly higher, at 14.20 minutes. These results were similar to the average time completion in the quantitative pilot. However, if the outliers were not excluded, the average time completion was significantly longer, at 217.33 minutes (equivalent to more than 3 hours). This could arise from the fact that participants could pause the survey and continue any time within seven days since they started.

[20]Some respondents (about 0.4%) indicated in the free-text comment of the survey that the tabulated DCE display was hard to read on portrait mode on their mobile phones. Some of them stated that due to the format, they were struggling to complete the tasks. For that reason, these respondents are excluded for a robustness check.

Table 4.3 Description of the responses from the main survey

Categories/ Groups	Data counts
ALL DATA	**4536**
Not finished/ not submitted	**566**
Unfinished by the time the survey was closed	261
Dropped out	305
Not consented	*265*
After introduction and consent	*2*
After or before completing Practice	*30*
While doing DCE	*6*
While doing COVD19 questions	*2*
Finished/Submitted	**= 4536 – 566 = 3970**
Rejected because quota full	347
Rejected because $<$ 5 mins completion	250
VALID	***= 3970 – 347 – 250 = 3373***
$<$ 30 mins completion	2865
$>$ 30mins completion	508
$>$ 40 mins completion	*364*
Average time completion	
Excluding outliers ($>$ 30 mins)	13.19 mins
Excluding outliers ($>$ 40 mins)	14.20 mins
Including outliers ($>$ 30 mins)	217.33 mins
The sample used in the regression	
Valid	**3373**
Not answering household size question (excluded from the regressions)	11
Included in the regressions	**= 3373 – 11 = 3362**

The 3373 valid responses were processed for the data cleaning process. However, 11 of them were excluded from the regressions as those respondents did not answer the self-reported question in household size, hence, it was not possible to compute equivalised disposable income for these responses. Therefore, only 3362 responses were included in the analyses in this chapter.

As mentioned previously, the data were collected with quotas set up to obtain a representative sample regarding gender and age. The references were based on the relevant figures in wave 9 of the UKHLS. The UKHLS data was chosen to use as the reference due to several reasons. First, the latest census data are from 2011 as it is carried out once every ten years. Second, ONS data for gender by country is available only up to 2015. By contrast, UKHLS wave 9 is from 2019. The data are more up to date than census and also cover all age groups in all four countries of the UK. The details of descriptive statistics related to gender and age in the survey sample compared with the UKHLS wave 9 are reported in Table 4.4 and Table 4.5.

Table 4.4 Representative sample regarding gender

	Male	**Female**	**Others/ Not answer**	**Total**
Counts	1500	1855	18	3373
%	44.47%	55%	0.53%	100%
UKHLS % - Wave 9	45%	55%	-	100%

Table 4.5 Representative sample regarding age groups

	18-25	**26-35**	**36-45**	**46-55**	**56-65**	**65+**	**Others/ Not answer**	**Total**
Counts	408	434	554	659	608	700	10	3373
%	12.10%	12.87%	16.42%	19.54%	18.03%	20.75%	0.30%	100%
UKHLS % - Wave 9	11%	13%	16%	19%	17%	24%	-	100.00%

4.4.2 The survey respondents

With the quotas set for gender and age based on the UKHLS 2019 data, the sample is largely representative of the UK public in terms of these characteristics. Overall, almost half of the participants reported the best levels for the Effect of Physical Health, the Effect of Mental Health and Loneliness. The majority were full-time employed or self-employed (37%) or retired (22%). Almost 85% of respondents had the best housing conditions. Similarly, most people (66%), were hardly ever concerned about the safety of their neighbourhood. In contrast, regarding household disposable income, more than 44% belonged to the bottom two deciles. About 7% of the respondents reported no problems in any of the non-income domains. Almost 60% of the respondents were either married or living as a couple and about 60% had the highest qualification at degree level or equivalent. About three-quarters of the respondents did not have dependent children living with them. Table C.5 in Appendix C summarises the distributions of different categories related to individual aspects including life domains and other demographic aspects.

Regarding profiles related to life domains of interest, about 7% of the respondents reported no problems in all non-income domains and almost 93% reported at least one life domain that was not optimal. The details of the top five majority profiles with and without income domain are reported in Table C.6 and Table C.7 in Appendix C. When considering only non-income domains, the top five profiles account for a cumulative 21.94%. Except for the 4th profile group, all the others include participants who reported optimal levels for the effect of physical health, the effect of mental health, loneliness, housing quality and neighbourhood safety. The 4th profile group reported second attribute level (i.e., some of the time feeling lonely and left out) while the other non-income non-employment domains were at optimal. Among all five groups, three main attribute levels were full-time employment or self-employment, part-time employment or self-employment, and retirement. When including the income domain, the total cumulative percentage of the top five profiles only accounts for 6% of the whole sample. Similar to the trend found in the top five profiles when considering only non-income domains, these groups with income also include participants reporting optimal levels in domains such as the effect of physical health, the effect of mental health, loneliness, housing quality and safety of the neighbourhood. The majority of respondents in these groups were either full-time employed or self-employed or retired. Regarding household disposable income, participants in the top five profiles overall belonged to low-income groups. The top four groups reported the two lowest income decile levels while the 5th group reported the 5th income decile.

4.4.3 Feedback from the survey

Overall, most respondents left positive feedback. About 30% of the respondents indicated that they were confident about their answers, whereas 12% were not sure about their answers. Less than 10% of the whole sample found that there were too many tasks within the survey. Besides the tick-box feedback, some of the free-text comments concerned the tabular format used in the DCE so that it should work better on a mobile phone.

Table 4.6 Tick box feedback from the main survey

Statements	**Number of responses**
Too many tasks	*321*
The task being asked is clear	1677
Not sure about my answers	*392*
Interesting survey	2009
Confident about my answers	1008
Layout is clear	1389
I could answer 5 or 6 more of the choices	556
Got tired half-way through	*376*
Boring	*376*
Difficult to distinguish between the scenarios	*587*
I would not want to answer any more of these tasks	*377*
Total chosen statements	9068
Average statement per respondent	2.7
Total negative statements	2429
Average statement per respondent	<1 (0.72)
Percentage of negative statements within all statements	26.79%

4.5 Results

4.5.1 Regression results

Table 4.7 Regression results of the main-effect model and interaction model

Variables	Main effects			Main effects & interactions		
	Coefficients	S.E	S.E with cluster	Coefficients	S.E	S.E with cluster
Little of the time accomplishing less due to physical health	-0.116***	0.025	0.026	-0.118***	0.025	0.026
Some of the time accomplishing less due to physical health	-0.135***	0.0025	0.026	-0.133***	0.025	0.026
Most of the time accomplishing less due to physical health	-0.479***	0.031	0.034	-0.466***	0.031	0.034
All of the time accomplishing less due to physical health	-0.837***	0.038	0.042	-0.828***	0.038	0.042
Little of the time accomplishing less due to mental health	-0.140***	0.027	0.027	-0.130***	0.027	0.027
Some of the time accomplishing less due to mental health	-0.215***	0.032	0.032	-0.203***	0.032	0.032
Most of the time accomplishing less due to mental health	-0.656***	0.038	0.039	-0.635***	0.038	0.040
All of the time accomplishing less due to mental health	-0.877***	0.044	0.049	-0.853***	0.044	0.049
Some of the time feeling lonely	-0.186***	0.025	0.024	-0.184***	0.025	0.024
Often feeling lonely	-0.591***	0.032	0.034	-0.579***	0.032	0.034
Ln of equivalised disposable income	1.282***	0.058	0.064	1.244***	0.064	0.069
Part-time employed or self-employed	0.033	0.032	0.034	0.096	0.199	0.198
Job-seeking	-0.283***	0.040	0.042	-0.753***	0.211	0.213
Full-time education	-0.184***	0.028	0.030	0.061	0.193	0.200
Taking care of a family member with chronic or disability	-0.755***	0.045	0.049	-1.047***	0.227	0.258
Not working	-0.221***	0.030	0.033	0.212	0.205	0.220
Reasonable housing quality: Partly true	-0.235***	0.025	0.024	-0.223***	0.025	0.025
Reasonable housing quality: Not true	-0.696***	0.029	0.032	-0.682***	0.029	0.033
Some of the time concerned about neighbourhood safety	-0.291***	0.023	0.021	-0.294***	0.023	0.022
Often concerned about neighbourhood safety	-0.599***	0.031	0.031	-0.586***	0.031	0.032

Table 4.7 –continued on next page

Table 4.7 – continued from previous page

PT employed or self-employed # ln income		-0.009	0.031	0.031
Job-seeking # ln income		0.075*	0.032	0.033
Full-time education # ln income		-0.038	0.030	0.031
Taking care of a family member [. . .] # ln income		0.048	0.034	0.039
Not working # ln income		-0.069*	0.031	0.034
Observations (Individuals)	67,240 (3,362)	67,240 (3,362)		
Log likelihood of model	-22141.500	-22128.089		
Log likelihood of model with intercept only	-23303.608	-23303.608		
LR chi^2	(20) 1634.16	(25) 2351.04		
McFadden's Pseudo R^2	0.0499	0.0504		
AIC	1.319	1.318		
BIC	-305863.111	-305827.395		

Utility functions

Main effects: $U_i = \beta_1 Ph + \beta_2 Mh + \beta_3 L + \beta_4 E + \beta_5 H + \beta_6 S + \gamma_1 lnY + \varepsilon_i$

Interactions: $U_i = \beta_1 Ph + \beta_2 Mh + \beta_3 L + \beta_4 E + \beta_5 H + \beta_6 S + \gamma_1 lnY + \gamma_2 E\#lnY + \varepsilon_i$

Base line: None of the time – Physical health/ Mental health affecting daily life; Hardly ever feeling lonely; FT employed; Housing quality: all true; Hardly ever concerned about the safety of the neighbourhood.

Robust standard errors are clustered by the individual. + $p < 0.1$ Hardly ever , * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

AIC, Akaike information criterion; BIC, Bayesian information criterion

Source: Primary data collected under SIPHER consortium

Table 4.7 reports the estimation results across the two DCE models: one with the main effects only and one with the main effects and interactions between income and employment. In the regression models, each observation is a life scenario. Hence, each choice task included in the model contributes two observations. The total number of observations is determined by the number of respondents included in the analyses (i.e. number of valid responses included in the regressions N = 3,362), a number of tasks per respondents (T = 10 choice tasks per respondent) and a number of alternatives per tasks (C = 2 for pairwise choice exercises). Therefore, the total number of observations for the whole sample is 67,240 ($obs = N \times T \times C = 3,362 \times 10 \times 2 = 67,240$).

Both regressions have the same baseline of all optimal levels of non-income life dimensions as noted in Table 4.7. Comparing the log-likelihood as an indicator of the model's relative explanatory power, the regression with interaction has less negative value than the log likelihood in the main-effect regression. Even though log likelihood solely cannot be used to conclude model fit, this result does imply that the interaction model seems to better explain the pattern of choices in data. One way to determine if including variables (i.e. including interactions in this case) significantly improves the model fit compared to a model without these variables is to compare the Log likelihood ratio chi-square test (LR chi^2). The model with interactions (i.e. 25 parameters, LR $chi^2 = 2351.04$) has a higher likelihood ratio than the model with only main effects (i.e. 20 parameters, LR $chi^2 = 1634.16$), which implies that the model with interactions fits data better. This could be explained as the DCE design was based on the specification including both main effects and interactions between employment and income. The last indicators to discuss regarding model fit are the Akaike information criterion (AIC) and Bayesian information criterion (BIC). These criteria assess the model's credibility and plausibility that minimises information loss, rather than improving the model's adequacy in data explanation (Hauber et al., 2016). The lower AIC and BIC measures are, the better the model is. As can be seen from the last two rows of the main results in Table 4.7, the model with interactions has lower AIC and BIC, even though the difference is very small, having interactions seems to minimise information loss and result in a better fit model.

Overall, in both models, the signs of all life domains except for Employment are as expected. Non-income domains including the Effect of Physical Health and the Effect of Mental Health, Loneliness, Housing Quality and Neighbourhood Safety are ordered. Household disposable income is positive and significant at 0.1%. In most cases, the robust standard errors are larger than non-robust standard errors, but the differences are very small.

Estimates suggest that people prefer having no health problems above having health problems either little of the time or some of the time. This goes for both the domains of physical and mental health and results are significant at the 0.1% significance level. The results do not allow us to reject the null hypothesis that having health problems little of the time on the one hand, or some of the time, on the other hand, give the same utility. The coefficients related to the other non-health domains including Loneliness, Housing Quality and Neighbourhood Safety are all significantly negative at 0.1%. The adjacent levels within a domain are significantly different at 5%. Regarding the employment domain, the coefficient related to the main effect of part-time employment or self-employment is positive while the interaction effect with income is negative and both are not significant. The main effects of job-seeking and taking care of a family member with chronic illness or disability both are negative and significant at 0.1%. The interactions, however, show positive effects, which is significant at 5% in the former category but insignificant in the latter category. The complex effect of job-seeking when including income interaction can be explained as, compared to the baseline of full-time employment, having “job-seeking" in the alternative makes it less likely to be chosen (i.e. negative and significant coefficients). When household disposable income is separated from the main effect (i.e. income = 0), having the “job-seeking" category in the choice makes it far less likely to be chosen (i.e. $\beta = -0.753$). The interaction effect tells us whether the impact on utility of becoming a job-seeker depends on how much income one has. The effects of full-time education and not working are similar, which combine positive but insignificant main effects and negative interaction effect (i.e. insignificant for full-time education and significant at 5% for not working) on the probability of the alternative with these levels to be selected.

In the main-effect model, compared to the baseline, all non-optimal levels of health and non-health domains (excluding employment) show negative, ordered, and significant effects at 0.1%. The adjacent levels within a domain are significant at 5%. In the Employment domain, part-time employment or self-employment is not statistically different from the baseline (i.e. full-time employment of self-employment).

The rank ordering of the absolute values of the coefficients in both models agree on that the top three most important domain-levels. They are the worst levels of the Effect of Physical Health and the Effect of Mental Health and “Taking care of a family member with chronic illness or disability", which are followed by the worst level in Housing Quality domain. People seem to care more about the safety of the neighbourhood than feeling lonely (i.e. The lowest ranking among all the worst levels of non-income non-health domains), which is shown by the lower ranking of the latter domain compared to the former.

Table 4.8 presents the rank ordering of the absolute values of the coefficients within each model using the whole sample. Both models agree that the worst levels (i.e. level 5) of the Effect of Physical health and the Effect of Mental health are the most important, which is in line with the marginal effect plots in the figures below. By contrast, from both regressions,

Table 4.8 Ranking of the absolute size of coefficients within each model

Variables	Main-effect	Interaction
Little of the time accomplishing less due to physical health	18	17
Some of the time accomplishing less due to physical health	17	16
Most of the time accomplishing less due to physical health	8	8
All of the time accomplishing less due to physical health	2	1
Little of the time accomplishing less due to mental health	16	18
Some of the time accomplishing less due to mental health	13	14
Most of the time accomplishing less due to mental health	5	5
All of the time accomplishing less due to mental health	1	2
Some of the time feeling lonely	14	12
Often feeling lonely	7	6
Part-time employed or self-employed	19	19
Job-seeking	10	9
Full-time education	15	15
Taking care of a family member with chronic illness or disability	3	3
Not working	12	13
Reasonable housing quality: Partly true	11	11
Reasonable housing quality: Not true	4	4
Some of the time concerning about the safety of the neighbourhood	9	10
Often concerning about the safety of the neighbourhood	6	7

being “Part-time employed or self-employed" is the least important. Across the two models, most of the attribute levels have similar rankings.

Besides the regression results, post-estimation coefficient plots and marginal effect plots are presented in Figure 4.1 and Figure 4.2 below. Overall, compared to baseline, large weights are placed on health aspects, which is in line with the ranking order discussed above. Between the main-effect model and the interaction model, only the employment domain shows some differences including changes in signs and increase in ranges of confidence interval when interactions between employment and ln of equivalised disposable income are included.

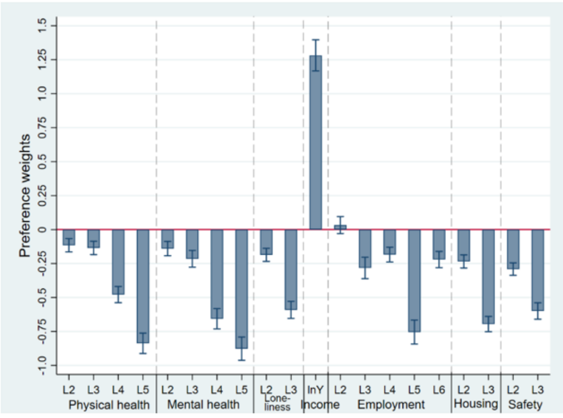

Figure 1a: Coef plot in main-effect model

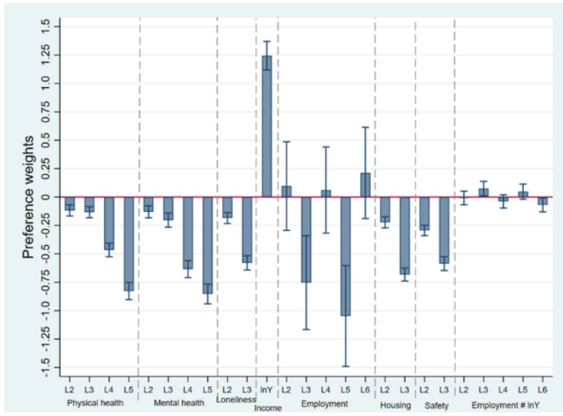

Figure 1b: Coef plot in the interaction model

Fig. 4.1 Coefficient plots

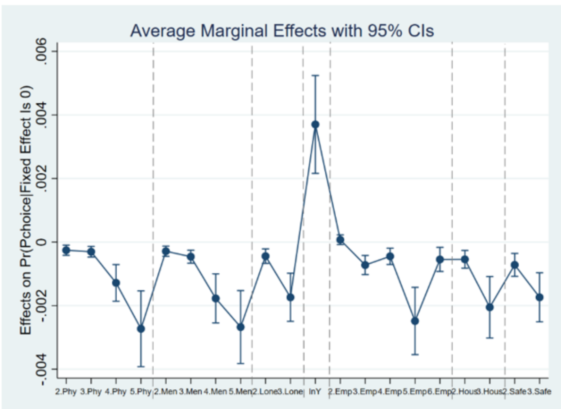

Figure 2a: Margin plot in main-effect model

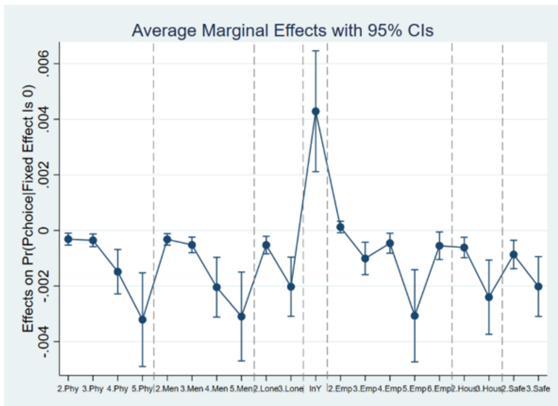

Figure 2b: Margin plot in the interaction model

Fig. 4.2 Margin plots

4.5.2 Computed Equivalent income and applications

Overall, the distribution of equivalent income calculated from the coefficients of the interaction model is right-skewed with the majority of individuals with low equivalent income of less than £1,000 per month. The pattern is similar across the genders although the percentage of female respondents in this survey sample having a low computed equivalent income is higher than the proportion of male respondents with the same level of equivalent income. Overall, equivalent income ranges between a minimum of £16/month and a maximum of £6,769/month. Histograms of equivalent income in the whole sample and across different gender and age subgroups are reported in Section C.4 in Appendix C. Across age groups, the patterns of equivalent income's distribution vary. While age groups 26 – 35, 36 – 45 and 46 – 55 years old have a similar distribution of equivalent income compared to the whole sample, the younger group has a high proportion of individuals with very low equivalent income. The pattern is flattened out at older age, which can be seen in histograms in age groups from 55 years old and older.

Table 4.9 gives summary statistics of equivalent income by subgroups when individuals have at least one problem in non-income life domains ($X < X^*$). Based on the values of standard deviation (SD), the values of equivalent income for the group including individuals with a degree or higher and one including respondents self-reporting 'excellent health' are spread out over a wider range. By contrast, the figures for those who self-reported 'poor health' tend to be closest to the mean of the set (i.e. lowest SD among all subgroups).

Table 4.9 Equivalent income when individuals have at least one problem in non-income domains

		N	**Mean (£pm)**	**SD (£pm)**	**Min. (£pm)**	**Max. (£pm)**
	Whole sample	54,720	697	701	16	6,769
Gender	Male	23,740	813	772	26	6,769
	Female	30,840	609	627	16	6,197
Age groups	Aged 18 – 25	6,300	402	582	23	6,769
	Aged 26 – 35	7,440	522	568	16	4,069
	Aged 36 – 45	8,980	631	671	26	5,654
	Aged 46 – 55	10,120	734	781	19	6,197
	Aged 56 – 65	9,500	792	726	50	6,197
	Aged 65+	12,300	901	678	39	5,645
Marital status	Living as couple	30,680	774	716	19	5,654
	Single	19,120	584	686	16	6,769
Qualification	Having no degree	30,060	568	531	16	4,069
	Having degree or higher	21,140	880	862	26	6,769
Self-assessed health	Excellent health	4,480	801	878	27	6,769
	Very good health	15,720	822	763	44	6,197
	Good health	18,500	723	684	23	6,197
	Fair health	10,840	592	603	16	5,166
	Poor health	5,120	359	352	19	2,720
Having dependent	Having children	13,640	538	577	16	3,455
children	Having no children	40,860	751	730	23	6,769

In the next part, some tests were carried out to further understand the correlation between equivalent income and life dimensions. The first test focuses on the overlaps between equivalised disposable income and equivalent income. To do so, both equivalised disposable income and equivalent income were divided into quintiles and tabulated across each matching group to examine the extent to which somebody who is in a given quintile group in actual income also in the same quintile group in equivalent income. The result is reported in Table 4.10.

Table 4.10 Overlap between Equivalised income and Equivalent income (quintiles)

Quintiles of equivalent income	**Quintiles of equivalised disposable income**					
	1	**2**	**3**	**4**	**5**	**Total**
1	**60.58%**	23.64%	7.76%	2.01%	0.00%	20.00%
2	36.35%	**34.83%**	1.35%	7.87%	1.72%	20.00%
3	3.07%	37.90%	**42.47%**	16.25%	3.10%	20.03%
4	0.00%	3.64%	36.30%	**53.94%**	16.87%	20.51%
5	0.00%	0.00%	0.00%	19.93%	**78.31%**	19.46%
Total	100%	100%	100%	100%	100%	100%

Although equivalent income is derived from equivalised disposable income, there remain discrepancies across the two measures of wellbeing. The highest percentage overlap is 78.31% in the 5th quintile (i.e. the highest income group), while the lowest degree of overlap is just above 30% in the 2nd quintile. The discrepancies between equivalised income and equivalent income occur mainly due to the fact that using equivalised income as a wellbeing measure ignores non-income domains of wellbeing. In addition, problems with non-income life dimensions are concentrated amongst those individuals with lower income (e.g. one with low income is more likely to live in a less safe area and a lower-quality house.).

Table 4.11 Correlation between the ordering of respondents in terms of their predicted equivalent income and reported the Effect of Physical Health and the Effect of Mental Health

(a) The Effect of Physical	**Equivalent income**					
health (by levels)	1	2	3	4	5	Total
The best level: 1	**57.84%**	43.73%	32.23%	18.69%	6.60%	41.97%
2	19.63%	**20.25%**	21.54%	16.51%	6.09%	18.92%
3	15.59%	22.22%	**28.30%**	29.28%	22.84%	21.56%
4	5.01%	9.86%	11.48%	**22.74%**	29.44%	10.88%
The worst level: 5	1.94%	3.94%	6.45%	12.77%	**35.03%**	6.68%
Total	100%	100%	100%	100%	100%	100%
(b) The Effect of Mental	**Equivalent income**					
health (by levels)	1	2	3	4	5	Total
The best level: 1	**65.78%**	43.27%	31.57%	10.81%	0%	45.97%
2	18.73%	**22.08%**	20.83%	14.19%	8.82%	18.88%
3	13.05%	25.85%	**31.07%**	28.04%	9.56%	20.51%
4	1.99%	7.72%	12.56%	**33.78%**	36.76%	10.03%
The worst level: 5	0.44%	1.08%	3.97%	13.18%	**44.85%**	4.61%
Total	100%	100%	100%	100%	100%	100%

With a particular interest in the health domain, the computed equivalent income is compared with the five levels of the Effect of Physical Health and the Effect of Mental Health domains to examine the correlation between the ordering of respondents in terms of their predicted equivalent income and reported Effects of Physical and the Effect of Mental health. First, respondents were ranked by their equivalent incomes in ascending order and divided into five groups with the same number of observations in each level of the Effect of Physical Health and the Effect of Mental Health from the best to the worst, and the extent to which somebody who is in a given group in health domains is in the same ordered group in equivalent income is examined.

As equivalent income is derived from estimated parameters from health (and other non-health) domains, it is expected for the highest percentages to be observed in the diagonal cells. However, there are discrepancies between the Effect of Physical Health and equivalent income and the Effect of Mental Health and equivalent income, which are shown by the spread of the percentage on other cells in the tables. The highest correlation between the ordering of respondents in terms of their predicted equivalent income and reported the Effects of Physical and the Effect of Mental Health is in the 1st group in both tables (i.e. the best level of the Effect of Physical and the Effect of Mental Health), at 57.84% and 65.78% respectively; while the lowest degree of correlation is just above 20% in the 2nd group.

The worst-off group with the lowest equivalent income and the worst level in the Effect of Physical and the Effect of Mental Health has a degree of correlation between 35% and 45%.

The second test aims to examine overlaps across wellbeing measures and life domains or wellbeing indicators when identifying the worst-off (see Table 4.12). This test can be conducted through multiple steps. Firstly, 10% of badly-off captured by equivalent income was identified. This group includes 295 individuals with the lowest level of equivalent income. The same process was replicated for equivalised disposable income to identify 295 respondents with the lowest equivalised income. It is noted that for actual income, the income values used to identify the worst-off are from equivalised disposable income rather than household disposable income as the measure should be at the individual level. Regarding non-income dimensions, employment was excluded due to its non-ordered nature, which basically means being in one category is not necessarily worse than being in the others. As for the effect of physical health, the effect of mental health, loneliness, housing quality and neighbourhood safety, a random seed was added to the process for each dimension because they are categorical variables. For example, 197 individuals were identified to report the worst physical health (i.e. in the past four weeks, an individual all of the time accomplished less than he/she would like with his/her work or other regular daily activities as a result of his/her physical health). The other 98 individuals belong to the group that reported ‘most of the time’ having physical health issues affecting their lives. Hence, the worst-off by physical health were identified with a random seed. The summary of the results that only report the combinations of wellbeing measures and life domains with the highest and the lowest percentage overlap in capturing the worst-off group is in Table 4.12. The full results are reported in the Appendix C.

The first column of Table 4.12 reports the number of wellbeing measures and life domains included in the test. The second column presents the measures and domains that, when combined together, result in either the highest or the lowest degree of overlap in individuals identified as the worst-off across indicators. The last two columns report the percentage overlap at the highest and the lowest.

For example, in total, 1126 individuals, amounting to 26.20% of the sample, were identified as being the worst-off by one or more of these measures and dimensions (the first result row of the table). As the number of measures to focus on is increased, the percentage overlap decreases drastically. Overall, the highest percentage overlap always involves equivalent income while the lowest figures involves equivalised income. When two measures/domains are included, percentage overlap is highest at around 12% between equivalent income and equivalised income, and between equivalent income and mental health. The lowest figures are slightly more than 3% between equivalised income and physical

Table 4.12 Summary of the highest and lowest percentage overlap across equivalent income and life domains

No. of domains	Measures/ dimensions included	Highest % overlap	Lowest % overlap
1		26.20%	
2	Equivalent income and mental health	12.57%	
	Equivalent income and income	11.99%	
	Income and physical health		3.04%
	Income and neighbourhood safety		3.26%
3	Equivalent income, physical health, mental health	5.91%	
	Equivalent income, mental health, loneliness	5.81%	
	Income, physical health, neighbourhood safety		0.35%
4	Equivalent income, physical health, mental health, loneliness	2.66%	
	Equivalent income, mental health, loneliness, housing quality	2.06%	
	Income, physical health, mental health, neighbourhood safety		0.15%
5	Equivalent income, physical health, mental health, loneliness, housing quality	0.96%	
	Income, physical health, mental health, loneliness, neighbourhood safety		0.08%
6	Equivalent income, income, physical health, mental health, loneliness, housing quality	0.28%	
	Income, physical health, mental health, loneliness, housing quality, neighbourhood safety		0.04%
7	Income, equivalent income, physical health, mental health, loneliness, housing quality, neighbourhood safety	0.04%	

health and between income and neighbourhood safety. Increasing the number of measures and domains of five or six reduces the percentage of overlap to less than 1%. The last row indicates that only 0.04% of the sample are identified as being the worst-off across all seven measures and indicators.

4.5.3 Application of willingness to pay

Equivalent income can help us to understand how much people are willing to pay to move from their current life (X, as captured by our seven life domains) to a life in which they enjoy the optimal level in each of the non-monetary life domains (X^*). Below are some examples of WTP and its proportion relative to equivalised disposable income[21]. The results are reported in Table 4.13. The first seven columns represent seven life domains. The last two columns report WTP in terms of values to achieve the best non-income life domains in each scenario and as a percentage of equivalised income. A $*$ denotes that the domain is at the best level.

On the 2nd row, people who "a little of the time accomplish less than they would like with their work or other regular activities as the result of their physical health" and the best levels of all the other domains are expected to be willing to pay 9% of their equivalised income to achieve the 'perfect' level in this domain. If the same individual now has the worst level in the Effect of Physical Health (the 3rd row), WTP is now five times larger and accounts for almost 50% of their income. On the 4th row, given that the Effect of Physical Health and other non-health domain are optimal (denoted by *), individuals' WTP to go from the worst to the best level of the Effect of Mental Health is slightly higher than the amount he is willing to pay for the Effect of Physical Health domain. If these individuals have the worst levels of the Effect of Physical Health and the Effect of Mental Health (the 5th row), they are now willing to give up more than 70% of their income to have the best levels of both domains. The next four rows show different examples in which each of the other non-health domains is at the worst levels. Overall, none of the non-health domains has as high WTP as the Effect of Physical and the Effect of Mental Health domains to move from the worst level to the best level. The last row indicates that if people have all domains at the worst levels, they are willing to give up 97% of their income to have all domains at the best. In other words, individuals are equally well-off if having all non-income life domains perfect with an income of less than £60/ month (i.e. equivalent income).

This application can be expanded by adding more of the non-optimal domains and then calculating the levels of WTP for everyone to achieve the best non-income life domains.

[21] The reported MWTPs calculated from the model are reported in Section C.6 in Appendix C.

Table 4.13 Willingness to pay to achieve the best profile in non-income domains

The Effect of Physical Health	**The Effect of Mental Health**	**Loneliness**	**Equivalised income (£/m)**	**Employment**	**Housing Quality**	**Neighbourhood Safety**	**WTP (£/m)**	**% WTP in Y in Y**
A lil' of the time	*	*	£1,743.60	*	*	*	**£157.80**	**9.05%**
All of the time	*	*	£1,743.60	*	*	*	**£847.44**	**48.60%**
*	All of the time	*	£1,743.60	*	*	*	**£865.27**	**49.63%**
All of the time	All of the time	*	£1,743.60	*	*	*	**£1,292.17**	**74.11%**
*	*	All of the time	£1,743.60	*	*	*	**£648.86**	**37.21%**
*	*	*	£1,743.60	Taking care...	*	*	**£741.30**	**42.52%**
*	*	*	£1,743.60	*	Not true	*	**£735.85**	**42.20%**
*	*	*	£1,743.60	*	*	All of the time	**£655.00**	**37.57%**
*	*	All of the time	£1,743.60	Taking care...	Not true	All of the time	**£1,516.51**	**86.98%**
All of the time	All of the time	All of the time	£1,743.60	Taking care...	Not true	All of the time	**£1,684.80**	**96.63%**

Key: WTP, willingness to pay. 'Taking care...': 'Taking care of the home and family'. Y, Equivalised disposable income
* means the domain is at the best level

4.6 subgroup analysis

In addition to the regressions using pooled data, the chapter further examines heterogeneous preferences across the subgroups. The coefficients estimated from these regressions were then used to compute equivalent income for select hypothetical scenarios and those values are compared across subgroups. The results are reported in figures below (For more details, see Table C.10 and regression results are in Appendix C).

Overall, there are some evidence to confirm preference heterogeneity in some scenarios. The details of the results for each scenario are discussed along with the plotted CIs of the estimations below. It is expected that if there is no overlap between the CI ranges across a pair or a group, there is preference heterogeneity. It is noted that, for the ease of the comparisons, these scenarios are relatively simple as in each of them, only one attribute or life domain is set at non-optimal level and other life domains that are not specified are assumed to be at optimal levels.

In each of the presented figures, the coloured bars exhibit CI ranges of equivalent income levels computed from estimated coefficients for each subgroup in a selected scenario. In particular, the black bar reflects the result of the whole population. Those blue bars indicate CIs of equivalent income for gender groups. The bars in orange-brown display data for age groups. The green, pink and yellow bars exhibit figures for marital status groups, educational level groups, and having dependent children groups respectively. The red vertical line in each figure represents the level of hypothetical equivalised income level in the scenarios, at just above £700/month (i.e. un-equivalised household income of £1,000/month for a 2-person household). The comparisons are visually based on whether across the subgroups, the corresponding bars overlap.

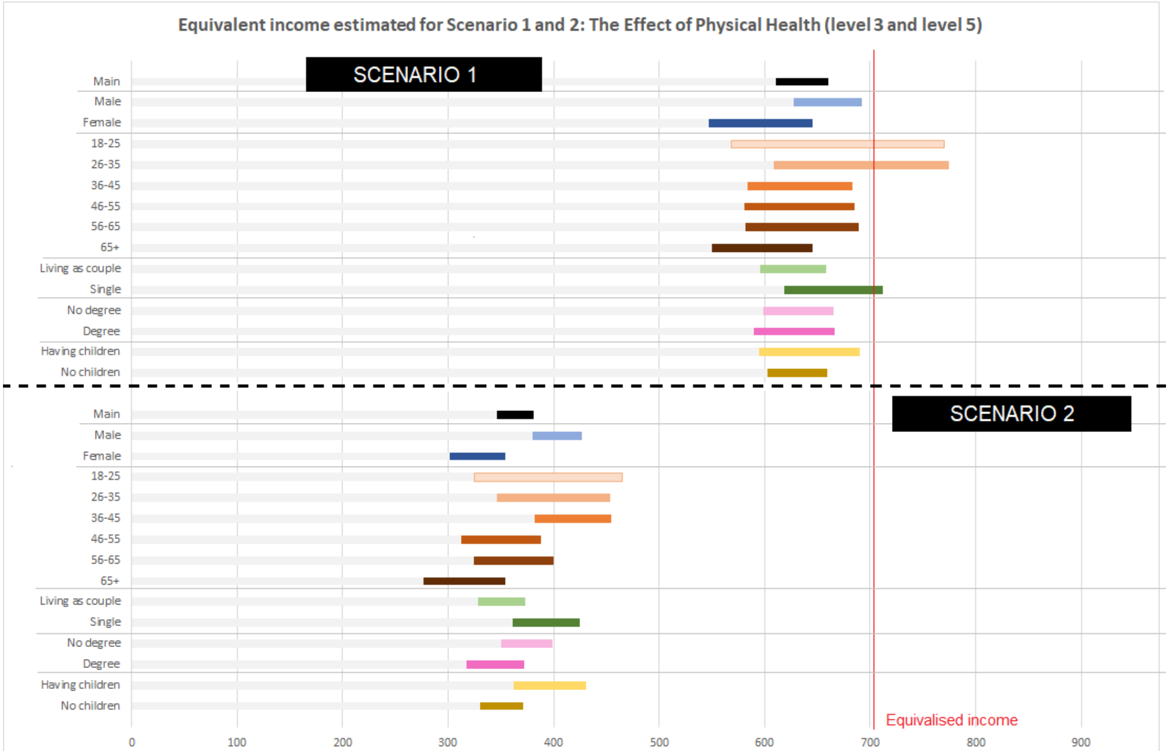

Fig. 4.3 Scenarios 1 and 2: The Effect of Physical Health (level 3 and level 5)

Scenario 1 is when individuals “some of the time accomplish less than they would like with their regular activities as the results of their physical health" and are “full-time employed". In this scenario, there is no clear evidence for preference heterogeneity within each subgroup as the CIs of individual subgroups overlap. Although female respondents seem to have lower equivalent income than male respondents, there is some overlap between the two. Similar pattern can be seen when comparing people who are single with those who live as a couple. The former group tends to be more affected, but not distinguished from the latter group. Very little differences are observed in equivalent income in terms of age, especially those group aged between 36 years old and 65 years old. Likewise, the ranges of equivalent income for those without a degree and those with a university degree almost the same.

Scenario 2 is when individuals “all of the time accomplish less than they would like with their regular activities as the results of their physical health" and are “full-time employed". There can be seen preference heterogeneity between men and women as there is no overlap between the CIs of the two. In this scenario, female respondents are noticeably affected, which results in a significantly lower equivalent income than their male counterparts. Regarding age groups, preference heterogeneity is only confirmed between age groups 36-45 years old and 65+ years old. Some slight differences can be seen across other subgroups, which does not provide enough evidence for preference heterogeneity.

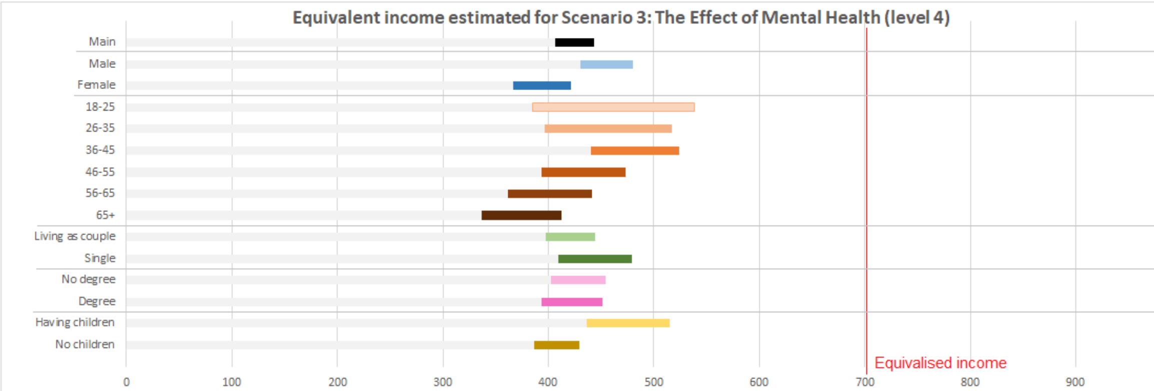

Fig. 4.4 Scenario 3: The Effect of Mental Health (level 4)

With regards to Scenario 3 (“most of the time accomplishing less than they would like with their regular activities as the results of their emotional problems" and being “full-time employed"), there is clear preference heterogeneity across the genders. Preference heterogeneity is also confirmed between age groups 36-45 and 56-65 and between groups 36-45 and 65+ as there is no overlap in CI between each pair. Similarly, there is significant difference in CIs of equivalent income in Scenario 3 for people who have dependent children and those who do not, in which the former group is estimated to have higher equivalent income. No preference heterogeneity is confirmed in marital status subgroup and education subgroup.

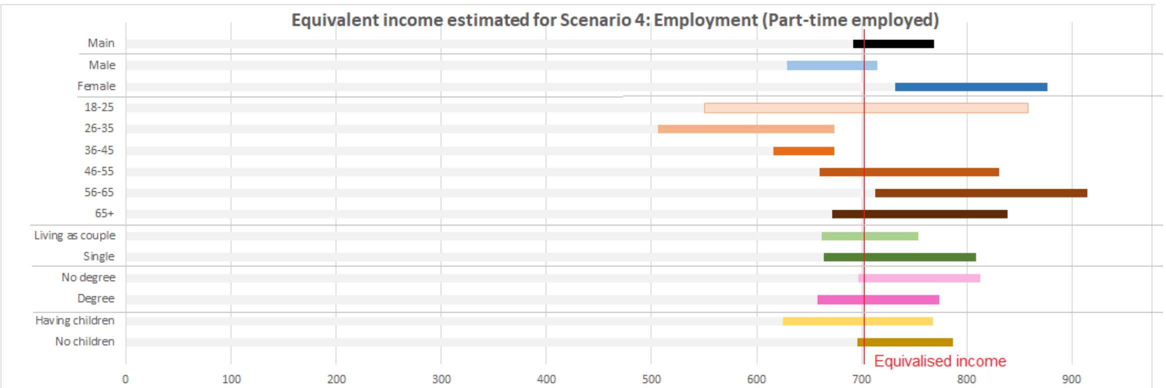

Fig. 4.5 Scenario 4: The Effect of Employment (Part-time employed)

In Scenario 4 (“being part-time employed"), the differences can be seen between male and female respondents. Women clearly prefer being part-time employed, which is indicated by a higher equivalent income (the CI range lies on the higher values than income level at the red line). The youngest age group (18-25 years old) is indifferent between full-time and part-time employment. People aged 26-55 prefer being full-time employed (i.e. CIs of equivalent income are lower than equivalised income) when the opposite trend is observed in individuals aged 56-65. There is no clear evidence for preference heterogeneity across other subgroups.

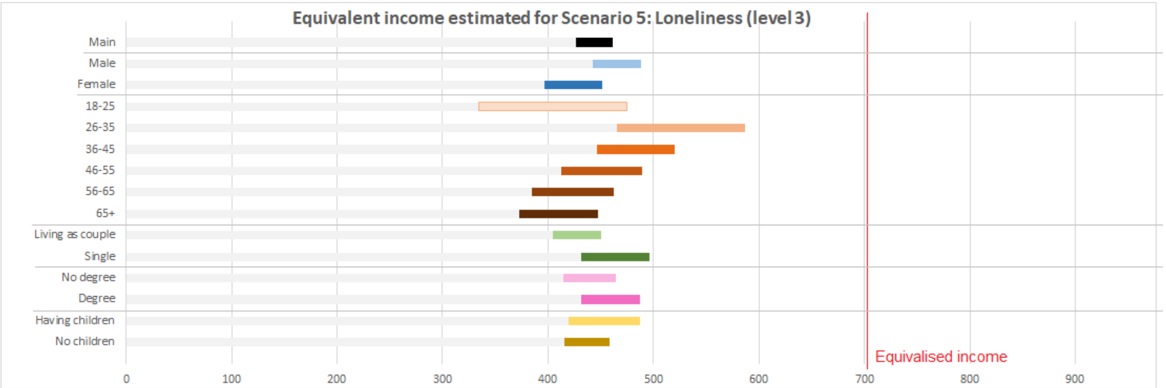

Fig. 4.6 Scenario 5: Loneliness (level 3)

When considering the worst level of Loneliness (“often feeling lonely and left out from others") in Scenario 5, the estimated equivalent income levels and corresponding CIs for all subgroups are lower than equivalised income. There is some evidence for preference heterogeneity between groups aged 26-35 versus aged 56-65 and groups aged 26-35 versus aged 65+ as each pair has no overlap in CIs.

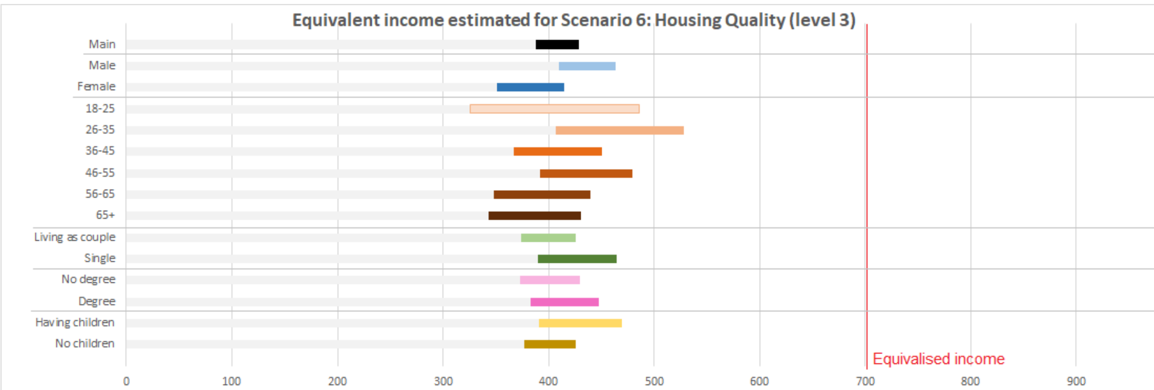

Fig. 4.7 Scenario 6: Housing Quality (level 3)

In Scenario 6, when the quality of housing is at the worst level (“home is in a reasonable state of repair, has reasonable facilities and provides reasonable warmth: Not true"), all of the subgroups are observed to have significantly lower level of estimated equivalent income and CIs than the equivalised income presented in the scenario. There is no clear heterogeneous preferences within any of the subgroups.

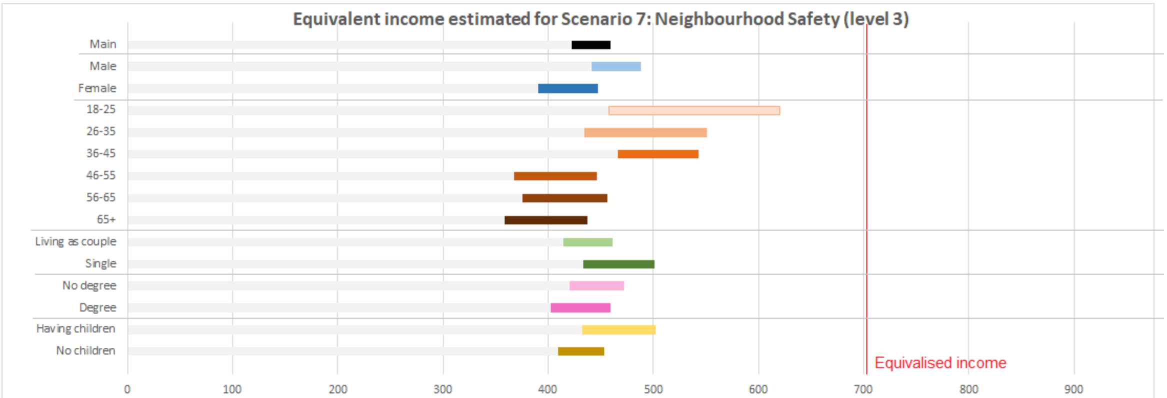

Fig. 4.8 Scenario 7: Neighbourhood Safety (level 3)

Scenario 7 is the situation with the worst Neighbourhood Safety (“often concerned about the safety of the neighbourhood you live in"), in which all of the subgroups are worse off. For most subgroups, there is no clear differences in preferences, except for some age groups. Preference heterogeneity could be seen between people aged 36-45 and those who are older (aged 46-55, 56-65 and 65+).

4.7 Robustness Checks

Some robustness checks were done by excluding potential inconsistent data points. In the first check, data from respondents who left the survey for longer than one hour was excluded from the regressions. This test aims to rule out participants who were mindlessly doing the survey. From the check, 265 respondents (equivalent to 5300 observations) were excluded from the regressions for both the main-effect model and interaction model. The regression results are reported in Appendix C.

The second test was based on respondents' feedback on the choice tasks. In this robustness check, 396 respondents (equivalent to 7920 observations) were excluded as they ticked the box “Not sure about my answers". When considering the note box for feedback, 25 respondents (equivalent to 500 observations) were also excluded as they stated either (i) they could not make the decisions/ choices; or (ii) their answers might not be accurate; or (iii) impossible to choose life A or B. Besides, about 15 respondents indicated in the free-text comment of the survey that the tabular format of the choice tasks did not display properly on the portrait mode of their phones, which made it hard to read the table of the exercises. These respondents were also excluded from this test. In sum, a total of 409 respondents (equivalent to 8180 observations) were excluded. Details of the regression results are presented in Appendix C.

The results from these two robustness checks are very stable and close to the whole sample results for both the main-effect model and interaction model. No major difference regarding magnitude, sign and significance of the coefficients were found, which means there is no change in preference ranking order.

4.8 Conclusion and Discussion

This study has reported an attempt to operationalise the concept of equivalent income using the stated preference approach. This main part of the survey is designed as a DCE to elicit public preferences over seven life domains, which are the Effect of Physical Health, the Effect of Mental Health, Loneliness, Disposable Income, Employment, Housing Quality and Neighbourhood Safety, and to compute equivalent income. The survey has ten variants to accommodate respondents with different income levels, where each respondent was given a set of ten DCE tasks and background questions. The DCE tasks are two-alternative forced-choice exercises based on a D-efficient partial profile design with non-zero priors. The survey was carried out online to collect responses from more than 3000 respondents from the UK general public and is largely representative in terms of age and sex. The DCE data from the survey were analysed using the condition logit model.

The coefficients from the regressions are used to estimate preferences and preference rankings across life domains. In relation to the reference levels as the optimal states for non-income domains (except for employment), the top three most important domain-levels are the worst levels of the Effect of Physical Health and the Effect of Mental Health and 'Taking care of a family member with chronic illness or disability'. They are followed by the worst level in Housing Quality domain. By contrast, Neighbourhood Safety and Loneliness are generally the least important.

