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DWP Department for Work and Pensions

Valuation Techniques for Social Cost-Benefit Analysis:

Stated Preference, Revealed Preference and Subjective Well-Being Approaches

A Discussion of the Current Issues

Daniel Fujiwara and Ross Campbell

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Foreword

The Government is committed to improving the way that well-being and social impacts are incorporated into policy decisions.

Social Cost-Benefit Analysis, as recommended by the Green Book, is a way of expressing the value of a proposed government policy to society. It seeks to express the full social costs and full social benefits of policies in monetary terms so that the consequences of a diverse range of policies can be compared using a common metric.

The full social costs and benefits extend beyond the financial consequences of the policy. The Green Book is clear that wider social and environmental impacts must be brought into the assessment as far as possible. These wider impacts are often much more difficult to assess. The full value of goods such as health, family and community stability, educational success, and environmental assets cannot simply be inferred from market prices. But we should not neglect such important social impacts in policy making. We therefore look to economic techniques to help us elicit values for these goods.

This paper presents us with three different valuation approaches, each with strengths and weaknesses. This includes a newer approach that uses subjective well-being measurement to uncover social impact estimates. This is a potentially exciting development since social welfare ultimately rests on individuals' subjective assessment of their own well being. However, because of measurement problems, economists have historically tended to use proxies.

Subjective well being is recognised for the first time in this Green Book discussion paper: inevitably, its methodology is still evolving and existing valuations are probably not robust enough yet for use in Social Cost Benefit Analysis.

However, subjective well being measurement may soon provide a complement to the more traditional economic approaches. And in the meantime it can play an important role in challenging decision makers to think more carefully about the full range of impacts of their proposed policies. It can help them to question the values that they may otherwise place implicitly on these impacts. Subjective measurement may also give us a better idea of the relative value of non-market goods, even if absolute values cannot yet be placed alongside market goods. All of this will help policy makers better ground their decisions in evidence.

The paper therefore represents an important step forward in the Government's well-being research agenda. It reveals that non-market good valuation, and specifically subjective well-being measurement, is very much a live research issue, and one which each department should challenge itself to pursue further. We are getting closer to having plausible estimates of value in new areas which are important determinants of society's well-being.

Nick Macpherson
Permanent Secretary to H M Treasury

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Permanent Secretary of the Department for Work and Pensions and Head of the Policy Profession

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1 Introduction

The Green Book refers to two techniques for the valuation of non-market impacts: **Stated Preference** and **Revealed Preference** methods. Stated Preference uses specially constructed questionnaires to elicit estimates of people's Willingness to Pay for (or Willingness to Accept) a particular outcome. Revealed preference observes people's behaviour in related markets. These 'preference-based' techniques have been in use for some time as an essential part of Social Cost-Benefit Analysis. During this time, the behavioural sciences and other research has built up an evidence base about the potential uses of these methods, as well as their limitations.

In contrast to these preference-based techniques, a newer, 'subjective well-being' approach, has been gaining popularity in recent years, which attempts to measure people's experiences rather than expose their preferences. The **Life Satisfaction Approach** uses reported life satisfaction in surveys such as the ONS's Integrated Household Survey, which began including questions on respondents' subjective well-being in April 2011, to value non-market impacts. The approach uses econometric methods to estimate the life satisfaction provided by non-market goods, and this is then converted into a monetary figure by also estimating the effect of income on life satisfaction. The approach therefore assesses the impact of policies on how people think and feel about their lives as a whole, instead of assessing impact based on what people say they want and what they choose.

This paper has been written with three main objectives in mind:

- First and foremost, to demonstrate that the valuation of non-market goods, and specifically the measurement of well-being, is a live research issue across government and academia, and one which Departments should be challenged to pursue further.

- To provide an introduction to how analysts should go about applying all three approaches in practice.

- To cover the strengths and weaknesses of the three methods in detail to enable analysts to use the findings generated appropriately and interpret them with the appropriate degree of caution or enthusiasm in order to provide decision makers with high quality advice. Specifically in this regard, we recognise that subjective well-being at the moment remains an evolving methodology, but one which may soon provide a complement to the more traditional economic approaches. In the meantime, it can play an important role in challenging analysts and decision makers to think about the full range of social impacts, and may give us a better idea of the relative value of non market goods".