The equivalent income computed using estimated coefficients from the interaction model has a right-skewed distribution with the majority of people belonging to the equivalent income group of less than £1,000 per month. When comparing the context of overlap in individuals identified by equivalent income and equivalised income, the highest degree of overlap is in the highest income group, while the low level of agreement across the two monetary measures is found in the lowest income group (i.e. the worst-off identified by equivalent income and equivalised income). This might be the result of the concentration of problems related to non-income domains such as housing and neighbourhood safety within the low-income individuals. Similarly, the cross-tabulations between equivalent income and the Effect of Physical Health and equivalent income and the Effect of Mental Health show the highest degree of overlap in those individuals with the best level of physical health and equivalent income and the group consisting of the best level of mental health and equivalent income.

When examining the worst-off groups captured by each life domain and by equivalent income, the cross-comparisons show that the overlap regarding the worst-off individuals is highest between equivalent income combined with non-income domains, whereas the lowest degree of overlap is found between equivalised income and non-income life domains such as the Effect of Physical Health, the Effect of Mental Health and Neighbourhood Safety.

In addition to equivalent income, WTP is also computed using the estimated coefficients from the regression. When keeping one non-income domain at the worst level while keeping the others at the best levels, WTP for the Effect of Physical Health and the Effect of Mental Health domains account for the highest percentage of equivalised income, which are followed by WTP to achieve the best levels in Employment and Housing Quality domains. The lowest WTP is related to Loneliness and Neighbourhood Safety domains.

In addition to the analyses using the whole sample, the chapter also examines heterogeneity across subgroups such as male versus female, different age groups, groups based on marital status, educational levels and whether or not having dependent children. The results confirm similar patterns in most groups compared to the main sample. Some evidence on preference heterogeneity is confirmed between men and women when comparing their equivalent income in scenarios where the Effect of Physical Health and the Effect of Mental Health are at the worst levels. While female respondents prefer part-time employment, male respondents favour full-time employment. In addition, some heterogeneous preferences are observed across different age groups regarding to physical health and mental health domains, loneliness and neighbourhood safety. The youngest group of 18-25 years old seem to be indifferent between full-time and part-time employment, while there are clear heterogeneous preferences between people aged 26-45 and those between 56 and 65 years old. No preference heterogeneity has been observed across most of the other subgroups in the set of scenarios analysed in this chapter, except for the comparison between those with and without children in the scenario with the worst mental health level.

In general, this study contributes to the literature of equivalent income by operationalising equivalent income using choice experiment data. In comparison to the existing empirical literature on equivalent income using the stated preference approach, this study explored the importance of some additional life domains such as Loneliness and Neighbourhood Safety in the calculation of equivalent income which are policy relevant. The DCE design used in this chapter is based on a Partial Profile design, which does not only potentially reduce cognitive burden of respondents (by having ties within each choice task) but does so without over-compromising the D-efficiency of the design. This feature of the DCE design has not been used in the literature of equivalent income.

Another contribution lies in the treatment of income at the household level and household size. In order to ensure that the respondents can relate to the income levels in the DCE, the approach was to divide respondents into groups based on their household income ranges (i.e. deciles) and the analysis equivalised the level of household income presented in the DCE scenarios using the household size information for each respondent. By doing so, the income range when pooling data across the ten DCE variants was not too wide thanks to small differences between income levels in each variant of the DCE as these levels were calculated based on 40%, 60 80%, 100% and 120% of mean deciles of UK income.

In contrast to most DCE contingent valuation studies that elicit WTP as the result of interest, this study aims to obtain equivalent income, which is the amount of household disposable income left after the WTP to achieve the best levels of non-income life domains. Hence, the challenge for calculating equivalent income at the individual level is that the DCE design does not account for household size. To tackle this challenge, the level of household income used in the DCE scenarios is equivalised using household size data from a background question before being applied to the calculation of equivalent income.

Regarding the method of implementing a DCE on an online survey, as the exercises are quite complex, many aspects needed to be considered, such as the number of the tasks, wording and explanation as well as time allocation to make it possible to run the survey online without the coordinator's presence. The study reports on the results of administering the DCE survey on an online platform considering the feedback from two pilots before launching the main survey.

Despite the contributions to the literature and potential policy relevance as well as the attempt to overcome different issues related to the DCE approach, this study has some limitations. The main drawback of the survey is the lack of checks on inconsistency. For example, this could have been done by including a repeated choice task or having a dominant choice exercise. In addition, the design and analysis assume scale and preference homogeneity and do not model preferences at the individual level. Another limitation is that the survey did not include a life satisfaction question, hence, it is challenging to make a link and comparison between equivalent income and life satisfaction. One possible suggestion is to map the survey data in this chapter with the UKHLS and use the estimated coefficients from this chapter to calculate equivalent income in the UKHLS and compare the results with life satisfaction. Finally, although the sample collected is largely representative regarding age and sex, it appears to be non-representative in terms of income.

With an attempt to operationalise equivalent income through an online survey using the DCE approach, the study has reported different issues along with positive results. It is suggested that future research should expand the generic and representative aspects of the survey by implementing quotas on other demographic characteristics, as well as incorporate relevant questions on life satisfaction and different wellbeing measures for cross-measure comparison.

Chapter 5

CONCLUSIONS

This thesis has presented three empirical studies on the topic of measuring wellbeing using UK data. There is substantial work in the literature but several aspects related to individual wellbeing remain elusive. With the aim to contribute to the literature and fill in the gaps, the thesis has addressed key research questions that were either unanswered previously or controversial. The main aims of this thesis are to make a link between subjective and objectives aspects of wellbeing and to combine different life domains into a single-index multidimensional measure of wellbeing.

The first study in this thesis examines the use of a SWB measure - life satisfaction - to capture changes in individual wellbeing following a health shock (i.e. the onset of impairment). In order to make cross-individual comparisons, the study relies on a classic assumption in the literature that SWB is interpersonally comparable, i.e., the reported levels of life satisfaction can be directly compared not only for the same individual over time but also across different individuals. This study examines changes in individual wellbeing following the onset of impairment and the effects of duration of health impairment, physical impairment and mental impairment on individual wellbeing, as well as adaptation to these categories of impairment. Expanding on this analysis, the study investigates the presence of heterogeneous effects of impairment on wellbeing and adaptation to impairment.

Study 1 relied on the assumption of interpersonal comparability of SWB, which does not take into account the fact that personal value judgements and aspirations may be different from one person to another. Study 2 presents a different approach to measuring wellbeing that considers both the subjective aspect and the objective aspect of wellbeing. By computing equivalent income, Study 2 is able to make more objective interpersonal wellbeing comparisons as this measure takes into account heterogeneous preferences across different life domains, namely income, health and employment. Using the same dataset from Study 1, equivalent income for each individual is computed using the estimated parameters from life satisfaction regressions. The study further investigates the use of equivalent income in measuring individual wellbeing by comparing and contrasting this measure with equivalised income and life satisfaction. Taking a small subgroup of the worst-off identified by equivalised income, life satisfaction and equivalent income, the analysis examines the overlap across these measures.

As the thesis attempts to combine different life domains into a single-index multidimensional measure of wellbeing, Study 3 continues this thread of research by proposing an alternative approach to sufficiently capture more relevant life domains of interest for the computation of equivalent income. As opposed to the use of national panel data in Study 1 and Study 2, this study opts to collect preference data using the stated preference approach. This approach is able to overcome several constraints related to the analyses based on actual choices and decisions as in previous studies. Deriving preference data from actual choices results in limited information as not all alternatives are available and not everyone reveals their preferences in the presence of risks and uncertainty (Bann, 2002). In this study, a DCE design is used to elicit preferences of the UK public over seven life domains. The data are used to estimate coefficients of each domain that are then used to compute equivalent income at the individual level.

This concluding chapter summarises the results of each study and the thesis as a whole. Following this, a discussion is presented on the implications and contributions of the thesis along with some potential future research avenues related to the topic of measuring wellbeing.

5.1 Summary of Results

The first empirical study in this thesis has examined the relationship between impairment and SWB using the ten latest waves of the UKHLS (2009 - 2020). Using overall life satisfaction as a measure of individual wellbeing, the study analysed the correlation between impairment and SWB and whether people adapt to impairment over time. This study was the first of its kind to investigate the differences in the impact of physical impairment and mental impairment on individual wellbeing and whether there are heterogeneous effects of impairment on life satisfaction and hedonic adaptation afterwards by gender. This study extends the main analysis to use of multiple imputation to address attrition problems in panel data and compares the the results between the original data and the imputed data. Using multiple imputations potentially reduces issues related to the possibility that those who do not adapt are more likely to drop out of the sample. However, this technique is complicated and care needs to be taken when applying the technique to correct data.

The second study discussed the framework of equivalent income as a single-index multidimensional measure of wellbeing, and described an empirical example to compute equivalent income using a life satisfaction function that combines both income and non-income life domains. Besides standard controls often used in SWB models, some scaling factors in this analysis were based on the findings from Study 1. That is, that impairment had negative and significant effects on individual wellbeing and there was some evidence for partial adaptation in some cases (even though the main sample did not confirm adaptation after nine years since onset). This study included a set of lags of impairment to control for the negative impact of impairment and any changes in aspiration due to hedonic adaptation. Equivalent income was estimated using the coefficients from the ordered logit FE models and compared against equivalised income and life satisfaction. The study used the worst-off group as an example to explain one empirical application of equivalent income as a measure of wellbeing and the different rankings of the worst-off when different wellbeing measures were used. It is noted that, in the main sample, there was no evidence for adaptation to health impairment during the period of the data, which is in accordance with the findings from the first study.

Following the second empirical study, the third study used a different approach to operationalise equivalent income. As opposed to the use of SWB function in Study 2, this study attempted to operationalise equivalent income using the stated preference approach, through a DCE. Compared to Study 2, this study expanded the number of non-income life domains included in the computation of equivalent income from two (i.e. employment and health) to six. The health aspect was divided into two domains, which are the Effect of Physical Health and the Effect of Mental Health. Employment was also included in this chapter, however with more categories than the similar domain in the second study. The other non-income life domains include Loneliness, Housing Quality and Neighbourhood Safety.

Similarly to Study 2, Study 3 computed equivalent income from the estimated coefficients from the econometric models and examined how the distribution of equivalent income differed from those from other wellbeing indicators across the survey sample. When comparing the individuals that are worst-off as identified by both equivalent income and equivalised income, a low degree of overlap was confirmed by both approaches from the two studies. This result highlights that a high income level does not guarantee a high level of wellbeing (and vice versa) when taking into account other non-income life domains. In addition, the results from the last two empirical studies confirm the importance of non-income life domains such as employment and health on individual wellbeing and the need to include these domains in measuring people's wellbeing.

Regarding the data used in this thesis, while the first and second empirical studies used the same secondary dataset, the UKHLS 2009 – 2020, the last study collected primary data through a DCE. The results from the second study identified some limitations of the analysis due to the use of secondary SWB data which were not specific to the need of the study. In particular, there were limited available data to allow for the inclusion of different non-income domains of interest in the computation of equivalent income in Study 2. Some could argue that the data from the UKHLS could be as sufficient as the data collected from the survey in Study 3 regarding life domains of interest. Indeed, a study has been done to map the attributes from the survey in Study 3 to the UKHLS variables to calculate equivalent income for the synthetic population using the UKHLS questions (Wu et al., n.d.). However, even with mapping, this kind of analysis relies on a series of assumptions to make the data comparable across the surveys. Having said that, the limited data on life domains from the UKHLS is not the main motivation for the stated preference approach in this study. It is, however, one of the drawbacks from the nature of panel data which are based on actual events, choices and decisions made by the respondents. The limitation here is similar to the revealed preference approach in which analysing actual decisions may limit the amount of information on preferences to be derived as many alternatives might be unavailable for actual choices (Bann, 2002). In addition, the decisions made may not reveal a person's preferences given the presence of uncertainty around the available information they have access to and risks related to the choices. When analysing data from revealed preferences, analysts do not know the choice set out of which a particular outcome was selected by a respondent. By contrast, the stated preference approach could potentially elicit non-use values or preferences that cannot be observed through actual decisions (Bann, 2002). In stated preference surveys, respondents are asked their values for different things that may not necessarily be available in their actual situations. Hence, through this method, one can elicit preferences over a wider ranges of attributes (i.e. life domains). Given this reasoning, the last study expanded the topic of equivalent income by following the stated preference approach and collecting primary data from elicitation of public preferences over seven life domains.

In addition to the analyses using the whole samples (i.e. the term 'main sample' or 'main analysis' were used interchangeably throughout the thesis), some sub-groups analyses were carried out in all three empirical studies. The decisions on which subgroups to be included were based on some evidence from the literature regarding whether some heterogeneity has been observed across different subgroups in previous studies, such as as gender (Decancq and Schokkaert, 2016*b*; Jones and Schurer, 2011), age groups (Tangian, 2005), marital status (Decancq and Neumann, 2014) or educational levels (Schokkaert et al., 2011). The thesis has only examined single-variate (i.e. considering one characteristics in each subgroup analysis, for example either genders or age) but has not attempted to combine multiple characteristics into each subgroup (e.g. a multi-variate attempt would be gender and marital status). In the first two empirical studies, including many interactions could require larger sample sizes and empirically not feasible. The last study observed similar issues when attempting to look at more than one characteristics within each subgroup, especially with significantly smaller number of observations compared to panel surveys.

Both the first and the third empirical studies examined gender subgroups to understand the differences between males and females. In the first empirical study, FE models were run separately for men and women in all three categories of impairment. The results confirm some heterogeneity regarding the effects of mental impairment and adaptation to mental impairment across male and female respondents. However, the coefficients estimated from the DCE models in the third study for male and female respondents could not be directly compared as they combine preference heterogeneity and scale heterogeneity, which are empirically challenging to disentangle. Interpreting regression coefficients without disengaging the two will result in a biased conclusion (Wright et al., 2018). Therefore, they were used to calculate equivalent income levels for men and women in a set of hypothetical scenarios. Following that, equivalent income and its corresponding confidence intervals were compared between men and women. The results confirm some preference heterogeneity, for example in the case where mental health is at the worst level or in a scenario of having a part-time job (with a reference of full-time employment).

Study 2 and Study 3 both examine differences in preferences related to educational sub-groups. While interactions between non-income domain (i.e. health) and education were included in the models in Study 2, Study 3 opted to having separate regressions for different groups. The regression results from Study 2 suggests that, comparing with the base category of individuals who report fair or poor health, are unemployed and have no university degree, life satisfaction of people with university degrees or equivalent is more influenced by given improvements in health compared to those with lower education levels. Study 3 however, did not confirm heterogeneity across groups with different education levels.

In additional to gender and educational subgroups, the third empirical study examined preference heterogeneity across different age groups, marital status groups, and groups of people with or without children. The comparisons of equivalent income and its CIs in a set of scenarios confirm some evidence for preference heterogeneity across some age groups. People with children and those having no children seem to have different preferences when it comes to mental health aspect.

5.2 Contributions, Implications, Limitations and Future Research

Overall, the results from this thesis have shed light on the topic of measuring wellbeing in the UK. The first empirical study contributes to the existing economic literature on the impact of impairment on SWB overtime, including potential adaptation. Firstly, compared to previous studies (see Oswald and Powdthavee, 2008; Pagan, 2010, 2011, 2012; Powdthavee, 2009), this study uses a different measure of ill-health (i.e. 'impairment') derived from the Health and disability module in UKHLS, which is arguably better in capturing individuals with ill-health than the measure used in the previous studies. Secondly, this study explored, for the first time, the onset of and adaptation to different types of impairment, by distinguishing between physical impairment and mental impairment, rather than by categorising health problems by severity.

The discussion from Study 2 raises the importance of the inclusion of non-income life domains in measuring wellbeing. Combining different aspects of life besides material standard of living will potentially bring about a more complete picture of people's life. Building on the first study, the analysis in this study takes into account the effect of hedonic adaptation on aspirations and changes in SWB levels. Despite an extensive literature investigating empirical computations and applications of equivalent income, no empirical studies to date have examined the effect of hedonic adaptation in general and adaptation to impairment in particular in this context. Adapting to changes in life is reflected on the levels of SWB reverting back to the baseline (Bottan and Truglia, 2011). Therefore, theoretically, controlling for hedonic adaptation is essential when SWB is used as an independent variable to estimate relevant parameters for equivalent income computation. In these specific studies (Study 1 and 2), as people do not adapt to impairment (when considering the whole population) within the time horizon studied, hedonic adaptation does not have a noticeable impact on the estimation of equivalent income. However, as discussed in Study 1, over a longer period, hedonic adaptation to impairment may happen and this is expected to affect the computation of equivalent income. To examine how hedonic adaptation may affect individuals' evaluations, this study controls for lags of impairment by including a set of dummies capturing impairment durations. This set of dummies is adopted from the analysis in Study 1. Secondly, by comparing equivalised income and life satisfaction with equivalent income, Study 2 contributes to strengthen the evidence that different wellbeing measures likely result in different conclusions when comparing individuals' wellbeing. The findings from this study highlight some discrepancies across wellbeing measures such as equivalised income and life satisfaction in comparison with equivalent income in ranking individual wellbeing.

Acknowledging different life domains and collapsing multi-dimensions into a single-index measure of wellbeing would provide a more informative view when public policies consider improving people's lives.

With the same focus on the computation of equivalent income, the third empirical study explored a different approach using the stated preference through a DCE to elicit public preferences across different life domains. This study has made several key contributions to the literature. Firstly, by surveying the public using stated preferences approach through a DCE, Study 3 contributes to the literature of equivalent income by testing and providing evidence on how to operationalise equivalent income using DCEs. A second contribution is made to the methods literature, which is to illustrate how preference data from a DCE are used to estimate equivalent income as a measure of wellbeing. The study reports on the results of administering the DCE survey on an online platform considering the feedback from two pilots before launching the main survey, which is considered to be a good practice in DCE studies. The final contribution lies in the inclusion of different non-income non-health domains in the DCE and analyses. Whilst including non-health non-income attributes (e.g. employment and housing quality) are not uncommon in DCEs generally (see Benjamin et al., 2014; Decancq and Watson, 2019; Watson et al., 2019), most of the previous studies using the stated preference approach to obtain equivalent income mainly focus on health and do not include other aspects such as safety or housing quality (Abasolo et al., 2018; Fleurbaey et al., 2013). From existing data of DCEs of wellbeing domains, there is potential use of these data to estimate equivalent income if the levels of the non-income attributes are sufficient to capture the differences between various life situations (i.e. more than two levels). Having only two attribute levels (such as in the study by Watson et al. (2019)) is to limited, as this only captures the worst and the best levels of each life domain as well as the trade-off to improve each aspect from the worst straight to the best.

Study 3 has considerably expanded the range of life domains included in the calculation of equivalent income. These domains are very policy-relevant and have been parts of many projects aiming to improve living standards such as Centre for Progressive Policy and Thriving Places Index (2019) and The Greater Manchester Outcomes by Greater Manchester Combined Authority (The Greater Manchester Combined Authority, n.d). Furthermore, the DCE design used is based on a Partial Profile design, which does not only potentially reduce cognitive burden of respondents (by having ties within each choice task) but does so without over-compromising the D-efficiency of the design (ChoiceMetrics Pty Ltd., 2018). This feature of the DCE design has facilitated the extension of attributes included in the DCE compared to previous studies in the literature of equivalent income, such as Fleurbaey et al. (2013) and Abasolo et al. (2018). In addition to these above-mentioned contributions to the literature, the findings from this chapter provide insights into average preferences of the UK public across different wellbeing domains and will potentially enable advisors to support policy makers with a more informed sense of likely public responses to changes in policies (see Tsuchiya, A. and Wu, C. on behalf of the SIPHER Consortium, 2021; Wu et al., n.d., for more discussion related to the application of this study). The use of equivalent income enables the conversion of the effects of different social and public policies into a monetary metric, which is quantifiable and potentially more effectively evaluated.

Despite these key contributions to the literature and potential policy relevance, there are still some limitations and opportunities for further research. The panel data used in the first and second empirical chapter is fairly recent, and this the time dimension of the data could be considered to be short compared to other panels used by previous studies (e.g. BHPS has 18 waves 1991 - 2008 (Institute for Social and Economic Research, nd.), GSOEP has 36 waves 1984 - 2019 (European University Institute, nd.)). This issue leaves more room for future research to explore the variation in SWB measures such as self-reported life satisfaction. In addition, the computation of equivalent income in the second study is only based on two non-income domains: health and unemployment, which results in a quite narrow-context measure of wellbeing. Furthermore, including hedonic adaptation to the computation of equivalent income in Study 2 is currently just an example of the application by including variables to capture adaptation to impairment. Future research would potentially extend the list of relevant non-income domains and adaptation to different life events, such as changes in employment or marital status, included in the computation of equivalent income. In the last empirical study, the main drawbacks of the survey is the lack of checks on inconsistency. For example, this could be improved by including a repeated choice task or having a dominant choice exercise. In addition, Study 3 survey did not have a life satisfaction question, which resulted in a missing in potential cross-link between different wellbeing measures. One possible suggestion could be to map the data from the DCE survey with data in a panel survey such as the UKHLS conditional on suitable assumptions. From the mapping, coefficients estimated from the DCE model could be used to compute equivalent income at the individual level in the panel data, which will enable the comparisons between life satisfaction and equivalent income as well as other wellbeing measures available in the panel data. Lastly, the design and analysis assume scale and preference homogeneity.

The framework of equivalent income discussed in this thesis is know to “respect individual preferences’ (Decancq, Fleurbaey and Schokkaert, 2015*b*; Fleurbaey et al., 2013). As mentioned before, including many interactions between life domains and individual characteristics and combining different characteristics is a challenging task that would require additional data. Whilst the third study involved primary data collection, it was also not possible to include as many interactions across life domains in the DCE design due to infeasible sample sizes required to obtain meaningful results. Indeed, different designs which included several interactions aiming to capture multi-variate group preferences were tested but the limited samples size is likely to restrict the statistical analysis. In the final design, this study looked at cross-links between income and employment. Future research could explore new ways of modelling preferences at the individual level as opposed to the subgroup level. In addition, including more waves into a DCE survey would potentially obtain more informative preference data and enable researchers to capture the impacts of shocks (e.g. COVID-19) or seasonal effects on preferences.

Overall, the thesis has attempted to understand the topic of wellbeing and measuring wellbeing. Each chapter of this thesis advances the general topic of measuring wellbeing and contributes to various aspects of the wellbeing literature. The results from the comparisons across different measures of wellbeing have demonstrated that we can get a different picture of individuals and ranking orders of individual wellbeing when different measures of wellbeing are used. The implications of this research suggest that care should be taken when analysing individual wellbeing. Future research in measuring wellbeing, especially those interested in equivalent income, should explore how individual preferences could be captured to better reflect individual wellbeing.

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Appendix A

Appendices to Chapter 2

A.1 Figures

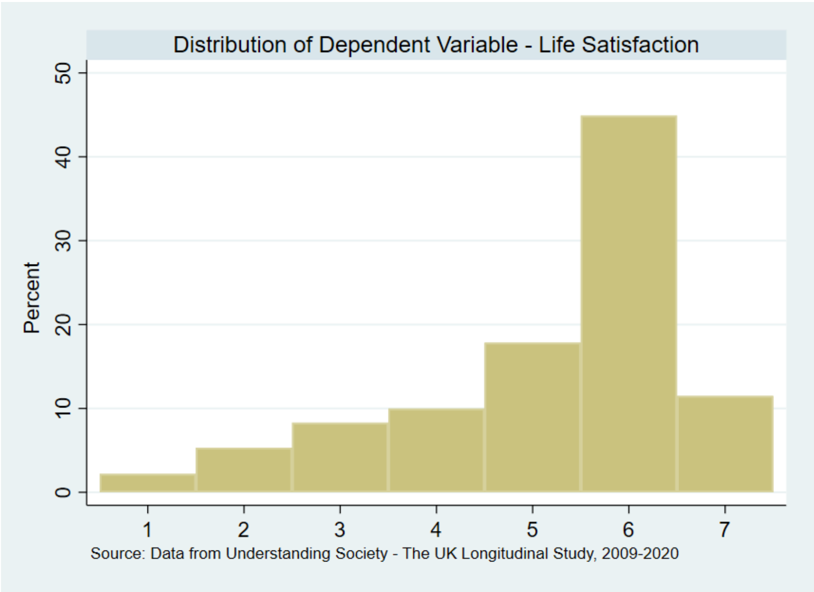


Fig. A.1 The distribution of life satisfaction

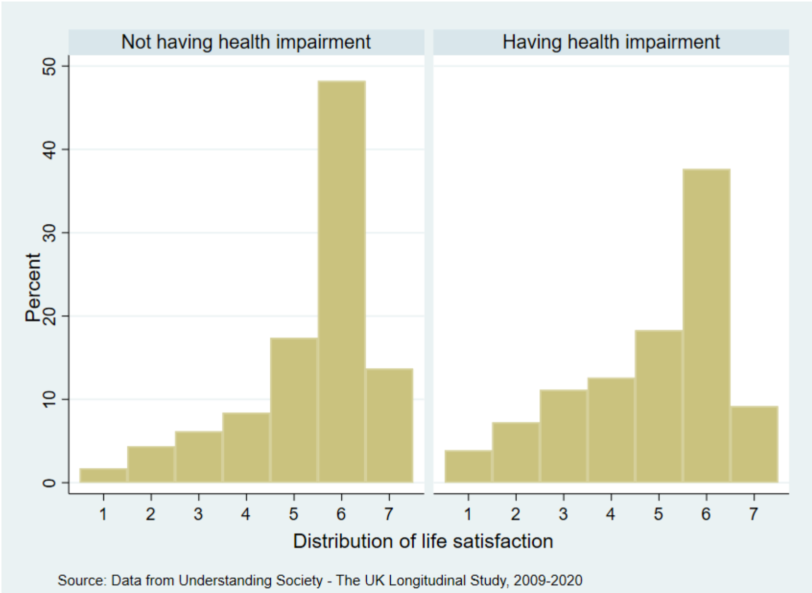


Fig. A.2 The distribution of life satisfaction for the those with and without health impairment

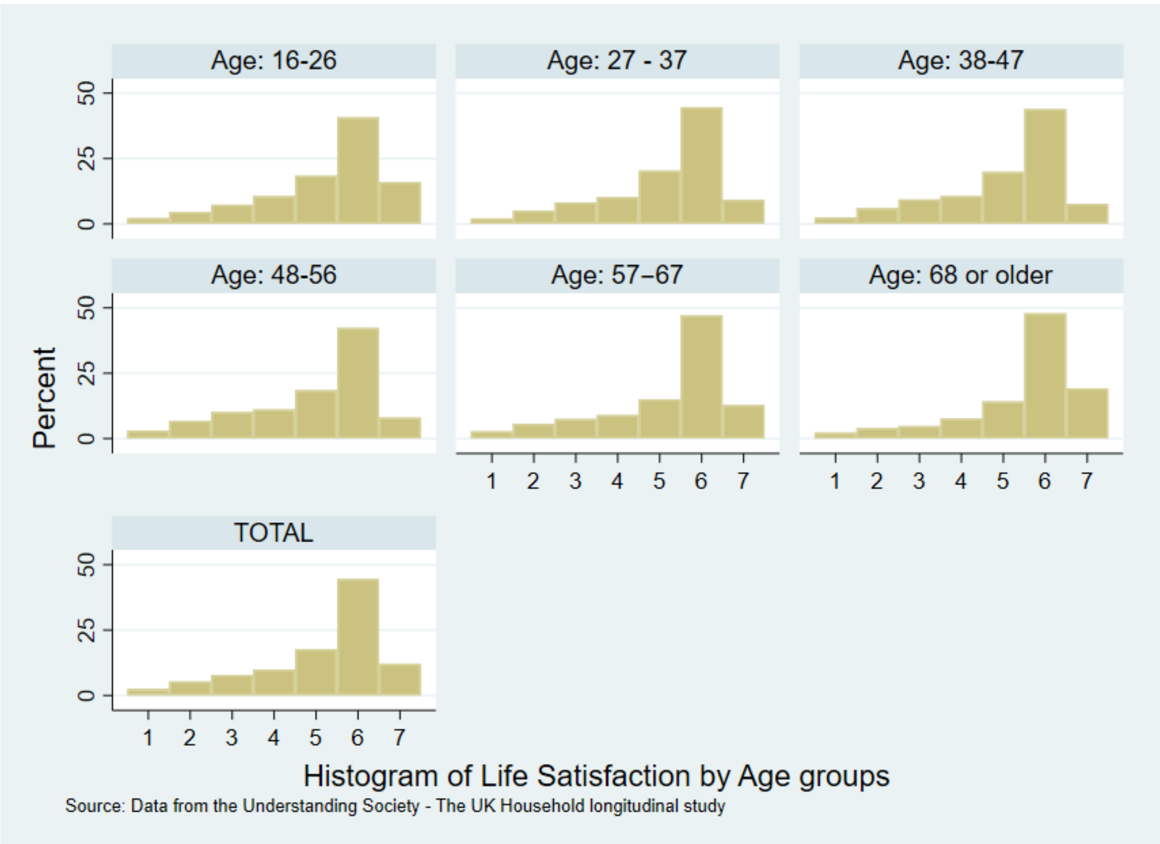
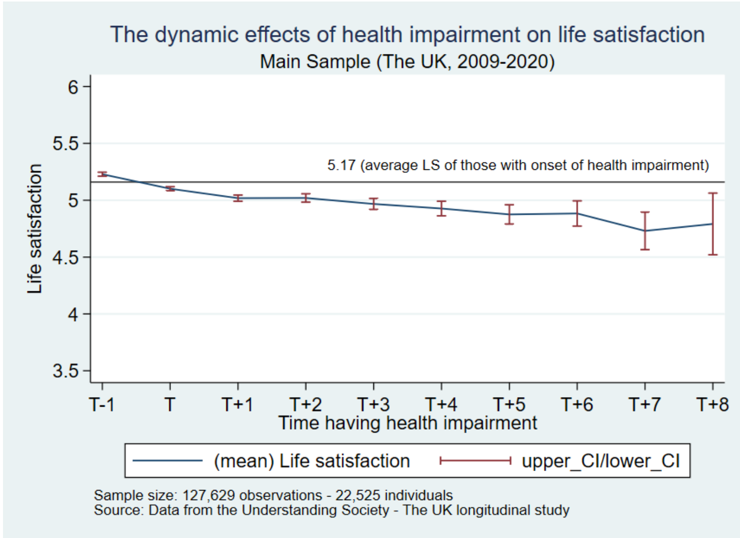
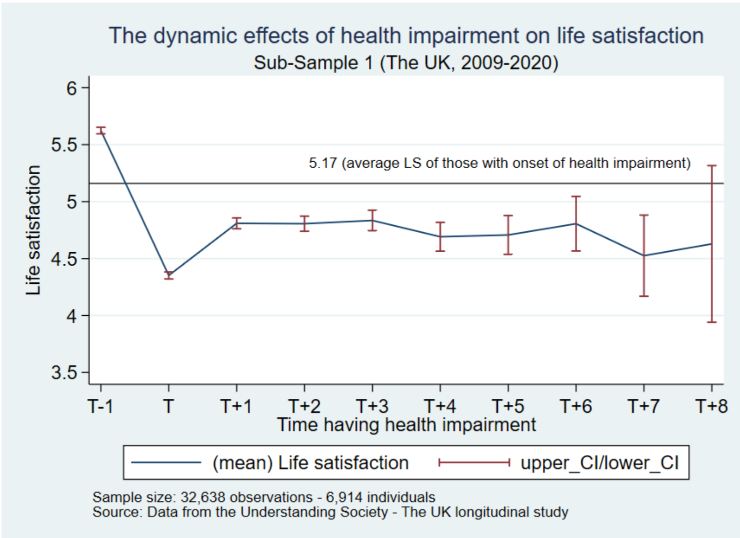


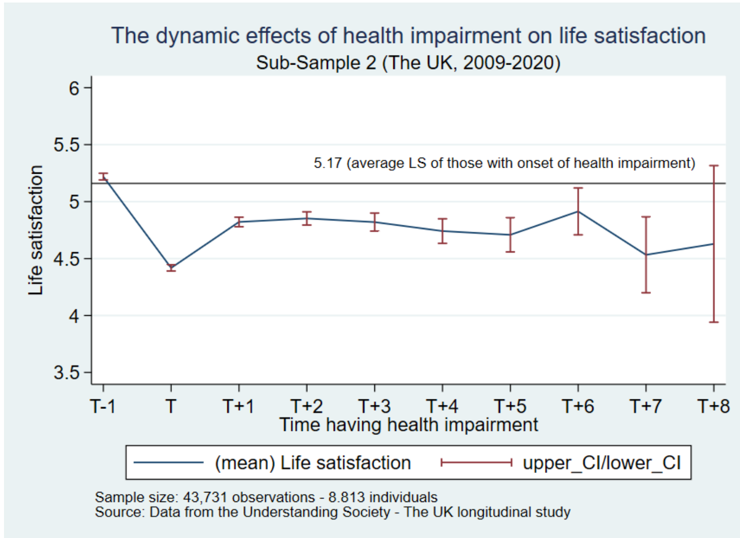
Fig. A.3 The distribution of life satisfaction for age groups



(a) Main Sample

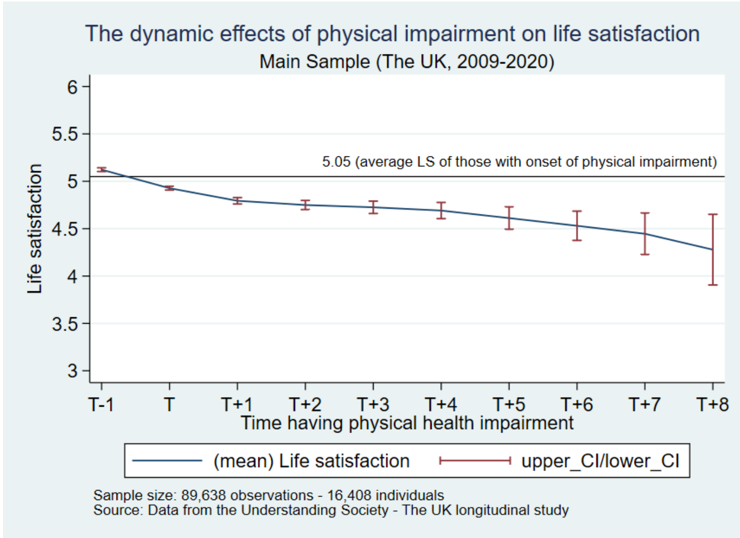


(b) Sub-sample 1



(c) Sub-sample 2

Fig. A.4 The effects of health impairment on life satisfaction



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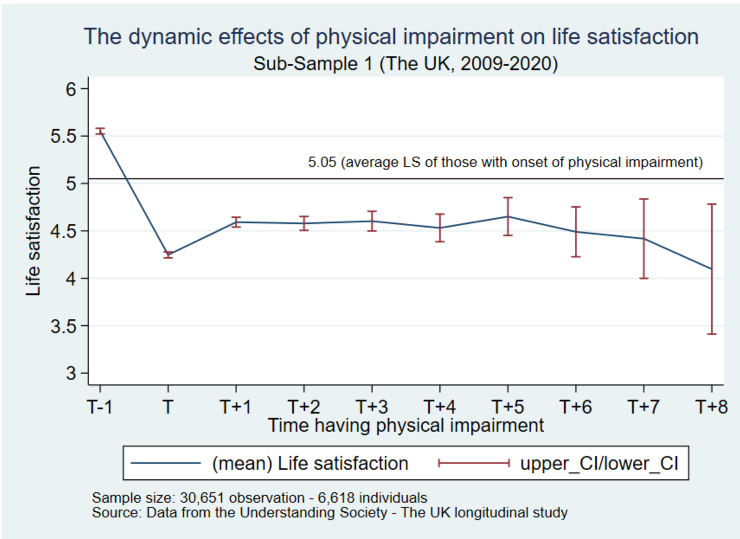

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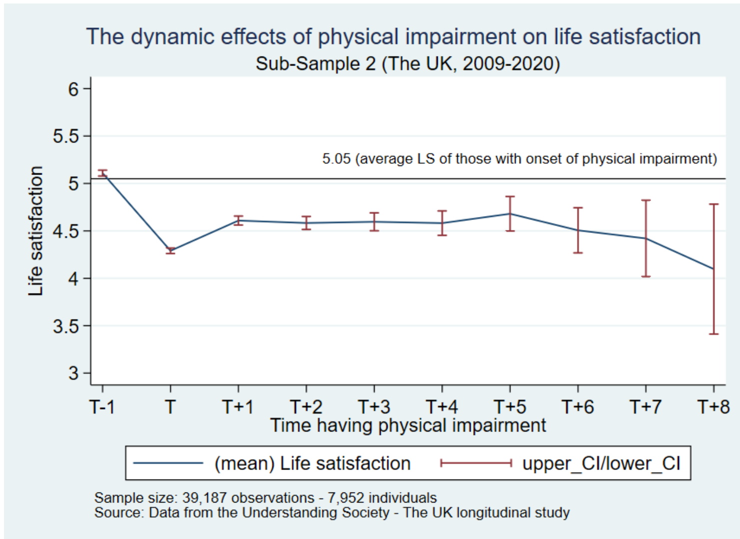
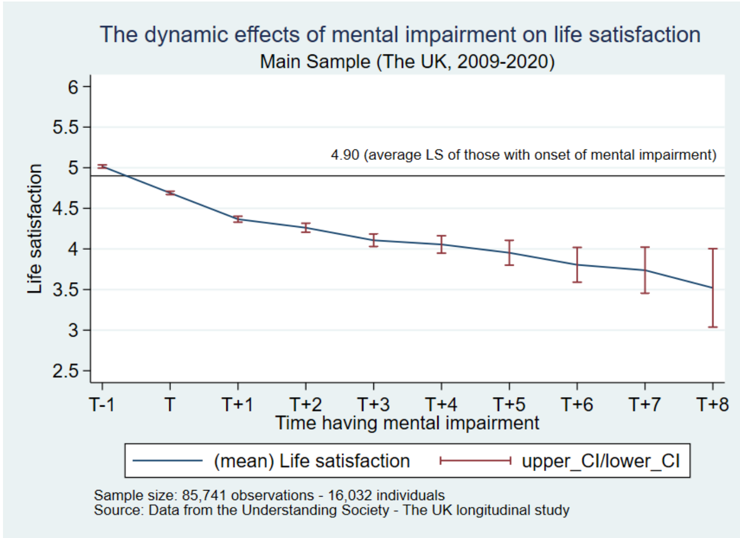
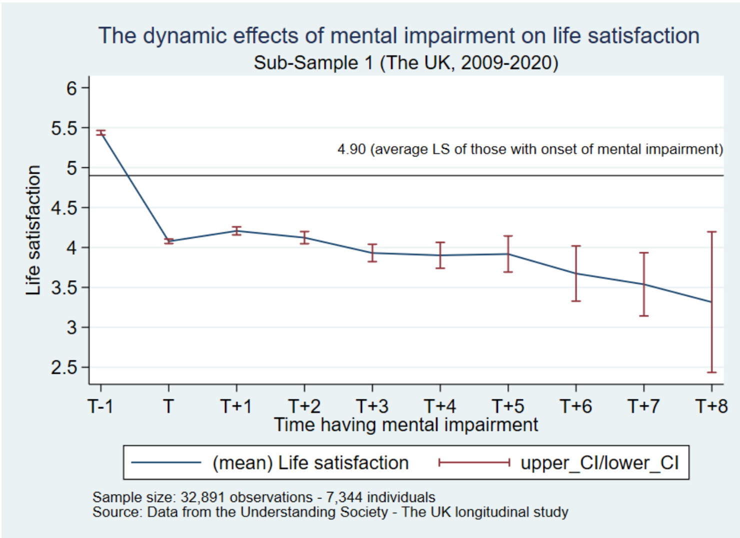


(c) Sub-sample 2

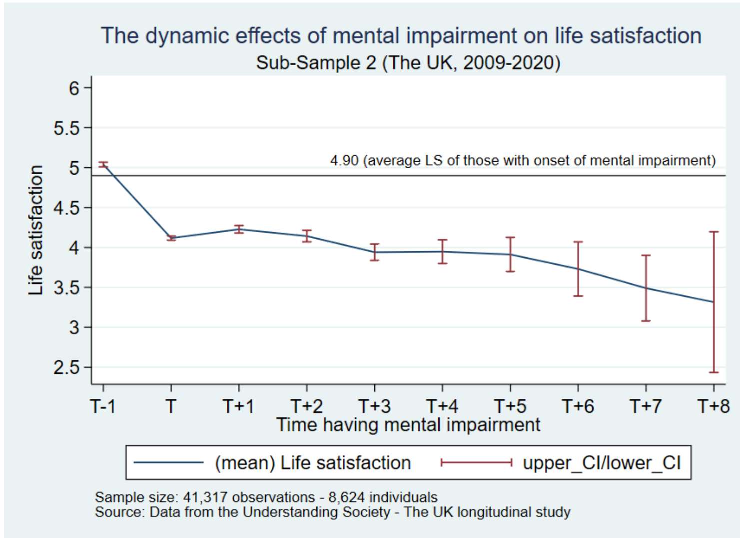
Fig. A.5 The effects of physical impairment on life satisfaction



(a) Main Sample



(b) Sub-sample 1



(c) Sub-sample 2

Fig. A.6 The effects of mental impairment on life satisfaction

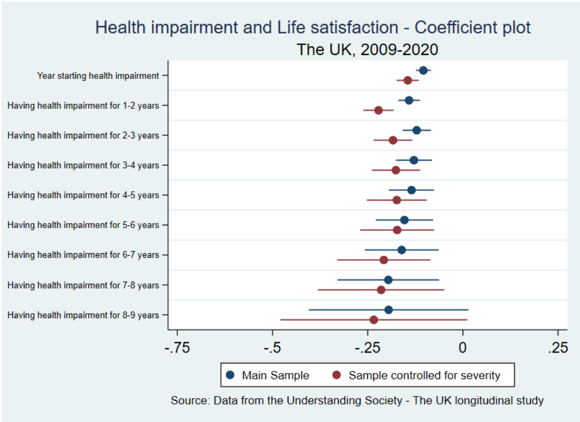


Fig. A.7 The effects of health impairment on life satisfaction - Coefficient Plot

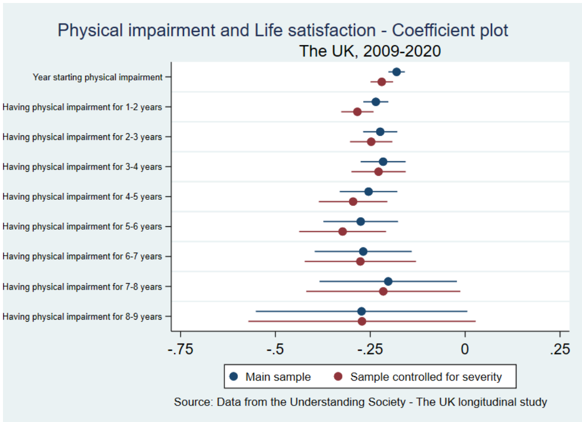


Fig. A.8 The effects of physical impairment on life satisfaction - Coefficient Plot

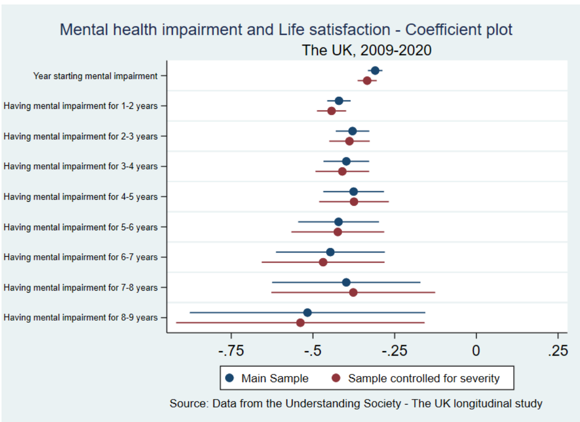


Fig. A.9 The effects of mental impairment on life satisfaction - Coefficient Plot

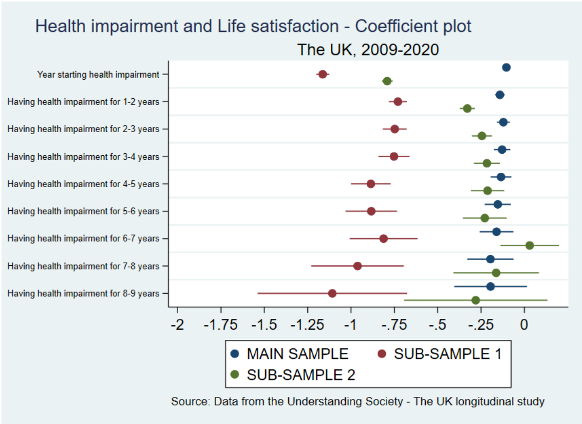


Fig. A.10 The effects of health impairment on life satisfaction - Coefficient Plot

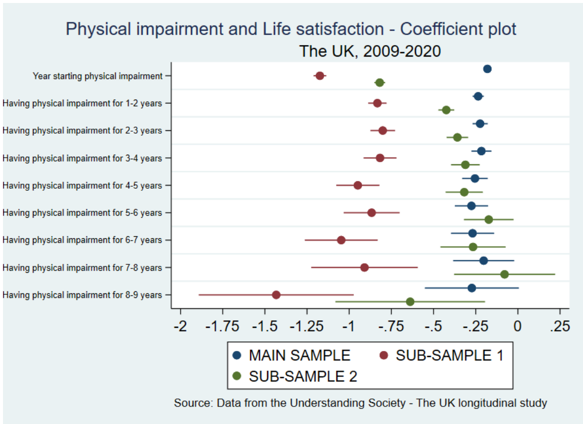


Fig. A.11 The effects of physical impairment on life satisfaction - Coefficient Plot

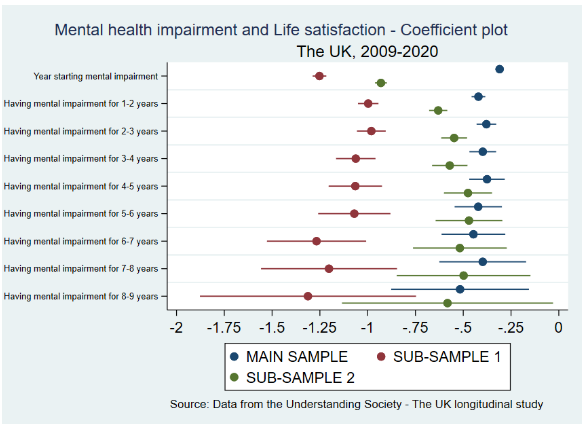


Fig. A.12 The effects of mental impairment on life satisfaction - Coefficient Plot