The rest of the paper proceeds as follows. Chapter 2 presents a brief overview of the economic theory underlying applied valuation. A concise description of the practical methodology of the three valuation approaches is laid out in Chapter 3. Chapter 4 contains the bulk of the paper and presents a comprehensive overview of the strengths and weaknesses of all three approaches. In particular the Chapter draws on findings from the field of behavioural economics which have shaped recent discussion on valuation in the economics literature. Chapter 5 builds on the discussion that precedes it to provide more detail on how to apply the life satisfaction approach in practice. This Chapter is written in order help Departments pursue the life satisfaction research agenda further. Chapter 6 discusses some issues that are likely to attract

attention in future valuation research. This includes evidence from the field of neuroscience which is increasingly being used to test the way people determine preferences and value. Chapter 7 concludes.

2 Background: Monetary Valuation

Economists seek to monetise the impact of a policy, good or life event by looking at the impact these things have on *utility*. Utility is a broad concept that refers to a person's welfare, well-being or happiness. The monetary value of something can be estimated as the monetary equivalent of the impact on utility. We can think of an individual's utility as being a function of the market (*C*) and non-market goods (*Q*) they consume:

$$u(C,Q) \quad (1)$$

To transform changes in utility into equivalent monetary values we can use the **indirect utility function**, which assesses utility in money metrics rather than in terms of the quantities of goods consumed:

$$v(p,Q,M) \quad (2)$$

An individual's indirect utility function gives the consumer's maximised level of utility when faced with price levels *p* for market goods, income *M* and non-market goods *Q*. This paper focuses on expressing the value of changes in the levels of non-market goods, *Q*. Included in the definition of a non-market good is any good or service which is not traded in markets, such as public goods, but also elements of and events in one's life such as health, employment and marriage. Quasi-market-goods, such as education and health, which are at times, or in part, traded in markets are included; as are non-market 'bads', such as pollution and crime.

2.1 Equivalent Variation and Compensating Variation

Value can be measured in two ways. **Equivalent Variation** (EV) is *the amount of additional income the individual would need to obtain the same level of utility that they would get from consuming the non-market good* (the *0 superscripts* denote conditions prior to provision of the non-market good and the *1 superscripts* denote conditions after its provision):

$$v(p^0,Q^1,M^0) = v(p^0,Q^0,M^o + EV) \quad (3)$$

Compensating Variation (CV) is *the amount of income which would need to be taken away from the individual after consuming the good to return the individual to their original level of utility*:

$$v(p^0,Q^0,M^0) = v(p^0,Q^1,M^o - CV) \quad (4)$$

Which measure to use will generally depend on the context of the analysis. EV is usually used in cases when a good or service is provided and is, in this sense, often associated with the term **Willingness to Pay** (**WTP**). CV is usually used in cases when there is a reduction in the good or service and is associated with **Willingness to Accept** (**WTA**).

In modern microeconomic theory changes in utility are measured by the degree to which one's preferences have been satisfied. The **Axioms of Revealed Preference** stipulate that people's preferences are *rational*. Rationality here implies that preferences are[1]:

- **Complete** – individuals are able to express a preference for any good or say they are indifferent between any pair of goods;
- **Transitive** – individuals who prefer (or are indifferent to) good x over good y, and who prefer (or are indifferent to) good y over good z, must also prefer (or be indifferent to) x over z; and
- **Reflexive** – individuals are indifferent between x and x.

People are assumed to *maximise utility* given a budget constraint and it is assumed that their preferences are *never fully satiated*, in that the individual always places a positive value on more consumption.

The two standard preference-based approaches to valuation in economics have developed from these rationality assumptions. That is, both approaches are based on the premise that people have well-defined pre-existing preferences and values for all goods and services. The task of the valuation exercise is to accurately recover these values. **Stated Preference techniques** use surveys in which people make statements in relation to their WTP (WTA) for a good ('bad'). **Revealed Preference techniques** infer people's WTP (WTA) for a good ('bad') by examining their actual real-life behaviour in a related market (hedonic pricing) or in the consumption of the good itself (travel cost). We categorise these approaches as **preference-based methods of valuation**.

A new **non-preference approach** has also been gaining popularity over the past decade. The **Life Satisfaction approach** estimates the value of non-market goods by looking at how they impact on people's reported well-being (life satisfaction). The cornerstone conjecture of the Life Satisfaction approach is that more direct measures of well-being, such as life satisfaction, rather than the degree to which one's preferences have been satisfied, better approximate an individual's underlying utility. Much of the motivation for this new approach stems from doubt over whether preferences do actually conform to the basic assumptions outlined above. A large literature from behavioural economics and psychology finds that people's preferences may not be good indicators of their actual welfare or well-being. We discuss the main findings from this literature in this paper.

[1] Continuity in preferences (ie, if x is preferred to y then bundles that are "sufficiently close" to x are also preferred to y) is also often included as an axiom to ensure the existence of a continuous utility function. The continuity axiom is not required for rationality.

3 Valuation Methods

This chapter presents a brief introduction to Stated Preference and Revealed Preference methods and then a more detailed introduction to the Life Satisfaction Method. We show that all three valuation methods are derived from the same theoretical basis. The Stated and Revealed preference discussion serves as a recap to readers familiar with economic valuation. A more detailed introduction to the issues involved in the application of these methods is set out in Annex A.

3.1 Stated Preference Methods

Stated preference methods use specially constructed questionnaires to elicit estimates of the WTP for or WTA a particular outcome. WTP is the maximum amount of money an individual is willing to give up to receive a good. WTA is the minimum amount of money they would need to be compensated for foregoing a good. In theory EV and CV are estimated as follows using stated preference methods:

$$v(p^0, Q^1, M^0) = v(p^0, Q^0, M^o + WTP_{SP}) \qquad (5)$$

where $WTP_{SP} = EV$

$$v(p^0, Q^0, M^0) = v(p^0, Q^1, M^o - WTA_{SP}) \qquad (6)$$

where $WTA_{SP} = CV$

There are two categories of stated preference methods:

- Contingent valuation methods, which focus on the valuation of a non-market good as a whole; and
- Choice modelling methods, which focus on valuing specific attributes of a non-market good.

3.1.1 Contingent Valuation Methods

Contingent valuation methods construct and present a hypothetical market to questionnaire respondents. A detailed description of a good, how it will be provided, and the method and frequency of payment are usually highlighted. Following this, questions are posed in order to infer a respondent's WTP or WTA. These valuation questions can be presented in a number of different ways, including open ended, bidding game, payment card, and dichotomous choice elicitation formats (see Annex A).

Contingent valuation questionnaires also normally contain additional questions to gain information on a respondent's socioeconomic and demographic characteristics, their attitudes towards the good, and the reasons behind their stated valuations. The responses to these questions are typically used to model the determinants of stated valuations and to identify invalid or protest valuations (e.g. respondents who state a zero WTP due to an ethical objection to paying for good).

The key outcome of the analysis of the responses is an estimate of the average WTP across the sample of people surveyed. If the sample is representative of the target population, then this estimate can be aggregated to obtain an estimate of the total value of the outcome or good.

3.1.2 Choice Modelling Methods

Most non-market goods can be described by their attributes. For example, a scheme to reduce sewage overflows into the River Thames could be described by its cost and the resultant reduction in fish deaths, health risks, and visual disamenity (Mourato et al, 2005). Choice modelling methods focus on a good's attributes and their values.

To uncover valuation estimates, choice modelling questionnaires present respondents with a series of alternative descriptions of a good. The alternative descriptions are constructed by varying the levels of the good's attributes. Depending on the specific choice modelling method adopted, respondents are either then asked to rank (contingent ranking), chose (choice experiments), rate (contingent rating), or choose then rate (paired comparisons) the descriptions presented (Hanley et al, 2001).

Choice experiments and contingent raking experiments usually include the status quo or 'do nothing' option alongside one or more alterative descriptions of the good. The 'do nothing' option in the sewage scheme mentioned above (Mourato et al., 2005), for example, is to pay nothing annually and to bear the expected annual negative side effects of the sewage overflows. For these methods, as long as cost or price is included as an attribute, statistical techniques can be used to recover WTP estimates for the other attributes of the good.