A.2 Sampling

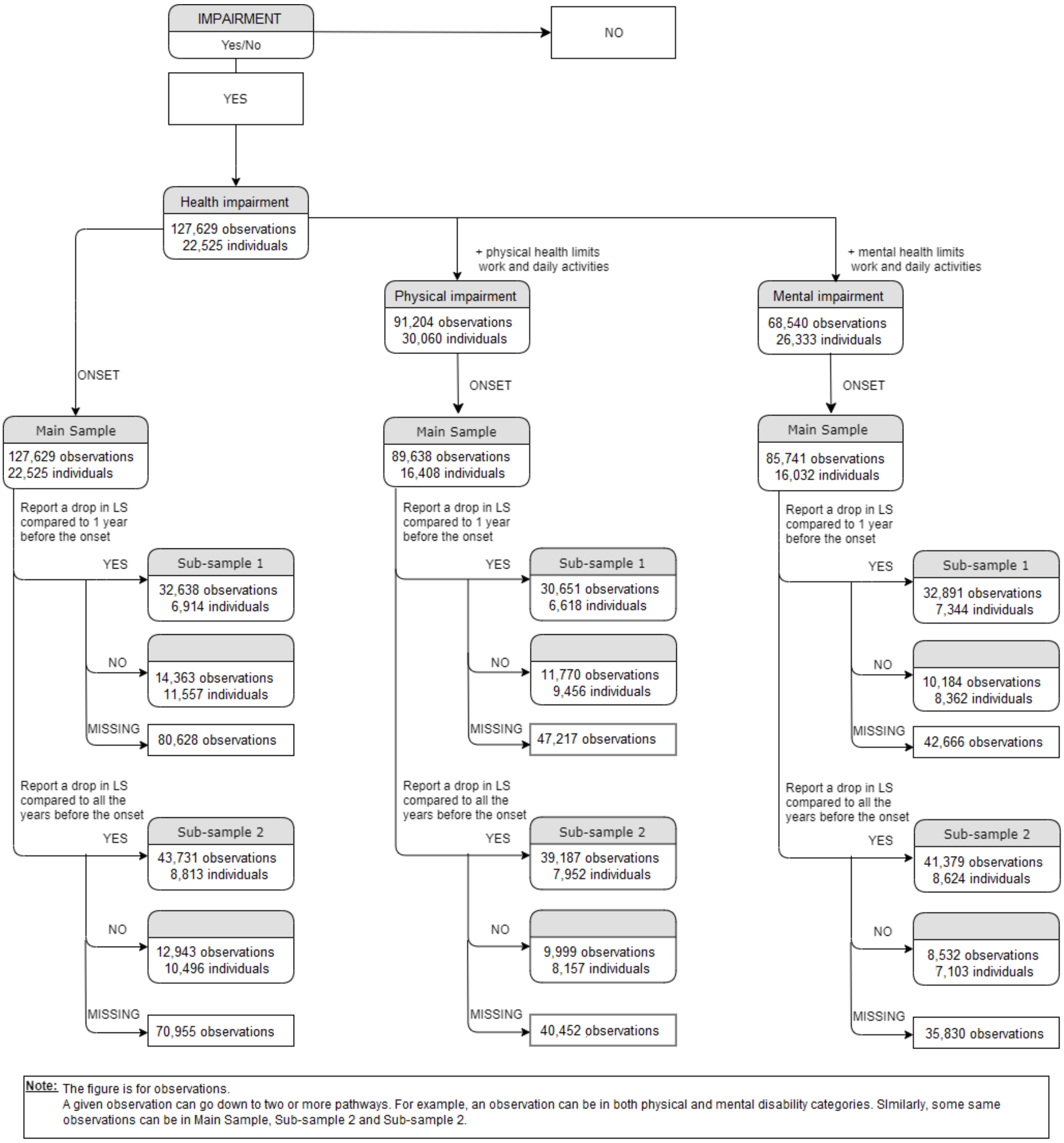


Fig. A.13 Sampling Process

A.3 Summary of literature review

Table A.1 Literature review on Adaptation to Life Events

Reference	Life events studied	Measure of SWB	Data source	Econometric method used	Restricted to those who remain in the circumstance over time	Adaptation or not	Other commentary
Clark et al. (2001)	Unemployment	Life satisfaction	GSOEP (1984-1994)	Ordered probit model	Restricted for being unemployed for the past 3 years	Habituation effect: negative wellbeing effect of unemployment is much lower for individuals having been jobless more often in the past.	The study focuses on respondents at the age between 25 and 55 years old in 1984
Lucas et al. (2003)	Marriage and widowhood	Life satisfaction	GSOEP (1984-1999)	Hierarchical linear model	At least 2 years after the events have occurred	Complete adaptation to marriage; Partial adaptation to widowhood	
Lucas et al. (2005)	Unemployment	Life satisfaction	GSOEP (1984-2000)	Hierarchical linear model	Individuals started the survey employed, experienced some periods of unemployment during the course of the study, and eventually regained employment	No adaptation after at least 2 years after unemployment	Findings show that people did start shifting back toward baseline during the adaptation phase, but the adaptation parameter was significantly smaller than the reaction parameter.
Lucas (2005)	Divorce	Life satisfaction	GSOEP (1984-1992)	Hierarchical linear model	Remain for at least 2 years	Partial adaptation	
Clark (2006)	Unemployment	Life satisfaction	GSOEP (1984-1998), BHPS (1996 - 1999), ECHP (1994-1997)	Ordered probit model	Unemployment for less than 1 year, 1 to 2 years and 2 years or more	Little evidence of adaptation	
Lucas and Clark (2006)	Marriage	Life satisfaction	GSOEP (1984-2003)	Hierarchical linear model	Individuals began the survey unmarried, got married at some point during the panel and remained married till the final wave.	Complete adaptation	Controlled for pre-marriage; Failure to treat age as varying with time
Zimmermann and Easterlin (2006)	Marriage and divorce	Life satisfaction	GSOEP (1984-2004)	Hierarchical linear model	Remain for more than 2 years	No adaptation after more than 2 years	Excluded first marriages ending in divorce within two years after marriage, those dissolved by death of a spouse, and first marriages of the foreign-born whose spouse is living in abroad
Gardner and Oswald (2006)	Divorce	Life satisfaction, GHQ-12	BHPS (1991-2001)	Ordinary least squares (OLS)	Remain for at least 2 years	Complete adaptation	
Clark et al. (2008)	marriage, divorce, widowhood, unemployment, a birth of a child, layoffs	Life satisfaction	GSOEP (1984-2003)	Lag and lead models	Not restricted	Complete adaptation in marital transitions including marriage, divorce, and widowhood; Little evidence of adaptation to unemployment; No adaptation to a birth of a child. Layoffs have no long-lasting effects.	Separate models for leads and lags
Clark and Georgellis (2013)	marriage, divorce, widowhood, unemployment, a birth of a child	Life satisfaction, GHQ-12	BHPS (1991-2008)	Lag and lead models	Not restricted	Complete adaptation in marital transitions including marriage, divorce, and widowhood; Little evidence of adaptation to unemployment;No adaptation to a birth of a child.	a contemporaneous model for leads and lags

Table A.2 Literature review on Adaptation to ill-health

Reference	Measure of SWB	Data source	Econometric method used	Restricted to those who remain disabled over time	Adaptation or not	Other commentary
Lucas (2007*b*)	Life satisfaction and psychological distress levels	GSOEP (1984-2002), BHPS (1991-2002)	Hierarchical Linear and Non-linear models	Remain at least 3 years after the onset.	No adaptation to disability when examining life satisfaction, and partial adaptation when using psychological distress.	Parameters reflecting income and employment status are included to test whether within-person effects of changes in income and occupation status prolong the effect of disability onset.
Oswald and Powdthavee (2008)	Life satisfaction	BHPS (1996-2004), GSOEP (1984-2003)	Random effects and Fixed effects models	No	Partial adaptation to disability of approximately 30% and 50% for severe disability and moderate disability, respectively.	GSOEP data are used as a check.
Powdthavee (2009)	Life satisfaction and 5 domains (social life, income, the use of leisure time, housing and partners)	BHPS (1996-2000) and (2002-2005)	Lead and lag model, two-layer model	No but focus on 5 years since onset	Adaptation to disability in almost all of the domains satisfaction for both Severe and Mild Disability, the former group often experiences incomplete adaptation. Full adaptation to mild disability using life satisfaction after 4 and more years following the onset, while no adaptation to severe disability.	Two-layer model to capture the weighted averages that individuals give multiple life domains
Pagan (2010)	Life satisfaction	GSOEP (1984-2006)	Lead and lag models	Remain at least 2 years after onset.	Full adaptation to the onset of disability after 6 or more years onset.	Focus on working-age males aged 21-58 years old
Boyce and Wood (2011)	Life satisfaction	GSOEP (2004-2009)	Hierarchical Linear and Non-linear models	Remain at least 2 years after onset.	Adaptation to disability after 4 years since the onset. Personality prior to disability may influence individuals' adaptation.	Checking for the effect of personality traits on adaptation to disability, using Big Five personality measures.
Pagan (2012)	Life satisfaction and 5 domains (health, household income, housing, job, and leisure)	GSOEP (1984-2006)	Lead and lag models	Remain at least 2 years after onset.	Full adaptation to disability after 5 year (using life satisfaction, satisfaction with household income, housing and leisure). Partial adaptation (40%-50%) (using satisfaction with health and job).	Focus on working-age males aged 21-58 years old
Anusic et al. (2014)	Life satisfaction	Swiss Household Panel (SHP) (2000-2012)	Hierarchical Linear and Non-linear models	Remain at least 3 years after the onset.	No adaptation to disability when examining life satisfaction.	Replicate Lucas (2007*b*)
McNamee and Mendolia (2014)	Life satisfaction	The Australian panel - Household, Income and Labour Dynamics of Australia Survey (HILDA)	OLS and ordered logit models with an extension using RE and FE models	Remain for 3 years after the onset.	Partial adaptation to chronic pain	Adaptation analysis follows Oswald and Powdthavee (2008)
Cubí-Mollá et al. (2017)	Self-assess health	Swiss Household Panel (SHP) (2000-2012)	Hierarchical Linear and Non-linear models	Remain at least 3 years after the onset.	Adaptation to heath states after at least 20 years	Using inverse probability weight (IPW) to correct attrition problem
de Hond et al. (2019)	Life satisfaction and self-perceived health	The Survey of Health, Ageing and Retirement in Europe (SHARE) (2004 - 2015)	FE ordered logit model	No	Full adaptation to functional limitations (life satisfaction); some evidence for adaptation to self-assessed health	

A.4 Descriptive statistics

Table A.3 Cross-tabulate between Disability Module Variables and Labour-status variable of the whole UKHLS sample 2009 - 2020

	Health impairment			
Current economics activities	No (0)	Yes (1)	Total	%
Self employed	25,701	8,562	34,263	7.74%
Paid employment (FT/ PT)	159,409	48,272	207,681	46.91%
Unemployed	14,275	7,667	21,942	4.96%
Retired	42,740	59,322	102,062	23.05%
On maternity leave	2,108	344	2,452	0.55%
Looking after family	16,725	7,739	24,464	5.53%
Full-time student	26,400	4,013	30,413	6.87%
Long-term sick or disabled	467	15,446	15,913	3.59%
In government training scheme	274	98	372	0.08%
Unpaid work family business	174	114	288	0.07%
On apprenticeship	401	82	483	0.11%
Others	1,524	882	2,406	0.54%
TOTAL	290,198	152,541	442,739	100.00%

	Physical impairment			
Current economics activities	No (0)	Yes (1)	Total	%
Self employed	24,787	4,262	29,049	7.59%
Paid employment (FT/ PT)	159,100	23,618	182,718	47.75%
Unemployed	13,613	4,669	18,282	4.78%
Retired	49,334	39,696	89,030	23.27%
On maternity leave	2,090	165	2,255	0.59%
Looking after family	15,510	4,864	20,374	5.32%
Full-time student	23,523	1,711	25,234	6.59%
Long-term sick or disabled	1,194	11,536	12,730	3.33%
In government training scheme	247	52	299	0.08%
Unpaid work family business	180	74	254	0.07%
On apprenticeship	402	33	435	0.11%
Others	1,499	513	2,012	0.53%
TOTAL	291,479	91,193	382,672	100.00%

	Mental impairment			
Current economics activities	No (0)	Yes (1)	Total	%
Self employed	26,009	3,016	29,025	7.59%
Paid employment (FT/ PT)	163,290	19,387	182,677	47.76%
Unemployed	13,667	4,625	18,292	4.78%
Retired	65,044	23,914	88,958	23.26%
On maternity leave	2,107	149	2,256	0.59%
Looking after family	16,069	4,295	20,364	5.32%
Full-time student	23,264	1,974	25,238	6.60%
Long-term sick or disabled	2,173	10,552	12,725	3.33%
In government training scheme	248	49	297	0.08%
Unpaid work family business	198	56	254	0.07%
On apprenticeship	396	37	433	0.11%
Others	1,529	479	2,008	0.52%
TOTAL	313,994	68,533	382,527	100.00%

Source: Calculation from The UKHLS 2009-2020

Table A.4 Description of variables

Variables	Definition	Module
	Dependent variable	
Life satisfaction	A self-reported wellbeing measure captured by the question: "How dissatisfied or satisfied you are with your life overall?" A 7-point scale in which 1 is 'completely dissatisfied' and 7 is 'completely satisfied'.	Self-Completion Satisfaction
	Key Independent variables	
Health impairment	The self-rated current state of an individual captured by the question: "Do you have any long-standing physical or mental impairment, illness or disability? By 'long-standing' we mean anything that has troubled you over a period of at least 12 months or that is likely to trouble you over a period of at least 12 months."	Disability module
Lags of health impairment	A set of dummy variables capturing previous experience of health impairment	Derived from Health impairment
Severity	A derived variable taking value between 0 and 12 (i.e. 0 means no severe health impairment; any values greater than 0 are classified as having severe health impairment).	Disability module
	Do you have any health problems or disabilities that mean you have substantial difficulties with any of the following areas of your life? Please select all of the answers that apply to you. 1 Mobility (moving around at home and walking) Mobility/ 2 Lifting, carrying or moving objects/ 3 Manual dexterity (using your hands to carry out everyday tasks)/ 4 Continence (bladder and bowel control)/ 5 Hearing (apart from using a standard hearing aid)/ 6 Sight (apart from wearing standard glasses)/ 7 Communication or speech problems/ 8 Memory or ability to concentrate, learn or understand/ 9 Recognising when you are in physical danger/ 10 Your physical co-ordination (e.g. balance)/ 11 Difficulties with own personal care (e.g. getting dressed, taking a bath or shower)/ 12 Other health problem	Subsequent question of the Health impairment
Physical impairment	The self-reported current state of an individual captured by 2 questions: "Do you have any long-standing physical or mental impairment, illness or disability?" and "During the past four weeks, how much of the time were you limited in the kind of work or other regular daily activities you do as a result of your physical health?"	Disability & Self-Completion SF12
Lags of physical impairment	A set of dummy variables capturing previous experience of physical disability	Derive from Physical Disability
Mental impairment	The self-reported current state of an individual captured by 2 questions: "Do you have any long-standing physical or mental impairment, illness or disability?" and "During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?"	Disability & Self-Completion SF12
Lags of mental impairment	A set of dummy variables capturing previous experience of mental impairment	Derived from Mental impairment
	Control Variables	
Monthly household income per capita	A calculated gross measure of household monthly income as the sum of personal monthly income of all household members. This number was then accounted for CPI to get real household monthly income and then divided by household size for capita value.	Derived variable
Sex	Respondents' sex (excluded dummy: female)	Household Grid Module
Age groups	Respondents' age group: 16-24, 25-34, 35-44, 45-54, 55-64, and 65 and over (excluded dummy: 16-24)	Derived variable from Household Grid
Marital Status	Individuals' marital status: single, married, cohabit, widowed, divorced, separated (excluded category: married)	Derived variable from Household Grid
Employment Status	Individuals' current economic activity: unemployed, employed, retired, not active in labour market (excluded category: employed)	Demographics
Highest Education Level	Individuals' highest education level: A-levels (and equivalent), University (and equivalent), no formal qualifications or qualifications not included in the other two categories (excluded category: the last one)	Derived variable from Initial Conditions
Household Size groups	The numbers of members in the household as groups: 1, 2, 3, 4 and more (excluded dummy: 1)	Household Grid
Number of Dependent Children	The numbers of dependent children (aged < 16) in the household as groups: 0, 1, 2, 3 and more (excluded dummy: 0)	Derived variable from Grid Variables
Owned Home Outright	A dummy captures whether household owns the accommodation outright	Household Questionnaire
Regions	12 Government Office Regions	Derived variable from Household Grid

Source: The UKHLS 2009-2020

Table A.5 The distribution of life satisfaction in the whole UKHLS sample for males and females

	Male		**Female**	
Life satisfaction	Count	Cumulative %	Count	Cumulative %
1	3,731	2.25	5,538	2.65
2	8,768	7.55	11,354	8.10
3	12,927	15.36	16,586	16.05
4	16,366	25.25	20,546	25.89
5	30,077	43.42	36,161	43.23
6	74,262	88.28	92,431	87.53
7	19,399	100.00	26,013	100.00
Total	165,530		208,629	
Mean	5.18		5.17	
Median	6		6	

Note: These figures refer to the sample aged 16 and over; higher figures indicate higher levels of life satisfaction.

Source: The UKHLS 2009-2020

Table A.6 Cross-tabulate between Health impairment, Physical impairment and Mental impairment in the whole UKHLS sample

	Physical impairment		
Health impairment	No (0)	Yes (1)	Total
No (0)	250,244	0	250,244
Yes (1)	41,308	91,204	132,512
Total	291,552	91,204	382,756

	Mental impairment		
Health impairment	No (0)	Yes (1)	Total
No (0)	250,141	0	250,141
Yes (1)	63,932	68,540	132,472
Total	314,073	68,540	382,613

	Mental impairment		
Physical impairment	No (0)	Yes (1)	Total
No (0)	280,101	11,055	291,156
Yes (1)	33,640	57,364	91,004
Total	313,741	68,419	382,160

Source: Calculation from The UKHLS 2009-2020

Table A.7 Correlations between Mental Impairment and Life Satisfaction in the whole UKHLS sample

	Life satisfaction	Mental impairment	Onset	1-2 years	2-3 years	3-4 years	4-5 years	5-6 years	6-7 years	7-8 years	8-9 years
Mental impairment	−0.205	1.000									
Onset	−0.081	0.702	1.000								
1-2 years	−0.104	0.357	−0.171	1.000							
2-3 years	−0.081	0.232	−0.111	−0.057	1.000						
3-4 years	−0.072	0.165	−0.079	−0.040	−0.026	1.000					
4-5 years	−0.056	0.120	−0.058	−0.029	−0.019	−0.014	1.000				
5-6 years	−0.046	0.088	−0.042	−0.022	−0.014	−0.010	−0.007	1.000			
6-7 years	−0.039	0.065	−0.031	−0.016	−0.010	−0.007	−0.005	−0.004	1.000		
7-8 years	−0.030	0.047	−0.022	−0.011	−0.007	−0.005	−0.004	−0.003	−0.002	1.000	
8-9 years	−0.022	0.029	−0.014	−0.007	−0.005	−0.003	−0.002	−0.002	−0.001	−0.001	1.000

Source: Calculation from The UKHLS 2009-2020 Note: There is no qualitative difference in the same correlation test for the Main Sample

Table A.8 The number of observations of duration since onset in the Main sample

	Males			**Females**		
Lags	Health impairment	Physical impairment	Mental impairment	Health impairment	Physical impairment	Mental impairment
0 - 1 year	13,628	9,346	8,818	16,800	12,660	12,654
1 - 2 years	5,750	3,266	2,624	7,278	4,755	4,181
2 - 3 years	3,027	1,593	1,129	3,950	2,425	1,891
3 - 4 years	1,754	856	545	2,338	1,320	998
4 - 5 years	1,063	509	291	1,405	773	542
5 - 6 years	635	288	156	789	433	293
6 - 7 years	358	158	72	455	253	169
7 - 8 years	180	76	34	225	119	92
8 - 9 years	64	27	11	87	52	37

Note: Sum of the 2 columns 'Physical impairment' and 'Mental impairment' does not equal to the figure in column 'Health impairment' because of 2 reasons: (i) Some people have both types of impairment (total figures of 2 categories are bigger than figure for 'health impairment', e.g. lags 1 - 2 years of females; and (ii) Some people have long-standing health impairment but their problems do not limit amount of work (the sum of 2 categories is smaller than the figure for 'health impairment', i.e. lags 6-7 years of males).

Source: The UKHLS 2009-2020

Table A.9 Definitions of trajectory types of impairment

Name	**Definition**	**Example patterns**
Never	Always non-impaired in all years of the panel	0000000000
One-off	Being impaired only 1 year	0010000000
Short repeated continuously	Being impaired for 2 or 3 years in total but not	0010100010
Short consecutive	Being continuously impaired for 2 or 3 years in total	0000111000
Long repeated not continuously	Being impaired for 4, 5 and up to 8 years in total but	1011001110
Long consecutive	Being continuously impaired for 4, 5, 6 and up to 8 years in total	0111111111
Always	Being impaired for all the interview years in the panel (either equal or less than 10 years)	11111111 or 1111111111 (eg. if individual appears in only 8 years of the panel)

Note: 0 means 'not impaired' and 1 means 'impaired'. Examples show only one of many possibilities in each group.

Table A.10 Descriptive Statistics of the Main sample from the UKHLS Wave 1 – 10 (2009 – 2020)

	Obs	Mean	S.D	Min	Max
Life satisfaction	110,191	5.174	1.460	1	7
Having health impairment	110,191	0.474	0.499	0	1
Having health impairment within one year	110,191	0.236	0.425	0	1
Having health impairment 1-2 year	110,191	0.104	0.305	0	1
Having health impairment 2-3 years	110,191	0.057	0.231	0	1
Having health impairment 3-4 years	110,191	0.034	0.180	0	1
Having health impairment 4-5 years	110,191	0.020	0.142	0	1
Having health impairment 5-6 years	110,191	0.012	0.109	0	1
Having health impairment 6-7 years	110,191	0.007	0.083	0	1
Having health impairment 7-8 years	110,191	0.003	0.058	0	1
Having health impairment 8-9 years	110,191	0.001	0.036	0	1
Having physical impairment	87,044	0.436	0.496	0	1
Having physical impairment within one year	87,044	0.244	0.429	0	1
Having physical impairment 1-2 year	87,044	0.090	0.287	0	1
Having physical impairment 2-3 years	87,044	0.046	0.209	0	1
Having physical impairment 3-4 years	87,044	0.025	0.156	0	1
Having physical impairment 4-5 years	87,044	0.015	0.121	0	1
Having physical impairment 5-6 years	87,044	0.009	0.092	0	1
Having physical impairment 6-7 years	87,044	0.005	0.070	0	1
Having physical impairment 7-8 years	87,044	0.002	0.048	0	1
Having physical impairment 8-9 years	87,044	0.001	0.031	0	1
Having mental impairment	83,106	0.403	0.490	0	1
Having mental impairment within one year	83,106	0.249	0.432	0	1
Having mental impairment 1-2 year	83,106	0.079	0.270	0	1
Having mental impairment 2-3 years	83,106	0.036	0.186	0	1
Having mental impairment 3-4 years	83,106	0.018	0.134	0	1
Having mental impairment 4-5 years	83,106	0.010	0.099	0	1
Having mental impairment 5-6 years	83,106	0.005	0.074	0	1
Having mental impairment 6-7 years	83,106	0.003	0.054	0	1
Having mental impairment 7-8 years	83,106	0.002	0.040	0	1
Having mental impairment 8-9 years	83,106	0.001	0.024	0	1
Log of real household income per capita	110,191	7.147	0.715	-3.075	10.023
Gender					
Female	110,191	0.565	0.496	0	1
Male	110,191	0.435	0.496	0	1
Marital Status					
Married	110,191	0.574	0.494	0	1
Cohabit	110,191	0.101	0.301	0	1
Single	110,191	0.154	0.361	0	1
Widowed	110,191	0.078	0.268	0	1
Divorced	110,191	0.075	0.263	0	1
Separated	110,191	0.018	0.132	0	1
Employment status					
Unemployed	110,191	0.042	0.201	0	1
Employed	110,191	0.523	0.499	0	1
Retired	110,191	0.327	0.469	0	1
Not active in labour market	110,191	0.108	0.310	0	1
Highest Qualification					
A-levels	110,191	0.395	0.489	0	1
No formal qualification	110,191	0.244	0.430	0	1
University Degree	110,191	0.360	0.480	0	1
Others					
Age	110,191	54.11	17.497	16	103
Household Size					
Household Size: 1	110,191	0.405	0.491	0	1
Household Size: 2	110,191	0.175	0.38	0	1
Household Size: 3	110,191	0.168	0.374	0	1
Household Size: 4+	110,191	0.252	0.434	0	1
Owned home outright	110,191	0.407	0.491	0	1
No. of children					
No. of children: 0	110,191	0.122	0.327	0	1
No. of children: 1	110,191	0.733	0.442	0	1
No. of children: 2	110,191	0.103	0.304	0	1
No. of children: 3+	110,191	0.042	0.201	0	1
Region	110,191	6.579	3.175	1	12
Wave	110,191	5.324	2.622	1	10

Source: The UK longitudinal study: 2009 - 2020

A.5 Regression results

Table A.11 The effects of Impairment - Main Sample and Severity-controlled Sample

	REG 1	REG 2	REG 3	REG 4	REG 5	REG 6
Onset of impairment	-0.104***	-0.145***	-0.181***	-0.220***	-0.310***	-0.334***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Impairment: 1-2 years	-0.141***	-0.222***	-0.235***	-0.284***	-0.420***	-0.443***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Impairment: 2-3 years	-0.121***	-0.184***	-0.224***	-0.248***	-0.379***	-0.388***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
Impairment: 3-4 years	-0.129***	-0.176***	-0.216***	-0.228***	-0.398***	-0.410***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
Impairment: 4-5 years	-0.135***	-0.174***	-0.255***	-0.295***	-0.376***	-0.374***
	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Impairment: 5-6 years	-0.153***	-0.173***	-0.275***	-0.323***	-0.422***	-0.424***
	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)
Impairment: 6-7 years	-0.161**	-0.208***	-0.269***	-0.276***	-0.447***	-0.469***
	(0.05)	(0.06)	(0.07)	(0.07)	(0.09)	(0.10)
Impairment: 7-8 years	-0.196**	-0.215*	-0.203*	-0.216*	-0.398***	-0.377**
	(0.07)	(0.08)	(0.09)	(0.10)	(0.12)	(0.13)
Impairment: 8-9 years	-0.195+	-0.234+	-0.273+	-0.272+	-0.517**	-0.538**
	(0.11)	(0.13)	(0.14)	(0.15)	(0.18)	(0.19)
Log of real household income per capita	0.041***	0.050***	0.034***	0.039**	0.041***	0.049***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age: 27-37	-0.102*	-0.123*	-0.132**	-0.156**	-0.054	-0.071
	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
Age: 38-47	-0.198***	-0.222***	-0.218***	-0.238**	-0.170**	-0.200**
	(0.05)	(0.06)	(0.06)	(0.08)	(0.06)	(0.08)
Age: 48-56	-0.177**	-0.200**	-0.221**	-0.260**	-0.168*	-0.237**
	(0.06)	(0.07)	(0.07)	(0.09)	(0.07)	(0.09)
Age: 57-67	-0.090	-0.135	-0.136+	-0.160	-0.109	-0.175+
	(0.07)	(0.08)	(0.08)	(0.10)	(0.08)	(0.10)
Age: 68 or older	-0.026	-0.086	-0.049	-0.085	-0.037	-0.112
	(0.07)	(0.09)	(0.09)	(0.11)	(0.09)	(0.11)
Single	-0.135***	-0.147**	-0.127**	-0.147**	-0.165***	-0.168**
	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
Cohabit	0.017	0.019	0.074*	0.040	0.047	0.032
	(0.03)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)
Widowed	-0.156***	-0.195***	-0.177***	-0.191**	-0.201***	-0.198**
	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)
Divorced	-0.150***	-0.142**	-0.093+	-0.071	-0.134**	-0.114+
	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
Separated	-0.268***	-0.260***	-0.201***	-0.266***	-0.236***	-0.270***
	(0.05)	(0.06)	(0.05)	(0.07)	(0.05)	(0.07)
Unemployed	-0.285***	-0.285***	-0.312***	-0.326***	-0.295***	-0.313***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Retired	0.131***	0.140***	0.128***	0.154***	0.110***	0.109***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Not active in labour market	-0.110***	-0.137***	-0.192***	-0.214***	-0.150***	-0.171***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
Edu: University	-0.188*	-0.164+	-0.217*	-0.119	-0.259*	-0.211+
	(0.08)	(0.10)	(0.10)	(0.12)	(0.10)	(0.13)
Edu: A Levels	-0.029	-0.016	-0.052	-0.007	-0.062	-0.003
	(0.07)	(0.09)	(0.08)	(0.10)	(0.09)	(0.11)
Household size: 2	-0.018	-0.041	-0.029	-0.012	-0.008	-0.004
	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)
Household size: 3	-0.043	-0.040	-0.053	0.012	-0.041	-0.026
	(0.03)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)
Household size: 4+	-0.038	-0.051	-0.045	-0.004	-0.026	-0.004
	(0.04)	(0.05)	(0.04)	(0.06)	(0.05)	(0.06)
Owned home outright	0.040+	0.058*	0.054*	0.058+	0.071**	0.072*
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
No. of dependent children: 1	0.021	0.024	0.022	0.015	-0.014	-0.039
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
No. of dependent children: 2	0.052+	0.075+	0.060	0.075	0.055	0.050
	(0.03)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)
No. of dependent children: 3+	0.114*	0.166**	0.210***	0.209**	0.123*	0.125+
	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)	(0.07)
Constant	5.268***	5.201***	5.309***	5.226***	5.159***	5.003***
	(0.19)	(0.23)	(0.21)	(0.26)	(0.22)	(0.27)
Waves & Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	110,191	80,355	87,044	62,378	83,106	61,819

Source: The UKHLS 2009-2020

Note: Standard errors in parentheses.. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Health impairment: REG 1-Main Sample, REG 2-Severity-controlled Sample. Physical impairment: REG 3-Main Sample, REG 4-Severity-controlled Sample. Mental impairment: REG 5-Main Sample, REG 6-Severity-controlled Sample

Table A.12 The effects of Impairment on life satisfaction – Genders

	MALE-H	FEMALE-H	MALE-P	FEMALE-P	MALE-M	FEMALE-M
Onset of impairment	-0.090***	-0.114***	-0.182***	-0.179***	-0.289***	-0.323***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Impairment: 1-2 years	-0.117***	-0.160***	-0.234***	-0.235***	-0.404***	-0.430***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Impairment: 2-3 years	-0.078**	-0.153***	-0.245***	-0.208***	-0.352***	-0.393***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
Impairment: 3-4 years	-0.075*	-0.167***	-0.219***	-0.213***	-0.318***	-0.443***
	(0.04)	(0.03)	(0.05)	(0.04)	(0.06)	(0.04)
Impairment: 4-5 years	-0.114*	-0.152***	-0.328***	-0.205***	-0.368***	-0.385***
	(0.05)	(0.04)	(0.06)	(0.05)	(0.08)	(0.06)
Impairment: 5-6 years	-0.121*	-0.180***	-0.225**	-0.316***	-0.409***	-0.429***
	(0.06)	(0.05)	(0.08)	(0.07)	(0.11)	(0.08)
Impairment: 6-7 years	-0.184*	-0.142*	-0.335**	-0.234**	-0.613***	-0.384***
	(0.07)	(0.07)	(0.10)	(0.08)	(0.15)	(0.10)
Impairment: 7-8 years	-0.199*	-0.193*	-0.254+	-0.179	-0.208	-0.482***
	(0.10)	(0.09)	(0.14)	(0.12)	(0.22)	(0.14)
Impairment: 8-9 years	-0.106	-0.248+	-0.057	-0.388*	-0.774*	-0.468*
	(0.16)	(0.14)	(0.24)	(0.18)	(0.39)	(0.21)
Log of household income per capita	0.055***	0.029*	0.034*	0.031*	0.053**	0.031*
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Age: 27-37	-0.346***	0.033	-0.406***	0.001	-0.348***	0.092
	(0.07)	(0.05)	(0.08)	(0.06)	(0.08)	(0.06)
Age: 38-47	-0.422***	-0.074	-0.555***	-0.042	-0.466***	-0.017
	(0.08)	(0.07)	(0.10)	(0.08)	(0.10)	(0.08)
Age: 48-56	-0.388***	-0.058	-0.593***	-0.019	-0.475***	-0.008
	(0.09)	(0.08)	(0.12)	(0.09)	(0.12)	(0.09)
Age: 57-67	-0.348***	0.068	-0.549***	0.097	-0.506***	0.117
	(0.10)	(0.09)	(0.13)	(0.10)	(0.13)	(0.10)
Age: 68 or older	-0.302**	0.145	-0.476***	0.194+	-0.439**	0.191+
	(0.11)	(0.10)	(0.14)	(0.11)	(0.14)	(0.11)
Single	-0.258***	-0.066	-0.264***	-0.062	-0.324***	-0.087
	(0.07)	(0.05)	(0.08)	(0.06)	(0.08)	(0.06)
Cohabit	-0.040	0.052	0.073	0.070	0.069	0.026
	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)
Widowed	-0.203*	-0.135*	-0.295**	-0.130*	-0.367***	-0.137*
	(0.08)	(0.06)	(0.09)	(0.06)	(0.10)	(0.06)
Divorced	-0.267***	-0.090+	-0.221**	-0.030	-0.229**	-0.089
	(0.08)	(0.05)	(0.08)	(0.06)	(0.09)	(0.06)
Separated	-0.316***	-0.241***	-0.346***	-0.132*	-0.302**	-0.207**
	(0.08)	(0.06)	(0.10)	(0.07)	(0.10)	(0.06)
Unemployed	-0.354***	-0.240***	-0.424***	-0.243***	-0.398***	-0.225***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)
Retired	0.126***	0.130***	0.072*	0.166***	0.053	0.147***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)
Not active in labour market	-0.235***	-0.066**	-0.391***	-0.112***	-0.251***	-0.104***
	(0.04)	(0.02)	(0.04)	(0.03)	(0.04)	(0.03)
Edu: University	-0.385**	-0.079	-0.243+	-0.227+	-0.337*	-0.251+
	(0.13)	(0.10)	(0.15)	(0.13)	(0.17)	(0.13)
Edu: A Levels	-0.106	0.025	0.037	-0.113	0.067	-0.148
	(0.11)	(0.09)	(0.13)	(0.11)	(0.14)	(0.12)
Household size: 2	0.003	-0.040	-0.025	-0.052	-0.044	-0.006
	(0.05)	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)
Household size: 3	-0.034	-0.060	-0.052	-0.075	-0.061	-0.048
	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)
Household size: 4+	-0.060	-0.034	-0.090	-0.038	-0.127+	0.016
	(0.06)	(0.05)	(0.07)	(0.06)	(0.07)	(0.06)
Owned home outright	0.010	0.061*	0.067+	0.041	0.072+	0.071*
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)
No. of dependent children: 1	-0.000	0.026	0.019	0.013	0.018	-0.045
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
No. of dependent children: 2	0.045	0.043	0.096	0.025	0.091	0.016
	(0.05)	(0.04)	(0.06)	(0.05)	(0.06)	(0.05)
No. of dependent children: 3+	0.197**	0.042	0.242**	0.170*	0.182+	0.062
	(0.07)	(0.06)	(0.09)	(0.07)	(0.10)	(0.07)
Constant	5.548***	5.084***	5.763***	4.991***	5.596***	4.985***
	(0.30)	(0.25)	(0.30)	(0.30)	(0.36)	(0.29)
Wave and Regional dummies	Yes	Yes	yes	Yes	Yes	yes
Observations	47,980	62,210	36,624	50,420	33,732	49,374

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Note: Health impairment: MALE-H and FEMALE-H; Physical impairment: MALE-P and FEMALE-P; Mental impairment MALE-M and FEMALE-M

Table A.13 The effects of Health impairment – Main Sample vs Sub-samples

	MAIN SAMPLE	SUB-SAMPLE 1	SUB-SAMPLE 2
Year starting health impairment	-0.104***	-1.163***	-0.791***
	(0.01)	(0.02)	(0.02)
Having health impairment for 1-2 years	-0.141***	-0.729***	-0.329***
	(0.01)	(0.03)	(0.02)
Having health impairment for 2-3 years	-0.121***	-0.748***	-0.245***
	(0.02)	(0.04)	(0.03)
Having health impairment for 3-4 years	-0.129***	-0.752***	-0.216***
	(0.02)	(0.05)	(0.04)
Having health impairment for 4-5 years	-0.135***	-0.886***	-0.212***
	(0.03)	(0.06)	(0.05)
Having health impairment for 5-6 years	-0.153***	-0.883***	-0.229***
	(0.04)	(0.08)	(0.06)
Having health impairment for 6-7 years	-0.161**	-0.812***	0.031
	(0.05)	(0.10)	(0.09)
Having health impairment for 7-8 years	-0.196**	-0.962***	-0.163
	(0.07)	(0.14)	(0.13)
Having health impairment for 8-9 years	-0.195+	-1.108***	-0.280
	(0.11)	(0.22)	(0.21)
Log of real household income per capita	0.041***	0.069***	0.061***
	(0.01)	(0.02)	(0.02)
Age: 27-37	-0.102*	-0.129	-0.171**
	(0.04)	(0.08)	(0.06)
Age: 38-47	-0.198***	-0.199*	-0.282***
	(0.05)	(0.10)	(0.08)
Age: 48-56	-0.177**	-0.150	-0.220*
	(0.06)	(0.11)	(0.09)
Age: 57-67	-0.090	-0.099	-0.113
	(0.07)	(0.13)	(0.11)
Age: 68 or older	-0.026	-0.034	0.016
	(0.07)	(0.14)	(0.12)
Single	-0.135***	-0.105	-0.109+
	(0.04)	(0.07)	(0.06)
Cohabit	0.017	0.083	0.063
	(0.03)	(0.06)	(0.05)
Widowed	-0.156***	-0.100	-0.151*
	(0.05)	(0.09)	(0.07)
Divorced	-0.150***	-0.242**	-0.155*
	(0.04)	(0.08)	(0.07)
Separated	-0.268***	-0.206*	-0.298***
	(0.05)	(0.08)	(0.07)
Unemployed	-0.285***	-0.271***	-0.251***
	(0.03)	(0.05)	(0.04)
Retired	0.131***	0.176***	0.147***
	(0.02)	(0.05)	(0.04)
Not active in labour market	-0.110***	-0.197***	-0.146***
	(0.02)	(0.04)	(0.03)
Edu: University	-0.188*	-0.051	-0.150
	(0.08)	(0.17)	(0.16)
Edu: A Levels	-0.029	0.148	0.148
	(0.07)	(0.15)	(0.15)
Household size: 2	-0.018	0.031	-0.012
	(0.03)	(0.06)	(0.05)
Household size: 3	-0.043	0.013	-0.046
	(0.03)	(0.06)	(0.05)
Household size: 4+	-0.038	0.071	0.010
	(0.04)	(0.07)	(0.06)
Owned home outright	0.040+	0.023	0.055
	(0.02)	(0.04)	(0.04)
No. of dependent children: 1	0.021	0.014	0.030
	(0.02)	(0.04)	(0.04)
No. of dependent children: 2	0.052+	0.038	0.037
	(0.03)	(0.06)	(0.05)
No. of dependent children: 3+	0.114*	0.125	0.116
	(0.05)	(0.09)	(0.07)
Constant	5.268***	4.681***	4.871***
	(0.19)	(0.35)	(0.30)
Wave and Regional dummies	Yes	Yes	Yes
Observations	110,193	31,968	42,851

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.14 The effects of Physical impairment – Main Sample vs Sub-samples

	MAIN SAMPLE	SUB-SAMPLE 1	SUB-SAMPLE 2
Year starting physical impairment	-0.181***	-1.174***	-0.819***
	(0.01)	(0.02)	(0.02)
Having physical impairment for 1-2 years	-0.235***	-0.833***	-0.424***
	(0.02)	(0.03)	(0.02)
Having physical impairment for 2-3 years	-0.224***	-0.801***	-0.359***
	(0.02)	(0.04)	(0.03)
Having physical impairment for 3-4 years	-0.216***	-0.817***	-0.311***
	(0.03)	(0.05)	(0.04)
Having physical impairment for 4-5 years	-0.255***	-0.949***	-0.318***
	(0.04)	(0.07)	(0.06)
Having physical impairment for 5-6 years	-0.275***	-0.867***	-0.173*
	(0.05)	(0.08)	(0.08)
Having physical impairment for 6-7 years	-0.269***	-1.047***	-0.266**
	(0.07)	(0.11)	(0.10)
Having physical impairment for 7-8 years	-0.203*	-0.909***	-0.079
	(0.09)	(0.16)	(0.15)
Having physical impairment for 8-9 years	-0.273^{+}	-1.433***	-0.638**
	(0.14)	(0.23)	(0.23)
Log of real household income per capita	0.034***	0.030	0.028^{+}
	(0.01)	(0.02)	(0.02)
Age: 27-37	-0.132**	-0.113	-0.246***
	(0.05)	(0.09)	(0.07)
Age: 38-47	-0.218***	-0.197^{+}	-0.375***
	(0.06)	(0.11)	(0.09)
Age: 48-56	-0.221**	-0.142	-0.366***
	(0.07)	(0.13)	(0.10)
Age: 57-67	-0.136^{+}	-0.031	-0.269*
	(0.08)	(0.14)	(0.12)
Age: 68 or older	-0.049	0.057	-0.134
	(0.09)	(0.15)	(0.13)
Single	-0.127**	-0.126	-0.055
	(0.05)	(0.08)	(0.07)
Cohabit	0.074*	0.117^{+}	0.116*
	(0.04)	(0.06)	(0.05)
Widowed	-0.177***	-0.090	-0.134^{+}
	(0.05)	(0.09)	(0.08)
Divorced	-0.093^{+}	-0.137^{+}	-0.077
	(0.05)	(0.08)	(0.07)
Separated	-0.201***	-0.147	-0.205**
	(0.05)	(0.09)	(0.08)
Unemployed	-0.312***	-0.344***	-0.316***
	(0.03)	(0.05)	(0.04)
Retired	0.128***	0.112*	0.102*
	(0.03)	(0.05)	(0.04)
Not active in labour market	-0.192***	-0.306***	-0.269***
	(0.02)	(0.04)	(0.03)
Edu: University	-0.217*	0.000	-0.016
	(0.10)	(0.19)	(0.17)
Edu: A-levels	-0.052	0.226	0.241
	(0.08)	(0.17)	(0.15)
Household size:2	-0.029	-0.009	-0.047
	(0.03)	(0.06)	(0.05)
Household size:3	-0.053	-0.077	-0.060
	(0.04)	(0.07)	(0.06)
Household size:4+	-0.045	-0.010	-0.000
	(0.04)	(0.08)	(0.07)
Owned home outright	0.054*	0.038	0.042
	(0.03)	(0.05)	(0.04)
No. of dependent children:1	0.022	-0.009	0.014
	(0.03)	(0.05)	(0.04)
No. of dependent children:2	0.060	0.108	0.080
	(0.04)	(0.07)	(0.06)
No. of dependent children:3+	0.210***	0.194*	0.240**
	(0.06)	(0.10)	(0.08)
Constant	5.309***	5.362***	5.596***
	(0.21)	(0.37)	(0.30)
Wave and Regional dummies	Yes	Yes	Yes
Observations	87,044	30,073	38,439

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.15 The effects of Mental impairment – Main Sample vs Sub-samples

	MAIN SAMPLE	SUB-SAMPLE 1	SUB-SAMPLE 2
Year starting mental impairment	-0.310***	-1.252***	-0.931***
	(0.01)	(0.02)	(0.02)
Having mental impairment for 1-2 years	-0.420***	-0.997***	-0.631***
	(0.02)	(0.03)	(0.02)
Having mental impairment for 2-3 years	-0.379***	-0.981***	-0.548***
	(0.03)	(0.04)	(0.03)
Having mental impairment for 3-4 years	-0.398***	-1.062***	-0.571***
	(0.04)	(0.05)	(0.05)
Having mental impairment for 4-5 years	-0.376***	-1.065***	-0.475***
	(0.05)	(0.07)	(0.06)
Having mental impairment for 5-6 years	-0.422***	-1.070***	-0.470***
	(0.06)	(0.10)	(0.09)
Having mental impairment for 6-7 years	-0.447***	-1.267***	-0.518***
	(0.09)	(0.13)	(0.13)
Having mental impairment for 7-8 years	-0.398***	-1.202***	-0.498**
	(0.12)	(0.18)	(0.18)
Having mental impairment for 8-9 years	-0.517**	-1.312***	-0.582*
	(0.18)	(0.29)	(0.28)
Log of real household income per capita	0.041***	0.085***	0.061***
	(0.01)	(0.02)	(0.02)
Age: 27-37	-0.054	0.036	-0.063
	(0.05)	(0.08)	(0.07)
Age: 38-47	-0.170**	-0.053	-0.184*
	(0.06)	(0.10)	(0.09)
Age: 48-56	-0.168*	-0.044	-0.221*
	(0.07)	(0.12)	(0.10)
Age: 57-67	-0.109	-0.004	-0.175
	(0.08)	(0.13)	(0.11)
Age: 68 or older	-0.037	0.074	-0.054
	(0.09)	(0.15)	(0.12)
Single	-0.165***	-0.188**	-0.216***
	(0.05)	(0.07)	(0.06)
Cohabit	0.047	0.012	0.008
	(0.04)	(0.06)	(0.05)
Widowed	-0.201***	-0.089	-0.148*
	(0.05)	(0.08)	(0.07)
Divorced	-0.134**	-0.123	-0.104
	(0.05)	(0.07)	(0.07)
Separated	-0.236***	-0.226**	-0.323***
	(0.05)	(0.08)	(0.07)
Unemployed	-0.295***	-0.285***	-0.297***
	(0.03)	(0.05)	(0.04)
Retired	0.110***	0.205***	0.121**
	(0.03)	(0.05)	(0.04)
Not active in labour market	-0.150***	-0.231***	-0.198***
	(0.02)	(0.04)	(0.03)
Edu: University	-0.259*	-0.292	-0.159
	(0.10)	(0.18)	(0.16)
Edu: A Levels	-0.062	-0.055	0.111
	(0.09)	(0.17)	(0.15)
Household size: 2	-0.008	0.026	-0.004
	(0.03)	(0.05)	(0.05)
Household size: 3	-0.041	0.001	-0.048
	(0.04)	(0.06)	(0.05)
Household size: 4+	-0.026	0.020	-0.037
	(0.05)	(0.07)	(0.06)
Owned home outright	0.071**	0.082+	0.082*
	(0.03)	(0.04)	(0.04)
No. of dependent children: 1	-0.014	0.026	0.042
	(0.03)	(0.04)	(0.04)
No. of dependent children: 2	0.055	0.119+	0.129*
	(0.04)	(0.06)	(0.05)
No. of dependent children: 3+	0.123*	0.208*	0.262***
	(0.06)	(0.09)	(0.08)
Constant	5.159***	4.624***	4.827***
	(0.22)	(0.38)	(0.32)
Wave and Regional dummies	Yes	Yes	Yes
Observations	83,106	32,248	40,566

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.16 Robustness Check - Frequency of physical (PI) and mental impairment (MI)

	PI (main)	PI (cutoff)	MI (main)	MI (cutoff)
Year starting physical/mental impairment	-0.181***	-0.238***	-0.310***	-0.423***
	(0.01)	(0.01)	(0.01)	(0.01)
Having physical/mental impairment for 1-2 years	-0.235***	-0.294***	-0.420***	-0.482***
	(0.02)	(0.02)	(0.02)	(0.02)
Having physical/mental impairment for 2-3 years	-0.224***	-0.296***	-0.379***	-0.467***
	(0.02)	(0.03)	(0.03)	(0.04)
Having physical/mental impairment for 3-4 years	-0.216***	-0.279***	-0.398***	-0.499***
	(0.03)	(0.04)	(0.04)	(0.05)
Having physical/mental impairment for 4-5 years	-0.255***	-0.327***	-0.376***	-0.459***
	(0.04)	(0.05)	(0.05)	(0.07)
Having physical/mental impairment for 5-6 years	-0.275***	-0.400***	-0.422***	-0.457***
	(0.05)	(0.07)	(0.06)	(0.09)
Having physical/mental impairment for 6-7 years	-0.269***	-0.439***	-0.447***	-0.496***
	(0.07)	(0.09)	(0.09)	(0.13)
Having physical/mental impairment for 7-8 years	-0.203*	-0.224+	-0.398***	-0.543**
	(0.09)	(0.13)	(0.12)	(0.17)
Having physical/mental impairment for 8-9 years	-0.273+	0.119	-0.517**	-0.212
	(0.14)	(0.20)	(0.18)	(0.26)
Age: 27-37	-0.132**	-0.084	-0.054	-0.054
	(0.05)	(0.07)	(0.05)	(0.06)
Age: 38-47	-0.218***	-0.205*	-0.170**	-0.192**
	(0.06)	(0.08)	(0.06)	(0.07)
Age: 48-56	-0.221**	-0.252**	-0.168*	-0.236**
	(0.07)	(0.09)	(0.07)	(0.08)
Age: 57=67	-0.136+	-0.206*	-0.109	-0.191*
	(0.08)	(0.10)	(0.08)	(0.10)
Age: 68 or older	-0.049	-0.182	-0.037	-0.112
	(0.09)	(0.11)	(0.09)	(0.11)
Log of real household income per capita	0.034***	0.036**	0.041***	0.041**
	(0.01)	(0.01)	(0.01)	(0.01)
Single	-0.127**	-0.124*	-0.165***	-0.153**
	(0.05)	(0.06)	(0.05)	(0.05)
Cohabit	0.074*	0.023	0.047	0.048
	(0.04)	(0.05)	(0.04)	(0.04)
Widowed	-0.177***	-0.159**	-0.201***	-0.186**
	(0.05)	(0.06)	(0.05)	(0.06)
Divorced	-0.093+	0.006	-0.134**	-0.118*
	(0.05)	(0.06)	(0.05)	(0.06)
Separated	-0.201***	-0.260***	-0.236***	-0.265***
	(0.05)	(0.07)	(0.05)	(0.06)
Unemployed	-0.312***	-0.316***	-0.295***	-0.286***
	(0.03)	(0.04)	(0.03)	(0.03)
Retired	0.128***	0.117***	0.110***	0.058+
	(0.03)	(0.03)	(0.03)	(0.03)
Not active in labour market	-0.192***	-0.259***	-0.150***	-0.206***
	(0.02)	(0.03)	(0.02)	(0.03)
Edu: University	-0.217*	-0.290*	-0.259*	-0.261*
	(0.10)	(0.13)	(0.10)	(0.12)
Edu: A Levels	-0.052	0.026	-0.062	0.019
	(0.08)	(0.11)	(0.09)	(0.10)
Household size: 2	-0.029	-0.029	-0.008	0.008
	(0.03)	(0.04)	(0.03)	(0.04)
Household size: 3	-0.053	0.032	-0.041	0.007
	(0.04)	(0.05)	(0.04)	(0.05)
Household size: 4+	-0.045	0.018	-0.026	0.005
	(0.04)	(0.06)	(0.05)	(0.05)
Owned home outright	0.054*	0.077*	0.071**	0.046
	(0.03)	(0.03)	(0.03)	(0.03)
No. of dependent children: 1	0.022	0.024	-0.014	-0.007
	(0.03)	(0.03)	(0.03)	(0.03)
No. of dependent children: 2	0.060	0.059	0.055	0.042
	(0.04)	(0.05)	(0.04)	(0.05)
No. of dependent children: 3+	0.210***	0.259***	0.123*	0.143*
	(0.06)	(0.07)	(0.06)	(0.07)
Constant	5.309***	5.370***	5.159***	5.399***
	(0.21)	(0.26)	(0.22)	(0.28)
Wave and Regional dummies	Yes	Yes	Yes	Yes
Observations	87,044	60,547	83,106	60,758

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.17 Robustness check: The effects of impairment in Balanced and Unbalanced Panels