3.2 Revealed Preference Methods

Revealed preference methods uncover estimates of the value of non-market goods by using evidence of how people behave in the face of real choices. The basic premise of the hedonic pricing revealed preference method, for example, is that non-market goods affect the price of market goods in other well-functioning markets. Price differentials in these markets can provide estimates of WTP and WTA. For marginal changes in *Q* EV is estimated as follows in the revealed preference method:

$$v(p^0, Q^1, M^0) = v(p^0 - p^1{}_{(EV)}, Q^0, M^o) \qquad (7)$$

where p^0 is a vector of prices for market goods before provision of the non-market good and $p^1{}_{(EV)}$ is a vector of prices identical in all elements, except for the complementary market good.

CV is estimated as follows:

$$v(p^0, Q^0, M^0) = v(p^0 + p^1{}_{(CV)}, Q^1, M^o) \qquad (8)$$

The two most common revealed preference methods are[1]:

- The **Hedonic Pricing Method**, which involves examining people's purchasing decisions in markets related to the non-market good in question; and

- The **Travel Cost Method**, which involves observing costs incurred in the consumption of the non-market good in question.

3.2.1 The Hedonic Pricing Method

The hedonic pricing method has most commonly been applied using data from housing and labour markets. In the former, the intuition is that the price differential between otherwise identical houses that differ in their exposure levels to non-market goods and bads such as pollution, noise, crime or education facilities reveals information regarding individuals' WTP for such goods. Labour market applications follow a similar logic, though the focus is typically on the compensating wage differentials that are paid in relation to job characteristics such as health and safety risks or job security.

Applications consist of estimating a hedonic wage or price regression function to capture the effect of a non-market good on wages or prices (Leggett and Bockstael, 2000; Chay and Greenstone, 2005). The price (p_i) of a house (h_i), for example, can be written as a function of its n characteristics [2]. Example characteristics include the number of bedrooms, size of the garden, commuting distance to nearby cities, quality of schools in the area and environmental qualities such as air quality:

$$p_i = f(h_{1i}, h_{2i}, ...h_{ni}) \qquad (9)$$

In a competitive market, the marginal implicit price of any of these characteristics (e.g. $\partial p_i / \partial h_{ni}$) represents a household's WTP for a marginal increase in that characteristic.

3.2.2 The Travel Cost Method

The travel cost method has most predominantly been used to estimate the value of recreational sites (e.g. a river, a park, or a beach). It has also been used to value changes in the characteristics of sites (e.g. ease of access).

The number of visits (q_i) to a site by an individual i over, for example, a year is likely to be related to the price they have to pay to visit the site (p_i), the price of substitute sites available to them (ps_i), and their income (m_i). It might also be suspected that visit frequency will vary across factors such as age, gender, education level and whether the individual has children (x_i). A simple travel cost model is given by

$$q_i = f(p_i, ps_i, m_i, x_i) \qquad (10)$$

[1] Behaviour can also be observed through the actions people take to insulate themselves from things that lower their utility. This forms the basis for the defensive expenditure method for non-market valuation. For example, in response to traffic noise or air pollution, households may purchase double glazed windows or hire window cleaners. Therefore, expenditures on market goods can be related to levels of non-market bads. This can be used to derive estimated changes in expenditure (the benefits) that result from exogenous changes in noise or pollution. Dickie (2003) gives an overview of this less commonly utilised revealed preference method.

[2] Any equation relating the price of a good to the good's characteristics is called a hedonic price function. The partial derivative of a hedonic price function with respect to any characteristic is called the marginal implicit price of that characteristic.

The total welfare (or **consumer surplus**) that an individual *i* derives from the site over a year (CS_i) is given by

$$CS_i = \int_{p_i}^{p_{choke}} f(p_i, ps_i, m_i, x_i)\, dp_i \qquad (11)$$

That is, the consumer surplus is given by the area under their demand curve between the price of their visits (p_i) and the price at which their visit frequency would fall to zero, known as their *choke price* (p_{choke}).

Simple travel cost model applications consist of collecting data in order to measure the variables in the equation (10) above. This equation is then estimated to derive an individual level demand curve for the site. Finally, to derive estimates of the total use value of the site the consumer surplus estimate from this demand curve is aggregated with either visitation or population totals. Parsons (2003) presents a more detailed treatment of the econometric model and aggregation steps for travel cost models.

3.3. The Life Satisfaction Approach

The central assumption of the life satisfaction approach is that measures of life satisfaction are good proxies of an individual's underlying utility. In this sense, the utility function and its level sets (the indifference curves) can be directly observed and it is possible to estimate the marginal rates of substitution (MRS) between income and the non-market good to provide an estimate of EV or CV. For example, if a 20% reduction in local crime rates increases the life satisfaction of an individual by 1 index point and an increase in household income of £5,000 p.a. also increases their life satisfaction by 1 index point, then we would conclude that the value of the 20% reduction in crime to them is £5,000 per year. Formally, EV and CV are estimated as follows in the LS approach:

$$v(p^0, Q^1, M^0) = v(p^0, Q^0, M^o + WTP_{LS}) \qquad (12)$$

where $WTP_{LS} = EV$

$$v(p^0, Q^0, M^0) = v(p^0, Q^1, M^o - WTA_{LS}) \qquad (13)$$

where $WTA_{LS} = CV$

In practice (12) and (13) are estimated econometrically using the direct utility function in (1). The direct utility function is estimated by applying regression analysis to panel or cross-sectional survey data to measure the impact of non-market goods on life satisfaction. Using panel data the following life satisfaction function is estimated:

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{it} + \varepsilon_{it} \qquad (14)$$

where M_{it} is the income of individual *i* at time *t*, Q_{it} is the level of a non-market good consumed or provided to individual *i* at *t* and X_{it} is a vector of individual characteristics and other factors that impact on life satisfaction. The coefficient β_2 is an estimate of the impact of the non-market good on life satisfaction. WTP_{LS} and WTA_{LS} can be estimated by calculating

the MRS between income and the non-market good using the estimated coefficients from (14). Formally WTP_{LS} can be represented as follows:

$$LS(\alpha+\beta_1 M_{it}^{\ 0}+\beta_2 Q_{it}^{\ 1}+\beta_3 X_{it}+\varepsilon_{it}) = LS(\alpha+\beta_1(M_{it}^{\ 0}+WTP_{LS})+\beta_2 Q_{it}^{\ 0}+\beta_3 X_{it}+\varepsilon_{it}) \quad (15)$$

re-arranging to give:

$$WTP_{LS} = \frac{\beta_2(Q_{it}^{\ 1}-Q_{it}^{\ 0})}{\beta_1} \quad (16)$$

Here WTP can be estimated using the sub-sample that *receives* or *gains* the non-market good. This is the sub-sample that experiences $Q^0 \rightarrow Q^1$.

Similarly, WTA_{LS} can be calculated as follows:

$$LS(\alpha+\beta_1 M_{it}^{\ 0}+\beta_2 Q_{it}^{\ 0}+\beta_3 X_{it}+\varepsilon_{it}) = LS(\alpha+\beta_1(M_{i}^{\ 0}-WTA_{LS})+\beta_2 Q_{it}^{\ 1}+\beta_3 X_{it}+\varepsilon_{it}) \quad (17)$$

$$WTA_{LS} = \frac{\beta_2(Q_{it}^{\ 1}-Q_{it}^{\ 0})}{\beta_1} \quad (18)$$

Here WTA can be estimated using the sub-sample that *loses* or *forgoes* the non-market good. This is the sub-sample that experiences $Q^1 \rightarrow Q^0$.

It is also possible to estimate equation (14) using other measures of well-being as the dependent variable. An implicit assumption in the literature is that out of the range of well-being variables that are available, life satisfaction represents the closest measure to the economist's notion of utility and has therefore been used most frequently. Clark and Oswald (2002) use life satisfaction and the General Health Questionnaire (GHQ) index of mental health as proxies for utility. Powdthavee and van Praag (2011) use a range of well-being indicators when valuing health states. Generally, using life satisfaction as the well-being measure results in lower value estimates because income is more strongly correlated with life satisfaction. In this paper we take the standard approach and focus on life satisfaction.

Estimation

Monetary values for a wide range of non-market goods and 'bads' have been estimated using the life satisfaction approach. Annex B tabulates the main life satisfaction method studies to date.