	Health impairment			Physical impairment			Mental impairment		
	UBL	BL 1	BL 2	UBL	BL 1	BL 2	UBL	BL 2	BL 2
· Onset of	-0.104***	-0.084***	-0.153***	-0.181***	-0.148***	-0.246***	-0.310***	-0.288***	-0.397***
impairment	(0.01)	(0.01)	(0.04)	(0.01)	(0.02)	(0.05)	(0.01)	(0.02)	(0.06)
· Impairment:	-0.141***	-0.097***	-0.215***	-0.235***	-0.193***	-0.364***	-0.420***	-0.395***	-0.554***
1-2 years	(0.01)	(0.02)	(0.04)	(0.02)	(0.02)	(0.05)	(0.02)	(0.03)	(0.06)
· Impairment:	-0.121***	-0.097***	-0.179***	-0.224***	-0.193***	-0.305***	-0.379***	-0.390***	-0.446***
2-3 years	(0.02)	(0.03)	(0.05)	(0.02)	(0.03)	(0.06)	(0.03)	(0.04)	(0.07)
· Impairment:	-0.129***	-0.126***	-0.108*	-0.216***	-0.183***	-0.288***	-0.398***	-0.369***	-0.323***
3-4 years	(0.02)	(0.03)	(0.05)	(0.03)	(0.04)	(0.06)	(0.04)	(0.05)	(0.07)
· Impairment:	-0.135***	-0.117**	-0.114^{+}	-0.255***	-0.227***	-0.275***	-0.376***	-0.392***	-0.315***
4-5 years	(0.03)	(0.04)	(0.06)	(0.04)	(0.05)	(0.07)	(0.05)	(0.06)	(0.09)
· Impairment:	-0.153***	-0.154***	-0.200**	-0.275***	-0.198***	-0.320***	-0.422***	-0.404***	-0.368***
5-6 years	(0.04)	(0.05)	(0.07)	(0.05)	(0.06)	(0.09)	(0.06)	(0.08)	(0.11)
· Impairment:	-0.161**	-0.163**	-0.192*	-0.269***	-0.160*	-0.307**	-0.447***	-0.270**	-0.356**
6-7 years	(0.05)	(0.06)	(0.08)	(0.07)	(0.07)	(0.11)	(0.09)	(0.10)	(0.13)
· Impairment:	-0.196**	-0.170*	-0.220*	-0.203*	-0.146	-0.253^{+}	-0.398***	-0.332**	-0.395*
7-8 years	(0.07)	(0.07)	(0.10)	(0.09)	(0.10)	(0.13)	(0.12)	(0.13)	(0.16)
· Impairment:	-0.195^{+}	-0.188^{+}	-0.240^{+}	-0.273^{+}	-0.231	-0.284	-0.517**	-0.498**	-0.446*
8-9 years	(0.11)	(0.11)	(0.13)	(0.14)	(0.14)	(0.17)	(0.18)	(0.18)	(0.22)
Log of household	0.041***	0.027*	0.036	0.034***	0.023^{+}	0.044	0.041***	0.031*	0.049
income p.capita	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)
Age: 27-37	-0.102*	-0.150*	-0.094	-0.132**	-0.190**	-0.303^{+}	-0.054	-0.144*	-0.253
	(0.04)	(0.06)	(0.12)	(0.05)	(0.07)	(0.18)	(0.05)	(0.07)	(0.17)
Age: 38-47	-0.198***	-0.320***	-0.352*	-0.218***	-0.298***	-0.580**	-0.170**	-0.282**	-0.548**
	(0.05)	(0.07)	(0.15)	(0.06)	(0.09)	(0.21)	(0.06)	(0.09)	(0.21)
Age: 48-56	-0.177**	-0.375***	-0.427*	-0.221**	-0.378***	-0.739**	-0.168*	-0.338***	-0.654**
	(0.06)	(0.08)	(0.17)	(0.07)	(0.10)	(0.24)	(0.07)	(0.10)	(0.25)
Age: 57-67	-0.090	-0.241**	-0.258	-0.136^{+}	-0.251*	-0.620*	-0.109	-0.231*	-0.544*
	(0.07)	(0.09)	(0.19)	(0.08)	(0.11)	(0.26)	(0.08)	(0.11)	(0.28)
Age: 68 or older	-0.026	-0.185^{+}	-0.150	-0.049	-0.159	-0.612*	-0.037	-0.172	-0.620*
	(0.07)	(0.10)	(0.21)	(0.09)	(0.12)	(0.28)	(0.09)	(0.12)	(0.31)
Single	-0.135***	-0.162**	-0.238*	-0.127**	-0.227***	-0.033	-0.165***	-0.182**	-0.041
	(0.04)	(0.06)	(0.12)	(0.05)	(0.06)	(0.15)	(0.05)	(0.07)	(0.17)
Cohabit	0.017	-0.009	-0.041	0.074*	-0.003	-0.018	0.047	0.036	-0.163
	(0.03)	(0.04)	(0.09)	(0.04)	(0.05)	(0.12)	(0.04)	(0.05)	(0.12)
Widowed	-0.156***	-0.235***	-0.270*	-0.177***	-0.254***	-0.143	-0.201***	-0.317***	-0.421*
	(0.05)	(0.06)	(0.12)	(0.05)	(0.07)	(0.15)	(0.05)	(0.07)	(0.17)
Divorced	-0.150***	-0.175**	-0.370**	-0.093^{+}	-0.143*	-0.115	-0.134**	-0.130^{+}	-0.291^{+}
	(0.04)	(0.06)	(0.12)	(0.05)	(0.06)	(0.13)	(0.05)	(0.07)	(0.15)
Separated	-0.268***	-0.269***	-0.295*	-0.201***	-0.235**	0.121	-0.236***	-0.122	0.056
	(0.05)	(0.07)	(0.13)	(0.05)	(0.08)	(0.18)	(0.05)	(0.08)	(0.18)
Unemployed	-0.285***	-0.307***	-0.297***	-0.312***	-0.345***	-0.438***	-0.295***	-0.325***	-0.304**
	(0.03)	(0.04)	(0.07)	(0.03)	(0.04)	(0.08)	(0.03)	(0.04)	(0.10)
Retired	0.131***	0.137***	0.202***	0.128***	0.139***	0.176*	0.110***	0.114***	0.014
	(0.02)	(0.03)	(0.06)	(0.03)	(0.03)	(0.07)	(0.03)	(0.03)	(0.09)
Not active in	-0.110***	-0.188***	-0.347***	-0.192***	-0.221***	-0.477***	-0.150***	-0.231***	-0.416***
labour market	(0.02)	(0.03)	(0.05)	(0.02)	(0.03)	(0.07)	(0.02)	(0.03)	(0.07)
Edu: University	-0.188*	-0.119	-0.071	-0.217*	-0.007	0.562*	-0.259*	-0.043	0.840*
	(0.08)	(0.13)	(0.22)	(0.10)	(0.14)	(0.27)	(0.10)	(0.15)	(0.37)
Edu: A Levels	-0.029	-0.014	-0.092	-0.052	0.087	0.651*	-0.062	0.088	0.825*
	(0.07)	(0.11)	(0.21)	(0.08)	(0.12)	(0.26)	(0.09)	(0.14)	(0.36)
Household size: 2	-0.018	0.006	-0.131^{+}	-0.029	-0.018	-0.064	-0.008	-0.035	0.054
	(0.03)	(0.04)	(0.08)	(0.03)	(0.04)	(0.10)	(0.03)	(0.05)	(0.11)
Household size: 3	-0.043	-0.047	-0.067	-0.053	-0.075	0.069	-0.041	-0.099^{+}	-0.012
	(0.03)	(0.05)	(0.09)	(0.04)	(0.05)	(0.12)	(0.04)	(0.05)	(0.13)
Household size: 4+	-0.038	-0.002	-0.038	-0.045	0.008	0.219	-0.026	-0.027	0.063
	(0.04)	(0.05)	(0.10)	(0.04)	(0.06)	(0.14)	(0.05)	(0.06)	(0.15)
Owned home	0.040^{+}	0.046	-0.046	0.054*	0.100**	-0.054	0.071**	0.115***	0.095
outright	(0.02)	(0.03)	(0.06)	(0.03)	(0.03)	(0.08)	(0.03)	(0.03)	(0.10)
No. of dependent	0.021	0.021	-0.024	0.022	0.037	-0.050	-0.014	-0.017	-0.070
children: 1	(0.02)	(0.03)	(0.07)	(0.03)	(0.04)	(0.09)	(0.03)	(0.04)	(0.10)
No. of dependent	0.052^{+}	-0.000	-0.008	0.060	0.008	0.015	0.055	-0.019	0.011
children: 2	(0.03)	(0.04)	(0.09)	(0.04)	(0.05)	(0.12)	(0.04)	(0.05)	(0.14)
No. of dependent	0.114*	0.065	0.040	0.210***	0.153^{+}	0.195	0.123*	0.033	0.183
children: 3+	(0.05)	(0.06)	(0.13)	(0.06)	(0.08)	(0.17)	(0.06)	(0.08)	(0.22)
Constant	5.268***	5.631***	5.520***	5.309***	5.550***	4.604***	5.159***	5.493***	4.766***
	(0.19)	(0.25)	(0.55)	(0.21)	(0.25)	(0.73)	(0.22)	(0.29)	(0.63)
Waves & Regions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	110,191	52,702	13,153	87,044	42,770	8,445	83,106	38,989	6,136

Note: Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. UBL, Unbalanced panel; BL 1, Balanced panel (10 waves); BL 2, Conditional balanced panel.

Source: The UK longitudinal study: 2009-2020

Table A.18 Robustness check: The effects of Health impairment on life satisfaction – OLS – RE – FE Estimations

	OLS	RE	FE
Year starting health impairment	-0.159***	-0.128***	-0.104***
	(0.01)	(0.01)	(0.01)
Having health impairment for 1-2 years	-0.250***	-0.187***	-0.141***
	(0.01)	(0.01)	(0.01)
Having health impairment for 2-3 years	-0.264***	-0.183***	-0.121***
	(0.02)	(0.02)	(0.02)
Having health impairment for 3-4 years	-0.335***	-0.212***	-0.129***
	(0.02)	(0.02)	(0.02)
Having health impairment for 4-5 years	-0.383***	-0.232***	-0.135***
	(0.03)	(0.03)	(0.03)
Having health impairment for 5-6 years	-0.432***	-0.264***	-0.153***
	(0.04)	(0.04)	(0.04)
Having health impairment for 6-7 years	-0.427***	-0.273***	-0.161**
	(0.05)	(0.05)	(0.05)
Having health impairment for 7-8 years	-0.562***	-0.331***	-0.196**
	(0.07)	(0.07)	(0.07)
Having health impairment for 8-9 years	-0.529***	-0.342**	-0.195+
	(0.12)	(0.10)	(0.11)
Age: 27-37	-0.349***	-0.255***	-0.102*
	(0.02)	(0.03)	(0.04)
Age: 38-47	-0.437***	-0.338***	-0.198***
	(0.02)	(0.03)	(0.05)
Age: 48-56	-0.435***	-0.303***	-0.177**
	(0.02)	(0.03)	(0.06)
Age: 57=67	-0.223***	-0.119***	-0.090
	(0.02)	(0.03)	(0.07)
Age: 68 or older	-0.091**	0.015	-0.026
	(0.03)	(0.04)	(0.07)
Log of real household income per capita	0.164***	0.107***	0.041***
	(0.01)	(0.01)	(0.01)
Male	-0.049***	-0.036**	
	(0.01)	(0.01)	
Single	-0.375***	-0.327***	-0.135***
	(0.02)	(0.02)	(0.04)
Cohabit	-0.117***	-0.101***	0.017
	(0.02)	(0.02)	(0.03)
Widowed	-0.208***	-0.165***	-0.156***
	(0.02)	(0.03)	(0.05)
Divorced	-0.446***	-0.385***	-0.150***
	(0.02)	(0.03)	(0.04)
Separated	-0.527***	-0.456***	-0.268***
	(0.03)	(0.04)	(0.05)
Unemployed	-0.544***	-0.408***	-0.285***
	(0.02)	(0.02)	(0.03)
Retired	0.253***	0.208***	0.131***
	(0.02)	(0.02)	(0.02)
Not active in labour market	-0.224***	-0.161***	-0.110***
	(0.02)	(0.02)	(0.02)
Edu: University	0.090***	0.108***	-0.188*
	(0.01)	(0.02)	(0.08)
Edu: A Levels	0.003	0.026	-0.029
	(0.01)	(0.02)	(0.07)
Household size: 2	-0.047**	-0.018	-0.018
	(0.02)	(0.02)	(0.03)
Household size: 3	-0.089***	-0.052*	-0.043
	(0.02)	(0.02)	(0.03)
Household size: 4+	-0.070**	-0.039	-0.038
	(0.02)	(0.03)	(0.04)
Owned home outright	0.149***	0.139***	0.040+
	(0.01)	(0.01)	(0.02)
No. of dependent children: 1	0.034*	0.015	0.021
	(0.02)	(0.02)	(0.02)
No. of dependent children: 2	0.105***	0.060**	0.052+
	(0.02)	(0.02)	(0.03)
No. of dependent children: 3+	0.095***	0.070*	0.114*
	(0.03)	(0.03)	(0.05)
Constant	4.688***	4.872***	5.268***
	(0.06)	(0.08)	(0.19)
Wave and Regional dummies	Yes	Yes	Yes
Observations	110,190	110,190	110,191

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.19 Robustness check: The effects of Physical impairment on life satisfaction – OLS – RE – FE Estimations

	OLS	RE	FE
Year starting physical impairment	-0.258***	-0.212***	-0.181***
	(0.01)	(0.01)	(0.01)
Having physical impairment for 1-2 years	-0.414***	-0.303***	-0.235***
	(0.02)	(0.02)	(0.02)
Having physical impairment for 2-3 years	-0.470***	-0.315***	-0.224***
	(0.02)	(0.02)	(0.02)
Having physical impairment for 3-4 years	-0.511***	-0.326***	-0.216***
	(0.03)	(0.03)	(0.03)
Having physical impairment for 4-5 years	-0.584***	-0.381***	-0.255***
	(0.04)	(0.04)	(0.04)
Having physical impairment for 5-6 years	-0.659***	-0.421***	-0.275***
	(0.05)	(0.05)	(0.05)
Having physical impairment for 6-7 years	-0.711***	-0.437***	-0.269***
	(0.07)	(0.06)	(0.07)
Having physical impairment for 7-8 years	-0.784***	-0.413***	-0.203*
	(0.10)	(0.09)	(0.09)
Having physical impairment for 8-9 years	-0.932***	-0.515***	-0.273+
	(0.16)	(0.14)	(0.14)
Age: 27-37	-0.369***	-0.280***	-0.132**
	(0.03)	(0.03)	(0.05)
Age: 38-47	-0.457***	-0.364***	-0.218***
	(0.03)	(0.03)	(0.06)
Age: 48-56	-0.453***	-0.325***	-0.221**
	(0.03)	(0.03)	(0.07)
Age: 57-67	-0.199***	-0.095**	-0.136+
	(0.03)	(0.04)	(0.08)
Age: 68 or older	0.010	0.095*	-0.049
	(0.03)	(0.04)	(0.09)
Male	-0.075***	-0.063***	
	(0.01)	(0.02)	
Log of real household income per capita	0.159***	0.097***	0.034***
	(0.01)	(0.01)	(0.01)
Single	-0.390***	-0.346***	-0.127**
	(0.02)	(0.03)	(0.05)
Cohabit	-0.083***	-0.068**	0.074*
	(0.02)	(0.02)	(0.04)
Widowed	-0.223***	-0.182***	-0.177***
	(0.02)	(0.03)	(0.05)
Divorced	-0.436***	-0.367***	-0.093+
	(0.02)	(0.03)	(0.05)
Separated	-0.557***	-0.452***	-0.201***
	(0.04)	(0.04)	(0.05)
Unemployed	-0.569***	-0.436***	-0.312***
	(0.02)	(0.02)	(0.03)
Retired	0.252***	0.217***	0.128***
	(0.02)	(0.02)	(0.03)
Not active in labour market	-0.288***	-0.245***	-0.192***
	(0.02)	(0.02)	(0.02)
Edu: University	0.090***	0.106***	-0.217*
	(0.01)	(0.02)	(0.10)
Edu: A-levels	0.017	0.031	-0.052
	(0.01)	(0.02)	(0.08)
Household size: 2	-0.049**	-0.025	-0.029
	(0.02)	(0.02)	(0.03)
Household size: 3	-0.094***	-0.066*	-0.053
	(0.02)	(0.03)	(0.04)
Household size: 4+	-0.110***	-0.070*	-0.045
	(0.03)	(0.03)	(0.04)
Owned home outright	0.171***	0.157***	0.054*
	(0.01)	(0.02)	(0.03)
No. of dependent children: 1	0.053**	0.022	0.022
	(0.02)	(0.02)	(0.03)
No. of dependent children: 2	0.159***	0.091**	0.060
	(0.02)	(0.03)	(0.04)
No. of dependent children: 3+	0.182***	0.138***	0.210***
	(0.03)	(0.04)	(0.06)
Constant	4.603***	4.813***	5.309***
	(0.07)	(0.09)	(0.21)
Wave and Regional dummies	Yes	Yes	Yes
Observations	87,044	87,044	87,044

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.20 Robustness check: The effects of Mental impairment on life satisfaction – OLS – RE – FE Estimations

	OLS	RE	FE
Year starting mental impairment	-0.431***	-0.357***	-0.310***
	(0.01)	(0.01)	(0.01)
Having mental impairment for 1-2 years	-0.722***	-0.537***	-0.420***
	(0.02)	(0.02)	(0.02)
Having mental impairment for 2-3 years	-0.802***	-0.542***	-0.379***
	(0.03)	(0.02)	(0.03)
Having mental impairment for 3-4 years	-0.948***	-0.607***	-0.398***
	(0.04)	(0.03)	(0.04)
Having mental impairment for 4-5 years	-1.014***	-0.621***	-0.376***
	(0.05)	(0.05)	(0.05)
Having mental impairment for 5-6 years	-1.082***	-0.680***	-0.422***
	(0.07)	(0.06)	(0.06)
Having mental impairment for 6-7 years	-1.194***	-0.738***	-0.447***
	(0.09)	(0.08)	(0.09)
Having mental impairment for 7-8 years	-1.266***	-0.729***	-0.398***
	(0.13)	(0.11)	(0.12)
Having mental impairment for 8-9 years	-1.423***	-0.883***	-0.517**
	(0.21)	(0.18)	(0.18)
Age: 27-37	-0.307***	-0.241***	-0.054
	(0.03)	(0.03)	(0.05)
Age: 38-47	-0.440***	-0.370***	-0.170**
	(0.03)	(0.03)	(0.06)
Age: 48-56	-0.472***	-0.359***	-0.168*
	(0.03)	(0.03)	(0.07)
Age: 57-67	-0.261***	-0.175***	-0.109
	(0.03)	(0.04)	(0.08)
Age: 68 or older	-0.050	0.009	-0.037
	(0.03)	(0.04)	(0.09)
Male	-0.125***	-0.107***	
	(0.01)	(0.02)	
Log of real household income per capita	0.149***	0.099***	0.041***
	(0.01)	(0.01)	(0.01)
Single	-0.348***	-0.320***	-0.165***
	(0.02)	(0.03)	(0.05)
Cohabit	-0.072***	-0.059**	0.047
	(0.02)	(0.02)	(0.04)
Widowed	-0.199***	-0.176***	-0.201***
	(0.02)	(0.03)	(0.05)
Divorced	-0.432***	-0.379***	-0.134**
	(0.02)	(0.03)	(0.05)
Separated	-0.471***	-0.414***	-0.236***
	(0.04)	(0.04)	(0.05)
Unemployed	-0.491***	-0.400***	-0.295***
	(0.02)	(0.03)	(0.03)
Retired	0.224***	0.191***	0.110***
	(0.02)	(0.02)	(0.03)
Not active in labour market	-0.193***	-0.180***	-0.150***
	(0.02)	(0.02)	(0.02)
Edu: University	0.106***	0.113***	-0.259*
	(0.01)	(0.02)	(0.10)
Edu: A Levels	0.015	0.028	-0.062
	(0.01)	(0.02)	(0.09)
Household size: 2	-0.032+	-0.013	-0.008
	(0.02)	(0.02)	(0.03)
Household size: 3	-0.061**	-0.044	-0.041
	(0.02)	(0.03)	(0.04)
Household size: 4+	-0.052*	-0.030	-0.026
	(0.03)	(0.03)	(0.05)
Owned home outright	0.145***	0.145***	0.071**
	(0.01)	(0.02)	(0.03)
No. of dependent children: 1	0.028	-0.005	-0.014
	(0.02)	(0.02)	(0.03)
No. of dependent children: 2	0.094***	0.069*	0.055
	(0.02)	(0.03)	(0.04)
No. of dependent children: 3+	0.095**	0.076+	0.123*
	(0.03)	(0.04)	(0.06)
Constant	4.653***	4.792***	5.159***
	(0.07)	(0.09)	(0.22)
Wave and Regional dummies	Yes	Yes	Yes
Observations	83,106	83,106	83,106

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table A.21 Robustness check: The effects of Health impairment (HI) on life satisfaction – Baseline Estimation

	HI	+Lags of HI	+Individual X	+ Household X	+Regions	+Waves
Health impairment	-0.154***					
	(0.01)					
Year starting health		-0.134***	-0.134***	-0.136***	-0.136***	-0.104***
impairment		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Having health impairment		-0.189***	-0.189***	-0.192***	-0.192***	-0.141***
for 1-2 years		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Having health impairment		-0.176***	-0.177***	-0.180***	-0.180***	-0.121***
for 2-3 years		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Having health impairment		-0.177***	-0.179***	-0.183***	-0.183***	-0.129***
for 3-4 years		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Having health impairment		-0.169***	-0.173***	-0.177***	-0.177***	-0.135***
for 4-5 years		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Having health impairment		-0.202***	-0.208***	-0.214***	-0.214***	-0.153***
for 5-6 years		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Having health impairment		-0.239***	-0.248***	-0.254***	-0.253***	-0.161**
for 6-7 years		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Having health impairment		-0.308***	-0.316***	-0.323***	-0.323***	-0.196**
for 7-8 years		(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Having health impairment		-0.332**	-0.348***	-0.354***	-0.353***	-0.195^{+}
for 8-9 years		(0.10)	(0.10)	(0.10)	(0.10)	(0.11)
Age: 27-37			-0.130**	-0.142***	-0.142***	-0.102*
			(0.04)	(0.04)	(0.04)	(0.04)
Age: 38-47			-0.270***	-0.285***	-0.287***	-0.198***
			(0.05)	(0.05)	(0.05)	(0.05)
Age: 48-56			-0.289***	-0.301***	-0.303***	-0.177**
			(0.06)	(0.06)	(0.06)	(0.06)
Age: 57-67			-0.234***	-0.251***	-0.254***	-0.090
			(0.06)	(0.06)	(0.06)	(0.07)
Age: 68 or older			-0.194**	-0.217**	-0.220**	-0.026
			(0.07)	(0.07)	(0.07)	(0.07)
Single			-0.117**	-0.120**	-0.122**	-0.135***
			(0.04)	(0.04)	(0.04)	(0.04)
Cohabit			0.019	0.020	0.022	0.017
			(0.03)	(0.03)	(0.03)	(0.03)
Widowed			-0.149***	-0.163***	-0.165***	-0.156***
			(0.04)	(0.05)	(0.05)	(0.05)
Divorced			-0.149***	-0.156***	-0.156***	-0.150***
			(0.04)	(0.04)	(0.04)	(0.04)
Separated			-0.261***	-0.266***	-0.267***	-0.268***
			(0.05)	(0.05)	(0.05)	(0.05)
Unemployed			-0.301***	-0.288***	-0.288***	-0.285***
			(0.03)	(0.03)	(0.03)	(0.03)
Retired			0.099***	0.104***	0.104***	0.131***
			(0.02)	(0.02)	(0.02)	(0.02)
Not active in			-0.120***	-0.113***	-0.113***	-0.110***
labour market			(0.02)	(0.02)	(0.02)	(0.02)
Edu: University			-0.243**	-0.250**	-0.248**	-0.188*
			(0.08)	(0.08)	(0.08)	(0.08)
Edu: A Levels			-0.062	-0.065	-0.063	-0.029
			(0.07)	(0.07)	(0.07)	(0.07)
Log of income per capita				0.028**	0.028**	0.041***
				(0.01)	(0.01)	(0.01)
Household size: 2				-0.009	-0.011	-0.018
				(0.03)	(0.03)	(0.03)
Household size: 3				-0.032	-0.035	-0.043
				(0.03)	(0.03)	(0.03)
Household size: 4+				-0.035	-0.038	-0.038
				(0.04)	(0.04)	(0.04)
Owned home outright				0.031	0.031	0.040^{+}
				(0.02)	(0.02)	(0.02)
No. of dependent children: 1				0.025	0.025	0.021
				(0.02)	(0.02)	(0.02)
No. of dependent children: 2				0.059^{+}	0.058^{+}	0.052^{+}
				(0.03)	(0.03)	(0.03)
No. of dependent children: 3+				0.119**	0.118*	0.114*
				(0.05)	(0.05)	(0.05)
Regional dummies					Yes	Yes
Wave dummies						Yes, (-) ***
Constant	5.245***	5.248***	5.608***	5.421***	5.368***	5.268***
	(0.01)	(0.01)	(0.07)	(0.10)	(0.19)	(0.19)
Observations	110,191	110,191	110,191	110,191	110,191	110,191

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitudinal study: 2009-2020

Table A.22 Robustness check: The effects of Physical impairment (PI) on life satisfaction – Baseline Estimation

	PI	+Lags of PI	+Individual X	+ Household X	+Regions	+Waves
Physical impairment	-0.241***					
	(0.01)					
Year starting physical impairment		-0.217***	-0.215***	-0.216***	-0.216***	-0.181***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Having physical impairment for 1-2 years		-0.289***	-0.287***	-0.288***	-0.288***	-0.235***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Having physical impairment for 2-3 years		-0.290***	-0.286***	-0.288***	-0.289***	-0.224***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Having physical impairment for 3-4 years		-0.277***	-0.276***	-0.278***	-0.278***	-0.216***
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Having physical impairment for 4-5 years		-0.293***	-0.294***	-0.297***	-0.298***	-0.255***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Having physical impairment for 5-6 years		-0.329***	-0.335***	-0.338***	-0.340***	-0.275***
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Having physical impairment for 6-7 years		-0.357***	-0.361***	-0.364***	-0.364***	-0.269***
		(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Having physical impairment for 7-8 years		-0.311***	-0.325***	-0.330***	-0.328***	-0.203*
		(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Having physical impairment for 8-9 years		-0.414**	-0.424**	-0.426**	-0.427**	-0.273+
		(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Age: 27-37			-0.160***	-0.177***	-0.180***	-0.132**
			(0.05)	(0.05)	(0.05)	(0.05)
Age: 38-47			-0.295***	-0.313***	-0.316***	-0.218***
			(0.06)	(0.06)	(0.06)	(0.06)
Age: 48-56			-0.353***	-0.362***	-0.365***	-0.221**
			(0.07)	(0.07)	(0.07)	(0.07)
Age: 57-67			-0.308***	-0.323***	-0.327***	-0.136+
			(0.07)	(0.07)	(0.07)	(0.08)
Age: 68 or older			-0.257***	-0.277***	-0.282***	-0.049
			(0.08)	(0.08)	(0.08)	(0.09)
Single			-0.111*	-0.114*	-0.112*	-0.127**
			(0.04)	(0.05)	(0.05)	(0.05)
Cohabit			0.076*	0.080*	0.082*	0.074*
			(0.04)	(0.04)	(0.04)	(0.04)
Widowed			-0.168***	-0.187***	-0.188***	-0.177***
			(0.05)	(0.05)	(0.05)	(0.05)
Divorced			-0.093*	-0.100*	-0.100*	-0.093+
			(0.05)	(0.05)	(0.05)	(0.05)
Separated			-0.192***	-0.198***	-0.198***	-0.201***
			(0.05)	(0.05)	(0.05)	(0.05)
Unemployed			-0.321***	-0.312***	-0.313***	-0.312***
			(0.03)	(0.03)	(0.03)	(0.03)
Retired			0.095***	0.095***	0.096***	0.128***
			(0.02)	(0.02)	(0.02)	(0.03)
Not active in labour market			-0.196***	-0.194***	-0.195***	-0.192***
			(0.02)	(0.02)	(0.02)	(0.02)
Edu: University			-0.284**	-0.290**	-0.288**	-0.217*
			(0.10)	(0.10)	(0.10)	(0.10)
Edu: A-levels			-0.091	-0.092	-0.091	-0.052
			(0.08)	(0.08)	(0.08)	(0.08)
Log of income per capita				0.020+	0.020+	0.034***
				(0.01)	(0.01)	(0.01)
Household size: 2				-0.024	-0.025	-0.029
				(0.03)	(0.03)	(0.03)
Household size: 3				-0.048	-0.050	-0.053
				(0.04)	(0.04)	(0.04)
Household size: 4+				-0.042	-0.045	-0.045
				(0.04)	(0.04)	(0.04)
Owned home outright				0.043+	0.043+	0.054*
				(0.03)	(0.03)	(0.03)
No. of dependent children: 1				0.030	0.029	0.022
				(0.03)	(0.03)	(0.03)
No. of dependent children: 2				0.070+	0.070+	0.060
				(0.04)	(0.04)	(0.04)
No. of dependent children: 3+				0.215***	0.215***	0.210***
				(0.06)	(0.06)	(0.06)
Regional dummies					Yes	Yes
Wave dummies						Yes, (-) ***
Constant	5.156***	5.160***	5.596***	5.468***	5.466***	5.309***
	(0.01)	(0.01)	(0.09)	(0.12)	(0.21)	(0.21)
Observations	87,044	87,044	87,044	87,044	87,044	87,044

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitidinal study: 2009-2020

Table A.23 Robustness check: The effects of Mental impairment (MI) on life satisfaction – Baseline Estimation

	MI	+Lags of MI	+Individual X	+ Household X	+Regions	+Waves
Mental impairment	-0.396***					
	(0.01)					
Year starting mental		-0.360***	-0.350***	-0.351***	-0.352***	-0.310***
impairment		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Having mental impairment		-0.497***	-0.481***	-0.483***	-0.483***	-0.420***
for 1-2 years		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Having mental impairment		-0.474***	-0.453***	-0.455***	-0.455***	-0.379***
for 2-3 years		(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Having mental impairment		-0.493***	-0.468***	-0.470***	-0.471***	-0.398***
for 3-4 years		(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Having mental impairment		-0.451***	-0.423***	-0.426***	-0.427***	-0.376***
for 4-5 years		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Having mental impairment		-0.523***	-0.490***	-0.494***	-0.496***	-0.422***
for 5-6 years		(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Having mental impairment		-0.583***	-0.545***	-0.550***	-0.552***	-0.447***
for 6-7 years		(0.08)	(0.08)	(0.08)	(0.08)	(0.09)
Having mental impairment		-0.551***	-0.522***	-0.528***	-0.528***	-0.398***
for 7-8 years		(0.11)	(0.11)	(0.11)	(0.11)	(0.12)
Having mental impairment		-0.690***	-0.649***	-0.655***	-0.655***	-0.517**
for 8-9 years		(0.18)	(0.18)	(0.18)	(0.18)	(0.18)
Age: 27-37			-0.106*	-0.118*	-0.116*	-0.054
			(0.05)	(0.05)	(0.05)	(0.05)
Age: 38-47			-0.288***	-0.301***	-0.300***	-0.170**
			(0.06)	(0.06)	(0.06)	(0.06)
Age: 48-56			-0.351***	-0.362***	-0.362***	-0.168*
			(0.07)	(0.07)	(0.07)	(0.07)
Age: 57-67			-0.347***	-0.368***	-0.369***	-0.109
			(0.07)	(0.07)	(0.07)	(0.08)
Age: 68 or older			-0.335***	-0.361***	-0.361***	-0.037
			(0.08)	(0.08)	(0.08)	(0.09)
Single			-0.147***	-0.147**	-0.144**	-0.165***
			(0.04)	(0.05)	(0.05)	(0.05)
Cohabit			0.056	0.057	0.058^{+}	0.047
			(0.04)	(0.04)	(0.04)	(0.04)
Widowed			-0.218***	-0.221***	-0.221***	-0.201***
			(0.05)	(0.05)	(0.05)	(0.05)
Divorced			-0.143**	-0.143**	-0.141**	-0.134**
			(0.05)	(0.05)	(0.05)	(0.05)
Separated			-0.230***	-0.231***	-0.231***	-0.236***
			(0.05)	(0.05)	(0.05)	(0.05)
Unemployed			-0.311***	-0.302***	-0.302***	-0.295***
			(0.03)	(0.03)	(0.03)	(0.03)
Retired			0.065*	0.065*	0.066*	0.110***
			(0.03)	(0.03)	(0.03)	(0.03)
Not active in			-0.161***	-0.156***	-0.157***	-0.150***
labour market			(0.02)	(0.02)	(0.02)	(0.02)
Edu: University			-0.331**	-0.335***	-0.337***	-0.259*
			(0.10)	(0.10)	(0.10)	(0.10)
Edu: A Levels			-0.095	-0.097	-0.098	-0.062
			(0.09)	(0.09)	(0.09)	(0.09)
Log of income per capita				0.021*	0.021*	0.041***
				(0.01)	(0.01)	(0.01)
Household size: 2				0.005	0.004	-0.008
				(0.03)	(0.03)	(0.03)
Household size: 3				-0.028	-0.030	-0.041
				(0.04)	(0.04)	(0.04)
Household size: 4+				-0.015	-0.017	-0.026
				(0.05)	(0.05)	(0.05)
Owned home outright				0.050^{+}	0.052*	0.071**
				(0.03)	(0.03)	(0.03)
No.of dependent children: 1				-0.007	-0.008	-0.014
				(0.03)	(0.03)	(0.03)
No.of dependent children: 2				0.060	0.061	0.055
				(0.04)	(0.04)	(0.04)
No.of dependent children: 3+				0.125*	0.125*	0.123*
				(0.06)	(0.06)	(0.06)
Regional dummies					Yes	Yes
Wave dummies						Yes, (-) ***
Constant	5.065***	5.071***	5.567***	5.413***	5.360***	5.159***
	(0.01)	(0.01)	(0.09)	(0.12)	(0.22)	(0.22)
Observations	83,106	83,106	83,106	83,106	83,106	83,106

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitudinal study: 2009-2020

Table A.24 Robustness check: Health impairment (Main sample) - adding lead effects

	Main sample	Lead 0-1	Lead 1-2
Having health impairment in 1-2 years			0.009
			(0.01)
Having health impairment within next year		-0.022^{+}	-0.010
		(0.01)	(0.01)
Year starting health impairment	-0.104^{***}	-0.117^{***}	-0.102^{***}
	(0.01)	(0.01)	(0.02)
Having health impairment for 1-2 years	-0.141^{***}	-0.155^{***}	-0.137^{***}
	(0.01)	(0.02)	(0.02)
Having health impairment for 2-3 years	-0.121^{***}	-0.135^{***}	-0.114^{***}
	(0.02)	(0.02)	(0.02)
Having health impairment for 3-4 years	-0.129^{***}	-0.142^{***}	-0.117^{***}
	(0.02)	(0.03)	(0.03)
Having health impairment for 4-5 years	-0.135^{***}	-0.148^{***}	-0.118^{***}
	(0.03)	(0.03)	(0.03)
Having health impairment for 5-6 years	-0.153^{***}	-0.166^{***}	-0.130^{**}
	(0.04)	(0.04)	(0.04)
Having health impairment for 6-7 years	-0.161^{**}	-0.171^{***}	-0.128^{*}
	(0.05)	(0.05)	(0.05)
Having health impairment for 7-8 years	-0.196^{**}	-0.201^{**}	
	(0.07)	(0.07)	
Having health impairment for 8-9 years	-0.195^{+}		
	(0.11)		
Log of household income per capita	0.041^{***}	0.040^{***}	0.040^{***}
	(0.01)	(0.01)	(0.01)
Age: 27-37	-0.102^{*}	-0.100^{*}	-0.100^{*}
	(0.04)	(0.04)	(0.04)
Age: 38-47	-0.198^{***}	-0.195^{***}	-0.194^{***}
	(0.05)	(0.05)	(0.05)
Age: 48-56	-0.177^{**}	-0.173^{**}	-0.172^{**}
	(0.06)	(0.06)	(0.06)
Age: 57-67	-0.090	-0.085	-0.084
	(0.07)	(0.07)	(0.07)
Age: 68 or older	-0.026	-0.023	-0.021
	(0.07)	(0.07)	(0.07)
Single	-0.135^{***}	-0.136^{***}	-0.137^{***}
	(0.04)	(0.04)	(0.04)
Cohabit	0.017	0.016	0.016
	(0.03)	(0.03)	(0.03)
Widowed	-0.156^{***}	-0.158^{***}	-0.158^{***}
	(0.05)	(0.05)	(0.05)
Divorced	-0.150^{***}	-0.150^{***}	-0.151^{***}
	(0.04)	(0.04)	(0.04)
Separated	-0.268^{***}	-0.267^{***}	-0.268^{***}
	(0.05)	(0.05)	(0.05)
Unemployed	-0.285^{***}	-0.286^{***}	-0.286^{***}
	(0.03)	(0.03)	(0.03)
Retired	0.131^{***}	0.130^{***}	0.130^{***}
	(0.02)	(0.02)	(0.02)
Not active in labour market	-0.110^{***}	-0.110^{***}	-0.111^{***}
	(0.02)	(0.02)	(0.02)
Edu: University	-0.188^{*}	-0.185^{*}	-0.185^{*}
	(0.08)	(0.08)	(0.08)
Edu: A Levels	-0.029	-0.028	-0.029
	(0.07)	(0.07)	(0.07)
Household size: 2	-0.018	-0.018	-0.018
	(0.03)	(0.03)	(0.03)
Household size: 3	-0.043	-0.043	-0.043
	(0.03)	(0.03)	(0.03)
Household size: 4+	-0.038	-0.038	-0.038
	(0.04)	(0.04)	(0.04)
Owned home outright	0.040^{+}	0.040^{+}	0.040^{+}
	(0.02)	(0.02)	(0.02)
No. of dependent children: 1	0.021	0.020	0.020
	(0.02)	(0.02)	(0.02)
No. of dependent children: 2	0.052^{+}	0.052^{+}	0.052^{+}
	(0.03)	(0.03)	(0.03)
No. of dependent children: 3+	0.114^{*}	0.115^{*}	0.115^{*}
	(0.05)	(0.05)	(0.05)
Constant	5.268^{***}	5.278^{***}	5.277^{***}
	(0.19)	(0.19)	(0.19)
Year and Regional dummies	Yes	yes	Yes
Observations	110,191	110,191	110,191

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitudinal study: 2009-2020

Table A.25 Robustness check: Physical impairment (Main sample) - adding lead effects

	Main sample	Lead 0-1	Lead 1-2
Having physical impairment in 1-2 years			0.014
			(0.02)
Having physical impairment within next year		-0.035**	-0.022
		(0.01)	(0.02)
Year starting physical impairment	-0.181***	-0.202***	-0.187***
	(0.01)	(0.01)	(0.02)
Having physical impairment for 1-2 years	-0.235***	-0.259***	-0.241***
	(0.02)	(0.02)	(0.02)
Having physical impairment for 2-3 years	-0.224***	-0.249***	-0.227***
	(0.02)	(0.03)	(0.03)
Having physical impairment for 3-4 years	-0.216***	-0.242***	-0.217***
	(0.03)	(0.03)	(0.03)
Having physical impairment for 4-5 years	-0.255***	-0.280***	-0.251***
	(0.04)	(0.04)	(0.04)
Having physical impairment for 5-6 years	-0.275***	-0.301***	-0.267***
	(0.05)	(0.05)	(0.05)
Having physical impairment for 6-7 years	-0.269***	-0.293***	-0.251***
	(0.07)	(0.07)	(0.07)
Having physical impairment for 7-8 years	-0.203*	-0.221*	
	(0.09)	(0.09)	
Having physical impairment for 8-9 years	-0.273+		
	(0.14)		
Log of household income per capita	0.034***	0.034***	0.034***
	(0.01)	(0.01)	(0.01)
Age: 27-37	-0.132**	-0.129**	-0.129**
	(0.05)	(0.05)	(0.05)
Age: 38-47	-0.218***	-0.213***	-0.213***
	(0.06)	(0.06)	(0.06)
Age: 48-56	-0.221**	-0.215**	-0.215**
	(0.07)	(0.07)	(0.07)
Age: 57-67	-0.136+	-0.131+	-0.130+
	(0.08)	(0.08)	(0.08)
Age: 68 or older	-0.049	-0.045	-0.045
	(0.09)	(0.09)	(0.09)
Single	-0.127**	-0.128**	-0.128**
	(0.05)	(0.05)	(0.05)
Cohabit	0.074*	0.073*	0.073*
	(0.04)	(0.04)	(0.04)
Widowed	-0.177***	-0.179***	-0.178***
	(0.05)	(0.05)	(0.05)
Divorced	-0.093+	-0.093+	-0.093+
	(0.05)	(0.05)	(0.05)
Separated	-0.201***	-0.200***	-0.201***
	(0.05)	(0.05)	(0.05)
Unemployed	-0.312***	-0.313***	-0.313***
	(0.03)	(0.03)	(0.03)
Retired	0.128***	0.127***	0.127***
	(0.03)	(0.03)	(0.03)
Not active in labour market	-0.192***	-0.193***	-0.193***
	(0.02)	(0.02)	(0.02)
Edu: University	-0.217*	-0.213*	-0.213*
	(0.10)	(0.10)	(0.10)
Edu: A Levels	-0.052	-0.050	-0.050
	(0.08)	(0.08)	(0.08)
Household size: 2	-0.029	-0.029	-0.029
	(0.03)	(0.03)	(0.03)
Household size: 3	-0.053	-0.053	-0.053
	(0.04)	(0.04)	(0.04)
Household size: 4+	-0.045	-0.045	-0.045
	(0.04)	(0.04)	(0.04)
Owned home outright	0.054*	0.054*	0.054*
	(0.03)	(0.03)	(0.03)
No. of dependent children: 1	0.022	0.022	0.022
	(0.03)	(0.03)	(0.03)
No. of dependent children: 2	0.060	0.060	0.060
	(0.04)	(0.04)	(0.04)
No. of dependent children: 3+	0.210***	0.211***	0.211***
	(0.06)	(0.06)	(0.06)
Constant	5.309***	5.318***	5.314***
	(0.21)	(0.21)	(0.21)
Year and Regional dummies	Yes	Yes	Yes
Observations	87,044	87,044	87,044

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitudinal study: 2009-2020

Table A.26 Robustness check: Mental impairment (Main sample) - adding lead effects

	Main sample	Lead 0-1	Lead 1-2
Having mental impairment in 1-2 years			-0.007
			(0.02)
Having mental impairment within next year		-0.043**	-0.040*
		(0.01)	(0.02)
Year starting mental impairment	-0.310***	-0.336***	-0.331***
	(0.01)	(0.01)	(0.02)
Having mental impairment for 1-2 years	-0.420***	-0.449***	-0.442***
	(0.02)	(0.02)	(0.02)
Having mental impairment for 2-3 years	-0.379***	-0.409***	-0.398***
	(0.03)	(0.03)	(0.03)
Having mental impairment for 3-4 years	-0.398***	-0.429***	-0.413***
	(0.04)	(0.04)	(0.04)
Having mental impairment for 4-5 years	-0.376***	-0.406***	-0.384***
	(0.05)	(0.05)	(0.05)
Having mental impairment for 5-6 years	-0.422***	-0.451***	-0.420***
	(0.06)	(0.06)	(0.07)
Having mental impairment for 6-7 years	-0.447***	-0.473***	-0.428***
	(0.09)	(0.09)	(0.09)
Having mental impairment for 7-8 years	-0.398***	-0.413***	
	(0.12)	(0.12)	
Having mental impairment for 8-9 years	-0.517**		
	(0.18)		
Log of household income per capita	0.041***	0.041***	0.041***
	(0.01)	(0.01)	(0.01)
Age: 27-37	-0.054	-0.052	-0.053
	(0.05)	(0.05)	(0.05)
Age: 38-47	-0.170**	-0.168**	-0.169**
	(0.06)	(0.06)	(0.06)
Age: 48-56	-0.168*	-0.166*	-0.167*
	(0.07)	(0.07)	(0.07)
Age: 57-67	-0.109	-0.109	-0.111
	(0.08)	(0.08)	(0.08)
Age: 68 or older	-0.037	-0.037	-0.038
	(0.09)	(0.09)	(0.09)
Single	-0.165***	-0.166***	-0.166***
	(0.05)	(0.05)	(0.05)
Cohabit	0.047	0.047	0.046
	(0.04)	(0.04)	(0.04)
Widowed	-0.201***	-0.203***	-0.203***
	(0.05)	(0.05)	(0.05)
Divorced	-0.134**	-0.135**	-0.135**
	(0.05)	(0.05)	(0.05)
Separated	-0.236***	-0.235***	-0.236***
	(0.05)	(0.05)	(0.05)
Unemployed	-0.295***	-0.295***	-0.296***
	(0.03)	(0.03)	(0.03)
Retired	0.110***	0.110***	0.109***
	(0.03)	(0.03)	(0.03)
Not active in labour market	-0.150***	-0.151***	-0.151***
	(0.02)	(0.02)	(0.02)
Edu: University	-0.259*	-0.256*	-0.254*
	(0.10)	(0.10)	(0.10)
Edu: A Levels	-0.062	-0.061	-0.061
	(0.09)	(0.09)	(0.09)
Non Edu	0.000	0.000	0.000
Household size: 2	-0.008	-0.007	-0.007
	(0.03)	(0.03)	(0.03)
Household size: 3	-0.041	-0.040	-0.040
	(0.04)	(0.04)	(0.04)
Household size: 4+	-0.026	-0.024	-0.024
	(0.05)	(0.05)	(0.05)
Owned home outright	0.071**	0.072**	0.071**
	(0.03)	(0.03)	(0.03)
No. of dependent of children: 1	-0.014	-0.014	-0.014
	(0.03)	(0.03)	(0.03)
No. of dependent of children: 2	0.055	0.055	0.055
	(0.04)	(0.04)	(0.04)
No. of dependent of children: 3+	0.123*	0.124*	0.124*
	(0.06)	(0.06)	(0.06)
Constant	5.159***	5.171***	5.166***
	(0.22)	(0.22)	(0.22)
Year and Regional dummies	Yes	Yes	Yes
Observations	83,106	83,106	83,106

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The UK longitudinal study: 2009-2020

A.6 Inverse probability weights by waves

Table A.27 Inverse probability weight by waves

Weights by waves	Mean	Std. Dev.	Min	Max
Wave 2	1.999985	2.182529	1.121682	9.000085
Wave 3	2.000003	2.412525	1.114597	9.726228
Wave 4	1.999998	2.569588	1.100483	10.69936
Wave 5	1.999994	2.707263	1.079492	12.87751
Wave 6	1.999987	2.945487	1.060079	16.02171
Wave 7	2.000005	3.072823	1.051631	17.80679
Wave 8	2.000035	3.225403	1.038846	21.81954
Wave 9	2.000082	3.428765	1.029449	27.03639
Wave 10	2.000086	3.557132	1.024537	30.52442

A.7 Hindrance Question in BHPS

From **Wave 1-8, 10-13**, and **15-18**:

Please look at this card and tell me which of these activities, if any, you would normally find difficult to manage on your own?

1 Doing the housework

2 Climbing stairs

3 Dressing yourself

4 Walking for at least 10 minutes

5 (None of these)

In **Wave 9** and **14**, the question was different.

A.8 Difficulty Question in UKHLS

Do you have any health problems or disabilities that mean you have substantial difficulties with any of the following areas of your life? Please select all of the answers that apply to you.

Options:

1 Mobility (moving around at home and walking) Mobility

2 Lifting, carrying or moving objects

3 Manual dexterity (using your hands to carry out everyday tasks)

4 Continence (bladder and bowel control)

		Yes, limited a lot	*Yes, limited a little*	*No, not limited at all*
a)	*Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports*	*1*	*2*	*3*
b)	*Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf*	*1*	*2*	*3*
c)	*Lifting or carrying groceries*	*1*	*2*	*3*
d)	*Climbing several flights of stairs*	*1*	*2*	*3*
e)	*Climbing one flight of stairs*	*1*	*2*	*3*
f)	*Bending, kneeling or stooping*	*1*	*2*	*3*
g)	*Walking more than a mile*	*1*	*2*	*3*
h)	*Walking half a mile*	*1*	*2*	*3*
i)	*Walking 100 yards*	*1*	*2*	*3*
j)	*Bathing or dressing yourself?*	*1*	*2*	*3*

Source: BHPS Questionnaires

5 Hearing (apart from using a standard hearing aid)
6 Sight (apart from wearing standard glasses)
7 Communication or speech problems
8 Memory or ability to concentrate, learn or understand
9 Recognising when you are in physical danger
10 Your physical co-ordination (e.g. balance)
11 Difficulties with own personal care (e.g. getting dressed, taking a bath or shower)
12 Other health problems

A.9 Extension: Attrition and Multiple imputations

A.9.1 Accounting for attritions in the panel

The estimation of equation (2.1) presents a challenge due to the existence of attrition between waves. Attrition from wave to wave in panel data may be related to endogenous factors such as age-related issues or ethnicity. An analysis by Lynn et al. (2018) shows that the magnitude of sample attrition in the general sample of UKHLS (wave 1-6) is greater than the figure for BHPS panel (i.e. 78% of the initial BHPS sample remained after six years while at wave 6 of the UKHLS only 52% of the sample were still participating). The main factors affecting attrition are similar across the two panels, which are age, gender, ethnicity, income and region (i.e. non-respondents are mostly the youngest age groups, male, black people; people with lower income levels and live in Greater London). Interestingly, Lynn et al. (2018) confirm no strong correlation between attrition rate and health status in either panel. The summary of attrition rate wave by wave in the latest ten waves of UKHLS is reported in Table A.28 and the report of attrition rate within the group of people with long-term sickness, impairment and disability is in Table A.29 below.

Table A.28 Attrition rate wave by wave

Waves	2	3	4	5	6	7	8	9	10
Compared to previous wave	24.78%	19.05%	15.32%	13.04%	17.90%	16.97%	16.18%	16.99%	14.19%
Compared to wave 1	24.78%	34.69%	40.15%	44.52%	51.17%	54.23%	57.54%	61.35%	63.40%

Source: Calculation from The UKHLS 2009-2020

Table A.29 Attrition rate wave by wave within the group of people with long-term sickness, impairment and disability

Waves	2	3	4	5	6	7	8	9	10
Compared to previous wave	21.84%	17.60%	13.93%	11.77%	16.04%	14.79%	14.28%	14.73%	12.63%
Compared to wave 1	21.84%	31.87%	37.52%	42.20%	48.59%	52.52%	56.25%	60.40%	62.55%

Source: Calculation from The UKHLS 2009-2020

From the tables above, it is clear that the UKHLS panel is likely to have problems with non-responses. Indeed, the test for the presence of endogenous attrition (i.e. non-random attrition or missing not at random) in the dataset using the Verbeek and Nijman (1992) test fails to reject the null hypothesis of having non-ignorable attrition problems. Two sources of missingness in panel data are within-wave missingness and whole-wave missingness. The former occurs when no valid response is recorded either because a participant did not answer the question or an interviewer did not manage to record the answer, while the latter results from non-participation in certain waves (Young and Johnson, 2015). It is noted that since there is no variable in the UKHLS to capture the information on whether whole-wave missingness occurs when respondents do not participate in certain waves or they die, it is not possible to distinguish these two cases.

There are different approaches to address attrition, for example using inverse probability weights (IPW) (see Cubí-Mollá et al., 2017, for more discussion), complete cases, and single or multiple imputation. It is noted that the attrition problem has not been addressed in the literature in adaptation to ill-health, an exception is the study by Cubí-Mollá et al. (2017). The IPW approach is based on the predicted probabilities derived from a probit regression using covariates from the main regression model and additional auxiliary variables that may determine attrition. The values of these variables are those from the first wave considered in the analysis. Weighting, however, might not be entirely satisfactory in a large panel as it generally requires different sets of weights for different combinations of waves used in the analysis (Goldstein, 2009), which practically is not very feasible. In addition, when using linear FE models, panel weights are required to be the same within individuals, which means an average weight needs to be computed across waves for each individual. Using weighting in the current setting of this chapter (i.e. 10-wave panel data, linear FE models) might not be efficient. Therefore, this chapter opts to use multiple imputation to address attrition. Multiple imputation allows for uncertainty around the missing values by generating several distinguishable plausible imputed datasets before combining them in the pooling analysis for the final results (Sterne et al., 2009). Multiple imputation should be used when missing data is not ignorable (i.e. the test discussed above confirms non-ignorable attrition problems) and the proportions of missing data are rather large (i.e. high attrition rate in the panel) (Jakobsen et al., 2017).

Multiple imputation consists of three phases (i) the imputation phase, (ii) the analysis phase, and (iii) the pooling phase (i.e. combining analysis results) (Harel and Zhou, 2007). There are two main steps in the imputation phase, which are including two steps: data preparation step and imputation step. First, data are prepared to have a suitable structure for the imputations using **mi set mlong** command. After the variables of interest are identified for the regression and auxiliary variables for the imputations, missing-data pattern is checked (**mi misstable nested**). The rule of thumb to choose variables for the imputation model is that all variables (both dependent and explanatory variables) to be included in the analysis model should be involved in the imputation process (Sassler and McNally, 2003). In addition, the imputation model should include any auxiliary variables that may contain information about missing data (StataCorp LLC, 2021*a*). Once being identified to include in the imputation model, variables are then registered either as imputed (i.e. variables that have missing values which will be used in the imputation procedure) or regular (i.e. variables that have the same values, whether missing or not, in all m; for example, gender and ethnicity) using **mi register imputed [vars]** and **mi register regular [vars]** (StataCorp LLC, 2021*a*). In the next step, the imputation method for multivariate imputations (**mi impute chained**) is chosen based on missing data pattern, which is arbitrary pattern or combination of any missing data patterns, and a mixed of different variable types. Different options will be added to the multivariate imputations to address continuous, categorical, and binary variables. In particular, option **regress** deals with continuous variables such as income, option **ologit** is for categorical variables such as age or marital status, and option **logit** is suitable for binary variables such as whether or not owning a home outright (Penn, 2009; StataCorp LLC, 2021*a*). Through this process, missing data are replaced by a random sample of plausible value imputations which are generated via some chosen imputation models to generate a number completed datasets or imputed datasets (StataCorp LLC, 2021*a*). The distribution of the missing data given in the observed data is used to draw the missing values in each of these datasets (Rubin, 1996) (The descriptive statistics of the original data and imputed data are reported below). In the second phase (i.e. completed-data estimation stage), each complete dataset is analysed and regression models are estimated separately for each of them (Penn, 2009). The estimations of parameters from these separate regressions are then combined in the last phase to yield the final results using FE regression via **mi estimate xtreg**.

Theoretically, five imputations are suggested to be sufficient (Horton and Lipsitz, 2001; Jakobsen et al., 2017; Rubin, 1987; Van Buuren, 2018). In this chapter, however, 10 imputations are used. The increased number of imputations potentially reduces sampling variability from the imputation process (Jakobsen et al., 2017)[1]. In the completed-data estimation step, the desired analysis (i.e. linear fixed effect regression in this chapter) is performed separately on each different dataset for which a different imputation procedure was used. In the second phase (i.e. pooling step), the model of interest (a linear FE regression in this chapter) is run within each of the completed datasets and the estimates including coefficients and standard errors obtained from those 10 imputed-data analyses are combined into a single multiple-imputation result. The estimated parameters from the final result are an arithmetic mean of those individual coefficients from each of the 10 regression models (StataCorp LLC, 2021*a*).

[1] I tried one model with 15 and 20 imputations to compare the results, which were not significantly different or improved from the current model with 10 imputations, but required a lot more powerful engine and time. Therefore, 10 imputations were the final number of imputations to use here.

A.9.2 The descriptive results

The results from the imputation step confirm the number of incomplete values of different variables that were successfully imputed (see Table A.30).

Table A.30 The imputation report on the number of complete, incomplete, and imputed values

Variable	Complete	Incomplete	Imputed	Total
Log of equivalised income	437,025	6,606	6,551	443,631
Life satisfaction	374,161	69,470	67,264	443,631
Having health impairment	442,889	742	716	443,631
Having physical impairment	382,756	60,875	58,672	443,631
Having mental impairment	382,613	61,018	58,811	443,631
Age	441,726	1,905	1,788	443,631
Number of dependent children	440,397	3,234	3,221	443,631
Marital status	442,830	801	789	443,631
Employment status	442,897	734	720	443,631
Highest education level	437,122	6,509	6,229	443,631
Household size	440,397	3,234	3,221	443,631
Region	443,440	191	187	443,631
Owned home outright	438,190	5,441	5,414	443,631

Source: Calculation from The UKHLS 2009-2020

To examine whether the imputed datasets are sensible, descriptive statistics of each imputed dataset is compared with those from the observed data using **mi xeq, summ [varlist]**. The results report mean and standard deviation of each variables in each individual imputed dataset and the figures for the original data. Overall, the summary statistics of the imputed datasets look reasonable as they are very close to the figures for the original data. Hence, only descriptive statistics of the first, the fifth and the last (the 10th) imputed dataset are reported below.

Overall, the summary statistics of the imputed datasets look reasonable as all parameters in the imputed data are close to the corresponding figures in the observed original data.

Table A.31 Descriptive statistics of the original data and the imputed data: Health impairment

	Original	sample	m=1		m=5		m=10	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Life satisfaction	5.17142	1.48194	5.16261	1.48466	5.16333	1.48417	5.16353	1.48425
Having health impairment	0.34450	0.47520	0.34455	0.47522	0.34453	0.47522	0.34455	0.47522
Log of equivalised income	7.07185	0.77440	7.07038	0.77475	7.07053	0.77475	7.07053	0.77452
Age	48.18696	18.63756	48.15866	18.63463	48.15887	18.63543	48.15941	18.63370
Marital status								
Married	0.52108	0.49956	0.52088	0.49956	0.52088	0.49956	0.52085	0.49957
Single	0.23270	0.42255	0.23295	0.42271	0.23294	0.42271	0.23297	0.42273
Cohabit	0.10846	0.31096	0.10844	0.31094	0.10844	0.31094	0.10844	0.31094
Widowed	0.05946	0.23649	0.05944	0.23644	0.05944	0.23644	0.05943	0.23643
Divorced	0.06105	0.23943	0.06106	0.23944	0.06105	0.23943	0.06105	0.23943
Separated	0.01724	0.13018	0.01724	0.13016	0.01725	0.13019	0.01724	0.13017
Employment status								
Employed	0.54689	0.49780	0.54681	0.49780	0.54684	0.49780	0.54683	0.49780
Unemployed	0.04970	0.21732	0.04978	0.21748	0.04979	0.21751	0.04978	0.21749
Retired	0.23081	0.42135	0.23051	0.42116	0.23050	0.42115	0.23051	0.42116
Not active in labour market	0.17260	0.37790	0.17291	0.37817	0.17287	0.37813	0.17288	0.37814
Highest education level								
University	0.35389	0.47818	0.35376	0.47814	0.35365	0.47810	0.35381	0.47815
A Levels	0.41790	0.49321	0.41817	0.49326	0.41813	0.49325	0.41803	0.49324
No formal qualification	0.22821	0.41968	0.22807	0.41959	0.22822	0.41968	0.22816	0.41965
Household size								
1	0.14392	0.35101	0.14374	0.35083	0.14375	0.35084	0.14386	0.35095
2	0.33710	0.47272	0.33573	0.47225	0.33585	0.47229	0.33577	0.47226
3	0.18621	0.38928	0.18623	0.38929	0.18626	0.38931	0.18625	0.38931
4+	0.33277	0.47120	0.33430	0.47175	0.33414	0.47169	0.33412	0.47168
No. of dependent children								
0	0.66920	0.47050	0.66830	0.47130	0.66440	0.47032	0.67020	0.48000
1	0.14949	0.35657	0.15049	0.35747	0.14957	0.36657	0.14957	0.36557
2	0.12548	0.33127	0.12568	0.34227	0.12568	0.34227	0.12618	0.33627
3+	0.05583	0.22959	0.05663	0.23059	0.05713	0.23006	0.05683	0.22989
Owned home outright	0.32475	0.46828	0.32385	0.46794	0.32377	0.46792	0.32372	0.46789
Region	6.60260	3.16277	6.60268	3.16272	6.60260	3.16279	6.60277	3.16284

Note: gender and ethnicity are registered as ‘regular’ variables, hence, don’t change over time

Source: Calculation from The UKHLS 2009-2020

Table A.32 Descriptive statistics of the original data and the imputed data: Physical impairment

	Original	sample	m=1		m=5		m=10	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Life satisfaction	5.17142	1.48194	5.16231	1.48527	5.16070	1.48622	5.16301	1.48500
Having physical impairment	0.23828	0.42603	0.23907	0.42652	0.23911	0.42654	0.23944	0.42674
Log of equivalised income	7.07185	0.77440	7.07044	0.77501	7.07079	0.77476	7.07063	0.77476
Age	48.18696	18.63756	48.16193	18.63364	48.16077	18.63287	48.16004	18.63489
Marital status								
Married	0.52108	0.49956	0.52091	0.49956	0.52087	0.49956	0.52089	0.49956
Single	0.23270	0.42255	0.23289	0.42268	0.23298	0.42273	0.23291	0.42268
Cohabit	0.10846	0.31096	0.10847	0.31098	0.10843	0.31092	0.10846	0.31096
Widowed	0.05946	0.23649	0.05945	0.23646	0.05945	0.23646	0.05944	0.23644
Divorced	0.06105	0.23943	0.06104	0.23940	0.06104	0.23940	0.06105	0.23943
Separated	0.01724	0.13018	0.01723	0.13014	0.01724	0.13016	0.01725	0.13021
Employment status								
Employed	0.54689	0.49780	0.54685	0.49780	0.54687	0.49780	0.54687	0.49780
Unemployed	0.04970	0.21732	0.04976	0.21745	0.04978	0.21749	0.04976	0.21745
Retired	0.23081	0.42135	0.23051	0.42116	0.23049	0.42115	0.23050	0.42115
Not active in labour market	0.17260	0.37790	0.17288	0.37814	0.17286	0.37812	0.17287	0.37814
Highest education level								
University	0.35389	0.47818	0.35376	0.47814	0.35357	0.47808	0.35365	0.47810
A Levels	0.41790	0.49321	0.41809	0.49325	0.41818	0.49326	0.41818	0.49326
No formal qualification	0.22821	0.41968	0.22815	0.41964	0.22825	0.41970	0.22817	0.41965
Household size								
1	0.14392	0.35101	0.14371	0.35079	0.14374	0.35082	0.14377	0.35085
2	0.33710	0.47272	0.33590	0.47231	0.33585	0.47229	0.33576	0.47226
3	0.18621	0.38928	0.18626	0.38931	0.18624	0.38930	0.18621	0.38927
4+	0.33277	0.47120	0.33413	0.47169	0.33417	0.47170	0.33427	0.47174
No. of dependent children								
0	0.66920	0.47050	0.66933	0.47170	0.67040	0.47260	0.66945	0.47064
1	0.14949	0.35657	0.14950	0.36257	0.14967	0.35752	0.14952	0.35678
2	0.12548	0.33127	0.13248	0.34527	0.12728	0.33453	0.12665	0.35027
3+	0.05583	0.22959	0.05783	0.23059	0.05708	0.22999	0.05593	0.22978
Owned home outright	0.32475	0.46828	0.32369	0.46788	0.32373	0.46790	0.32381	0.46793
Region	6.60260	3.16277	6.60253	3.16284	6.60251	3.16282	6.60269	3.16283

Note: gender and ethnicity are registered as ‘regular’ variables, hence, don’t change over time

Source: Calculation from The UKHLS 2009-2020

Table A.33 Descriptive statistics of the original data and the imputed data: Mental impairment

	Original	sample	m=1		m=5		m=10	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Life satisfaction	5.17142	1.48194	5.16323	1.48476	5.16277	1.48471	5.16382	1.48458
Having mental impairment	0.17914	0.38347	0.18020	0.38436	0.17972	0.38396	0.17965	0.38389
Log of equivalised income	7.07185	0.77440	7.07045	0.77472	7.07087	0.77463	7.07059	0.77479
Age	48.18696	18.63756	48.16152	18.63362	48.16031	18.63304	48.15920	18.63307
Marital status								
Married	0.52108	0.49956	0.52087	0.49956	0.52088	0.49956	0.52090	0.49956
Single	0.23270	0.42255	0.23297	0.42272	0.23295	0.42271	0.23294	0.42271
Cohabit	0.10846	0.31096	0.10840	0.31089	0.10846	0.31096	0.10844	0.31093
Widowed	0.05946	0.23649	0.05946	0.23648	0.05943	0.23643	0.05942	0.23641
Divorced	0.06105	0.23943	0.06106	0.23945	0.06104	0.23940	0.06106	0.23944
Separated	0.01724	0.13018	0.01723	0.13014	0.01724	0.13018	0.01725	0.13019
Employment status								
Employed	0.54689	0.49780	0.54686	0.49780	0.54682	0.49780	0.54683	0.49780
Unemployed	0.04970	0.21732	0.04979	0.21750	0.04979	0.21751	0.04977	0.21747
Retired	0.23081	0.42135	0.23050	0.42115	0.23051	0.42116	0.23049	0.42115
Not active in labour market	0.17260	0.37790	0.17285	0.37812	0.17288	0.37815	0.17291	0.37817
Highest education level								
University	0.35389	0.47818	0.35370	0.47812	0.35383	0.47816	0.35382	0.47815
A Levels	0.41790	0.49321	0.41822	0.49327	0.41796	0.49322	0.41810	0.49325
No formal qualification	0.22821	0.41968	0.22808	0.41960	0.22822	0.41968	0.22809	0.41960
Household size								
1	0.14392	0.35101	0.14372	0.35080	0.14379	0.35088	0.14373	0.35082
2	0.33710	0.47272	0.33579	0.47227	0.33581	0.47227	0.33576	0.47226
3	0.18621	0.38928	0.18627	0.38933	0.18625	0.38931	0.18627	0.38933
4+	0.33277	0.47120	0.33422	0.47172	0.33415	0.47169	0.33424	0.47172
No. of dependent children								
0	0.66920	0.47050	0.67120	0.47107	0.66988	0.47240	0.67120	0.47123
1	0.14949	0.35657	0.14963	0.35896	0.14974	0.35679	0.15049	0.37657
2	0.12548	0.33127	0.12579	0.33563	0.12573	0.33623	0.12648	0.33573
3+	0.05583	0.22959	0.05591	0.22987	0.05913	0.22962	0.05723	0.23020
Owned home outright	0.32475	0.46828	0.32376	0.46791	0.32375	0.46791	0.32363	0.46786
Region	6.60260	3.16277	6.60262	3.16273	6.60261	3.16279	6.60275	3.16277

Note: gender and ethnicity are registered as ‘regular’ variables, hence, don’t change over time

Source: Calculation from The UKHLS 2009-2020

A.9.3 The regression results

The regression results from the model using imputed data are compared with the results from the main analyses using the original (un-repaired) data for each impairment category. Overall, the results are consistent across the two regressions in each category. Although the effects of lag of impairment at each duration seem to be more negative in the regression using the imputed data compared to the main analyses, they are not statistically different from each other. Most of the controls show similar results, except for an interesting finding that indicates negative and significant effects of owning home outright on life satisfaction in all regressions using imputed data (while the same variable has positive and significant effect in regressions using the original data).

Table A.34 Regression results for Health impairment: Imputed data versus Original data

	IMPUTED DATA	ORIGINAL DATA
Year starting health impairment	-0.163***	-0.104***
	(0.01)	(0.01)
Having health impairment for 1-2 years	-0.198***	-0.141***
	(0.02)	(0.01)
Having health impairment for 2-3 years	-0.169***	-0.121***
	(0.02)	(0.02)
Having health impairment for 3-4 years	-0.196***	-0.129***
	(0.03)	(0.02)
Having health impairment for 4-5 years	-0.206***	-0.135***
	(0.03)	(0.03)
Having health impairment for 5-6 years	-0.222***	-0.153***
	(0.04)	(0.04)
Having health impairment for 6-7 years	-0.217***	-0.161**
	(0.05)	(0.05)
Having health impairment for 7-8 years	-0.250***	-0.196**
	(0.07)	(0.07)
Having health impairment for 8-9 years	-0.251*	-0.195+
	(0.11)	(0.11)
Log of real household income per capita	0.050***	0.041***
	(0.01)	(0.01)
Age: 27 - 37	-0.108*	-0.102*
	(0.04)	(0.04)
Age: 38 - 47	-0.192***	-0.198***
	(0.05)	(0.05)
Age: 48 - 56	-0.181**	-0.177**
	(0.06)	(0.06)
Age: 57 - 67	-0.095	-0.090
	(0.07)	(0.07)
Age: 68 or older	-0.025	-0.026
	(0.08)	(0.07)
Single	-0.162***	-0.135***
	(0.04)	(0.04)
Cohabit	-0.014	0.017
	(0.03)	(0.03)
Widowed	-0.150**	-0.156***
	(0.05)	(0.05)
Divorced	-0.189***	-0.150***
	(0.05)	(0.04)
Separated	-0.290***	-0.268***
	(0.05)	(0.05)
Unemployment	-0.306***	-0.285***
	(0.03)	(0.03)
Retired	0.169***	0.131***
	(0.02)	(0.02)
Not active in labour market	-0.124***	-0.110***
	(0.02)	(0.02)
Edu: University	-0.090	-0.188*
	(0.07)	(0.08)
Edu: A Levels	-0.001	-0.029
	(0.06)	(0.07)
Household size: 2	-0.005	-0.018
	(0.03)	(0.03)
Household size: 3	-0.033	-0.043
	(0.04)	(0.03)
Household size: 4+	-0.019	-0.038
	(0.04)	(0.04)
Owned home outright	-0.067**	0.040+
	(0.02)	(0.02)
No. of dependent children: 1	0.031	0.021
	(0.02)	(0.02)
No. of dependent children: 2	0.068*	0.052+
	(0.03)	(0.03)
No. of dependent children: 3+	0.127**	0.114*
	(0.05)	(0.05)
Constant	5.336***	5.268***
	(0.20)	(0.19)
Wave and regional dummies	Yes	Yes
Observations	126,656	110,191

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UK longitudinal study: 2009-2020

Table A.35 Regression results for Physical impairment: Imputed data versus Original data

	IMPUTED DATA	ORIGINAL DATA
Year starting physical impairment	-0.187***	-0.181***
	(0.01)	(0.01)
Having physical impairment for 1-2 years	-0.242***	-0.235***
	(0.02)	(0.02)
Having physical impairment for 2-3 years	-0.228***	-0.224***
	(0.02)	(0.02)
Having physical impairment for 3-4 years	-0.227***	-0.216***
	(0.03)	(0.03)
Having physical impairment for 4-5 years	-0.268***	-0.255***
	(0.04)	(0.04)
Having physical impairment for 5-6 years	-0.290***	-0.275***
	(0.05)	(0.05)
Having physical impairment for 6-7 years	-0.282***	-0.269***
	(0.07)	(0.07)
Having physical impairment for 7-8 years	-0.222*	-0.203*
	(0.09)	(0.09)
Having physical impairment for 8-9 years	-0.296*	-0.273+
	(0.14)	(0.14)
Log of real household income per capita	0.034***	0.034***
	(0.01)	(0.01)
Age: 27 - 37	-0.132**	-0.132**
	(0.05)	(0.05)
Age: 38 - 47	-0.215***	-0.218***
	(0.06)	(0.06)
Age: 48 - 56	-0.224**	-0.221**
	(0.07)	(0.07)
Age: 57 - 67	-0.139+	-0.136+
	(0.08)	(0.08)
Age: 68 or older	-0.048	-0.049
	(0.09)	(0.09)
Single	-0.134**	-0.127**
	(0.05)	(0.05)
Cohabit	0.071*	0.074*
	(0.04)	(0.04)
Widowed	-0.169**	-0.177***
	(0.05)	(0.05)
Divorced	-0.112*	-0.093+
	(0.05)	(0.05)
Separated	-0.214***	-0.201***
	(0.05)	(0.05)
Unemployed	-0.308***	-0.312***
	(0.03)	(0.03)
Retired	0.130***	0.128***
	(0.03)	(0.03)
Not active in labour market	-0.191***	-0.192***
	(0.02)	(0.02)
Edu: University	-0.128	-0.217*
	(0.09)	(0.10)
Edu: A-levels	-0.011	-0.052
	(0.08)	(0.08)
Household size:2	-0.025	-0.029
	(0.03)	(0.03)
Household size:3	-0.050	-0.053
	(0.04)	(0.04)
Household size:4+	-0.043	-0.045
	(0.04)	(0.04)
Owned home outright	-0.054*	0.054*
	(0.03)	(0.03)
No. of dependent children:1	0.021	0.022
	(0.03)	(0.03)
No. of dependent children:2	0.063+	0.060
	(0.04)	(0.04)
No. of dependent children:3+	0.210***	0.210***
	(0.06)	(0.06)
Constant	5.311***	5.309***
	(0.21)	(0.21)
Wave and regional dummies	Yes	Yes
Observations	89,206	87,044

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UK longitudinal study: 2009-2020

Table A.36 Regression results for Mental impairment: Imputed data versus Original data

	IMPUTED DATA	ORIGINAL DATA
Year starting mental impairment	-0.317***	-0.310***
	(0.01)	(0.01)
Having mental impairment for 1-2 years	-0.430***	-0.420***
	(0.02)	(0.02)
Having mental impairment for 2-3 years	-0.393***	-0.379***
	(0.03)	(0.03)
Having mental impairment for 3-4 years	-0.413***	-0.398***
	(0.04)	(0.04)
Having mental impairment for 4-5 years	-0.398***	-0.376***
	(0.05)	(0.05)
Having mental impairment for 5-6 years	-0.447***	-0.422***
	(0.06)	(0.06)
Having mental impairment for 6-7 years	-0.466***	-0.447***
	(0.08)	(0.09)
Having mental impairment for 7-8 years	-0.426***	-0.398***
	(0.12)	(0.12)
Having mental impairment for 8-9 years	-0.537**	-0.517**
	(0.18)	(0.18)
Log of real household income per capita	0.038***	0.041***
	(0.01)	(0.01)
Age: 27 - 37	-0.058	-0.054
	(0.05)	(0.05)
Age 38 - 47	-0.179**	-0.170**
	(0.06)	(0.06)
Age 48 - 56	-0.191**	-0.168*
	(0.07)	(0.07)
Age: 57 - 67	-0.133+	-0.109
	(0.08)	(0.08)
Age: 68 or older	-0.059	-0.037
	(0.09)	(0.09)
Single	-0.164***	-0.165***
	(0.05)	(0.05)
Cohabit	0.046	0.047
	(0.03)	(0.04)
Widowed	-0.187***	-0.201***
	(0.05)	(0.05)
Divorced	-0.136**	-0.134**
	(0.05)	(0.05)
Separated	-0.231***	-0.236***
	(0.05)	(0.05)
Unemployed	-0.301***	-0.295***
	(0.03)	(0.03)
Retired	0.111***	0.110***
	(0.03)	(0.03)
Not active in labour market	-0.156***	-0.150***
	(0.02)	(0.02)
Edu: University	-0.153	-0.259*
	(0.10)	(0.10)
Edu: A Levels	0.003	-0.062
	(0.09)	(0.09)
Household size: 2	0.001	-0.008
	(0.03)	(0.03)
Household size: 3	-0.032	-0.041
	(0.04)	(0.04)
Household size: 4+	-0.012	-0.026
	(0.05)	(0.05)
Owned home outright	-0.069**	0.071**
	(0.03)	(0.03)
No. of dependent children: 1	-0.013	-0.014
	(0.03)	(0.03)
No. of dependent children: 2	0.054	0.055
	(0.04)	(0.04)
No. of dependent children: 3	0.112*	0.123*
	(0.06)	(0.06)
Constant	5.171***	5.159***
	(0.23)	(0.22)
Wave and regional dummies	Yes	Yes
Observations	85,295	83,106

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The Understanding Society - The UK longitudinal study: 2009-2020

Appendix B

Appendices to Chapter 3

B.1 Additional example on heterogeneity in preferences

In this example, individual *i* is richer and cares more about health, while individual *j* is poorer and cares less about health, as opposed to the example used in Figure 3.3 and 3.4 in the main text.

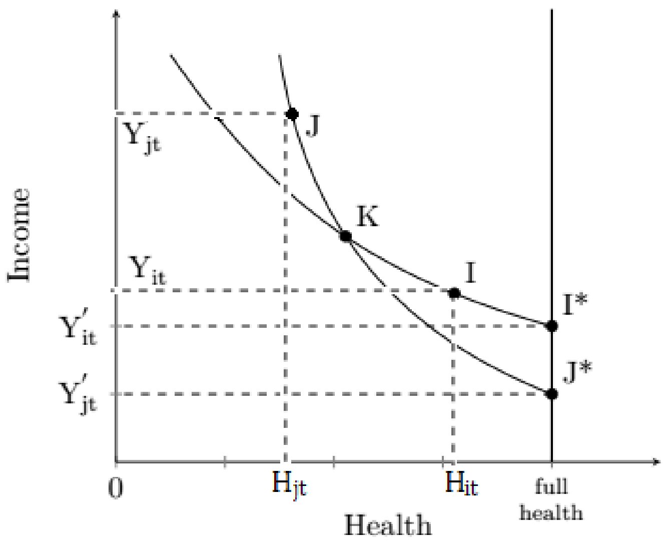


Fig. B.1 Additional example: Heterogeneity in preferences and Equivalent income

From the figure above, the current life situation of individual *i* at point '*I*' gives him/her the same level of wellbeing compared to a hypothetical situation 'I^*' (i.e. I^* combines full health and income Y'_{it}) as they are on the same indifference curve. Similarly, individual *j* indifferences between his/her current life situation '*J*' and the hypothetical situation 'J^*' at full health and income Y'_{jt}. Individual *j* has a higher current income Y_{jt} but worse health H_{jt} than individual *i*'s current situation. As the richer (individual *j*) cares more about their poor health and the poorer (individual *i*) does not mind their health as much, individual *j* is worse-off than individual *i* in this example as *j*'s equivalent income (Y'_{jt}) is lower than *i*'s equivalent income (Y'_{it}) .

B.2 Descriptive statistics

Table B.1 Descriptive Statistics

Variable	No. of Obs	Mean	Std. Dev.	Min	Max
Life satisfaction	173,731	5.20	1.38	1.00	7.00
Equivalent Income	173,731	1,445.83	2,358.39	0.00	247,768.70
Income and Non-income Life Domains					
Income domain					
Equivalised income	173,731	2,318.30	2,367.59	0.10	247,768.70
Log equivalised income	173,731	7.60	0.52	-2.32	12.42
Average equivalised income	131,578	2,280.66	1,726.40	35.95	139,837.60
Log average equivalised income	131,263	7.58	0.47	2.61	11.55
Health domain					
Self-assessed health	173,731	2.36	0.94	1	5
Excellent health	173,731	0.18	0.39	0	1
Very good health	173,731	0.40	0.49	0	1
Good health	173,731	0.30	0.46	0	1
Fair health	173,731	0.10	0.30	0	1
Poor health	173,731	0.02	0.12	0	1
Excellent and Very good health	173,731	0.59	0.49	0	1
Fair and poor health	173,731	0.11	0.32	0	1
Employment domain					
Employed	173,731	0.96	0.20	0	1
Unemployed	173,731	0.00	0.05	0	1
Not active in labour market	173,731	0.04	0.20	0	1
Scaling factors and controls					
Disability and adaptation					
Onset of disability	173,731	0.08	0.27	0	1
Disabled for 1-2 years	173,731	0.03	0.17	0	1
Disabled for 2-3 years	173,731	0.02	0.12	0	1
Disabled for 3+ years	173,731	0.02	0.13	0	1
Marital status					
Married and as married	173,731	0.70	0.46	0	1
Single	173,731	0.20	0.40	0	1
Divorced	173,731	0.06	0.24	0	1
Widowed	173,731	0.01	0.11	0	1
Separated	173,731	0.02	0.13	0	1
Other demographic characteristics					
Age	173,731	43.64	13.01	16	92
Male	173,730	0.47	0.50	0	1
Education: University	173,731	0.46	0.50	0	1
Own home outright	173,731	0.22	0.41	0	1
Living with others	173,731	0.90	0.31	0	1
Having children	173,731	0.40	0.49	0	1
Living in rural area	173,731	0.24	0.43	0	1
Having high social status	173,731	0.44	0.50	0	1
Having middle social status	173,731	0.39	0.49	0	1
Having low social status	173,731	0.17	0.38	0	1
Wave	173,731	5.67	2.60	1	10
Year	173,731	2014.14	2.66	2009	2020

Source: The UK longitudinal study 2009 - 2020

B.3 Overlap between individuals identified as the worst-off by equivalent income and equivalised income, and equivalent income and life satisfaction

Table B.2 Worst-off Overlap Captured by Different Wellbeing Measures

	% Overlap between EI and equivalised income										
	Wave 1	Wave 2	Wave 3	Wave4	Wave5	Wave6	Wave7	Wave8	Wave9	Wave10	Pool data
10% lowest EI (no. of obs)	3,920	4,264	4,029	3,859	3,692	3,516	3,625	3,471	3,191	3,073	36,639
No. of worst-off captured by at least 1 measure	7,041	7,438	7,063	6,748	6,444	6,331	6,354	6,013	5,458	5,359	64,201
No. of worst-off captured by both measures	799	1,090	995	970	940	701	896	929	924	787	9,077
% overlap between EI and equivalised income	11.35	14.65	14.09	14.37	14.59	11.07	14.10	15.45	16.93	14.69	14.14

Source: Own calculations based on The UK longitudinal study: 2009 - 2020

Table B.3 Cross-tabulation of Equivalised income and Equivalent income (Wave 1: 2009 - 2011)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.35	0.31	0.32	0.02	0.00	1.00
2	0.30	0.27	0.12	0.31	0.00	1.00
3	0.22	0.14	0.17	0.45	0.03	1.00
4	0.08	0.19	0.17	0.21	0.34	1.00
5	0.06	0.09	0.22	0.00	0.63	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.4 Cross-tabulation of Equivalised income and Equivalent income (Wave 2: 2010 - 2012)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.34	0.35	0.23	0.07	0.00	1.00
2	0.27	0.27	0.09	0.36	0.00	1.00
3	0.22	0.12	0.22	0.41	0.04	1.00
4	0.11	0.16	0.21	0.16	0.36	1.00
5	0.05	0.10	0.25	0.00	0.60	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.5 Cross-tabulation of Equivalised income and Equivalent income (Wave 3: 2011 - 2013)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.32	0.30	0.38	0.00	0.00	1.00
2	0.25	0.30	0.22	0.24	0.00	1.00
3	0.21	0.19	0.10	0.50	0.02	1.00
4	0.15	0.12	0.15	0.27	0.32	1.00
5	0.08	0.10	0.16	0.00	0.67	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.6 Cross-tabulation of Equivalised income and Equivalent income (Wave 4: 2012 - 2014)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.32	0.30	0.38	0.00	0.00	1.00
2	0.26	0.28	0.26	0.19	0.00	1.00
3	0.21	0.20	0.07	0.51	0.02	1.00
4	0.14	0.11	0.14	0.30	0.31	1.00
5	0.06	0.12	0.14	0.00	0.67	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.7 Cross-tabulation of Equivalised income and Equivalent income (Wave 5: 2013 - 2015)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.32	0.31	0.35	0.01	0.00	1.00
2	0.25	0.28	0.18	0.28	0.00	1.00
3	0.22	0.16	0.13	0.46	0.03	1.00
4	0.14	0.14	0.16	0.24	0.32	1.00
5	0.07	0.10	0.18	0.00	0.65	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.8 Cross-tabulation of Equivalised income and Equivalent income (Wave 6: 2014 - 2016)

Quintiles of Equivalised Income	Quintiles of Equivalent Income 1	2	3	4	5	Total
1	0.30	0.31	0.38	0.00	0.00	1.00
2	0.27	0.28	0.19	0.26	0.00	1.00
3	0.20	0.18	0.11	0.48	0.03	1.00
4	0.15	0.12	0.15	0.25	0.32	1.00
5	0.07	0.11	0.17	0.00	0.65	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.9 Cross-tabulation of Equivalised income and Equivalent income (Wave 7: 2015 - 2017)

Quintiles of Equivalised Income	Quintiles of Equivalent Income 1	2	3	4	5	Total
1	0.30	0.32	0.32	0.05	0.00	1.00
2	0.26	0.27	0.13	0.34	0.00	1.00
3	0.21	0.15	0.16	0.43	0.04	1.00
4	0.15	0.15	0.17	0.18	0.34	1.00
5	0.07	0.10	0.21	0.00	0.61	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.10 Cross-tabulation of Equivalised income and Equivalent income (Wave 8: 2016 - 2018)

Quintiles of Equivalised Income	Quintiles of Equivalent Income 1	2	3	4	5	Total
1	0.32	0.33	0.28	0.08	0.00	1.00
2	0.28	0.25	0.09	0.38	0.00	1.00
3	0.21	0.13	0.21	0.40	0.05	1.00
4	0.13	0.18	0.17	0.15	0.36	1.00
5	0.06	0.11	0.25	0.00	0.59	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.11 Cross-tabulation of Equivalised income and Equivalent income (Wave 9: 2017 - 2019)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.33	0.35	0.18	0.14	0.00	1.00
2	0.27	0.22	0.13	0.38	0.00	1.00
3	0.23	0.13	0.21	0.36	0.07	1.00
4	0.11	0.21	0.20	0.11	0.37	1.00
5	0.06	0.09	0.28	0.00	0.56	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.12 Cross-tabulation of Equivalised income and Equivalent income (Wave 10: 2018 - 2020)

	Quintiles of Equivalent Income					
Quintiles of Equivalised Income	1	2	3	4	5	Total
1	0.33	0.34	0.19	0.15	0.00	1.00
2	0.29	0.19	0.14	0.38	0.00	1.00
3	0.22	0.15	0.21	0.36	0.06	1.00
4	0.10	0.23	0.19	0.11	0.38	1.00
5	0.07	0.09	0.28	0.00	0.56	1.00
Total	1.00	1.00	1.00	1.00	1.00	

Source: Calculations based on the UK household longitudinal study

Table B.13 Cross-tabulation of Equivalent Income and Life satisfaction

	Lowest life satisfaction: LS = 1 or 2 or 3										
Quartiles of Equivalent Income	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	Wave 8	Wave 9	Wave 10	Full Sample
1	44.65	46.12	42.87	43.61	43.29	44.84	49.1	48.57	46.41	48.27	45.58
2	25.71	25.44	24.48	24.26	25.86	24.98	24.85	25.71	25.67	24.9	25.16
3	17.68	17.09	18.61	18.05	17.65	18.5	15.59	15.4	16.87	16.99	17.21
4	11.96	11.35	14.04	14.08	13.2	11.68	10.46	10.32	11.06	9.83	12.04
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total no. of observations	9,357	10,462	10,438	10,906	10,420	8,227	8,510	8,608	8,376	8,228	93,532

Source: Calculations based on the UK household longitudinal study 2009 - 2020

B.4 Spearman Rank Correlation - full results

Table B.14 Spearman Rank Correlation Between Wellbeing measures and Life Domains

Waves	Dimensions or WB measure	Equivalent income	Equivalised income	Life satisfaction	Self-assessed health	Employment	Not active in labour market
Wave 1	Equivalised income	0.53	1.00				
	Life satisfaction	0.28	0.12	1.00			
	Self-assessed health	-0.82	-0.19	-0.28	1.00		
	Employment	0.33	0.42	-0.01	-0.22	1.00	
	Not active in LM	-0.17	-0.32	0.06	0.21	-0.88	1.00
	Unemployment	-0.33	-0.22	-0.10	0.04	-0.29	-0.20
Wave 2	Equivalised income	0.52	1.00				
	Life satisfaction	0.31	0.12	1.00			
	Self-assessed health	-0.85	-0.20	-0.31	1.00		
	Employment	0.34	0.37	-0.01	-0.27	1.00	
	Not active in LM	-0.20	-0.28	0.06	0.26	-0.89	1.00
	Unemployment	-0.33	-0.21	-0.10	0.05	-0.27	-0.19
Wave 3	Equivalised income	0.53	1.00				
	Life satisfaction	0.28	0.13	1.00			
	Self-assessed health	-0.81	-0.18	-0.28	1.00		
	Employment	0.30	0.35	-0.01	-0.23	1.00	
	Not active in LM	-0.16	-0.26	0.06	0.22	-0.90	1.00
	Unemployment	-0.31	-0.21	-0.10	0.04	-0.27	-0.19
Wave 4	Equivalised income	0.54	1.00				
	Life satisfaction	0.30	0.13	1.00			
	Self-assessed health	-0.81	-0.20	-0.30	1.00		
	Employment	0.29	0.33	0.01	-0.25	1.00	
	Not active in LM	-0.16	-0.24	0.04	0.23	-0.90	1.00

Table B.14 –continued on next page

Table B.14 – continued from previous page

	Unemployment	-0.31	-0.20	-0.10	0.06	-0.26	-0.18
Wave 5	Equivalised income	0.52	1.00				
	Life satisfaction	0.31	0.13	1.00			
	Self-assessed health	-0.83	-0.19	-0.31	1.00		
	Employment	0.27	0.31	0.01	-0.23	1.00	
	Not active in LM	-0.15	-0.24	0.04	0.22	-0.91	1.00
	Unemployment	-0.29	-0.19	-0.10	0.05	-0.25	-0.17
Wave 6	Equivalised income	0.51	1.00				
	Life satisfaction	0.31	0.14	1.00			
	Self-assessed health	-0.83	-0.18	-0.30	1.00		
	Employment	0.29	0.31	-0.01	-0.26	1.00	
	Not active in LM	-0.18	-0.24	0.05	0.24	-0.92	1.00
	Unemployment	-0.28	-0.19	-0.10	0.04	-0.24	-0.17
Wave 7	Equivalised income	0.48	1.00				
	Life satisfaction	0.36	0.11	1.00			
	Self-assessed health	-0.85	-0.16	-0.37	1.00		
	Employment	0.24	0.30	-0.02	-0.21	1.00	
	Not active in LM	-0.13	-0.23	0.05	0.19	-0.92	1.00
	Unemployment	-0.28	-0.18	-0.09	0.05	-0.24	-0.17
Wave 8	Equivalised income	0.48	1.00				
	Life satisfaction	0.36	0.11	1.00			
	Self-assessed health	-0.86	-0.17	-0.38	1.00		
	Employment	0.25	0.28	-0.02	-0.24	1.00	
	Not active in LM	-0.15	-0.22	0.06	0.22	-0.93	1.00
	Unemployment	-0.27	-0.17	-0.10	0.05	-0.23	-0.16
Wave 9	Equivalised income	0.46	1.00				
	Life satisfaction	0.36	0.12	1.00			
	Self-assessed health	-0.87	-0.17	-0.38	1.00		
	Employment	0.22	0.26	-0.04	-0.21	1.00	
	Not active in LM	-0.12	-0.20	0.07	0.19	-0.93	1.00

Table B.14 –continued on next page

Table B.14 – continued from previous page

	Unemployment	-0.27	-0.16	-0.09	0.06	-0.22	-0.16
Wave 10	Equivalised income	0.46	1.00				
	Life satisfaction	0.38	0.14	1.00			
	Self-assessed health	-0.87	-0.17	-0.39	1.00		
	Employment	0.22	0.24	-0.03	-0.22	1.00	
	Not active in LM	-0.12	-0.18	0.06	0.20	-0.93	1.00
	Unemployment	-0.26	-0.16	-0.10	0.05	-0.22	-0.16

Source: Calculations based on the UK household longitudinal study: 2009 - 2020

B.5 The worst-off identified by life dommains and wellbeing measures (across waves)

Table B.15 Average characteristics of the worst-off in Wave 1: 2009 - 2011

	Full sample N = 22,315	Income N=1,008	Equivalent Income N=1,008	Life satisfaction N=1,008	Self-assessed health N=1,008	Unemployment N=1,008
Life satisfaction (mean between 1-7)	5.30	5.15	4.11	1.00	4.04	4.71
Equivalised income (£/month)	1,814.62	61.21	741.96	1,191.58	1,129.79	848.21
Average equivalised income (£/month)	N/A	N/A	N/A	N/A	N/A	N/A
Health aspect						
Self-assessed health (mean between 1-5)	2.34	2.69	4.21	3.33	5.00	2.70
Excellent and very good health (in %)	58.82	47.82	0.58	31.91	0.00	44.86
Good health (in %)	28.73	25.30	5.14	19.40	0.00	30.72
Fair and poor health (in %)	12.45	26.88	94.28	48.69	100.00	24.42
Having long-term disability	26.52	34.06	67.48	55.96	90.76	31.17
Onset of disability	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 1-2 years	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 2-3 years	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 3+ years	0.00	0.00	0.00	0.00	0.00	0.00
Employment aspect						
Employed (in %)	94.23	11.58	14.83	31.10	14.73	0.00
Unemployed (in %)	0.31	18.68	63.37	12.31	6.20	100.00
Not active in labour market (in %)	4.24	69.75	21.80	56.59	79.07	0.00
Marital status						
Married and as married (in %)	69.38	35.60	45.68	45.83	54.17	44.76
Single (in %)	20.91	42.09	32.10	27.81	15.50	42.62
Others (in %)	9.71	22.31	22.22	26.36	30.33	12.62
Age (mean)	41.65	45.72	43.92	47.94	57.56	36.41
Male	46.76	50.19	47.29	41.47	42.64	55.14
Education: University (in %)	43.13	28.78	45.54	18.70	13.27	20.89
Own home outright (in %)	18.89	28.39	19.75	24.05	29.86	12.16
Living with others (in %)	89.16	61.72	74.71	74.81	74.81	84.69
Having children (in %)	40.06	17.05	35.95	30.91	22.29	43.51
Living in rural area (in %)	21.91	12.98	13.76	18.12	15.70	11.82
Having high social status (in %)	41.84	37.89	36.88	26.39	32.30	26.67
Having middle social status (in %)	40.54	49.47	40.00	43.99	44.72	33.33
Having low social status (in %)	17.62	12.63	23.13	29.62	22.98	40.00
WTP for perfect health (£/month)	1,607.88	58.75	741.54	1,181.14	1,129.52	811.37
% of EI in income to achieve perfect health	11.39%	4.02%	0.06%	0.88%	0.02%	4.34%
WTP for being employed (£/month)	14.10	34.99	715.00	495.35	1,129.52	843.98
% of EI in income to achieve 'employment'	99.22%	42.84%	3.63%	58.43%	0.02%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.16 Average characteristics of the worst-off in Wave 2: 2010 - 2012

	Full sample N = 18,855	Income N = 1,181	Equivalent Income N = 1,181	Life satisfaction N = 1,181	Self-assessed health N = 1,181	Unemployment N = 1,181
Life satisfaction (mean between 1-7)	5.27	4.85	3.92	1.00	3.62	4.52
Equivalised income (£/month)	1,899.41	245.51	905.58	1,291.07	1,357.94	996.61
Average equivalised income (£/month)	1,911.14	641.07	1,037.44	1,252.33	1,307.44	1,050.07
Health aspect						
Self-assessed health (mean between 1-5)	2.38	2.75	4.16	3.47	5.00	2.85
Excellent and very good health (in %)	56.85	41.45	0.34	27.61	0.00	38.56
Good health (in %)	33.58	35.90	5.50	20.14	0.00	34.96
Fair and poor health (in %)	9.58	22.65	94.16	52.25	100.00	26.47
Having long-term disability	24.14	32.85	69.97	57.37	94.58	31.86
Onset of disability	7.40	8.72	12.19	7.75	7.35	7.55
Disabled for 1-2 years	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 2-3 years	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 3+ years	0.00	0.00	0.00	0.00	0.00	0.00
Employment aspect						
Employed (in %)	95.65	21.10	19.64	30.65	11.60	0.00
Unemployed (in %)	0.25	21.69	55.63	14.14	5.93	100.00
Not active in labour market (in %)	4.10	57.20	24.72	55.21	82.47	0.00
Marital status						
Married and as married (in %)	71.21	39.20	48.94	51.99	53.85	43.18
Single (in %)	19.77	40.47	28.20	24.05	13.89	46.66
Others (in %)	9.02	20.33	22.86	23.96	32.26	10.16
Age (mean)	42.30	44.44	46.59	49.64	59.02	36.52
Male	47.16	46.99	47.93	39.97	39.54	57.83
Education: University (in %)	41.63	23.58	53.01	16.54	16.41	18.37
Own home outright (in %)	20.42	28.38	22.56	24.07	34.07	14.86
Living with others (in %)	90.54	63.08	75.02	77.98	71.21	86.19
Having children (in %)	40.42	26.67	33.53	31.07	16.43	43.14
Living in rural area (in %)	25.56	21.20	18.81	20.76	20.54	16.51
Having high social status (in %)	41.51	31.39	45.99	25.98	34.72	31.03
Having middle social status (in %)	40.60	48.43	35.86	44.36	45.14	34.48
Having low social status (in %)	17.89	20.18	18.14	29.66	20.14	34.48
WTP for perfect health (£/month)	1,664.23	235.44	905.44	1,282.63	1,357.59	964.57
% of EI to achieve perfect health	12.38%	4.10%	0.02%	0.65%	0.03%	3.21%
WTP for being employed (£/month)	9.30	158.20	855.68	608.37	185.03	991.64
% of EI to achieve 'employment'	99.51%	35.56%	5.51%	52.88%	86.37%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.17 Average characteristics of the worst-off in Wave 3: 2011 - 2013

	Full sample N = 21,544	Income N = 826	Equivalent Income N = 826	Life satisfaction N = 826	Self-assessed health N = 826	Unemployment N = 826
Life satisfaction (mean between 1-7)	5.15	4.84	4.00	1.00	3.74	4.41
Equivalised income (£/month)	2,049.05	292.15	996.11	1,599.42	1,397.71	1,078.31
Average equivalised income (£/month)	2,027.86	715.16	1,089.62	1,547.22	1,381.36	1,181.47
Health aspect						
Self-assessed health (mean between 1-5)	2.26	2.64	4.19	2.88	5.00	2.71
Excellent and very good health (in %)	63.17	49.03	4.58	45.00	0.00	44.80
Good health (in %)	26.18	27.97	3.76	19.62	0.00	31.22
Fair and poor health (in %)	10.65	23.00	95.78	35.38	0.00	23.98
Having long-term disability	24.49	34.23	69.02	44.55	94.31	32.94
Onset of disability	8.68	10.30	14.71	8.65	7.92	9.91
Disabled for 1-2 years	2.65	3.04	5.52	3.12	5.47	4.37
Disabled for 2-3 years	0.00	0.00	0.00	0.00	0.00	0.00
Disabled for 3+ years	0.00	0.00	0.00	0.00	0.00	0.00
Employment aspect						
Employed (in %)	95.58	22.27	26.14	39.87	17.23	0.00
Unemployed (in %)	0.28	23.56	49.95	11.73	5.96	100.00
Not active in labour market (in %)	4.13	54.17	23.83	48.40	76.81	0.00
Marital status						
Married and as married (in %)	70.30	41.98	51.51	56.19	56.37	41.15
Single (in %)	20.61	39.14	29.51	25.94	16.59	48.30
Others (in %)	9.09	18.88	18.98	17.87	27.04	10.55
Age (mean)	42.34	44.03	45.07	47.65	55.89	36.49
Male	46.99	48.85	43.81	40.24	41.06	59.40
Education: University (in %)	43.34	22.05	59.76	22.04	18.68	21.40
Own home outright (in %)	20.04	26.40	20.55	27.61	30.06	14.39
Living with others (in %)	90.05	65.99	77.91	81.67	72.41	86.07
Having children (in %)	41.10	26.49	37.86	31.53	19.80	42.53
Living in rural area (in %)	25.09	15.69	17.14	22.55	20.90	15.40
Having high social status (in %)	42.01	24.32	38.57	31.91	30.05	26.47
Having middle social status (in %)	40.19	56.76	40.61	44.72	46.11	44.12
Having low social status (in %)	17.80	18.92	20.82	23.37	23.83	29.42
WTP for perfect health (£/month)	1,748.18	276.52	995.99	1,558.68	1,397.37	1,030.76
% of EI to achieve perfect health	14.68%	5.35%	0.01%	2.55%	0.02%	4.41%
WTP for being employed (£/month)	14.22	198.59	922.11	651.65	206.18	1,072.93
% of EI to achieve 'employment'	99.31%	32.02%	7.43%	59.26%	85.25%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.18 Average characteristics of the worst-off in Wave 4: 2012 - 2014