In Chapter 4 below we discuss the main methodological challenges associated with the life satisfaction approach. With reflection on this, in Chapter 5 we then provide some guidelines and a description of the estimation procedure for the life satisfaction approach.

4 The Strengths and Weaknesses of the Three Methods

4.1 Introduction

In section 4.2 we address the main issues relevant to the strengths and weaknesses of all the methods (such as whether preferences or life satisfaction are the better measure of utility). Section 4.3 then tackles some additional issues which are *specific* to each of the methods (such as the potential for survey related biases when using stated preference). Section 4.4 presents some conclusions.

4.2 Issues relevant to all three methods

There are a number of issues relevant to the strength of all three methods. Below we deal with:

- whether preferences are a good measure of utility;
- whether stated life satisfaction is a good measure of utility;
- setting up the empirical study; and
- econometric methodology issues

4.2.1 Whether preferences are a good measure of utility

Broadly speaking there are three accounts of well-being or utility (Parfit, 1984):

1. Preference satisfaction
2. Mental states
3. Objective lists

The preference satisfaction approach is based on the premise that we can infer utility from people's choices because "*what is best for someone is what would best fulfil all of his desires*" (Parfit, 1984: 494). Traditional approaches to valuation (stated and revealed preference methods) focus on preference satisfaction accounts. These methods rest fundamentally on the assumption that people seek to maximise their expected utility subject to a budget constraint and that their preferences can be defined by the preference axioms in Chapter 2.

Mental state accounts refer to people's statements about their own utility, ie, measures of subjective well-being (SWB). Objective list accounts of well-being are based on assumptions about basic human needs and rights (Dolan et al., 2011a). The life satisfaction approach is based on the mental state account. In this paper we therefore focus on preference satisfaction and mental state (SWB) accounts.

Behavioural economics challenges the preference axioms by taking empirical findings from psychology. Here we cover the main findings relating to whether people behave in accordance with the standard economic model. For in-depth reviews the reader is directed to Hastie and Dawes (2010)[1] and Kahneman and Tversky (2000)[2]. It should also be noted that much of the

[1] Hastie and Dawes (2010) Rational Choice in an Uncertain World, 2nd edition. Sage: London

[2] Kahneman and Tversky (ed.s) (2000). Choice, Values and Frames.Cambridge University Press: Cambridge, UK.

discussion here is also relevant to the non-monetary valuation of health states using quality-adjusted life years (QALYS). The standard gamble (SG) and time trade-off (TTO) mechanisms of assigning utilities to different health states essentially ask people to state their subjective values and thus share many of the problems related to stated preference techniques discussed below. Our attention in this paper is on monetary valuation techniques and thus we do not cover issues related to QALYS in further detail. Interested readers are directed to Dolan and Kahneman (2008) for a full discussion.

Decision-making is a core element of preference-based methods; whether in a survey or real-world market setting economists observe people's decisions in order to infer values. Simon's (1955) theory of bounded rationality also sharply criticised the economist's view of individual decision-making by highlighting the role of perception, cognition and learning in the decision-making process. The resulting concept of preferences is that they are constructed at the time of elicitation and are context-dependent (Slovic, 2000). Ariely et al. (2006) even go as far as to say that people have no notion as to whether a good or product is even good or bad for them.

Work in the fields of cognitive psychology and decision science highlights the notion that in the decision-making process people use a number of cognitive shortcuts, especially when the issues with which they are faced are unfamiliar and complex[3]. These shortcuts or 'rules of thumb', which are used by individuals to simplify and speed up the decision making process, are called *heuristics*. Heuristics can lead to the generation of irrational preference relations and choices. This has obvious implications for both stated and revealed preference techniques.

Heuristics

Here we consider two categories of empirical finding that are thought to emerge from the use of heuristics:

i. 'utility misprediction'; and
ii. 'anchoring':

i) Utility mis-prediction

Preference-based valuation methods require people to be able to predict the future utility consequences of consuming or foregoing a good. Numerous experiments have shown that people are unable to do this with accuracy (Kahneman, 2000). Kahneman and Snell (1992), for example, report that people find it very hard to predict how much pleasure they will derive from consuming even everyday goods such as music, yogurt and ice cream. Participants were asked to consume these goods each day for a week. They rated their liking of the goods after each consumption and also predicted their liking and enjoyment of the goods for the following day. Correlations between predicted and actual enjoyment were negligible even in relatively large sample sizes. Nisbett and Kanouse (1969) and Read and van Leeuwen (1998) find evidence that shoppers who have recently eaten cannot forecast their future food consumption and appetites accurately. Gilbert (2007) and Kahneman and Snell (1992) attribute these findings to a **presentism** heuristic; people project current tastes and desires on to their predicted future preferences.