	Full sample N = 21,984	Income N = 1,074	Equivalent Income N = 1,074	Life satisfaction N = 1,074	Self-assessed health N = 1,074	Unemployment N = 1,074
Life satisfaction (mean between 1-7)	5.11	4.76	3.80	1.00	3.58	4.33
Equivalised income (£/month)	2,154.88	330.00	1,027.30	1,755.68	1,498.45	1,138.40
Average equivalised income (£/month)	2,143.34	795.83	1,150.18	1,712.13	1,508.16	1,201.39
Health aspect						
Self-assessed health (mean between 1-5)	2.24	2.62	4.21	3.04	5.00	2.76
Excellent and very good health (in %)	64.52	51.21	0.19	40.97	0.00	43.84
Good health (in %)	25.02	25.26	3.35	20.02	0.00	27.67
Fair and poor health (in %)	10.46	23.53	96.46	39.01	100.00	28.49
Having long-term disability	23.80	33.86	70.03	48.97	94.41	30.93
Onset of disability	7.81	10.24	15.00	8.68	8.33	8.11
Disabled for 1-2 years	3.77	4.53	7.96	5.31	5.05	3.78
Disabled for 2-3 years	1.63	2.05	3.06	1.74	3.17	1.51
Disabled for 3+ years	0.00	0.00	0.00	0.00	0.00	0.00
Employment aspect						
Employed (in %)	95.51	21.23	23.46	38.92	15.74	0.00
Unemployed (in %)	0.21	23.18	54.84	10.06	6.05	100.00
Not active in labour market (in %)	4.28	55.59	21.69	51.02	78.21	0.00
Marital status						
Married and as married (in %)	70.04	38.62	49.44	53.96	54.66	40.51
Single (in %)	20.70	42.07	29.55	24.60	16.14	47.99
Others (in %)	9.26	19.31	21.01	21.44	29.20	11.50
Age (mean)	42.61	44.09	45.10	48.57	56.89	36.13
Male	46.84	46.65	45.34	39.11	39.85	56.89
Education: University (in %)	44.54	23.43	55.21	21.89	19.05	21.37
Own home outright (in %)	20.17	29.83	20.73	29.32	29.77	15.74
Living with others (in %)	90.03	66.20	77.37	80.73	71.32	88.64
Having children (in %)	41.03	30.07	38.18	28.86	18.72	43.95
Living in rural area (in %)	25.15	19.63	18.39	23.90	22.20	16.77
Having high social status (in %)	42.67	25.70	36.76	28.74	35.03	16.00
Having middle social status (in %)	39.63	49.07	43.08	44.86	39.55	48.00
Having low social status (in %)	17.69	25.23	20.16	26.40	25.42	36.00
WTP for perfect health (£/month)	1,820.61	311.59	1,027.17	1,723.12	1,498.09	1,099.36
% of EI to achieve perfect health	15.51%	5.58%	0.01%	1.85%	0.02%	3.43%
WTP for being employed (£/month)	5.21	221.85	968.67	612.94	223.49	1,132.72
% of EI to achieve 'employment'	99.76%	32.77%	5.71%	65.09%	85.09%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.19 Average characteristics of the worst-off in Wave 5: 2013 - 2015

	Full sample N = 21,390	Income N = 976	Equivalent Income N = 976	Life satisfaction N = 976	Self-assessed health N = 976	Unemployment N = 976
Life satisfaction (mean between 1-7)	5.11	4.59	3.81	1.00	3.61	4.25
Equivalised income (£/month)	2,229.70	335.62	1,118.99	1,711.41	1,521.44	1,175.87
Average equivalised income (£/month)	2,283.52	895.78	1,285.11	1,734.85	1,553.10	1,302.17
Health aspect						
Self-assessed health (mean between 1-5)	2.32	2.79	4.22	3.13	5.00	2.81
Excellent and very good health (in %)	60.59	44.24	0.31	37.09	0.00	39.49
Good health (in %)	28.16	28.33	2.66	22.23	0.00	33.24
Fair and poor health (in %)	11.24	27.43	97.03	37.09	100.00	27.26
Having long-term disability	22.64	33.98	68.89	49.13	92.93	34.19
Onset of disability	7.09	7.58	12.64	9.63	6.92	9.05
Disabled for 1-2 years	3.44	5.17	8.93	3.76	6.39	4.35
Disabled for 2-3 years	2.13	3.22	5.58	2.99	5.32	3.06
Disabled for 3+ years	1.09	1.26	2.18	1.44	3.41	0.71
Employment aspect						
Employed (in %)	95.39	21.93	31.15	37.91	15.57	0.00
Unemployed (in %)	0.21	20.59	47.64	10.76	5.94	100.00
Not active in labour market (in %)	4.40	57.48	21.21	51.33	78.48	0.00
Marital status						
Married and as married (in %)	69.13	38.97	50.31	56.15	55.49	40.35
Single (in %)	21.84	41.64	28.19	22.23	15.28	50.62
Others (in %)	9.03	19.39	21.50	21.62	29.23	9.03
Age (mean)	42.78	45.47	45.69	49.50	58.04	36.72
Male	46.85	48.87	43.34	41.19	41.50	56.76
Education: University (in %)	45.71	26.06	62.30	21.38	19.61	24.30
Own home outright (in %)	20.98	30.79	21.23	28.60	35.34	15.57
Living with others (in %)	89.86	63.11	77.97	80.23	71.72	87.40
Having children (in %)	40.11	27.56	36.58	28.59	18.14	39.34
Living in rural area (in %)	24.49	19.18	18.95	21.23	21.72	16.91
Having high social status (in %)	43.12	23.47	39.29	27.15	33.33	22.73
Having middle social status (in %)	39.10	55.87	43.83	46.74	42.86	45.45
Having low social status (in %)	17.78	20.66	16.88	26.11	23.81	31.82
WTP for perfect health (£/month)	1,944.40	323.81	1,118.87	1,685.77	1,521.08	1,140.15
% of EI to achieve perfect health	12.80%	3.52%	0.01%	1.50%	0.02%	3.04%
WTP for being employed (£/month)	4.85	208.96	1,025.49	637.38	219.32	1,170.01
% of EI to achieve 'employment'	99.78%	37.74%	8.36%	62.76%	85.58%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.20 Average characteristics of the worst-off in Wave 6: 2014 - 2016

	Full sample N = 20,271	Income N = 607	Equivalent Income N = 607	Life satisfaction N = 607	Self-assessed health N = 607	Unemployment N = 607
Life satisfaction (mean between 1-7)	5.27	4.86	3.95	1.00	3.87	4.62
Equivalised income (£/month)	2,481.91	208.70	1,143.84	1,743.18	1,622.63	1,320.96
Average equivalised income (£/month)	2,381.55	854.47	1,247.46	1,745.56	1,649.17	1,340.57
Health aspect						
Self-assessed health (mean between 1-5)	2.27	2.50	4.24	3.01	5.00	2.74
Excellent and very good health (in %)	62.76	53.71	0.43	42.67	0.00	44.97
Good health (in %)	26.77	26.19	0.18	19.45	0.00	28.62
Fair and poor health (in %)	10.47	20.10	97.83	37.88	0.00	26.41
Having long-term disability	24.51	27.99	72.05	49.28	94.20	35.57
Onset of disability	10.01	7.57	10.94	8.83	8.89	9.42
Disabled for 1-2 years	3.15	3.79	6.97	4.73	3.69	4.41
Disabled for 2-3 years	1.96	2.98	6.18	2.68	4.70	2.41
Disabled for 3+ years	2.04	4.32	6.66	5.05	7.38	2.20
Employment aspect						
Employed (in %)	95.39	16.20	19.13	37.83	14.20	0.00
Unemployed (in %)	0.24	23.07	62.90	10.43	7.83	100.00
Not active in labour market (in %)	4.38	60.73	17.97	51.74	77.97	0.00
Marital status						
Married and as married (in %)	69.82	38.00	45.64	52.83	52.98	42.58
Single (in %)	21.38	47.42	32.12	26.42	17.13	47.58
Others (in %)	8.80	14.58	22.24	20.75	29.89	9.84
Age (mean)	43.18	41.62	46.70	50.38	57.96	37.27
Male	47.25	50.72	44.35	43.04	40.43	53.19
Education: University (in %)	45.86	29.80	48.55	20.78	19.00	22.24
Own home outright (in %)	22.03	21.21	19.51	31.76	32.84	13.83
Living with others (in %)	90.01	63.62	75.80	80.44	71.93	87.05
Having children (in %)	39.50	24.93	32.32	28.24	18.71	40.06
Living in rural area (in %)	24.68	9.13	18.26	23.62	21.74	13.62
Having high social status (in %)	43.36	24.18	33.58	27.41	41.18	22.22
Having middle social status (in %)	38.59	61.54	47.76	50.37	33.33	44.44
Having low social status (in %)	18.05	14.29	18.66	22.22	25.49	33.33
WTP for perfect health (£/month)	2,123.50	203.89	1,143.68	1,706.49	1,622.24	1,269.19
% of EI to achieve perfect health	14.44%	2.30%	0.01%	2.10%	0.02%	3.92%
WTP for being employed (£/month)	8.12	139.18	1,101.55	628.98	366.94	1,314.37
% of EI to achieve 'employment'	99.67%	33.31%	3.70%	63.92%	77.39%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.21 Average characteristics of the worst-off in Wave 7: 2015 - 2017

	Full sample N = 21,051	Income N = 771	Equivalent Income N = 771	Life satisfaction N = 771	Self-assessed health N = 771	Unemployment N = 771
Life satisfaction (mean between 1-7)	5.30	5.06	3.83	1.00	3.55	4.53
Equivalised income (£/month)	2,427.12	314.76	1,151.73	1,743.18	1,652.74	1,279.23
Average equivalised income (£/month)	2,473.76	872.02	1,322.10	1,817.48	1,659.76	1,359.54
Health aspect						
Self-assessed health (mean between 1-5)	2.40	2.64	4.23	3.44	5.00	2.82
Excellent and very good health (in %)	56.71	48.77	0.22	31.25	0.00	42.90
Good health (in %)	31.59	29.05	2.90	14.54	0.00	27.58
Fair and poor health (in %)	11.70	22.18	96.88	54.21	0.00	29.53
Having long-term disability	22.95	30.56	71.56	57.09	94.60	37.39
Onset of disability	7.48	9.41	13.90	8.11	7.51	9.00
Disabled for 1-2 years	4.46	4.44	5.74	4.32	5.83	4.35
Disabled for 2-3 years	1.84	2.02	6.12	2.03	4.92	3.34
Disabled for 3+ years	2.69	2.42	9.18	6.76	10.36	3.34
Employment aspect						
Employed (in %)	95.10	24.38	27.23	33.25	16.69	0.00
Unemployed (in %)	0.27	10.25	52.23	10.20	8.04	100.00
Not active in labour market (in %)	4.64	55.37	20.54	56.54	75.27	0.00
Marital status						
Married and as married (in %)	68.73	40.22	47.09	49.28	53.61	39.86
Single (in %)	22.78	42.81	32.17	28.19	16.47	50.72
Others (in %)	8.49	16.97	20.74	22.53	29.92	9.42
Age (mean)	43.07	43.10	47.45	50.21	57.88	37.76
Male	46.99	49.33	40.51	40.22	42.26	51.26
Education: University (in %)	46.17	29.52	58.38	24.14	22.33	24.65
Own home outright (in %)	2.19	30.12	21.05	29.76	32.97	17.57
Living with others (in %)	90.07	64.40	75.78	77.97	72.77	87.09
Having children (in %)	40.31	31.81	34.04	24.70	18.19	37.27
Living in rural area (in %)	23.12	14.29	17.75	20.53	20.79	16.09
Having high social status (in %)	43.79	26.90	38.84	27.95	36.81	47.22
Having middle social status (in %)	38.66	56.35	38.84	49.49	34.03	38.89
Having low social status (in %)	17.55	16.75	22.31	22.56	29.17	13.89
WTP for perfect health (£/month)	2,166.45	298.31	1,151.60	1,732.54	1,652.37	1,240.01
% of EI to achieve perfect health	10.74%	5.23%	0.01%	0.61%	0.02%	3.07%
WTP for being employed (£/month)	10.51	194.33	1,076.38	604.84	394.83	1,272.85
% of EI to achieve 'employment'	99.57%	38.26%	6.54%	65.30%	76.11%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.22 Average characteristics of the worst-off in Wave 8: 2016 - 2018

	Full sample N = 19,738	Income N = 767	Equivalent Income N = 767	Life satisfaction N = 767	Self-assessed health N = 767	Unemployment N = 767
Life satisfaction (mean between 1-7)	5.26	4.91	3.82	1.00	3.56	4.46
Equivalised income (£/month)	2,512.16	304.78	1,157.13	1,801.91	1,732.44	1,340.40
Average equivalised income (£/month)	2,496.81	969.87	1,349.39	1,807.10	1,757.67	1,480.76
Health aspect						
Self-assessed health (mean between 1-5)	2.41	2.71	4.18	3.48	5.00	2.94
Excellent and very good health (in %)	55.80	43.42	0.59	29.56	0.00	34.82
Good health (in %)	32.48	33.25	4.40	16.69	0.00	33.90
Fair and poor health (in %)	11.73	23.34	95.01	53.75	100.00	31.27
Having long-term disability	23.83	31.93	70.18	59.52	93.56	39.55
Onset of disability	8.34	9.31	12.65	8.89	6.92	9.83
Disabled for 1-2 years	3.40	4.17	9.12	4.18	5.26	5.20
Disabled for 2-3 years	2.75	3.06	5.17	3.23	4.49	3.51
Disabled for 3+ years	3.21	4.72	11.84	6.33	11.41	4.07
Employment aspect						
Employed (in %)	95.29	30.50	27.11	32.38	14.98	0.00
Unemployed (in %)	0.23	18.66	52.67	10.24	5.47	100.00
Not active in labour market (in %)	4.48	50.84	20.21	57.38	79.55	0.00
Marital status						
Married and as married (in %)	68.79	42.86	47.02	49.76	50.77	41.50
Single (in %)	22.71	41.31	34.61	30.31	19.50	50.42
Others (in %)	8.50	15.83	18.37	19.93	29.73	8.08
Age (mean)	43.47	44.23	46.28	49.88	58.67	37.84
Male	47.24	47.32	42.09	37.81	39.48	50.06
Education: University (in %)	48.36	30.19	59.57	21.80	20.15	25.25
Own home outright (in %)	22.15	30.90	21.56	28.97	31.65	18.25
Living with others (in %)	89.48	63.25	76.93	77.93	69.74	87.94
Having children (in %)	39.87	33.06	34.13	25.45	18.42	37.15
Living in rural area (in %)	23.60	16.77	17.72	19.86	20.36	13.10
Having high social status (in %)	44.42	27.04	40.28	24.44	38.76	24.00
Having middle social status (in %)	38.27	51.57	36.49	52.96	43.41	32.00
Having low social status (in %)	17.31	21.38	23.22	22.59	17.83	44.00
WTP for perfect health (£/month)	2,253.18	292.45	1,156.99	1,790.98	1,732.03	1,340.26
% of EI to achieve perfect health	10.31%	4.05%	0.01%	0.61%	0.02%	0.01%
WTP for being employed (£/month)	7.71	179.08	1,083.26	625.08	208.21	1,333.72
% of EI to achieve ‘employment’	99.69%	41.24%	6.38%	65.31%	87.98%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.23 Average characteristics of the worst-off in Wave 9: 2017 - 2019

	Full sample N = 17,760	Income N = 771	Equivalent Income N = 771	Life satisfaction N = 771	Self-assessed health N = 771	Unemployment N = 771
Life satisfaction (mean between 1-7)	5.17	4.77	3.76	1.00	3.47	4.41
Equivalised income (£/month)	2,608.22	317.89	1,172.13	2,028.55	1,892.83	1,469.14
Average equivalised income (£/month)	2,595.40	929.41	1,392.51	2,021.39	1,839.36	1,588.68
Health aspect						
Self-assessed health (mean between 1-5)	2.49	2.80	4.21	3.50	5.00	2.91
Excellent and very good health (in %)	51.97	40.99	0.00	28.08	0.00	38.74
Good health (in %)	35.38	33.98	4.25	17.65	0.00	28.83
Fair and poor health (in %)	12.66	25.03	95.75	54.27	100.00	32.43
Having long-term disability	25.23	37.01	70.48	61.57	95.03	39.48
Onset of disability	8.58	11.97	13.76	8.15	6.78	10.67
Disabled for 1-2 years	4.02	4.56	9.26	5.69	5.88	5.55
Disabled for 2-3 years	2.18	3.28	6.22	3.36	4.73	3.27
Disabled for 3+ years	4.18	7.12	13.36	8.80	12.66	5.83
Employment aspect						
Employed (in %)	94.86	33.25	27.59	33.49	17.22	0.00
Unemployed (in %)	0.23	19.17	51.42	9.67	7.08	100.00
Not active in labour market (in %)	4.90	47.57	20.99	56.84	75.71	0.00
Marital status						
Married and as married (in %)	68.90	42.06	49.23	49.82	51.65	42.99
Single (in %)	22.56	40.28	30.65	29.99	19.74	47.86
Others (in %)	8.54	17.66	20.12	20.19	28.61	9.15
Age (mean)	44.01	44.97	46.95	49.76	57.05	37.76
Male	46.81	46.82	42.22	41.04	40.09	47.88
Education: University (in %)	49.20	30.16	58.61	25.96	25.18	26.76
Own home outright (in %)	23.18	32.09	25.12	31.99	30.17	20.05
Living with others (in %)	88.99	60.73	77.59	77.83	72.69	89.48
Having children (in %)	38.49	32.55	33.73	25.21	18.81	38.99
Living in rural area (in %)	24.48	15.48	17.92	24.41	22.43	16.16
Having high social status (in %)	45.03	32.14	35.89	34.62	35.86	34.38
Having middle social status (in %)	37.65	52.98	45.45	37.41	40.00	40.63
Having low social status (in %)	17.33	14.88	18.66	27.97	24.14	25.00
WTP for perfect health (£/month)	2,387.39	307.06	1,171.99	2,017.81	1,892.43	1,436.14
% of EI to achieve perfect health	8.47%	3.41%	0.01%	0.53%	0.02%	2.25%
WTP for being employed (£/month)	7.16	191.19	1,092.01	2,017.81	374.82	1,461.81
% of EI to achieve 'employment'	99.73%	39.86%	6.84%	0.53%	80.20%	0.50%

Source: Own calculations based on The UK longitudinal study

Table B.24 Average characteristics of the worst-off in Wave 10: 2018 - 2020

	Full sample N = 16,702	Income N = 649	Equivalent Income N = 649	Life satisfaction N = 649	Self-assessed health N = 649	Unemployment N = 649
Life satisfaction (mean between 1-7)	5.16	4.67	3.62	1.00	3.50	4.35
Equivalised income (£/month)	2,713.32	256.78	1,194.98	1,839.18	1,957.27	1,435.03
Average equivalised income (£/month)	N/A	N/A	N/A	N/A	N/A	N/A
Health aspect						
Self-assessed health (mean between 1-5)	2.50	2.77	4.20	3.67	5.00	3.06
Excellent and very good health (in %)	52.57	41.29	0.28	23.50	0.00	31.67
Good health (in %)	33.82	35.90	3.98	15.53	0.00	31.21
Fair and poor health (in %)	13.61	22.80	95.73	60.97	100.00	37.12
Having long-term disability	25.40	32.18	69.61	62.37	94.71	40.83
Onset of disability	8.21	8.31	11.04	6.08	6.86	7.81
Disabled for 1-2 years	3.93	4.89	9.28	6.90	4.21	6.42
Disabled for 2-3 years	2.65	2.61	4.96	3.94	4.21	4.51
Disabled for 3+ years	4.89	6.03	12.48	11.00	19.19	7.47
Employment aspect						
Employed (in %)	94.93	38.16	23.47	33.62	16.98	0.00
Unemployed (in %)	0.21	16.93	58.32	11.97	6.42	100.00
Not active in labour market (in %)	4.86	44.91	18.21	54.42	76.60	0.00
Marital status						
Married and as married (in %)	69.29	41.65	50.43	45.35	51.86	41.49
Single (in %)	22.03	38.94	32.81	32.62	19.20	50.79
Others (in %)	8.68	19.41	16.76	22.03	28.94	7.72
Age (mean)	44.39	44.50	45.93	49.23	58.71	38.60
Male	46.05	45.52	43.53	38.69	39.26	49.36
Education: University (in %)	50.29	33.53	54.48	26.60	22.14	27.33
Own home outright (in %)	23.27	27.27	23.18	26.29	32.70	20.15
Living with others (in %)	88.92	62.02	79.52	76.47	75.91	87.17
Having children (in %)	38.30	35.99	34.71	25.29	19.16	37.32
Living in rural area (in %)	24.42	16.64	17.09	18.21	20.77	15.67
Having high social status (in %)	45.46	31.71	36.30	29.03	32.23	28.57
Having middle social status (in %)	37.58	51.22	43.15	43.32	44.63	46.43
Having low social status (in %)	16.97	17.07	20.55	27.65	23.14	25.00
WTP for perfect health (£/month)	2,491.34	247.16	1,194.82	1,833.29	1,956.83	1,415.30
% of EI to achieve perfect health	8.18%	3.75%	0.01%	0.32%	0.02%	1.37%
WTP for being employed (£/month)	3.36	142.09	1,138.64	749.26	329.61	1,427.87
% of EI to achieve 'employment'	99.88%	44.66%	4.71%	59.26%	83.16%	0.50%

Source: Own calculations based on The UK longitudinal study

B.6 Regression results

Table B.25 Ordered Logit models: Income versus Average Income in OLOGIT and BUCOLOGIT

	BUCOLOGIT (Yit)	BUCOLOGIT (Average Yit)	OLOGIT (Yit)	OLOGIT (Average Yit)
Log Equivalised income/ Average income per capita	0.109***	0.122**	0.284***	0.340***
	(0.03)	(0.04)	(0.01)	(0.01)
Excellent or Very Good Health	0.856***	0.856***	1.517***	1.509***
	(0.04)	(0.04)	(0.02)	(0.02)
Good health	0.497***	0.496***	0.725***	0.719***
	(0.04)	(0.04)	(0.02)	(0.02)
Employed and self-employed	0.472**	0.475**	0.410***	0.411***
	(0.16)	(0.16)	(0.11)	(0.11)
Not active in labour market	0.504**	0.508**	0.573***	0.575***
	(0.17)	(0.17)	(0.11)	(0.11)
Excellent or Very Good Health # University	0.251***	0.251***	0.008	0.007
	(0.07)	(0.07)	(0.03)	(0.03)
Good Health # University	0.171**	0.172**	0.004	0.006
	(0.06)	(0.06)	(0.04)	(0.04)
Year became disabled	-0.076**	-0.076**	-0.056**	-0.056**
	(0.03)	(0.03)	(0.02)	(0.02)
Disabled for 1-2 years	-0.137**	-0.137**	-0.051+	-0.050+
	(0.04)	(0.04)	(0.03)	(0.03)
Disabled for 2-3 years	-0.116+	-0.116+	-0.019	-0.019
	(0.06)	(0.06)	(0.04)	(0.04)
Disabled for 3 years or more	-0.118+	-0.119+	-0.070+	-0.070+
	(0.07)	(0.07)	(0.04)	(0.04)
Age	-0.106+	-0.105+	-0.108***	-0.108***
	(0.06)	(0.06)	(0.01)	(0.01)
Age squared	0.003**	0.003**	0.001***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Age cubic	-0.000+	-0.000+	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Married or as married	0.382***	0.382***	0.509***	0.499***
	(0.07)	(0.07)	(0.02)	(0.02)
Single	0.100	0.099	-0.011	-0.011
	(0.07)	(0.07)	(0.02)	(0.02)
Education: University	-0.186+	-0.187+	-0.026	-0.033
	(0.11)	(0.11)	(0.03)	(0.03)
Owned home outright	0.085+	0.087+	0.175***	0.176***
	(0.05)	(0.05)	(0.01)	(0.01)
Living with others	-0.024	-0.019	-0.087***	-0.093***
	(0.06)	(0.06)	(0.02)	(0.02)
Having children	0.056	0.055	0.052***	0.063***
	(0.04)	(0.04)	(0.01)	(0.01)
Living in rural area	0.119+	0.122+	0.078***	0.076***
	(0.07)	(0.07)	(0.01)	(0.01)
Higher social status	0.016	0.016	-0.008	-0.024
	(0.05)	(0.05)	(0.02)	(0.02)
Middle social status	0.017	0.016	-0.050**	-0.056***
	(0.04)	(0.05)	(0.02)	(0.02)
Wave dummies	Yes	Yes	Yes	Yes
Pseudo R^2	0.0148	0.0146	0.0391	0.0394
Log likelihood	-93544.244	-93555.405	-190241.34	-190195.01
Observations	131,263	131,263	131,263	131,263

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Note: Baseline: having fair and poor health, being unemployed, not disabled, neither married nor single, having no university degree, not own home, living alone, having no dependent children, living in urban area and having lower social status

Table B.26 Robustness Check: OLS - FE - OLOGIT - BUCOLOGIT

	OLS	Fixed Effect	Ordered Logit RE	Ordered Logit FE (BUCOLOGIT)
Log Equivalised income	0.176^{***}	0.059^{***}	0.280^{***}	0.113^{***}
	(0.01)	(0.01)	(0.01)	(0.02)
Excellent or Very Good Health	1.025^{***}	0.511^{***}	1.536^{***}	0.890^{***}
	(0.01)	(0.02)	(0.02)	(0.04)
Good health	0.591^{***}	0.304^{***}	0.738^{***}	0.504^{***}
	(0.01)	(0.02)	(0.02)	(0.03)
Employed and self-employed	0.318^{***}	0.348^{***}	0.403^{***}	0.599^{***}
	(0.07)	(0.07)	(0.09)	(0.13)
Not active in labour market	0.381^{***}	0.356^{***}	0.534^{***}	0.622^{***}
	(0.07)	(0.07)	(0.10)	(0.14)
Excellent or Very Good Health # University	0.085^{***}	0.087^{**}	0.028	0.267^{***}
	(0.02)	(0.03)	(0.03)	(0.06)
Good Health # University	0.049^{*}	0.077^{**}	0.018	0.191^{***}
	(0.02)	(0.03)	(0.03)	(0.05)
Year became disabled	-0.049^{***}	-0.061^{***}	-0.072^{***}	-0.114^{***}
	(0.01)	(0.01)	(0.02)	(0.02)
Disabled for 1-2 years	-0.052^{**}	-0.082^{***}	-0.071^{**}	-0.160^{***}
	(0.02)	(0.02)	(0.03)	(0.04)
Disabled for 2-3 years	-0.013	-0.067^{**}	-0.015^{+}	-0.127^{*}
	(0.03)	(0.02)	(0.04)	(0.05)
Disabled for 3 years or more	-0.041	-0.074^{**}	-0.079^{*}	-0.155^{**}
	(0.02)	(0.03)	(0.03)	(0.06)
Age	-0.067^{***}	-0.039^{*}	-0.104^{***}	-0.074
	(0.01)	(0.02)	(0.01)	(0.05)
Age squared	0.001^{***}	0.001^{***}	0.001^{***}	0.002^{**}
	(0.00)	(0.00)	(0.00)	(0.00)
Age cubic	-0.000^{*}	-0.000^{*}	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Married or as married	0.331^{***}	0.230^{***}	0.493^{***}	0.409^{***}
	(0.01)	(0.02)	(0.02)	(0.05)
Single	-0.007	0.075^{**}	-0.009	0.111^{+}
	(0.01)	(0.03)	(0.02)	(0.06)
Education: University	-0.052^{**}	-0.067^{+}	-0.048^{+}	-0.187^{*}
	(0.02)	(0.04)	(0.03)	(0.09)
Owned home outright	0.100^{***}	0.043^{**}	0.176^{***}	0.093^{*}
	(0.01)	(0.02)	(0.01)	(0.04)
Living with others	-0.063^{***}	-0.040^{+}	-0.088^{***}	-0.072
	(0.01)	(0.02)	(0.02)	(0.05)
Having children	0.033^{***}	0.024^{+}	0.050^{***}	0.038
	(0.01)	(0.01)	(0.01)	(0.03)
Living in rural area	0.049^{***}	0.048^{*}	0.077^{***}	0.101^{+}
	(0.01)	(0.02)	(0.01)	(0.06)
Higher social status	0.023^{*}	-0.003	-0.004	-0.003
	(0.01)	(0.02)	(0.01)	(0.04)
Middle social status	-0.015^{+}	-0.007	-0.045^{***}	-0.010
	(0.01)	(0.02)	(0.01)	(0.04)
Wave dummies	Yes	Yes	Yes	Yes
Constant	3.804^{***}	3.762^{***}		
	(0.12)	(0.52)		
R^2	0.0937			
Adjusted R^2	0.0935			
R^2 within		0.0150		
R^2 between		0.0182		
R^2 overall		0.0154		
Pseudo R^2			0.0396	0.0168
Log likelihood			-253478.18	-132814.30
Observations	173,731	173,731	173,731	173,731

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: The UK longitudinal study: 2009-2020

Table B.27 Robustness Check: Unbalanced Panel versus Balanced Panel

	Unbalanced Panel	Balanced Panel
Log Equivalised income	0.113***	0.162***
	(0.02)	(0.03)
Excellent or Very Good Health	0.890***	0.840***
	(0.04)	(0.06)
Good health	0.504***	0.487***
	(0.03)	(0.05)
Employed and self-employed	0.599***	0.331
	(0.13)	(0.21)
Not active in labour market	0.622***	0.337
	(0.14)	(0.23)
Excellent or Very Good Health # University	0.267***	0.351***
	(0.06)	(0.09)
Good Health # University	0.191***	0.235**
	(0.05)	(0.08)
Year became disabled	-0.114***	-0.117***
	(0.02)	(0.03)
Disabled for 1-2 years	-0.160***	-0.116*
	(0.04)	(0.05)
Disabled for 2-3 years	-0.127*	-0.153*
	(0.05)	(0.07)
Disabled for 3 years or more	-0.155**	-0.164*
	(0.06)	(0.08)
Age	-0.074	-0.169*
	(0.05)	(0.07)
Age squared	0.002**	0.003*
	(0.00)	(0.00)
Age cubic	-0.000	-0.000
	(0.00)	(0.00)
Married or as married	0.409***	0.424***
	(0.05)	(0.08)
Single	0.111+	0.079
	(0.06)	(0.09)
Education: University	-0.187*	-0.071
	(0.09)	(0.15)
Owned home outright	0.093*	0.143**
	(0.04)	(0.05)
Living with others	-0.072	-0.034
	(0.05)	(0.07)
Having children	0.038	0.009
	(0.03)	(0.05)
Living in rural area	0.101+	0.046
	(0.06)	(0.09)
Higher social status	-0.003	-0.074
	(0.04)	(0.07)
Middle social status	-0.010	-0.008
	(0.04)	(0.06)
Wave dummies	Yes	Yes
Pseudo R^2	0.0168	0.0168
Log likelihood	-132814.300	-57783.738
Observations	173,731	67,189

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Baseline: having fair and poor health, being unemployed, not disabled, neither married nor single, having no university degree, not own home, living alone, having no dependent children, living in urban area and having lower social status

B.7 Figures

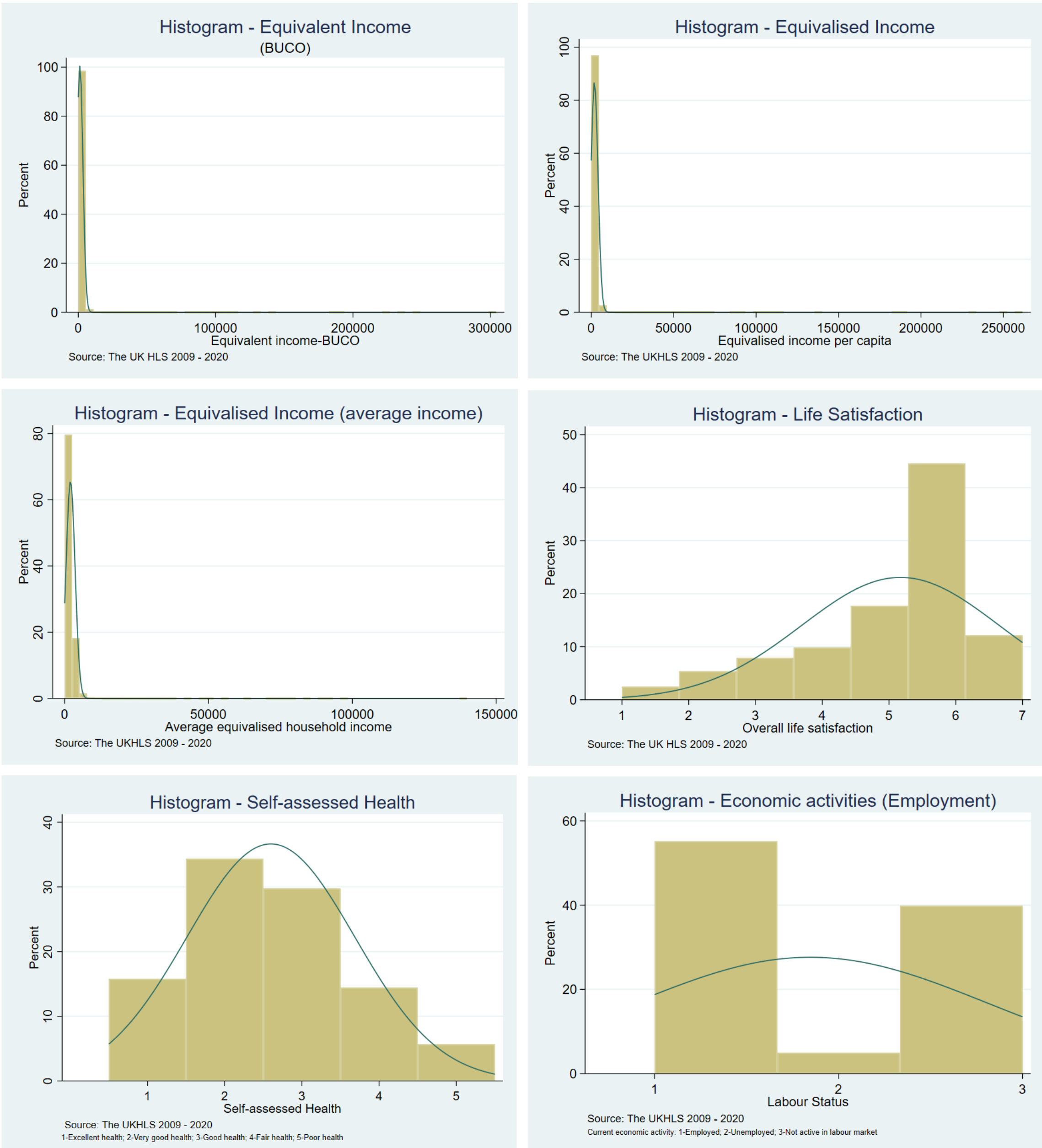


Fig. B.2 Histogram of wellbeing measures and life aspects

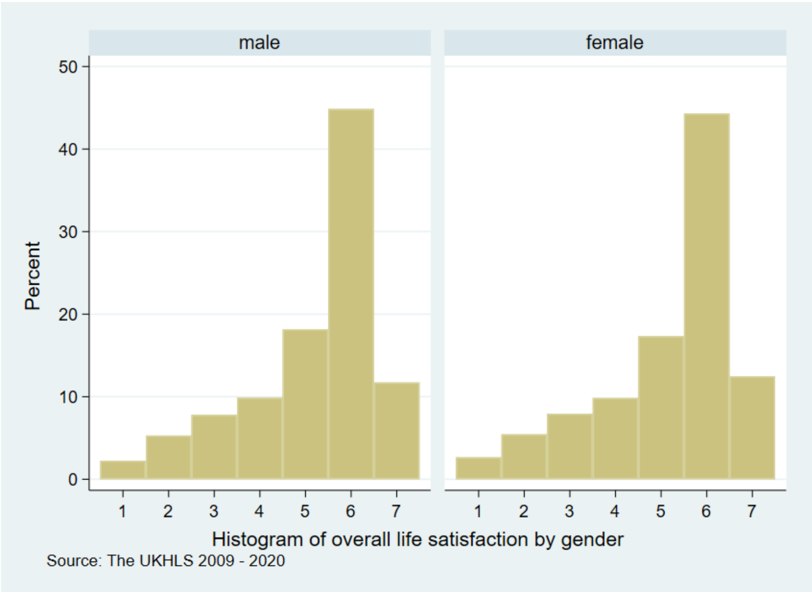


Fig. B.3 Histogram of life satisfaction by gender

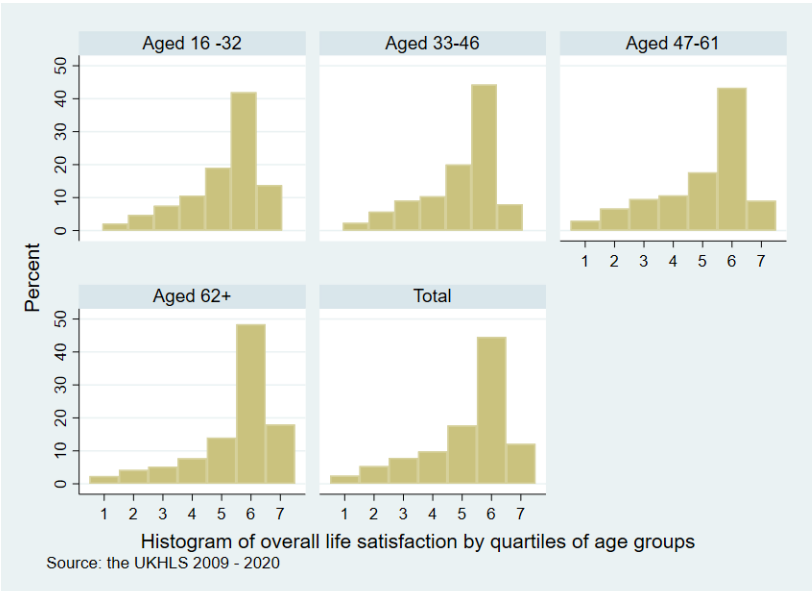


Fig. B.4 Histogram of life satisfaction by age groups

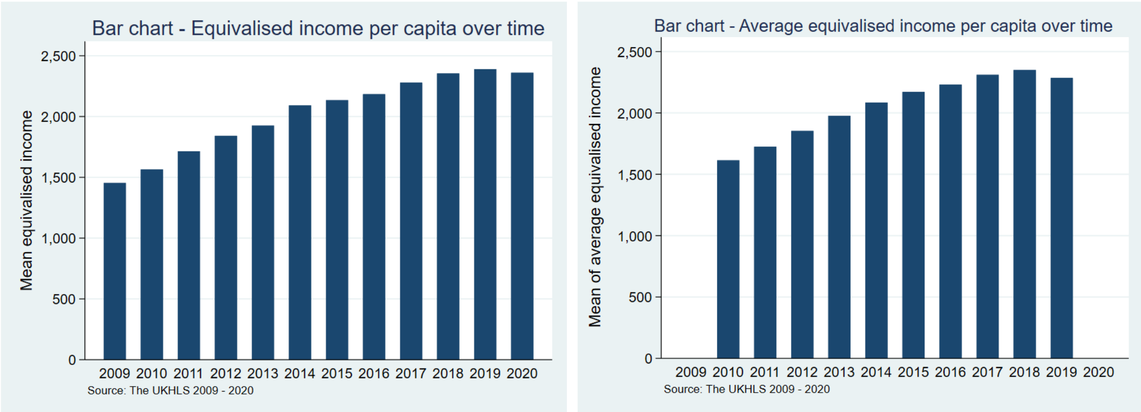


Fig. B.5 Bar chart - Annual Mean values of Equivalised Income and Average Equivalised Income

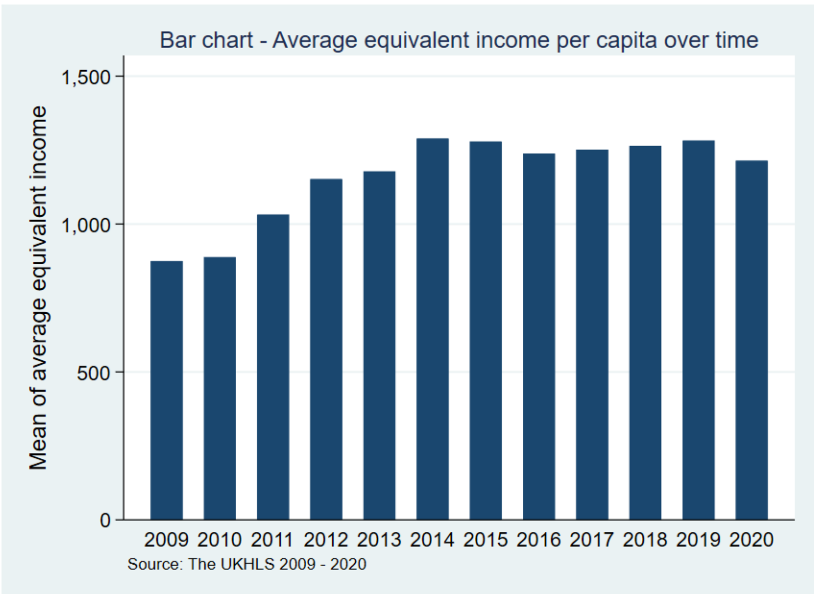


Fig. B.6 Bar chart - Annual Mean values of Equivalent Income

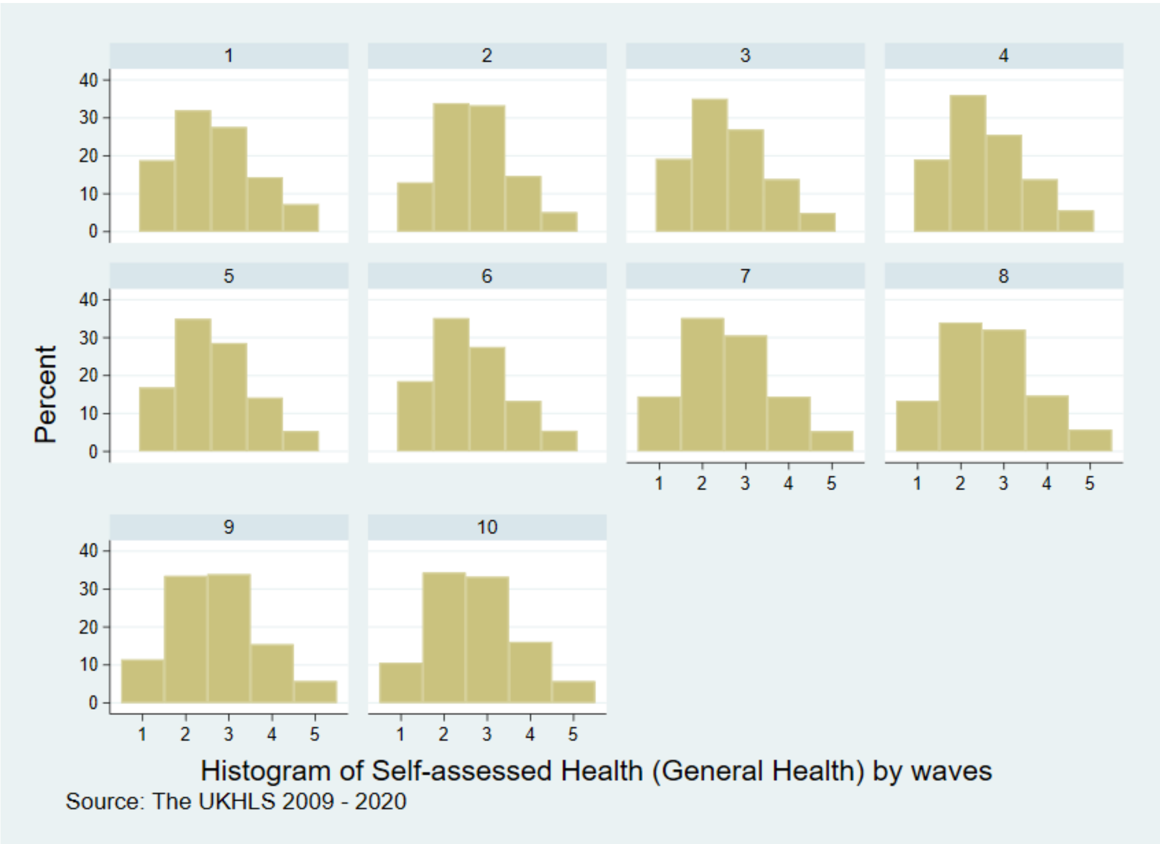


Fig. B.7 Histogram - Self-assessed health by waves

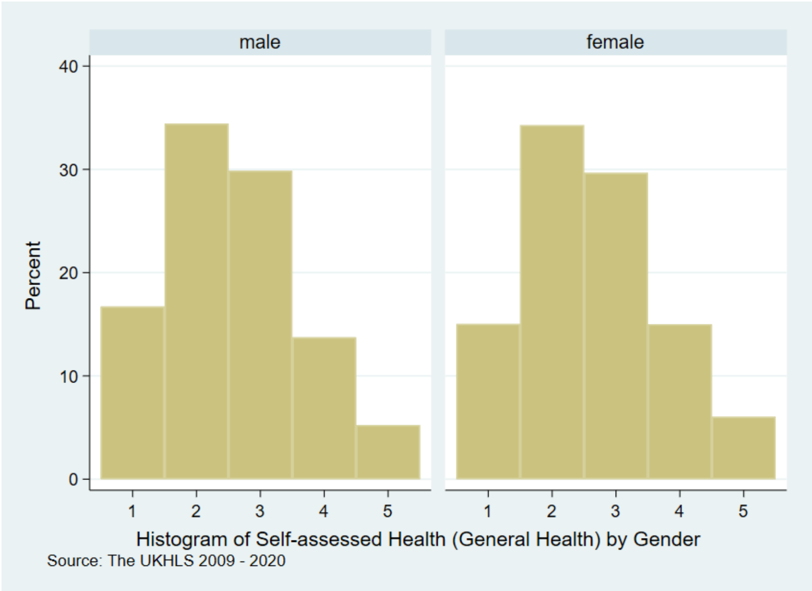


Fig. B.8 Histogram - Self-assessed health by gender

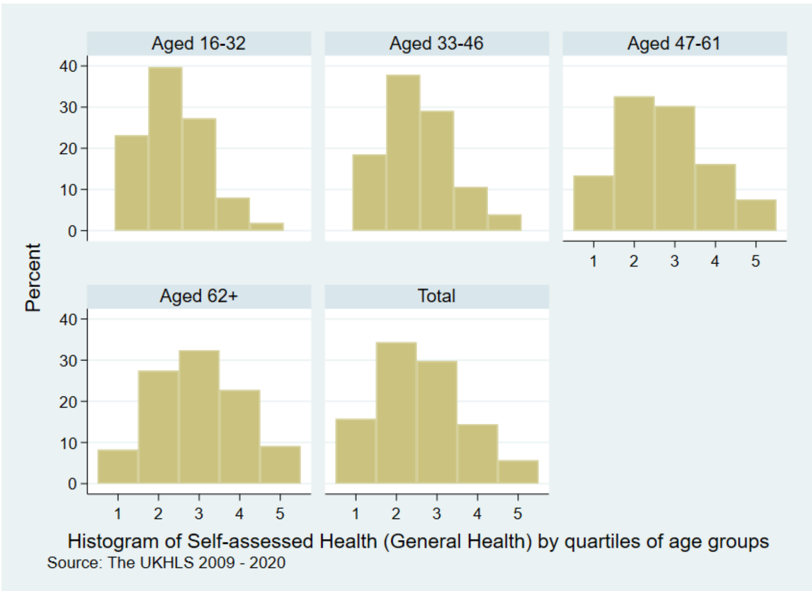


Fig. B.9 Histogram - Self-assessed health by age groups

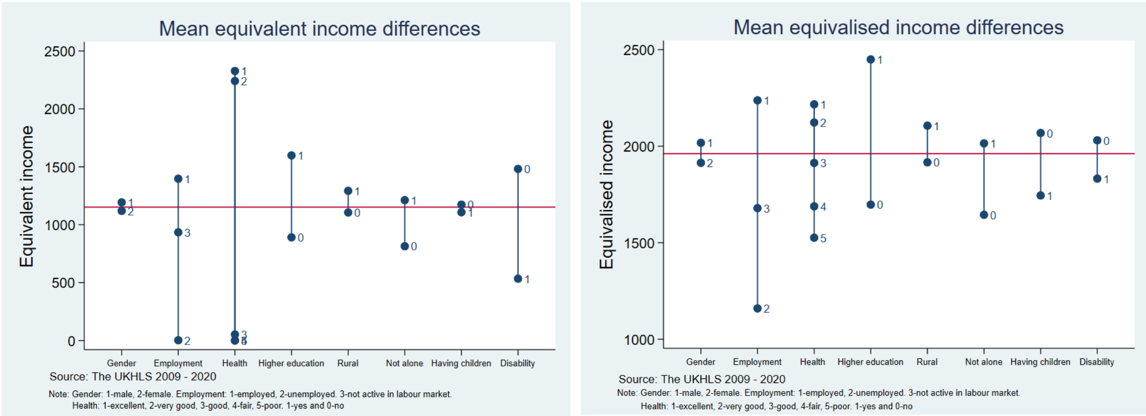


Fig. B.10 Differences in mean of income and equivalent income across groups - pooled data (2009 - 2020)

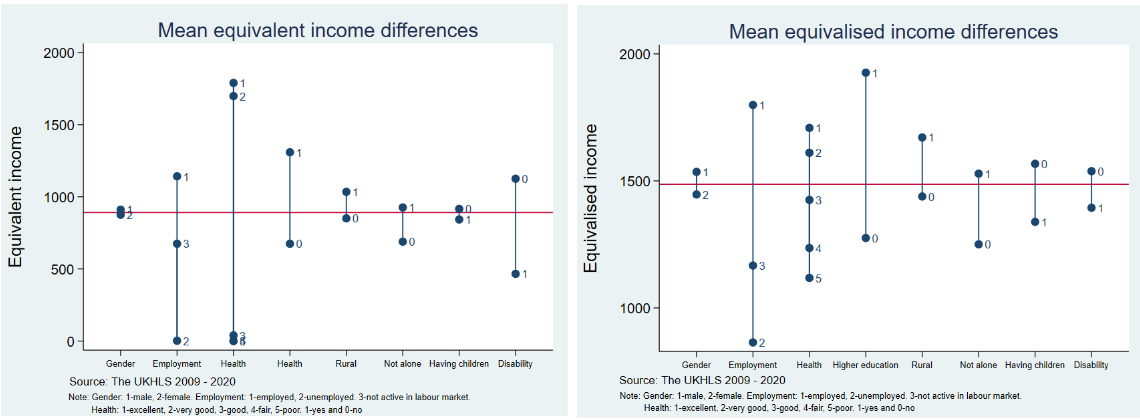


Fig. B.11 Differences in mean of income and equivalent income across groups - Wave 1: 2009-11

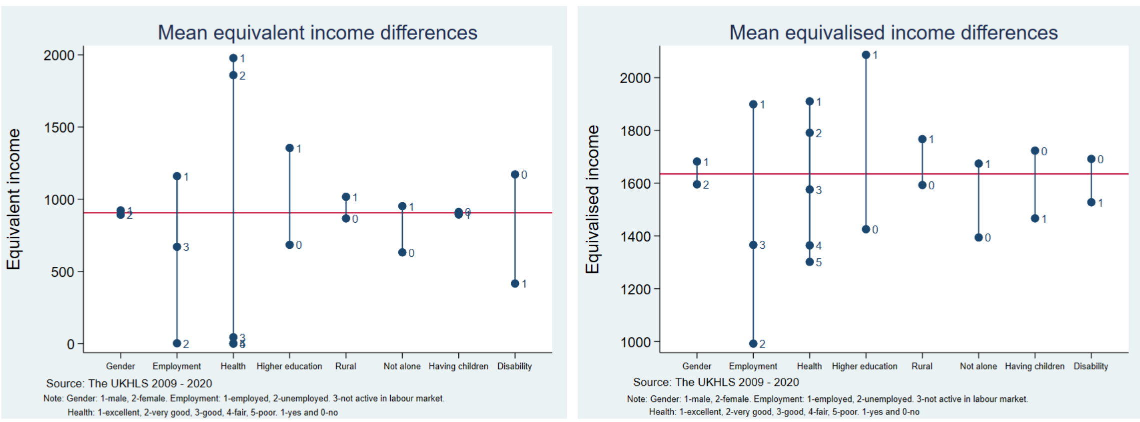


Fig. B.12 Differences in mean of income and equivalent income across groups - Wave 2: 2010-12

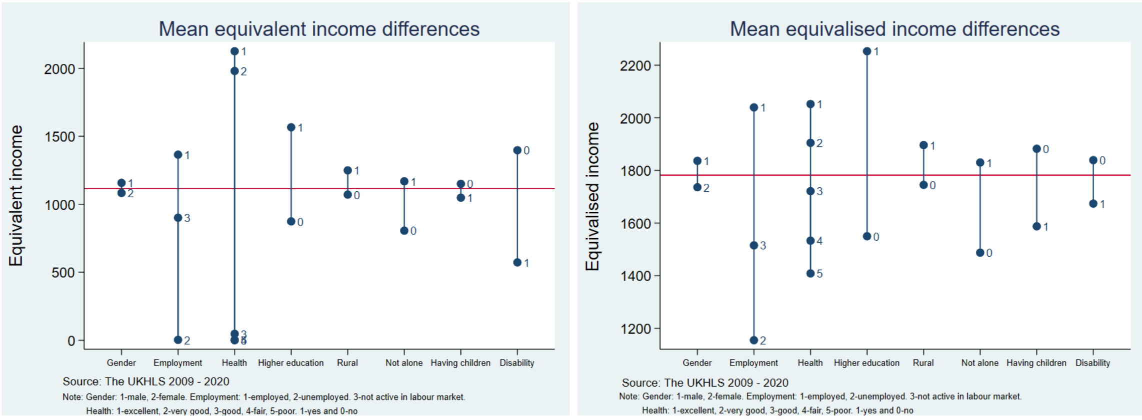


Fig. B.13 Differences in mean of income and equivalent income across groups - Wave 3: 2011-13

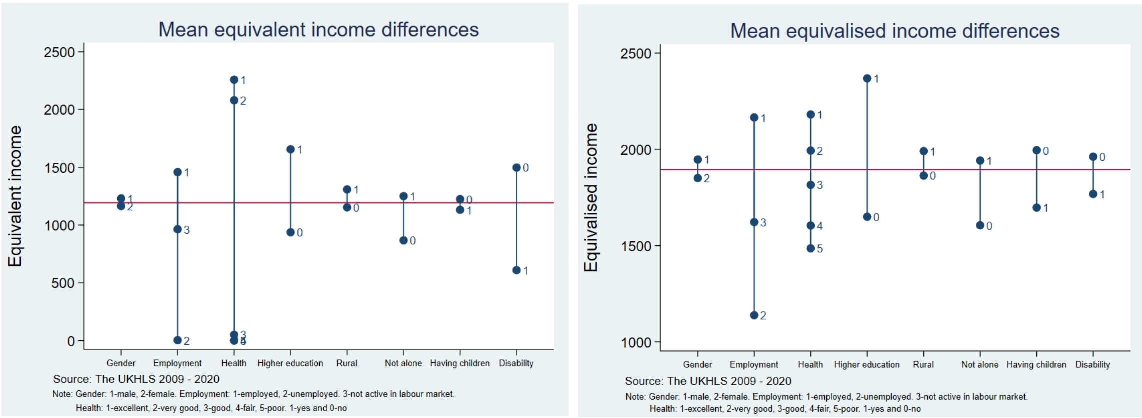


Fig. B.14 Differences in mean of income and equivalent income across groups - Wave 4: 2012-14

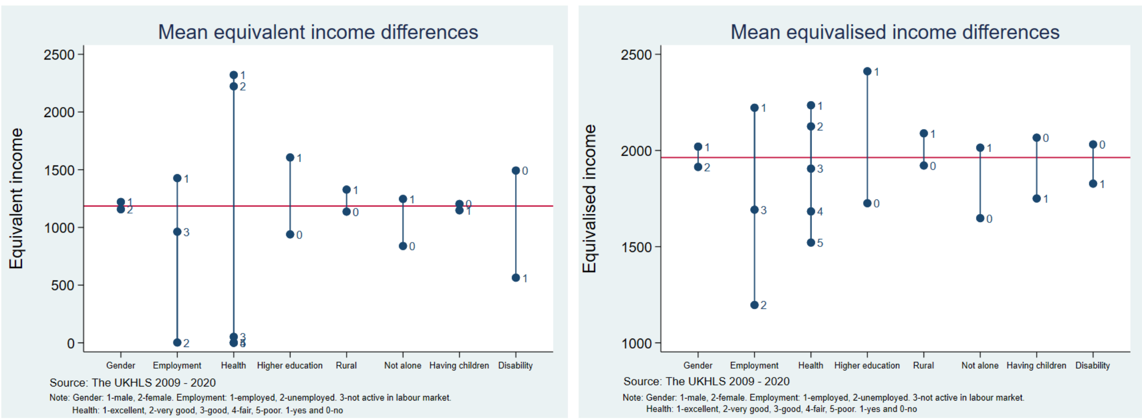


Fig. B.15 Differences in mean of income and equivalent income across groups - Wave 5: 2013-15

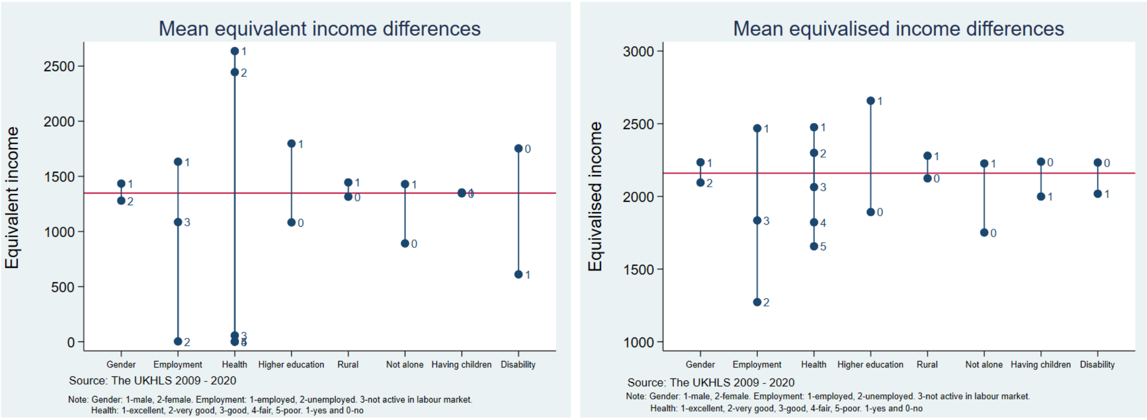


Fig. B.16 Differences in mean of income and equivalent income across groups - Wave 6: 2014-16

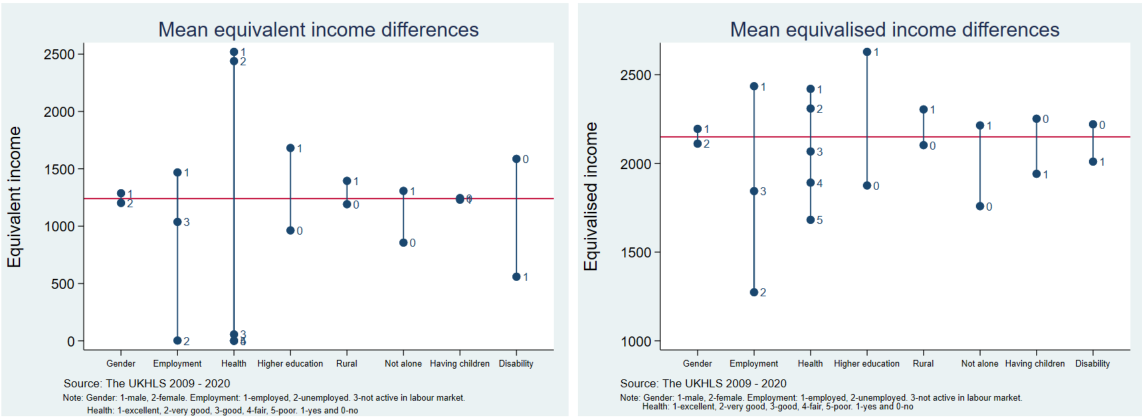


Fig. B.17 Differences in mean of income and equivalent income across groups - Wave 7: 2015-17

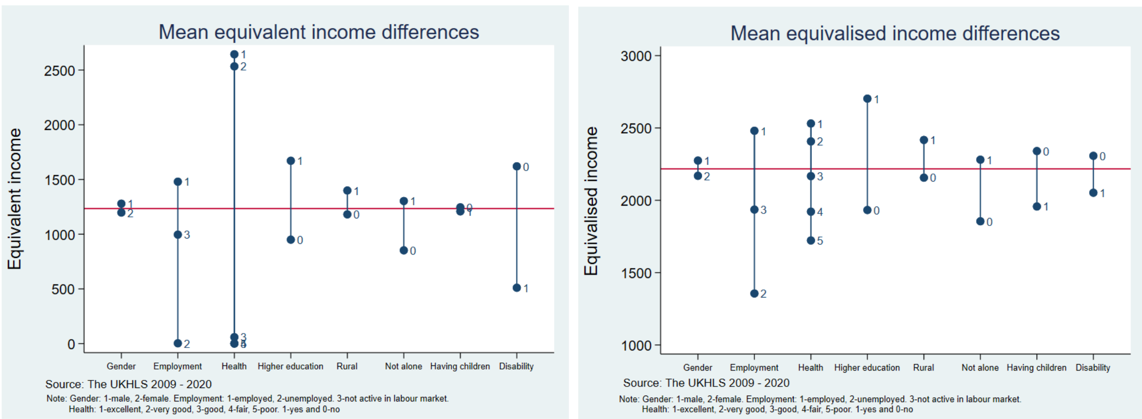


Fig. B.18 Differences in mean of income and equivalent income across groups - Wave 8: 2016-18

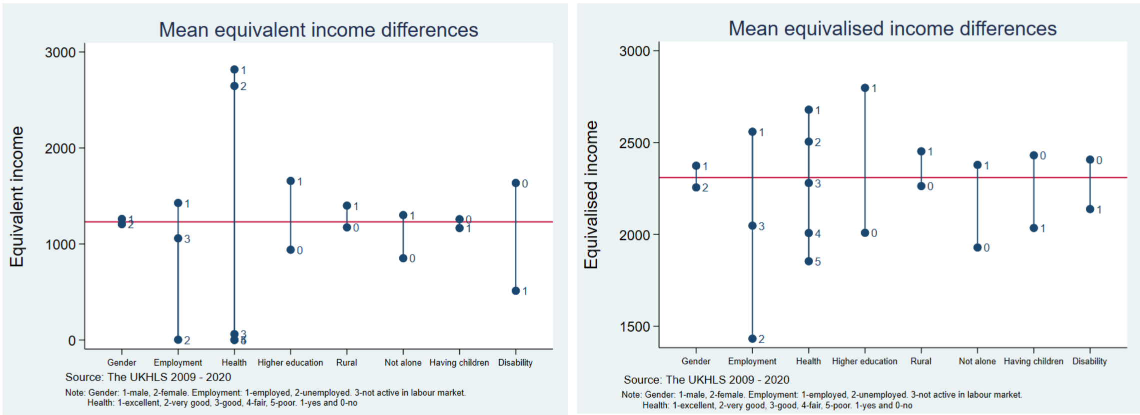


Fig. B.19 Differences in mean of income and equivalent income across groups - Wave 9: 2017-19

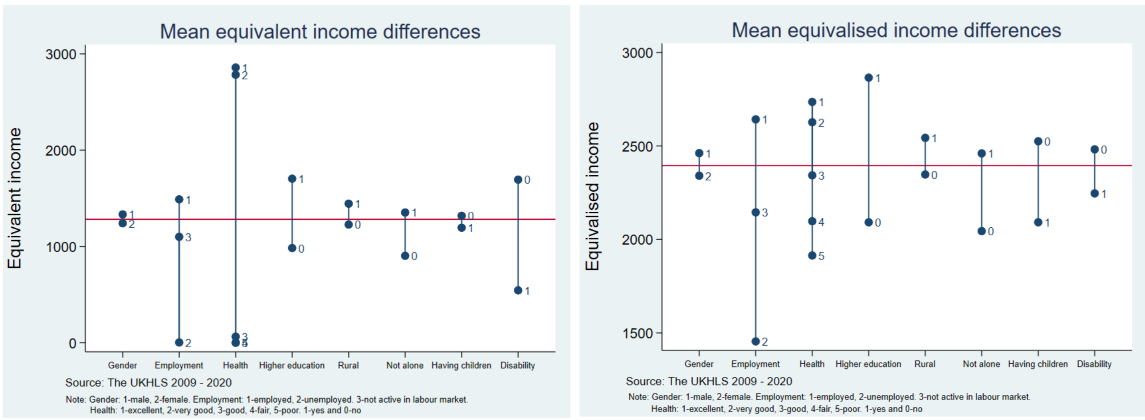


Fig. B.20 Differences in mean of income and equivalent income across groups - Wave 10: 2018-20

B.8 BUC (BUCOLOGIT) programming

The programming code was provided in the study by Dickerson et al. (2014).

capture program drop bucologit

program bucologit version 11.1 syntax varlist [if] [in], Id(varname)

preserve

marksample touse markout ‘touse’ ‘id’

gettoken yraw x : varlist tempvar y qui egen ‘y’ = group(‘yraw’)

qui keep ‘y’ ‘x’ ‘id’ ‘touse’ qui keep if ‘touse’

qui sum ‘y’ local ymax = r(max) forvalues i = 2(1)‘ymax’ qui gen ‘yraw’‘i’ = ‘y’ >= ‘i’ drop ‘y’

tempvar n cut newid qui gen ‘n’ = $_n quireshapelong`yraw', i(`n') j(`cut') quiegen`newid' = group(`id'`cut') sort`newid' clogit`yraw'`x', group(`newid') cluster(`id')$

restore end

Appendix C

Appendices to Chapter 4

C.1 The original DCE design and the pilots

C.1.1 The original DCE design

In the process of generating the DCEs, different designs were created at different stages. The survey designs were then transferred to Qualtrics to set up the online survey. In this section, the designs used in each stage will be explained in detail.

The initial utility function combined all main effects of the seven domains and all of the possible interactions between non-income aspects with disposable income and between physical health accomplishment and mental health accomplishment. In this design, all the priors are 0.

$$U_i = \sum_{n=1}^{N} \beta_n X + \gamma_1 I + \gamma_2 I^2 + \sum_{m=1}^{M} \gamma_m X\#I + \varepsilon_i \tag{C.1}$$

In this initial design, disposable income (I) is not in natural logarithm form but the absolute value of household disposable income. Parameters β_n capture the main effects of the non-income domains which are categorical variables, γ_1 is related to continuous variable (household disposable income), γ_2 is related to income squared and parameters γ_m capture the interactions between income and non-income life domains.

With minimum of 56 choices (i.e. equation C.1 has 56 parameters which were then used in a pairwise exercise), the design for the Qualitative Pilot had 60 rows with six blocks of ten choice tasks each. The choice design software Ngene was used to generate a design based on D-efficiency.

C.1.2 The qualitative pilot

Methods - the survey protocol and the method of analysis

The qualitative pilot was carried out through video interviews using Google Hangout Meets. During the video interview, respondents were asked to complete an online survey with the presence of a researcher (i.e. the author). The video interviews were recorded, and for analysis, they were downloaded as audio-data only. The audio recording and the transcripts were used only for the purpose of the pilot study, which was to summarise feedback from respondents and to amend and improve the survey. Nobody outside the pilot study team could access the original recordings. For participating, the participants of the pilot survey were paid a £15 gift voucher, which was in line with common research practice. Respondents were informed that they could withdraw their interviews at any time within 24 hours after the completion of the video interview without any negative consequences and no reason needed to be given.

Although the information sheet was emailed to the participants beforehand, before the start of the interview, the interviewer (i.e. the author) went through the information sheet and instructions with the participants. Potential participants needed to give informed consent before proceeding with the interview.

During the interview, participants were asked to read the instruction and wording carefully and give comments if any parts were not clear or understandable. Participants were asked to start with the first section of the survey about self-reported questions related to the seven life domains. For each domain, respondents were asked to explain how they interpreted the question. Interviewees had some discussion with the interviewer regarding their views and opinions about the domains and categories belonging to each of them. However, they did not need to answer these self-reported questions if they did not wish to do so. In the second section, they were asked to complete four practice DCE choice tasks. In the practice questions, the ties (i.e those domains that had same levels) had grey shading to signalise that they were the same across the two life scenarios. However, in the actual choice experiments, there was no grey shading, which was meant to see if it was necessary to have the shading in the choice tasks. The interviewer timed how long it took each respondent to complete the four practice questions and asked them if they needed any further explanation or clarification at this stage.

Once participants completed the practice, participants were asked to actually complete the main DCE in their own pace and feedback on spot if they found any pairs of choices that were highly unlikely or did not make sense in practice. Both the practice and the main choice experiment were timed to have a better insight of how it took people to complete the tasks. Toward the end of the main choice task, participants were invited to comment on what they thought of the exercises and give feedback on their experience doing the experiment. The next part of the survey was self-reported questions on demographics and other life aspects, such as education, age, and martial status. Participants did not need to complete these questions but were asked to give feedback on the wording used in them. The last part of the survey was COVID-19 related questions. Similar to the self-reported questions, participants did not need to actually answer these questions but feedback on the wordings and how the questions were set up.

Once participants completed all sections of the survey, they were asked a set of questions related to their experience doing the whole survey and if they could suggest anything to improve the survey. Finally, the interviewer explained the conditions for participants to withdraw their interviews within 24 hours and how to receive the gift card as the payment for their participation.

Results

The invitation email to non-academic non-researcher staff at the University of Sheffield was sent to the volunteer list in June 2020. The register form was opened for five days and had a total of 18 volunteers registered, of which 17 were on the first day. Out of ten participants in the Google Meet interviews, one person failed to submit the online survey, resulting in only nine responses. There were two male and eight female participants. 70% of participants were at the aged of 45 – 54 years old, 20% were 55 – 64 years old and 10% belonged to 25 – 34 age group.

Regarding how respondents interpreted different components of the survey, the results are summarised in three parts including self-reported questions, practice and main DCE, and COVID-19 related questions. Generally, respondents found self-reported questions clear enough for them to understand and no further clarification was needed. In ***Disposable income*** domain, 9/10 participants agreed that having disposable income figures per month was easier to answer than weekly or annual levels. More than half found weekly disposable income levels were more useful then per year figures.

"[. . .]people get paid either on weekly basis or a monthly basis, maybe if you put in, if you were going to ask specifically about per month or per week so maybe if you put in what is your disposable income and then put monthly stroke weekly [. . .]" (R7)

"[. . .] If you say for example you earned a thousand pounds a month obviously it's quite easy to work out per year but if someone had six hundred and thirty seven pounds for example they'd say 'oh my God what's that per year?' so I think it would probably make it a bit more confusing for people if you put it in per year. Most people, ninety nine percent of people I reckon would just look at it per month, so most people get paid monthly or the

majority of people get paid monthly, I know some get paid weekly, but I bet most get paid monthly so monthly is probably the best one to do." (R9)

In ***Employment*** domain, there was some confusion regarding the meaning of "informal care giving". When being asked to distinguish between two categories including "Taking care of the home and family/ Home maker" and "Informal care giving", about half of the participants thought that the latter category could belong to the former.

"I think the only one I didn't quite get is what informal care giving was." (R6)

"I think number six (i.e informal caregiving) is probably a bit more ambiguous so taking care of the home and family/ homemaker I would probably say that they're probably the same as informal care giving in my opinion. I'm not sure I could probably articulate what the difference was between them. I mean informal care giving, I suppose the difference for me informal care giving could be somebody else outside of your home and family so that's probably the only difference I would probably say there is between the two of them." (R9)

Also, all ten participants agreed that informal care giving included taking care of a child or children that had special needs.

"My assumption would have been that it would be for elderly people or sick people. But yes probably if you had a child with additional needs it would be included yes." (R3)

In addition, participants were asked to comment on what they thought of the phrase "home maker" used in one of the categorical answers and to suggest any synonym that covered the group of people who stayed home and took care of the family. Seven of ten respondents believed that the term "home maker" was an old fashion while the other three thought that it was appropriate to use. Some suggestions for alternatives were proposed such as full-time mum/dad/parents, stay-at-home mum/dad/parents.

Regarding ***Physical health*** and ***Mental health*** domains, all participants interpreted the questions as they are meant to be without additional explanation from the interviewer. However, some feedback were to add further clarification to the questions which originally were "In the past 4 weeks, you accomplished less because of your physical health…" and "In the past 4 weeks, you accomplished less because of emotional problems…".

"'in the past four weeks you accomplished less because of your physical health' is that meaning to say less than you would usually? […] So that's what I'm wondering. So say I was disabled or had a long term illness over the last four weeks I wouldn't be doing any less than I had the previous four weeks because my situation hadn't changed but my physical illness would have affected my ability to do things. So if I was answering that question I think I wouldn't fully understand what less means." (R2)

"[…] It might be worth putting in as well, so in the past four weeks you accomplished less because of your physical health, less than what? So is it less than what you

normally accomplish, less than what you normally achieve, is there a benchmark to sort of base it against? So you might want to add something in there for both of them. So for example it could be you accomplished less than a normal week, or what you would normally achieve or something along those lines and then I think people then might have something to sort of benchmark it against. An irregular week, a typical week you know something like that." (R9)

In ***Neighbourhood safety*** domain, a suggestion made by a participant was to clarify what exactly meant by "(your) neighbourhood".

"What exactly do you call your neighbourhood did you cover that initially? Is that immediate neighbourhood; is that a village, a town, a city?" (R4)

In addition, some comments were made regarding how frequent people were concerned about safety of their neighbourhood.

"Maybe there could be more, so hardly ever, some of the time, often maybe there could be another one in there. So all the time, cause some people might feel like that all the time. You know if you live in a really rough area and you're frightened it could be all the time. Probably change the word often to never. Yeah maybe you could just have a few more categories in there." (R8)

Domain ***Housing quality*** was generally straight forward, and all respondents found it clear to understand and answer the question. However, one suggestion was made regarding the categorical answers in self-reported question as:

"Your home is in a reasonable state of repair, has reasonable facilities cooking/ washing and provides reasonable warmth, this is a really picky thing but I would only use the word some for plural more than one so if only one of those things was true I wouldn't tick none of these but I also might feel like some of these is wrong. If it was yes to some or one of these or something, then I would know that was the one for me. Otherwise, if only one was relevant I would feel like I was somewhere between the two. [. . .] I don't know if it's helpful to know the difference between some and one and if it is then I guess you would have them as separate answers but if it isn't it could just be yes to all of these, yes to some maybe in brackets or one of these or none of these." (R2)

Regarding the last domain, Social isolation, most people said that they found the wording confusing due to the current situation of COVID-19 and agreed that the term loneliness sounded better than social isolation.

"It's one that you could get confused by because the circumstances at the moment with the Corona virus means that most people feel isolated in one way or another because life isn't what we're used to, but I think that if I felt lonely and isolated it would be because I

didn't feel connected with people in my home or who are also outside of my home whether that be work colleagues, family or friends." (R3)

"So this for me relates to lockdown and not being able to see anyone else. So you know if you're at home by yourself if you don't have any family or loved ones with you. And you're in your home by yourself you can't see anyone, you can't, unless it's by video chat, and how it would be affecting you." (R7)

"I think some people might not always understand isolation or they might think isolation, they might feel lonely sometimes, but they might not necessarily consider them self isolated." (R10)

The second part of the survey that participants were invited to give feedback on the presentation was the Practice section. In average, it took each respondent almost four minutes to complete four practice questions and 40% claimed that it was quite hard to understand the structure of the questions at first. It was suggested that some more description and explanation would be useful.

After completing the practice questions, most participants were able to speed up in the completion of ten choice tasks at the average of six minutes. Three out of ten participants thought that ten choice tasks were too many while the others found that the number was doable, of which one respondent said that he could do two to three more exercises. Overall, the qualitative pilot indicated that ten DCE choice tasks can be completed by a non-technical sample within a reasonable time. It was, therefore, decided that the design with ten choice tasks is used in the main survey.

Regarding the feedback on the DCE, some participants found it challenging when *"looking at different aspects"* (R1) as they *"had to give up something to gain something else and it's, would you rather have one thing or the other, and it's a difficult question to ask sometimes, and to answer"* (R10). However, none of the respondents found the choice exercises distressing or upsetting at any point of the survey.

"I thought provoking yes but not distressing." (R3)

"It was just interesting to put myself in those scenarios and thinking out of scenario A and scenario B as in life A, life B which one I want out of the two." (R7)

Interestingly, some respondents found disposable income dominant and affected their choices as the domain appeared first in the list of life aspects in the choice exercises.

"It's starting with, especially because money is the top one which is such a measurable thing, one has more money than the other one, so you can pretty easily decide which one of those you prefer. But also you don't like to think that's how you make all your decisions and then with each one you sort of have to weigh up how it compares to the money. And it's hard as someone who doesn't have some of those problems to fully entertain what their

impact would be, if that makes sense? [. . .] I started wondering, oh well, if in this situation I had lots of money but one of the down sides is my neighbourhood isn't safe or my house is in repair it says its only for a year and you can there are things you can do with money to make those things more tolerable so that's what I was thinking." (R2)

When being asked about their experience doing the choice tasks with grey shading on the ties between scenarios A and B (i.e as in the Practice part) versus without the shading (i.e as in the main DCE), 80% of the respondents preferred no shading in the choice tasks, while 30% found it useful in terms of speed as they could skipped reading those with gray shading.

"In terms of speed definitely (useful) cause I could in the same way I said money is at the top so you can pair them it meant I could quickly see right all these are the same what are the differences. It made it a lot quicker. It probably made me think about it slightly less. [. . .] I read it but didn't pay that much attention. I just thought of it as neutral in a way because its, so even of something in grey was really amazing or really terrible I didn't really think about it because I just thought there the same anyway and I've got to pick one of them." (R2)

"I think that the grey shading prevents you from reading it thoroughly." (R3)

"I would prefer without. I think that might confuse people more because they might have to go back to refer what that shading means or, you know, for me it was easier without." (R5)

Regarding the self-reported questions related to demographics, all respondents found the wording clear and understandable. However, some participants found the categorical answers under marital status question confusing as there were too many options. The last part of the survey, COVID-19 related questions, was clearly explained and no suggestion on wording was given.

Table C.1 Summary of changes after the qualitative pilot

Changes	**Details of these changes (i.e in italic and bold)**	
	Qualitative pilot	**Quantitative pilot**
The DCE design		
Change in the design	60 choice tasks divided into 6 blocks of 10 choices each. Only one version of the DCE	120 choice tasks divided into 12 blocks of 10 choices each. 2 variants of the DCE were used in the pilot: the 3rd income decile and the 8th income decile variants. Please note that the only difference between these two variants was the household disposable income levels appearing in the choice tasks. All non-income domains were the same across variants.
Structure of the survey		
Order of the domains appeared in the self-reported questions and the DCE	Disposable income, Employment, Physical health, Mental health, Housing quality, Neighbourhood safety, Social Isolation	Physical health, Mental health, Loneliness, Disposable income, Employment, Housing quality, Neighbourhood safety
Move self-reported question about gender to the first part of the survey to set quota	Gender question was in self-reported part after DCE	Gender question was moved to the first part (i.e slef-reported question related to life domain) before Practice and DCE
Add a question about household size to the self-reported question section related to life dimensions (before Practice and DCE) This information was then used to calculate equivalised disposable income.		***How many people are there in your household?*** o I am living alone (1 person) o 2 people o 3 people o 4 people o 5 or more people ***I prefer not to answer***
Add an explanation on differences in the the categories of “Employment domain" between self-reported question and the DCE	There was no explanation.	In the previous questions, where we asked about your current situation, the domain on Employment and main daily activity had ten answer options. But because that is a lot, we are now going to use only six of these. They are: o Full-time employment - this includes self-employment and being on leave o Part-time employment - this includes self-employment and being on leave o Job-seeking (looking for employment) o Full-time education/training/apprenticeship o Taking care of a family member with chronic illness or disability o Not working, and not looking for paid employment
Self-reported questions		

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Rename "Loneliness" domain and the definition of this domain	Social Isolation: this is about whether you feel lonely and isolated from others.	Loneliness: this is about whether you feel lonely for whatever *reason and* ***left out from others.***
Add further clarification to the definition of "Disposable income" domain and underline key words.	This means the amount of money that you and your immediate family can spend each month (or week). It is your monthly (or weekly) household income, after deducting your tax, national insurance, any occupational pension contributions, and after deducting your rent, mortgage payments or other housing costs.	This means the amount of money that you and your immediate family can spend each month (or week). It is your monthly (or weekly) household income (wage, pension, benefit, etc.), after deducting your tax, national insurance, any occupational pension contributions, and after deducting your rent, mortgage payments or other housing costs.
Data points used in "Disposable income"	Quintiles of household disposable income	Deciles of household disposable income
Add further clarification to the definition of "Neighbourhood safety" domain	This is about the area you live in and how safe you feel about it.	this is about the area you live in and how safe you feel within your immediate neighbourhood.
Add further clarification to the definition of "Physical health"	In the past 4 weeks, have you accomplished less as a result of your physical health…	In the past 4 weeks, have you accomplished less than you would like with your work or other regular daily activities as a result of your physical health…
Add further clarification to the definition of "Mental health" domains	In the past 4 weeks, have you accomplished less as a result of your emotional problems…	In the past 4 weeks, have you accomplished less than you would like with your work or other regular daily activities as a result of your emotional problems (such as feeling depressed or anxious)…
o Reduce the number of categorical answers in self-reported question in "Employment" o Rephrase some options	Ten options (and other): 1. In full-time employment or self-employment 2. In part-time employment 3. In full-time education/ training/ apprenticeship 4. In part-time education/ training/ apprenticeship 5. Volunteering 6. Informal caregiving 7. Taking care of the home and family/ Homemaker 8. Job seeking 9. Retired 10. Long-term sick or disabled Other (please describe if you wish)	Eight options (and other): 1. In full-time employment or self-employment 2. In part-time employment or self-employment 3. Job-seeking (looking for employment) 4. Long-term sick or disabled *5. Taking care of a family member with chronic illness or disability (rephrased from category 6 in qualitative pilot)* *6. Looking after the home and family (rephrased from category 7 in qualitative pilot)* 7. Retired 8. In full-time education/ training/ apprenticeship ***(option for part-time was deleted)*** Other (please describe if you wish) ***Option "Volunteer" was deleted.***
Change in one categorical answer under self-reported question in "Housing quality" domain	Your home is in a reasonable state of repair, has reasonable facilities (cooking/washing) and provides reasonable warmth… o Yes to all of these	o Yes to all of these

Table C.1 –continued on next page

Table C.1 – continued from previous page

	o Yes to some of these o None of these I prefer not to answer	o Yes to one or more of these o None of these o I prefer not to answer
Change in one categorical answer under self-reported question in “Neighbourhood safety" domain	You are concerned about the safety of the neighbourhood you live in . . . o Hardly ever o Some of the time o Often o I prefer not to answer	o Hardly ever o Some of the time o All of the time o I prefer not to answer
Reduce the number of categorical answers in self-reported question about marital status	o Single and never married/in civil partnership o Married o In a registered same-sex civil partnership o Separated but legally married o Divorced o Widowed o Separated from civil partner o A former civil partner o A surviving civil partner o Living as couple o Other (please describe if you wish) I prefer not to answer	o Living as couple o Single o Other (please describe if you wish) o I prefer not to answer
Add more details to the answers for self-reported question about dependent children	Do you have responsibility for any dependent children aged under 18? (Please select all options that apply) o Yes o No o I prefer not to answer	o Yes, aged 12 or younger o Yes, aged 13 - 16 o Yes, aged 17 o No o I prefer not to answer
Practice part and DCE		
Remove grey shading in the Practice questions	Grey shading was in the two ties between scenarios A and B	No grey shading
Reduce the number of practice questions	Four practice questions	o Three practice questions (question 4 was removed to reduce the number of questions in the survey) o In three remaining questions, except for disposable income, all the other domains remained the same. The income levels used in these questions were from relevant levels from the new design (i.e income levels calculated from deciles of household disposable income) o Explanation of how the tabular format of the DCE worked was added as an option for participants to check before

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		answering Practice 1 and Practice 2.
Changes in the design of the DCE Changes in the design of the DCE	Partial profile design with 6 blocks of 10 choice tasks each, based on function (C.1) (i.e. the DCE initial design)	Partial profile design with 12 blocks of 10 choice tasks each, based on function (C.1) Only blocks using household disposable income variant of the 3rd and 8th deciles were included.
Feedback part		
Remove 2 options in Feedback section after the DCE		Deleted these options: o Imagined the health scenarios happening to myself o Difficult to judge other people's lives

C.1.3 The quantitative pilot

Methods - the survey protocol and the method of analysis

The design used in this pilot was still a D-efficient partial-profile design but had 120 rows and 12 blocks of 10 choices each and zero priors were included. Besides, a notable difference between the DCE in the quantitative pilot and those used in the Qualitative pilot is that the quantitative survey allocated respondents to different variants of the DCE based on their household income levels. The survey was designed with ten income variants. However, as the plan was to recruit only 100 respondents, only the 3rd and 8th income variants were used. Respondents who had household disposable income belonged to the 1st to 5th deciles and those who did not answer the income self-reported question were allocated to the 3rd income variant of the survey. Participants with the 6th to 10th income deciles got the 8th variant one. In addition, a quota of 50-50 male-female ratio was imposed.

The DCE data collected from the quantitative pilot was analysed using Conditional (fixed-effects) logistic regression. Various regressions were analysed ranging from one having only the main effects to those that included some of the possible interactions between income and non-income dimensions and one involving all interactions between income and non-income variables and interactions between physical health and mental health domains. In addition, a version of main-effect-only regression using dummy-coding was compared with one using effects-coding.

Results

Out of 100 respondents, only 97 sets of answers were valid, while three others dropped before finishing the survey (e.g they either did not finish the choice tasks or the self-reported section at the end of the survey). Most of the participants finished the survey between ten and 20 minutes, as shown in Figure C.1. On average, the completion time is almost 18 minutes among those 97 respondents. However, when excluding those who completed the survey in more than 30 minutes, the average time completion is around 13 minutes.

Overall, when considering each life dimension separately, the majority of the sample reported no or little problems. In particular, about 40% to 50% of the respondents reported ‘none of the time’ having physical health and mental health problems. Almost 60% hardly ever felt lonely and left out from others. More than one third of the sample reported as being full-time employed or self-employed. Regarding housing quality, more than 90% of the participants reported that their homes were in “all reasonable state of repair, had reasonable facilities for cooking and washing, and provided reasonable warmth when it was cold outside". About 66% of the sample were hardly ever concerned about the safety of their neighbourhood. Regarding household disposable income, most respondents had low income with the majority has an earning belonging to the 1st and 2nd decile groups. When

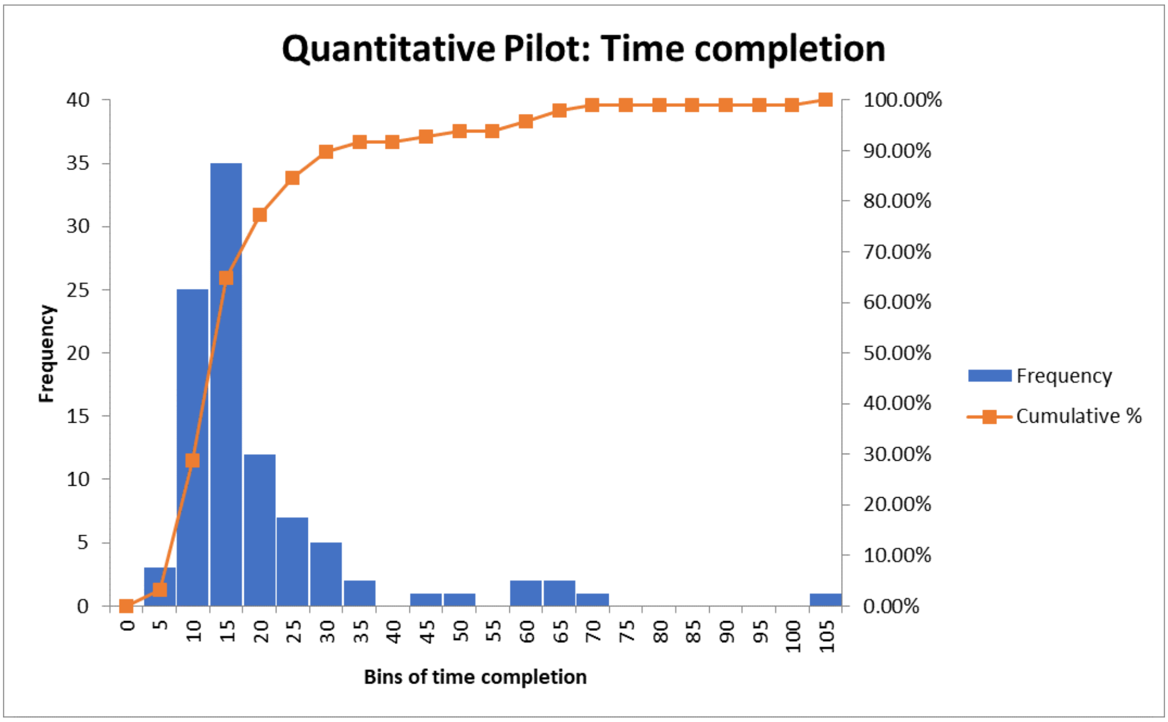

Fig. C.1 Histogram of time completion of the quantitative pilot

considering all non-income life dimension at the same time, 10.30% of the quantitative sample reported no problems regarding those non-income life aspects of interest.

The valid data was analysed using conditional logit fixed effects regressions. The regression results of the model of only main effects and one with interactions are reported in Table C.2.

Overall, for all ordered variables including physical health, mental health, loneliness, housing quality and neighbourhood safety, relevant coefficients show expected sign. In particular, compared to the baseline of optimal level, the worse the ordered non-income life dimensions are, the more negative the coefficients become. Besides, log of equivalised disposable income is positive and significant at 0.1%.

Employment, by contrast, is not an ordered variable. Across the model with only main effects and one with interactions between employment and log of equivalised disposable income, the above-mentioned parameters are not statistically different. However, when including interactions between employment and log of equivalised disposable income, sign, magnitude and significance of the relevant parameters change. Except for part-time employment, of which the coefficient related to the main effect remains positive, all the other coefficients change in sign. For example, when income is controlled, being a job-seeker or being in full-time education or taking care of of a family member with chronic illness or disability are related to positive but insignificant coefficient. However, the corresponding coefficients related to the interactions are negative and insignificant. By contrast, the coeffi-

Table C.2 Regression results from the quantitative pilot

Variables	**Main effects**	**Main effects and interactions**
Little of the time accomplishing less due to physical health	-0.128	-0.105
Some of the time accomplishing less due to physical health	-0.339^{+}	-0.331
Most of the time accomplishing less due to physical health	-0.771^{***}	-0.760^{***}
All of the time accomplishing less due to physical health	-1.152^{***}	-1.162^{***}
Little of the time accomplishing less due to mental health	-0.476^{**}	-0.473^{*}
Some of the time accomplishing less due to mental health	-0.788^{***}	-0.802^{***}
Most of the time accomplishing less due to mental health	-1.141^{***}	-1.144^{***}
All of the time accomplishing less due to mental health	-1.442^{***}	-1.448^{***}
Some of the time feeling lonely	-0.388^{***}	-0.374^{**}
Often feeling lonely	-0.894^{***}	-0.884^{***}
Log of equivalised disposable income	1.604^{***}	1.692^{***}
Part-time employed or self-employed	0.079	2.090
Job-seeking	-0.365^{+}	1.660
Full-time education	-0.098	0.123
Taking care of a family member with chronic or disability	-0.988^{***}	0.290
Not working	0.012	-1.349
Reasonable housing quality: Partly true	-0.292^{+}	-0.295^{+}
Reasonable housing quality: Not true	-0.740^{***}	-0.735^{***}
Some of the time concerned about neighbourhood safety	-0.211	-0.215
Often concerned about neighbourhood safety	-0.851^{***}	-0.877^{***}
PT employed or self-employed # log income		-0.276
Job-seeking # log income		-0.277
Full-time education # log income		-0.030
Taking care of a family member [...] # log income		-0.174
Not working # log income		0.188
Observations (Individuals)	1,940 (97)	1,940 (97)

Base line: None of the time – Physical health/ Mental health affecting daily life; Hardly ever feeling lonely; FT employed; Housing quality: all true; Hardly ever concerned about the safety of the neighbourhood.

Robust standard errors are clustered by the individual.

$^{+}$ $p < 0.1$ Hardly ever , * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Primary data collected under SIPHER consortium cient related to main effect of not working changes from positive to negative; both of which are insignificant.

The parameters estimated from the regression with interactions were then used as priors in the design for the main survey based on the utility function in equation (4.9).

Besides the results from regressions using data from 97 responses from the quantitative pilot, feedback on the survey was also summarised to improve the main survey.

Table C.3 Tick box feedback – Quantitative pilot

Statements	**Number of responses**
Too many tasks	*12*
The task being asked is clear	47
Not sure about my answers	*5*
Interesting survey	52
Confident about my answers	40
Layout is clear	49
I could answer 5 or 6 more of the choices	15
Got tired half-way through	*4*
Boring	*5*
Difficult to distinguish between the scenarios	*11*
I would not want to answer any more of these tasks	*9*
Total chosen statements	249
Average statement per respondent	3.0 (2.57)
Total negative statements	46
Average statement per respondent	< 1 (0.47)
Percentage of neg. statements within all statements	18.47%

Overall, most respondents left positive feedback, such as “The task being asked is clear" or “Interesting survey". There were 12/97 respondents finding that there were too many tasks within the survey and 9/97 ticked the feedback box that they “would not want to answer any more of these tasks". In contrast, 15 others stated that they “could answer 5 or 6 more of the choices". Being quite consistent with the conclusion from the qualitative pilot, having ten choice tasks in the survey seemed to be a reasonable number for participants to complete in an average of less than 20 minutes.

Besides the tick-box feedback, some noted comments from participants were as follows:

• Earnings and metal health were my drivers. If I had a decent income I would be able to carry house repairs and hopefully by finding an interest stop being lonely.

• Absolutely stupid scenarios

• Didn't take into account people over 65

• Quite difficult to choose between the options

• Would have been better if there was a percentage completion bar so you knew how much longer the questions were going on for. The areas could have been done as a pie chart or bar chart rather than comparing different things or on a scale of 1 to 10.

• Several of the comparative scenarios did not make sense

The changes made to the DCE design as a result of the quantitative pilot

As mentioned before, the main objective of the quantitative pilot was to estimate relevant parameters to use as priors in the design of the main survey. The coefficients in the model with interactions were added to Ngene codes to generate a new design for the main survey. Similar to the design used in the quantitative pilot, the new design has 120 choice tasks divided into 12 blocks of ten choices each. The main survey also uses a partial profile design in which there are two ties in non-income dimensions.

However, there were some differences between the quantitative survey and the main survey. The main improvement from the design used in the quantitative pilot and one used in the main survey is the inclusion of non-zero priors. Having information on prior would improve the stability of the survey design, which is particularly true for an efficient design (ChoiceMetrics Pty Ltd., 2018). In addtion, the main survey employed all ten variants of the choice tasks based on the decile groups of household disposable income, while the quantitative pilot had only two variants. The details of those changes are presented in Table C.4.

Table C.4 Summary of changes after the quantitative pilot

Changes	Details of these changes	
	Quantitative pilot	**Main survey**
	The DCE design	
Utility function	Function (C.1): the original DCE design · Used household disposable income and income squared · Included all interactions between income and non-income domains · Included interactions between physical health and mental health	Function (4.9): The final DCE design · Used natural logarithm of household disposable income · Included only interactions between employment and the natural logarithm of household disposable income
Change in the design	Zero priors (i.e. No prior was used in the design)	Incorporated priors into the design. These priors were estimated from relevant parameters in regression with interactions between employment and log of household disposable income using data from the quantitative pilot
	Structure of the survey	
Different variants of the DCE used and how they were distributed	2 variants of the DCE were used: the 3rd income decile and the 8th income decile variants. Respondents whose household disposable income belonged to the 1st to the 5th decile and those who did not answer the self-reported income question were given the 3rd income decile variant of the DCE. Respondents whose household disposable income belonged to the 6th to the 10th decile were given the 8th income decile variant.	10 variants of the DCE were used, which were based on 10 decile income groups. Respondents after answering the income question were given the variant that relevant to their household disposable income group. Those who chose not to answer the self-reported income question were given the 4th decile variant.
	The presentation of the survey	
Considering a comment from one participant “Would have been better if there was a percentage completion bar so you knew how much longer the questions were going on for".	No completion bar or percentage completion was presented in the pilot	Added a completion bar to allow respondents to see their progress.

C.2 Treatment of income

The utility function estimated in the econometric model using equivalised disposable income is written as:

$$U_i = \beta X^k + \gamma_1 ln\left(\frac{I}{\sqrt{hs_i}}\right) + \beta_4 E + \gamma_2 E\#ln\left(\frac{I}{\sqrt{hs_i}}\right) + \varepsilon_i \tag{C.2}$$

In Equation (C.2), hs_i is the respondent's household size, and $\frac{I}{\sqrt{hs_i}}$ is equivalised disposable income, corresponding to Y_i in Equations (4.9) to (4.11). Decomposing the natural log of equivalised disposable income into two components including household disposable income and household size, we have:

$$ln\left(\frac{I}{\sqrt{hs_i}}\right) = ln(I) - ln(\sqrt{hs_i}) \tag{C.3}$$

In the econometric model, household size variable hs_i on its own is omitted as household size is invariant within a respondent. However, the interaction between Employment and household size was not omitted as Employment was displayed at different hypothetical levels in the DCE, which varied within each respondent.