Other reasons for mis-predicting utility are **adaptation** and **focussing illusions**. Evidence from a number of different contexts suggests that individuals systematically fail to fully consider the extent to which they adapt to changes in circumstances. They therefore tend to over-estimate the utility gain that will result from events, circumstances or outcomes (Kahneman and Thaler, 2006; Loewenstein and Adler, 1995). Frey and Stutzer (2004), for example,argue that people underestimate how quickly they will adapt to extrinsic goods, such as money. They therefore end

[3] Dellavigna (2009) provides a comprehensive survey of the empirical evidence relating to deviations from the standard economic model, divided into three categories – i) non-standard preferences, ii) non-standard beliefs, and iii) non-standard decision making

up sacrificing too many intrinsic goods, such as time with family and friends, for time spent at work and commuting. Schkade and Kahneman (1998) present evidence that people are not able to predict the satisfaction they would derive from moving from the Midwest to California. Individuals tended to focus on one or two salient aspects associated with California, such as the weather (which in reality does not feature so saliently in people's actual day-to-day lives), when forecasting utility.

An issue related to focussing illusions is **proportion dominance**. People attach great weight to information formats that use proportions, percentages or probabilities, since these formats put the outcome dimension into perspective; these formats have upper and lower bounds which allow people to place where a given value falls (Slovic et al., 2002). This leads to some anomalous findings. For example, in a study on airport safety equipment, people in different groups were offered equipment that, in the event of a crash landing, would save 150 lives and equipment that would save 98% of 150 lives (Fetherstonhaugh et al., 1997). In general people stated that they valued the latter equipment higher although the outcome (in terms of lives saved) was not as good. In fact they found that saving 98%, 95%, 90% and 85% of 150 lives were all more valuable options than saving 150 lives.

ii) Anchoring

People's stated values can be influenced by irrelevant cues. Ariely et al. (2003) found, for example, that people's WTP for a range of everyday consumer goods and their WTA values for small annoyances, such as high pitched sounds, were heavily anchored around their social security (SS) numbers. People were asked to write down the last two digits of their SS number and were then asked whether they would be willing to pay or accept a value equal to that number. Values were increased or reduced from the initial SS number anchor until the respondents' maximum (minimum) WTP (WTA) values were derived. US SS numbers are randomly generated, which means that they could not provide any information on the quality of the good. In general, people with higher SS numbers were willing to pay significantly more for the goods. An interesting second finding was a marked stability of relative preference. For example, although people's absolute valuations of a superior and inferior wine were subject to normatively irrelevant number anchors, the vast majority of people valued the highly rated product more than the inferior product. Therefore, the evidence suggests that people did not know how much they were truly WTP for each of the wines, but they did know that they were WTP more for the superior wine. This, and other evidence, lead the authors to claim that people's preferences and valuations were coherently arbitrary; "consumers' absolute valuation of experience goods is surprisingly arbitrary, even under "full information" conditions. However, consumers' relative valuations of different amounts of the good appear orderly, as if supported by demand curves derived from fundamental preferences" (Ariely et al., 2003).

The neurological basis of anchoring is gaining understanding. Research suggests that the medial orbitofrontal cortex (mOFC) is a key area of the brain associated with experienced pleasantness (Plassmann et al., 2008; McCLure et al., 2004). In a wine tasting experiment Plassmann et al., (2008) gave the same wine to different groups, manipulating only the price across the groups. Using functional magnetic resonance imaging (fMRI), they found that reported experience/pleasantness *and* activity in the mOFC both increased with price (although the wine was identical). A follow-up experiment eight weeks later had the participants taste the wines again, but this time without a price anchor. There were no reported differences among the wines. Therefore, with anchoring it may be not just a case of people mis-reporting a value in contingent valuation (ie, feeling one thing but reporting another because of the influence of the anchor) but that people actually *subjectively experience* goods differently because of the anchor.