Indeed, the regression results showed that those parameters related to the non-income non-employment domains (captured by vector X^k) and those coefficients related to the log of equivalised household disposable income and the log of unadjusted household disposable income were largely similar. In contrast, the parameters of Employment and those from interactions between the log of equivalised disposable income and Employment versus those from interactions between the log of unadjusted household disposable income and Employment were different. Moreover, the observed effects of those interactions between the log of equivalised disposable income and Employment were captured by the sum of parameters related to interactions between the log of household disposable income and Employment and interactions between the log of the square root of household size and Employment.

Using equivalised disposable income in regressions is necessary as the coefficients estimated from the model were used to compute equivalent income at the individual level. However, household size is not a life domain of interest or choice variable, and therefore, not a part of the choice design. As a result, the priors from the interactions between Employment and log of the square root of household size were not parts of the utility function in the DCE design. Therefore, the Disposable Income domain in the choice design should be in terms of log of un-adjusted household disposable income instead of log of equivalised disposable income. By removing household size hs_i from the utility function, the model could be re-estimated without household size.

C.3 Descriptive Statistics of the survey sample

Table C.5 Descriptive statistics of the sample

Aspects	Categories	Percent
Effects of physical Health	*None of the time*	*41.88%*
Your body affects your activities.	Little of the time	18.47%
	Some of the time	21.09%
	Most of the time	10.74%
	All of the time	6.75%
	Not answered	1.07%
Effects of Mental Health	*None of the time*	*45.42%*
Your mind affects your activities.	Little of the time	18.35%
	Some of the time	20.79%
	Most of the time	9.88%
	All of the time	4.58%
	Not answered	0.98%
Loneliness	*Hardly ever*	*47.98%*
You feel lonely and isolated from others.	Some of the time	35.48%
	Often	15.97%
	Not answered	0.57%
Disposable Household Income	1st decile	*27.16%*
Your monthly (or weekly) disposable	2nd decile	*17.01%*
household income after housing costs	3rd decile	10.26%
	4th decile	7.85%
	5th decile	7.91%
	6th decile	5.15%
	7th decile	5.29%
	8th decile	3.90%
	9th decile	3.45%
	10th decile	3.00%
	Not answered	9.01%
Employment Your main daily activity.	*Full-time employment or self-employment*	*36.94%*
	Part-time employment or self-employment	15.59%
	Job-seeking	5.65%
	Long-term sick or disabled	7.23%
	Taking care of a family member with chronic illness or disability	1.34%
	Looking after the home and family	5.59%
	Retired	22.28%
	Full-time education/ training/ apprenticeship	3.69%

Table C.5 –continued on next page

Table C.5 – continued from previous page

	Furloughed	0.21%
	Others	0.77%
	Not answered	0.71%
Housing	*All true*	*84.80%*
Your home is in a reasonable state of repair,	Partly true	12.14%
has reasonable facilities for cooking	Not true	2.41%
and washing, and provides reasonable warmth when it is cold outside	Not answered	0.65%
Neighbourhood Safety – Safe (G)	*Hardly ever*	*65.68%*
You are concerned about the safety of	Some of the time	29.21%
your neighbourhood.	Often	4.43%
	Not answered	0.68%
Gender	Male	44.47%
	Female	55.00%
	Other	0.36%
	Not answered	0.18%
Age	18-25	12.10%
	26-35	12.87%
	36-45	16.43%
	46-55	19.54%
	56-65	18.03%
	65+	20.73%
	Not answered	0.30%
Marital status	Living as a couple or Married †	*59.40%*
	Single	34.98%
	Others	5.00%
	Not answered	0.62%
Education	No formal qualification	4.67%
	GCSE or equivalent	25.01%
	A level or equivalent	25.79%
	Degree or equivalent ±	*31.71%*
	Other higher degree	9.13%
	Others	3.00%
	Not answered	0.68%
Self-assessed health	Excellent	8.96%
	Very good	*30.35%*
	Good	*33.59%*
	Fair	18.21%
	Poor	8.57%
	Not answered	0.33%
Having dependent children	Aged 12 or younger	13.09%
	Aged 13 – 16	7.61%
	Aged 17	3.18%

Table C.5 –continued on next page

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	None	*75.28%*
	Not answered	0.83%
Profile	Report no problems (non-income domain $X = X^*$)	7.03%
	Report at least one problem (non-income domain $X < X^*$)	92.97%

Note: † The categories in the question do not include Married but many respondents chose Others and indicated Married, hence were grouped in this category

± The answer in the survey was “Degree" only but many people with degree equivalent (advanced diploma, HNC, HND, etc.) chose Others and indicated their qualifications, hence, were grouped in this category.

Table C.6 Top 5 majority profiles with Income domain

Details of the coding for attributes and levels

Attributes	**Levels**
Effects of physical health (PhyH)/ Effects of mental health (MenH)	1. None of the time
	2. Little of the time
	3. Some of the time
	4. Most of the time
	5. All of the time
Feeling lonely and left out (Lonely)	1. Hardly ever
	2. Some of the time
	3. Often
Disposable household income after housing costs (Inc)	1st decile, 2nd decile… 10th decile
Employment: Main daily activity (Emp)	1. FT employed
	2. PT employed
	3. Job seeking
	4. Long-term sickness/ disabled
	5. Taking care of a family member with chronic illness or disability
	6. Looking after the home and family
	7. Retired
	8. FT education/ training/ apprenticeship
Housing quality (Hous)	1. Yes to all of these
	2. Yes to one or more of these
	2. Yes to one or more of these
Neighbourhood safety (Safe)	1. Hardly ever
	2. Some of the time
	3. All of the time

Obs	**Profile**	**%**	**Cum. %**
46	PhyH – 1	1.56%	1.56%
	MenH – 1		
	Lonely – 1		
	Inc: 2nd decile (£851 - £1,220/m)		
	Emp – 7		
	Hous – 1		
	Safe – 1		
38	PhyH – 1	1.29%	2.85%
	MenH – 1		
	Lonely – 1		
	Inc: 1st decile ($\leq$ £850/m)		
	Emp – 7		
	Hous – 1		
	Safe – 1		
36	PhyH – 1	1.22%	4.07%
	MenH – 1		
	Lonely – 1		
	Inc: 2nd decile (£851 - £1,220/m)		
	Emp – 1		
	Hous – 1		
	Safe – 1		
29	PhyH – 1	0.98%	5.05%
	MenH – 1		
	Lonely – 1		
	Inc: 1st decile ($\leq$ £850/m)		
	Emp – 1		
	Hous – 1		
	Safe – 1		
28	PhyH – 1	0.95%	6.00%
	MenH – 1		
	Lonely – 1		
	Inc: 5th decile (£1,911 - £2,310/m)		
	Emp – 1		
	Hous – 1		
	Safe – 1		

Table C.7 Top 5 majority profiles without Income domain

Details of the coding for attributes and levels		Obs	Profile	%	Cum. %
Attributes	**Levels**	246	PhyH – 1	7.66%	7.66%
Effects of physical health (PhyH)/	1. None of the time		MenH – 1		
Effects of mental health (MenH)	2. Little of the time		Lonely – 1		
	3. Some of the time		*Emp – 7*		
	4. Most of the time		Hous – 1		
	5. All of the time		Safe – 1		
Feeling lonely and left out (Lonely)	1. Hardly ever	237	PhyH – 1	7.38%	15.04%
	2. Some of the time		MenH – 1		
	3. Often		Lonely – 1		
Employment: Main daily activity (Emp)	1. FT employed		Emp – 1		
	2. PT employed		Hous – 1		
	3. Job seeking		Safe – 1		
	4. Long-term sickness/ disabled	100	PhyH – 1	3.11%	18.15%
	5. Taking care of a family member with chronic illness or disability		MenH – 1 MenH – 1		
	6. Looking after the home and family		Lonely – 1		
	7. Retired		*Emp - 2*		
	8. FT education/ training/ apprenticeship		Hous – 1		
Housing quality (Hous)	1. Yes to all of these		Safe – 1		
	2. Yes to one or more of these	66	PhyH – 1	2.05%	20.20%
	2. Yes to one or more of these		MenH – 1		
Neighbourhood safety (Safe)	1. Hardly ever		*Lonely – 2*		
	2. Some of the time		*Emp – 2*		
	3. All of the time		Hous – 1		
			Safe – 1		
		56	*PhyH – 2*	1.74%	21.94%
			MenH – 1		
			Lonely – 1		
			Emp – 7		
			Hous – 1		
			Safe – 1		

C.4 Histograms

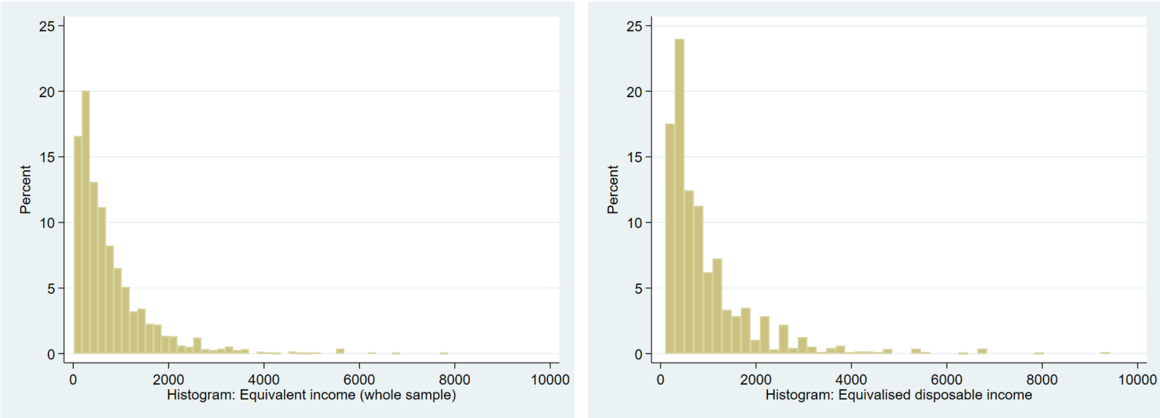

Fig. C.2 Histograms of equivalised income and equivalent income of the whole sample

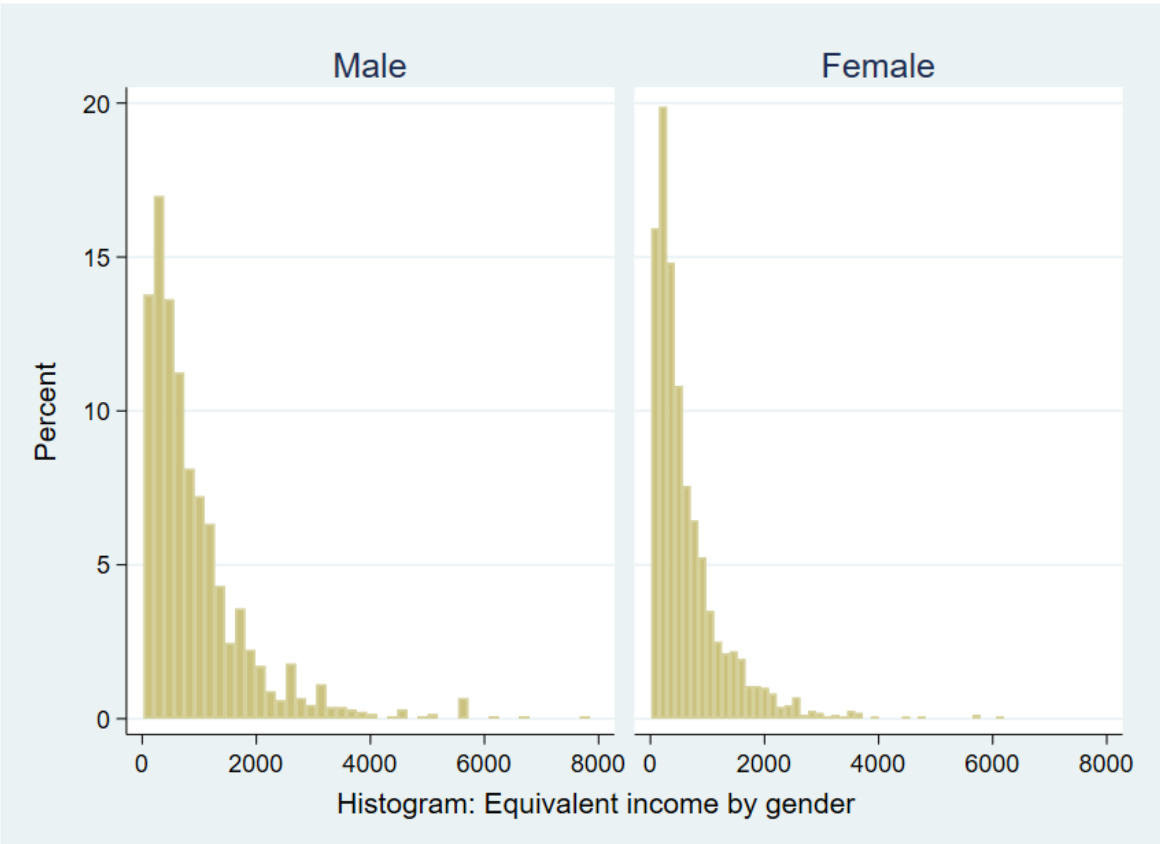

Fig. C.3 Histograms of equivalent income in gender sub-samples

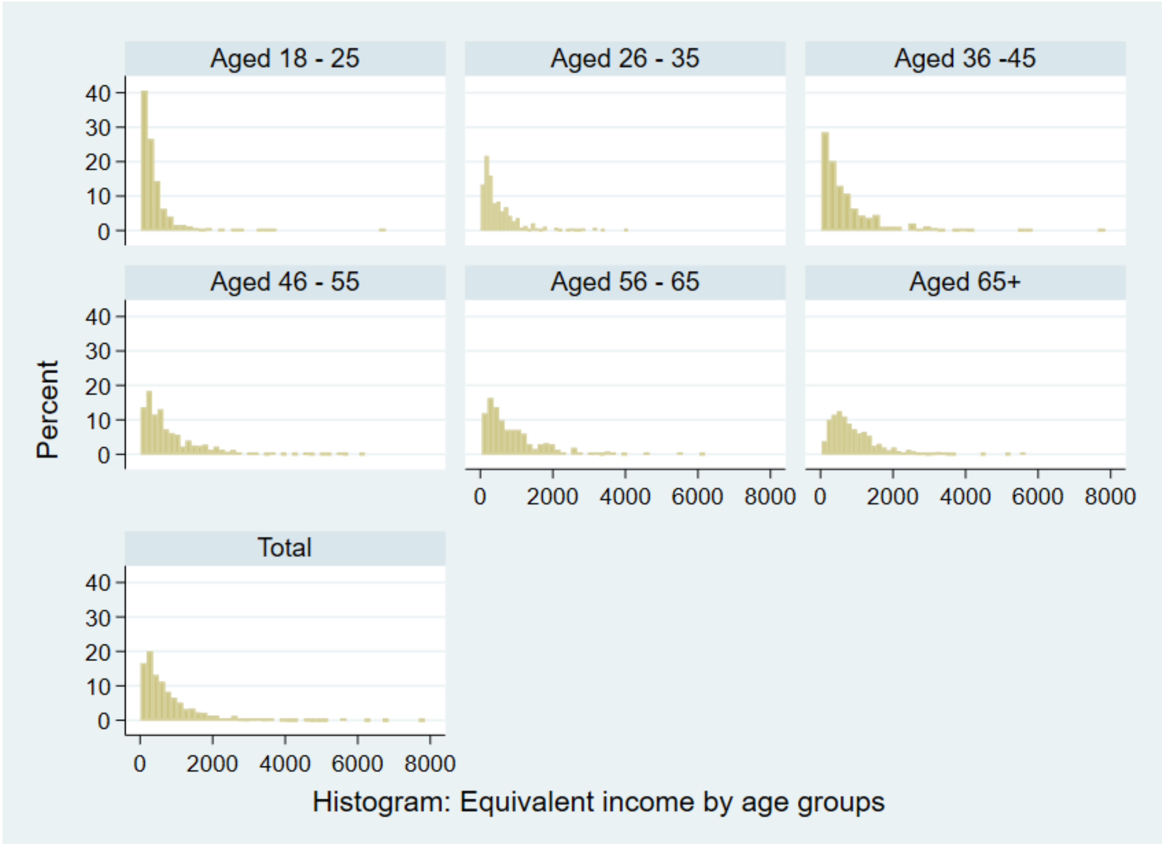

Fig. C.4 Histograms of equivalent income by age

C.5 Overlaps between equivalent income and life domains

Table C.8 Overlaps between equivalent income and life domains

	Equivalent income		Income	Physical health	Mental health	Loneliness	Housing quality	Safety	%
1 indicator									26.20%
2 indicators	Equivalent income	**x**	**x**						**11.99%**
		x		x					9.81%
		x			**x**				**12.57%**
		x				x			10.00%
		x					x		8.86%
		x						x	6.78%
	Income		x	x					3.04%
			x		x				4.27%
			x			x			4.40%
			x				x		4.65%
			x					x	3.26%
	Physical health			x	x				10.30%
				x		x			6.00%
				x			x		4.41%
				x				x	4.65%
	Mental health				x	x			8.65%
					x		x		6.06%
					x			x	5.34%

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	Loneliness					x	x		5.72%
						x		x	4.56%
	Housing quality						x	x	6.13%
3 indicators	Equivalent income	x	x	x					2.88%
		x	x		x				4.10%
		x	x			x			3.71%
		x	x				x		4.04%
		x	x					x	2.30%
		x		**x**	**x**				**5.91%**
		x		x		x			3.67%
		x		x			x		3.05%
		x		x				x	2.56%
		x			**x**	**x**			**5.81%**
		x			x		x		4.25%
		x			x			x	3.17%
		x				x	x		3.29%
		x				x		x	2.51%
		x					x	x	2.86%
	Income		x	x	x				1.34%
			x	x		x			0.83%
			x	x			x		0.95%
			x	x				x	0.35%
			x		x	x			1.68%

Table C.8 –continued on next page

Table C.8 – continued from previous page

			x		x		x		1.32%
			x		x			x	0.68%
			x			x	x		1.21%
			x			x		x	0.64%
			x				x	x	0.94%
	Physical health			x	x	x			3.54%
				x	x		x		2.38%
				x	x			x	2.53%
				x		x	x		1.52%
				x		x		x	1.47%
				x			x	x	1.23%
	Mental health				x	x	x		2.49%
					x	x		x	1.96%
					x		x	x	1.68%
	Loneliness					x	x	x	1.58%
4 indicators	Equivalent income	x	x	x	x				1.34%
		x	x	x		x			0.83%
		x	x	x			x		0.95%
		x	x	x				x	0.34%
		x		**x**	**x**	**x**			**2.66%**
		x		x	x		x		1.99%
		x		x	x			x	1.61%
		x			**x**	**x**	**x**		**2.06%**

Table C.8 –continued on next page

Table C.8 – continued from previous page

		x			x	x		x	1.50%
		x				x	x	x	1.01%
	Income		x	x	x	x			0.58%
			x	x	x		x		0.52%
			x	x	x			x	0.15%
			x		x	x	x		0.60%
			x		x	x		x	0.31%
			x			x	x	x	0.22%
	Physical health			x	x	x	x		1.01%
				x	x	x		x	0.91%
				x		x	x	x	0.47%
	Mental health				x	x	x	x	0.75%
5 indicators	Equivalent income	x	x	x	x	x			0.58%
		x	x	x	x		x		0.52%
		x	x	x	x			x	0.15%
		x		**x**	**x**	**x**	**x**		**0.96%**
		x		x	x	x		x	0.72%
		x			x	x	x	x	0.62%
	Income		x	x	x	x	x		0.28%
			x	x	x	x		x	0.08%
	Physical health			x	x	x	x	x	0.28%
6 indicators	Equivalent income	**x**	**x**	**x**	**x**	**x**	**x**		**0.28%**
		x	x	x	x	x		x	0.08%

Table C.8 –continued on next page

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		x		x	x	x	x	x	0.26%
	Income		x	x	x	x	x	x	0.04%
7 indicators	Equivalent income	x	x	x	x	x	x	x	0.04%

C.6 Marginal Willingness To Pay

As discussed in Section 4.3, marginal willingness to pay (MWTP) can be calculated using the estimated coefficients from the regression. One thing to note is that the equivalised income from the models in this chapter is in natural logarithm form, hence the ratios of non-income and income coefficients were transformed back to income levels to calculate MWTP in Table C.9. In addition, the 95% confidence intervals around MWTP estimates using the Delta method (see Wooldridge, 2002) are also reported.

Table C.9 Marginal willingness to pay (MWTP) to transform from a certain attribute level to the optimal level

Attributes and Attribute levels	Main effects			Main effects & Interactions		
	MWTP	95% CI		MWTP	95% CI	
Little of the time accomplishing less due to physical health	1.09***	1.05	1.14	1.10***	1.06	1.14
Some of the time accomplishing less due to physical health	1.11***	1.07	1.15	1.11***	1.07	1.16
Most of the time accomplishing less due to physical health	1.45***	1.4	1.51	1.46***	1.4	1.51
All of the time accomplishing less due to physical health	1.92***	1.84	2.00	1.95***	1.85	2.04
Little of the time accomplishing less due to mental health	1.12***	1.07	1.16	1.11***	1.07	1.16
Some of the time accomplishing less due to mental health	1.18***	1.13	1.23	1.18***	1.13	1.23
Most of the time accomplishing less due to mental health	1.67***	1.61	1.73	1.67***	1.6	1.74
All of the time accomplishing less due to mental health	1.98***	1.91	2.06	1.99***	1.9	2.08
Some of the time feeling lonely	1.16***	1.12	1.20	1.16***	1.12	1.2
Often feeling lonely	1.59***	1.53	1.64	1.59***	1.53	1.66
Part-time employed or self-employed	-1.03***	-1.08	1.02	-1.07	-1.54	1.33
Job-seeking	1.25***	1.18	1.31	1.73**	1.15	2.59
Full-time education	1.15***	1.11	1.20	-1.02	-1.45	1.39
Taking care of a family member with chronic illness or disability	1.80***	1.72	1.89	2.23**	1.45	3.44
Not working	1.19***	1.13	1.25	-1.21	-1.62	1.29
Reasonable housing quality: Partly true	1.20***	1.16	1.25	1.20***	1.15	1.24
Reasonable housing quality: Not true	1.72***	1.65	1.80	1.73***	1.65	1.82
Some of the time concerning about the safety of the neighbourhood	1.26***	1.21	1.30	1.27***	1.22	1.32
Often concerning about the safety of the neighbourhood	1.60***	1.54	1.65	1.60***	1.54	1.67

Note: *** significant 0.1%, ** significant 1%, * significant 5%. CI, confidence interval.

C.7 Sub-group analysis: Equivalent income estimated for selected scenarios

Table C.10 Subgroup analysis: Equivalent income estimated for different subgroups

		MAIN		**GENDER**			
				Male		**Female**	
		EI [95 CI]	**EI/Y (%)**	**EI [95 CI]**	**EI/Y (%)**	**EI [95 CI]**	**EI/Y (%)**
1	Some of the time accomplishing less than you would like [...] as the results of your physical health. Full-time employed.	£635 [611 - 660]	90%	£660 [627 - 692]	93%	£609 [547 - 645]	86%
2	All of the time accomplishing less than you would like [...] as the results of your physical health. Full-time employed.	£363 [346 - 381]	51%	£403 [380 - 427]	57%	£327 [301 - 354]	46%
3	Most of the time accomplishing less than you would like [...] as the results of your emotional problems. Full-time employed.	£425 [406 - 443]	60%	£455 [430 - 480]	64%	£394 [367 - 421]	56%
4	Part-time employed.	£730 [692 - 769]	103%	£672 [629 - 715]	95%	£805 [732 - 877]	114%
5	Often feeling lonely. Full-time employed.	£444 [426 - 461]	63%	£465 [442 - 488]	66%	£424 [397 - 451]	60%
6	Reasonable housing quality: Not true. Full-time employed.	£409 [388 - 429]	58%	£436 [410 - 463]	62%	£383 [351 - 415]	54%
7	Often concerning about the safety of the neighbourhood. Full-time employed.	£441 [423 - 459]	62%	£465 [441 - 488]	66%	£419 [391 - 447]	59%

	AGE GROUPS											
	18-25		**26-35**		**36-45**		**46-55**		**56-65**		**65+**	
	EI	**EI/Y**	**EI**	**EI/Y**	**EI**	**EI/Y**	**EI**	**EI/Y**	**EI**	**EI/Y**	**EI**	**EI/Y**

Table C.10 –continued on next page

Table C.10 – continued from previous page

	[95 CI]	(%)	[95 CI]	(%)	[95 CI]	(%)	[95 CI]	(%)	[95 CI]	(%)	[95 CI]	(%)
1	£669 [568 - 770]	95%	£692 [609 - 775]	98%	£634 [584 - 683]	90%	£633 [581 - 685]	90%	£635 [582 - 689]	90%	£597 [550 - 645]	84%
2	£395 [325 - 465]	56%	£400 [346 - 454]	57%	£419 [382 - 455]	59%	£350 [312 - 388]	50%	£362 [324 - 400]	51%	£316 [277 - 354]	45%
3	£461 [385 - 538]	65%	£457 [397 - 517]	65%	£482 [440 - 524]	68%	£434 [394 - 473]	61%	£401 [362 - 440]	57%	£374 [337 - 412]	53%
4	£706 [551 - 858]	100%	£590 [506 - 674]	83%	£687 [616 - 759]	97%	£746 [660 - 831]	105%	£814 [713 - 915]	115%	£755 [672 - 839]	107%
5	£404 [334 - 475]	57%	£526 [465 - 587]	74%	£483 [446 - 520]	68%	£451 [413 - 489]	64%	£423 [385 - 462]	60%	£410 [373 - 447]	58%
6	£406 [326 - 486]	57%	£468 [407 - 528]	66%	£409 [367 - 451]	58%	£436 [392 - 479]	62%	£394 [348 - 440]	56%	£387 [343 - 431]	55%
7	£539 [458 - 620]	76%	£492 [434 - 551]	70%	£505 [466 - 543]	71%	£407 [368 - 446]	58%	£416 [376 - 456]	59%	£398 [359 - 437]	56%

	MARITAL STATUS				EDUCATION				DEPENDENT CHILDREN			
	Living as couple		Single		No degree		Degree		Having children		No children	
	EI [95 CI]	EI/Y (%)	EI [95 CI]	EI/Y (%)	EI [95 CI]	EI/Y (%)	EI [95 CI]	EI/Y (%)	EI [95 CI]	EI/Y (%)	EI [95 CI]	EI/Y (%)
1	£627 [596 - 658]	89%	£666 [619 - 712]	94%	£632 [599 - 665]	89%	£628 [590 - 666]	89%	£643 [595 - 690]	91%	£631 [603 - 659]	89%
2	£350	50%	£393	56%	£374	53%	£345	49%	£397	56%	£351	50%

Table C.10 –continued on next page

Table C.10 – continued from previous page

	[328 - 373]		[361 - 425]		[350 - 399]		[317 - 372]		[362 - 431]		[330 - 371]	
3	£421	60%	£444	63%	£429	61%	£422	60%	£475	67%	£408	58%
	[398 - 444]		[409 - 479]		[403 - 454]		[394 - 451]		[436 - 515]		[387 - 429]	
4	£708	100%	£737	104%	£755	107%	£716	101%	£696	98%	£741	105%
	[662 - 754]		[664 - 809]		[697 - 813]		[658 - 774]		[625 - 768]		[696 - 787]	
5	£427	60%	£464	66%	£440	62%	£459	65%	£453	64%	£437	62%
	[405 - 450]		[431 - 496]		[415 - 464]		[431 - 487]		[420 - 487]		[416 - 458]	
6	£400	57%	£427	60%	£402	57%	£415	59%	£430	61%	£402	57%
	[374 - 426]		[390 - 464]		[373 - 430]		[383 - 448]		[391 - 469]		[377 - 426]	
7	£438	62%	£467	66%	£446	63%	£431	61%	£467	66%	£432	61%
	[415 - 461]		[433 - 501]		[421 - 472]		[403 - 459]		[432 - 502]		[410 - 453]	

Note: All the life domains which are not specified in the scenarios are assumed to be at the optimal levels.
Key: CI, confidence interval; EI, equivalent income; Y, equivalised income.

C.8 Regression results - Sub-groups

Table C.11 Conditional Logit FE models-Main Survey (by gender)

	Whole Sample	Female	Male
Little of the time accomplishing	-0.118***	-0.101**	-0.130***
less due to physical health	(0.03)	(0.04)	(0.03)
Some of the time accomplishing	-0.133***	-0.099**	-0.166***
less due to physical health	(0.03)	(0.04)	(0.03)
Most of the time accomplishing	-0.466***	-0.452***	-0.487***
less due to physical health	(0.03)	(0.05)	(0.04)
All of the time accomplishing	-0.828***	-0.800***	-0.856***
less due to physical health	(0.04)	(0.06)	(0.05)
Little of the time accomplishing	-0.130***	-0.162***	-0.104**
less due to mental health	(0.03)	(0.04)	(0.04)
Some of the time accomplishing	-0.203***	-0.220***	-0.192***
less due to mental health	(0.03)	(0.05)	(0.04)
Most of the time accomplishing	-0.635***	-0.630***	-0.649***
less due to mental health	(0.04)	(0.06)	(0.05)
All of the time accomplishing	-0.853***	-0.843***	-0.878***
less due to mental health	(0.04)	(0.07)	(0.06)
Some of the time feeling lonely	-0.184***	-0.184***	-0.184***
	(0.02)	(0.04)	(0.03)
Often feeling lonely	-0.579***	-0.597***	-0.568***
	(0.03)	(0.05)	(0.04)
Log of equivalised income	1.244***	1.426***	1.111***
	(0.06)	(0.10)	(0.09)
Part-time employed or self-employed	0.096	0.147	-0.122
	(0.20)	(0.30)	(0.27)
Job-seeking	-0.753***	-0.619+	-0.814**
	(0.21)	(0.32)	(0.28)
Full-time education	0.061	0.009	0.069
	(0.19)	(0.29)	(0.26)
Taking care of a family member	-1.047***	-1.131**	-1.080***
with chronic or disability	(0.23)	(0.35)	(0.31)
Not working	0.212	0.395	0.136
	(0.21)	(0.31)	(0.28)
Reasonable housing quality:	-0.223***	-0.247***	-0.208***
Partly true	(0.02)	(0.04)	(0.03)
Reasonable housing quality:	-0.682***	-0.688***	-0.681***
Not true	(0.03)	(0.04)	(0.04)
Some of the time concerned about	-0.294***	-0.325***	-0.271***
neighbourhood safety	(0.02)	(0.03)	(0.03)
Often concerned about neighbourhood	-0.586***	-0.599***	-0.582***
safety	(0.03)	(0.05)	(0.04)
PT employed or self-employed	-0.009	-0.033	0.040
# log income	(0.03)	(0.05)	(0.04)
Job-seeking # log income	0.075*	0.053	0.084+
	(0.03)	(0.05)	(0.04)
Full-time education # log income	-0.038	-0.034	-0.038
	(0.03)	(0.04)	(0.04)
Taking care of a family member [...]	0.048	0.044	0.064
# log income	(0.03)	(0.05)	(0.05)
Not working # log income	-0.069*	-0.086+	-0.067
	(0.03)	(0.05)	(0.04)
Observations	67,240	29,900	37,040

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.12 Conditional Logit FE models-Main Survey (by age groups)

	18-25	26-35	36-45	46-55	56-65	65+
Little of the time accomplishing	0.025	-0.026	-0.052	-0.171**	-0.198***	-0.202***
less due to physical health	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Some of the time accomplishing	-0.050	-0.023	-0.164**	-0.146*	-0.144*	-0.229***
less due to physical health	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Most of the time accomplishing	-0.276**	-0.324***	-0.472***	-0.465***	-0.538***	-0.663***
less due to physical health	(0.09)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)
All of the time accomplishing	-0.522***	-0.636***	-0.787***	-0.926***	-0.903***	-1.090***
less due to physical health	(0.11)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)
Little of the time accomplishing	-0.092	-0.172*	-0.112+	-0.076	-0.186**	-0.128*
less due to mental health	(0.08)	(0.08)	(0.07)	(0.06)	(0.06)	(0.06)
Some of the time accomplishing	-0.091	-0.237**	-0.219**	-0.176*	-0.244**	-0.209**
less due to mental health	(0.09)	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)
Most of the time accomplishing	-0.383***	-0.487***	-0.576***	-0.643***	-0.762***	-0.861***
less due to mental health	(0.11)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)
All of the time accomplishing	-0.609***	-0.635***	-0.792***	-0.823***	-1.055***	-1.118***
less due to mental health	(0.12)	(0.12)	(0.11)	(0.10)	(0.10)	(0.10)
Some of the time feeling lonely	-0.201**	-0.090	-0.183**	-0.192***	-0.242***	-0.188***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Often feeling lonely	-0.502***	-0.330***	-0.574***	-0.592***	-0.691***	-0.736***
	(0.09)	(0.09)	(0.08)	(0.07)	(0.08)	(0.07)
Log of equivalised income	0.897***	1.116***	1.502***	1.317***	1.347***	1.352***
	(0.18)	(0.17)	(0.16)	(0.15)	(0.15)	(0.15)
Part-time employed or	-0.330	0.969+	0.554	0.323	-0.052	0.044
self-employed	(0.56)	(0.54)	(0.46)	(0.45)	(0.49)	(0.51)
Job-seeking	-0.078	-0.233	-0.238	-0.668	-0.920+	-1.004+
	(0.59)	(0.59)	(0.49)	(0.47)	(0.52)	(0.54)
Full-time education	-0.587	-0.311	0.624	-0.402	0.319	0.072
	(0.54)	(0.53)	(0.44)	(0.44)	(0.49)	(0.50)
Taking care of a family member	-1.170+	-0.361	-0.196	-1.847***	-0.784	-0.949+
with chronic or disability	(0.65)	(0.63)	(0.53)	(0.51)	(0.56)	(0.58)
Not working	-0.548	0.052	0.764	0.137	0.381	1.486**
	(0.59)	(0.58)	(0.48)	(0.46)	(0.51)	(0.51)
Reasonable housing quality:	-0.136+	-0.213**	-0.283***	-0.222***	-0.247***	-0.208***
Partly true	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Reasonable housing quality:	-0.498***	-0.461***	-0.822***	-0.638***	-0.788***	-0.814***
Not true	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Some of the time concerned about	-0.127+	-0.204**	-0.204***	-0.333***	-0.349***	-0.468***
neighbourhood safety	(0.07)	(0.06)	(0.06)	(0.05)	(0.06)	(0.05)
Often concerned about	-0.244**	-0.404***	-0.507***	-0.727***	-0.713***	-0.779***
neighbourhood safety	(0.09)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)
PT employed or self-employed	0.050	-0.178*	-0.091	-0.039	0.037	0.007
# log income	(0.09)	(0.09)	(0.07)	(0.07)	(0.08)	(0.08)
Job seeking # log income	-0.022	-0.045	-0.023	0.049	0.112	0.137+
	(0.09)	(0.09)	(0.08)	(0.07)	(0.08)	(0.08)
Full-time education # log income	0.094	0.003	-0.119+	0.026	-0.077	-0.049
	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Taking care of a family member [...]	0.083	-0.088	-0.099	0.168*	0.014	0.039
# log income	(0.10)	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)
Not working # log income	0.023	-0.090	-0.175*	-0.074	-0.071	-0.203**
	(0.09)	(0.09)	(0.07)	(0.07)	(0.08)	(0.08)
Observations	8,120	8,600	11,040	13,180	12,140	13,980

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.13 Conditional Logit FE models-Main Survey (by marital status)

	Living as couple	Single
Little of the time accomplishing	-0.130***	-0.075+
less due to physical health	(0.03)	(0.04)
Some of the time accomplishing	-0.156***	-0.069
less due to physical health	(0.03)	(0.04)
Most of the time accomplishing	-0.546***	-0.371***
less due to physical health	(0.04)	(0.05)
All of the time accomplishing	-0.912***	-0.668***
less due to physical health	(0.05)	(0.06)
Little of the time accomplishing	-0.132***	-0.115*
less due to mental health	(0.04)	(0.05)
Some of the time accomplishing	-0.244***	-0.150**
less due to mental health	(0.04)	(0.05)
Most of the time accomplishing	-0.673***	-0.529***
less due to mental health	(0.05)	(0.06)
All of the time accomplishing	-0.941***	-0.677***
less due to mental health	(0.06)	(0.07)
Some of the time feeling lonely	-0.174***	-0.209***
	(0.03)	(0.04)
Often feeling lonely	-0.653***	-0.481***
	(0.04)	(0.05)
Log of equivalised income	1.298***	1.139***
	(0.09)	(0.11)
Part-time employed or self-employed	0.293	0.129
	(0.26)	(0.34)
Job-seeking	-0.652*	-0.711*
	(0.28)	(0.36)
Full-time education	0.242	-0.077
	(0.26)	(0.32)
Taking care of a family member	-1.048***	-1.018**
with chronic or disability	(0.30)	(0.39)
Not working	0.458+	-0.281
	(0.27)	(0.35)
Reasonable housing quality:	-0.262***	-0.145***
Partly true	(0.03)	(0.04)
Reasonable housing quality:	-0.740***	-0.575***
Not true	(0.04)	(0.05)
Some of the time concerned about	-0.313***	-0.248***
neighbourhood safety	(0.03)	(0.04)
Often concerned about neighbourhood	-0.621***	-0.472***
safety	(0.04)	(0.05)
PT employed or self-employed	-0.044	-0.013
# log income	(0.04)	(0.05)
Job-seeking # log income	0.050	0.078
	(0.04)	(0.06)
Full-time education # log income	-0.072+	-0.010
	(0.04)	(0.05)
Taking care of a family member [. . .]	0.037	0.059
# log income	(0.05)	(0.06)
Not working # log income	-0.112**	-0.002
	(0.04)	(0.05)
Observations	37,740	23,500

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.14 Conditional Logit FE models-Main Survey (by education levels)

	No degree	Degree or higher
Little of the time accomplishing	-0.114***	-0.145***
less due to physical health	(0.03)	(0.04)
Some of the time accomplishing	-0.136***	-0.150***
less due to physical health	(0.03)	(0.04)
Most of the time accomplishing	-0.423***	-0.554***
less due to physical health	(0.04)	(0.05)
All of the time accomplishing	-0.770***	-0.910***
less due to physical health	(0.05)	(0.06)
Little of the time accomplishing	-0.128***	-0.113*
less due to mental health	(0.04)	(0.04)
Some of the time accomplishing	-0.171***	-0.226***
less due to mental health	(0.04)	(0.05)
Most of the time accomplishing	-0.605***	-0.652***
less due to mental health	(0.05)	(0.06)
All of the time accomplishing	-0.816***	-0.876***
less due to mental health	(0.06)	(0.07)
Some of the time feeling lonely	-0.164***	-0.200***
	(0.03)	(0.04)
Often feeling lonely	-0.575***	-0.546***
	(0.04)	(0.05)
Log of equivalised income	1.209***	1.266***
	(0.09)	(0.10)
Part-time employed or self-employed	-0.107	0.355
	(0.27)	(0.32)
Job-seeking	-0.710*	-0.710*
	(0.29)	(0.34)
Full-time education	0.144	-0.131
	(0.27)	(0.32)
Taking care of a family member	-1.048***	-1.213**
with chronic or disability	(0.31)	(0.37)
Not working	-0.010	0.287
	(0.28)	(0.34)
Reasonable housing quality:	-0.245***	-0.209***
Partly true	(0.03)	(0.04)
Reasonable housing quality:	-0.685***	-0.674***
Not true	(0.04)	(0.05)
Some of the time concerned about	-0.264***	-0.336***
neighbourhood safety	(0.03)	(0.04)
Often concerned about neighbourhood	-0.557***	-0.627***
safety	(0.04)	(0.05)
PT employed or self-employed	0.028	-0.052
# log income	(0.04)	(0.05)
Job-seeking # log income	0.071	0.066
	(0.05)	(0.05)
Full-time education # log income	-0.051	-0.003
	(0.04)	(0.05)
Taking care of a family member [...]	0.059	0.066
# log income	(0.05)	(0.05)
Not working # log income	-0.026	-0.091+
	(0.04)	(0.05)
Observations	36,780	25,960

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C.15 Conditional Logit FE models-Main Survey (by whether or not having dependent children)

	Having dependent children	Having no dependent children
Little of the time accomplishing	-0.116*	-0.122***
less due to physical health	(0.05)	(0.03)
Some of the time accomplishing	-0.124*	-0.140***
less due to physical health	(0.05)	(0.03)
Most of the time accomplishing	-0.414***	-0.495***
less due to physical health	(0.06)	(0.04)
All of the time accomplishing	-0.753***	-0.861***
less due to physical health	(0.08)	(0.04)
Little of the time accomplishing	-0.066	-0.149***
less due to mental health	(0.06)	(0.03)
Some of the time accomplishing	-0.148*	-0.216***
less due to mental health	(0.06)	(0.04)
Most of the time accomplishing	-0.518***	-0.676***
less due to mental health	(0.08)	(0.04)
All of the time accomplishing	-0.711***	-0.900***
less due to mental health	(0.09)	(0.05)
Some of the time feeling lonely	-0.187***	-0.193***
	(0.05)	(0.03)
Often feeling lonely	-0.579***	-0.592***
	(0.07)	(0.04)
Log of equivalised income	1.304***	1.229***
	(0.13)	(0.07)
Part-time employed or self-employed	0.484	-0.020
	(0.39)	(0.24)
Job-seeking	-0.655	-0.789**
	(0.42)	(0.25)
Full-time education	-0.247	0.119
	(0.38)	(0.23)
Taking care of a family member	-0.574	-1.216***
with chronic or disability	(0.44)	(0.27)
Not working	0.160	0.238
	(0.40)	(0.24)
Reasonable housing quality:	-0.255***	-0.208***
Partly true	(0.05)	(0.03)
Reasonable housing quality:	-0.649***	-0.696***
Not true	(0.06)	(0.03)
Some of the time concerned about	-0.235***	-0.315***
neighbourhood safety	(0.05)	(0.03)
Often concerned about	-0.541***	-0.607***
safety	(0.06)	(0.04)
PT employed or self-employed	-0.077	0.012
# log income	(0.06)	(0.04)
Job-seeking # log income	0.046	0.086*
	(0.07)	(0.04)
Full-time education # log income	0.019	-0.049
	(0.06)	(0.03)
Taking care of a family member [...]	-0.034	0.075^{+}
# log income	(0.07)	(0.04)
Not working # log income	-0.080	-0.067^{+}
	(0.06)	(0.04)
Observations	16,060	50,620

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.9 Robustness checks

Table C.16 Conditional Logit FE models-Main Survey (Robustness check by time completion

	Main effects models		Interactions models	
	Main analysis	Robustness check	Main analysis	Robustness check
Little of the time accomplishing less due to physical health	-0.116***	-0.118***	-0.118***	-0.119***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time accomplishing less due to physical health	-0.135***	-0.132***	-0.133***	-0.129***
	(0.03)	(0.03)	(0.03)	(0.03)
Most of the time accomplishing less due to physical health	-0.479***	-0.480***	-0.466***	-0.468***
	(0.03)	(0.03)	(0.03)	(0.03)
All of the time accomplishing less due to physical health	-0.837***	-0.822***	-0.828***	-0.811***
	(0.04)	(0.04)	(0.04)	(0.04)
Little of the time accomplishing less due to mental health	-0.140***	-0.146***	-0.130***	-0.136***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time accomplishing less due to mental health	-0.215***	-0.209***	-0.203***	-0.197***
	(0.03)	(0.03)	(0.03)	(0.03)
Most of the time accomplishing less due to mental health	-0.656***	-0.656***	-0.635***	-0.634***
	(0.04)	(0.04)	(0.04)	(0.04)
All of the time accomplishing less due to mental health	-0.877***	-0.878***	-0.853***	-0.855***
	(0.04)	(0.05)	(0.04)	(0.05)
Some of the time feeling lonely	-0.186***	-0.183***	-0.184***	-0.180***
	(0.02)	(0.03)	(0.02)	(0.03)
Often feeling lonely	-0.591***	-0.595***	-0.579***	-0.582***
	(0.03)	(0.03)	(0.03)	(0.03)
Log of equivalised income	1.282***	1.267***	1.244***	1.228***
	(0.06)	(0.06)	(0.06)	(0.07)
Part-time employed or self-employed	0.033	0.042	0.096	0.067
	(0.03)	(0.03)	(0.20)	(0.21)
Job-seeking	-0.283***	-0.270***	-0.753***	-0.712**
	(0.04)	(0.04)	(0.21)	(0.22)
Full-time education	-0.184***	-0.179***	0.061	0.075
	(0.03)	(0.03)	(0.19)	(0.20)
Taking care of a family member with chronic or disability	-0.755***	-0.742***	-1.047***	-1.120***
	(0.04)	(0.05)	(0.23)	(0.24)
Not working	-0.221***	-0.220***	0.212	0.282
	(0.03)	(0.03)	(0.21)	(0.21)
Reasonable housing quality: Partly true	-0.235***	-0.233***	-0.223***	-0.220***
	(0.02)	(0.03)	(0.02)	(0.03)
Reasonable housing quality: Not true	-0.696***	-0.684***	-0.682***	-0.670***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time concerned about neighbourhood safety	-0.291***	-0.294***	-0.294***	-0.297***
	(0.02)	(0.02)	(0.02)	(0.02)
Often concerned about safety	-0.599***	-0.602***	-0.586***	-0.589***
	(0.03)	(0.03)	(0.03)	(0.03)
PT employed or self-employed # log income			-0.009	-0.003
			(0.03)	(0.03)
Job-seeking # log income			0.075*	0.071*
			(0.03)	(0.03)
Full-time education # log income			-0.038	-0.040
			(0.03)	(0.03)
Taking care of a family member [...] # log income			0.048	0.061+
			(0.03)	(0.04)
Not working # log income			-0.069*	-0.080*
			(0.03)	(0.03)
Observations	67,240	61,940	67,240	61,940

Source: Primary data collected under SIPHER consortium

Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Note: The check excluded respondents who took more than an hour to submit the survey.

Table C.17 Conditional Logit FE models-Main Survey (Robustness check by feedback)

	Main effects models		Interactions models	
	Main analysis	Robustness check	Main analysis	Robustness check
Little of the time accomplishing less due to physical health	-0.116***	-0.123***	-0.118***	-0.124***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time accomplishing less due to physical health	-0.135***	-0.121***	-0.133***	-0.119***
	(0.03)	(0.03)	(0.03)	(0.03)
Most of the time accomplishing less due to physical health	-0.479***	-0.475***	-0.466***	-0.463***
	(0.03)	(0.03)	(0.03)	(0.03)
All of the time accomplishing less due to physical health	-0.837***	-0.839***	-0.828***	-0.830***
	(0.04)	(0.04)	(0.04)	(0.04)
Little of the time accomplishing less due to mental health	-0.140***	-0.146***	-0.130***	-0.136***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time accomplishing less due to mental health	-0.215***	-0.221***	-0.203***	-0.209***
	(0.03)	(0.03)	(0.03)	(0.03)
Most of the time accomplishing less due to mental health	-0.656***	-0.667***	-0.635***	-0.646***
	(0.04)	(0.04)	(0.04)	(0.04)
All of the time accomplishing less due to mental health	-0.877***	-0.879***	-0.853***	-0.858***
	(0.04)	(0.05)	(0.04)	(0.05)
Some of the time feeling lonely	-0.186***	-0.192***	-0.184***	-0.190***
	(0.02)	(0.03)	(0.02)	(0.03)
Often feeling lonely	-0.591***	-0.589***	-0.579***	-0.578***
	(0.03)	(0.03)	(0.03)	(0.03)
Log of equivalised income	1.282***	1.287***	1.244***	1.257***
	(0.06)	(0.06)	(0.06)	(0.07)
Part-time employed or self-employed	0.033	0.036	0.096	0.118
	(0.03)	(0.03)	(0.20)	(0.21)
Job-seeking	-0.283***	-0.295***	-0.753***	-0.685**
	(0.04)	(0.04)	(0.21)	(0.22)
Full-time education	-0.184***	-0.167***	0.061	0.060
	(0.03)	(0.03)	(0.19)	(0.20)
Taking care of a family member with chronic or disability	-0.755***	-0.762***	-1.047***	-0.995***
	(0.04)	(0.05)	(0.23)	(0.24)
Not working	-0.221***	-0.256***	0.212	0.232
	(0.03)	(0.03)	(0.21)	(0.22)
Reasonable housing quality: Partly true	-0.235***	-0.241***	-0.223***	-0.230***
	(0.02)	(0.03)	(0.02)	(0.03)
Reasonable housing quality: Not true	-0.696***	-0.674***	-0.682***	-0.662***
	(0.03)	(0.03)	(0.03)	(0.03)
Some of the time concerned about neighbourhood safety	-0.291***	-0.286***	-0.294***	-0.289***
	(0.02)	(0.02)	(0.02)	(0.02)
Often concerned about safety	-0.599***	-0.593***	-0.586***	-0.580***
	(0.03)	(0.03)	(0.03)	(0.03)
PT employed or self-employed # log income			-0.009	-0.011
			(0.03)	(0.03)
Job-seeking # log income			0.075*	0.062+
			(0.03)	(0.03)
Full-time education # log income			-0.038	-0.036
			(0.03)	(0.03)
Taking care of a family member [...] # log income			0.048	0.038
			(0.03)	(0.04)
Not working # log income			-0.069*	-0.078*
			(0.03)	(0.03)
Observations	67,240	59,060	67,240	59,060

Source: Primary data collected under SIPHER consortium. Standard errors in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The check excluded respondents who were not sure about their answers or could not make the decisions, or stated that their answers might not be accurate/ its impossible to choose life A or B, and complained that the format of the survey did not display properly on their phones