The role and implications of **neuroscience** for valuation techniques is discussed in more detail in Chapter 6.

Loomes (2006) reviews a number of contingent valuation studies (for goods relating to individuals' health and safety) that find excessive sensitivity to factors within an elicitation format that should, in conventional economic terms, be irrelevant. More specifically, he presents evidence showing that:

- estimates derived through the bidding game format have been found to be subject to **starting point effects**: The higher the opening offer is, the larger the valuation estimates are; and
- estimates found under the payment card elicitation format have been found to be sensitive to **range effects**: A presented range of £0-100, for example, attracting higher valuation estimates than a range of £0-50.

Dubourg, Jones-Lee, and Loomes (1997), for example, report results from a stated preference study for the UK Department of Transport that looked at the value people attach to reductions in the risk of road injuries. In an elicitation format similar to the bidding game, they found that a £75 starting point resulted in mean WTP estimates from 1.89 to 2.87 times as large as those elicited with a £25 starting point.[4] In a different round of piloting they utilised a payment card elicitation format. Using a range from £0 to £500 for one sample and from £0 to £1500 for another, they found that the latter generated higher WTP estimates in nine out of ten of their comparisons.

Loomes also discusses efforts by Guria et al (2003) and Chilton et al (2004) to eliminate such anomalous effects. The former presented respondents with a starting value in a bidding game format that was clearly a computerised random draw. The hope was that the randomness of the initial bid would cause respondents to attach less significance to it. Although the starting point effect became weaker in later questions, it still persisted. Chilton et al (2004) adopted a random card sorting procedure elicitation format in an attempt to counter the effects. This consisted of the interviewer visibly shuffling a small pack of cards; each one having a different sum of money printed on it. The respondent then turned over each card and declared whether they 'certainly would pay,' 'certainly would not pay,' or were 'unsure whether they would pay' the amount shown on the card. Having seen the pack being shuffled, the amount on the first card turned over should have had no effect. The results showed, however, that there was a significant positive linear correlation between the amount on the first card and respondents' stated WTP.

An important outcome of context-dependent preferences and heuristics is the phenomenon of **preference reversals.** There is a large body of evidence demonstrating that preferences can be reversed by changing from one mode of elicitation to another that is formally equivalent (Slovic, 2000). An early example of this is Slovic and Lichtenstein's (1971) study of gambling preferences. People were offered two different bets of the same expected value; a probability bet (high probability of winning a small amount – eg, an 80% chance of winning $5) and a dollar bet (low probability of winning a large payout - eg, a 10% chance of winning $40). In lab experiments as well as field experiments in casinos the overwhelming majority of people chose to play probability bets over dollar bets, but when both of the bets were given to them and they were asked to sell them back to the House, the majority assigned higher prices (higher WTA values) to the dollar bet. These preference reversals were explained as an anchoring effect. '*Respondents setting a price on an attractive gamble appeared to start with the amount they could win and adjust it downward to account for the probabilities of winning and losing as well as for the amount that could be lost. The adjustment process was relatively imprecise, with the price response greatly influenced by the starting point payoff. Rating and choices, on the other hand appeared to be governed by different rules, leading to greater emphasis on probabilities*' (Slovic, 2000).

[4] Respondents were allocated at random to either a £75 or £25 sample. They used an elicitation procedure to identify respondent's min, max, and best estimates. They also manipulated the levels of injury and the life of the safety feature (next 12 months or the rest of their life) across questionnaires. The comparative estimates reported here refer to the best estimates.

Preference reversals have also been found in risk-free experiments. Hsee (2000) finds that preferences can be reversed by changing from whether the good is evaluated on its own to whether it is evaluated jointly against another similar good. For example, Hsee's *Dictionary Study* asked students to state their WTP values for the following two music dictionaries:

	Dictionary A	**Dictionary B**
Year of publication:	1993	1993
Number of entries:	10,000	20,000
Any defects?	No, it's like new.	Yes, the cover is torn; otherwise, it's like new.

Respondents were assigned to three different groups: i) subjects who were shown both dictionary descriptions and asked to state their WTP for each (joint evaluation mode); ii) subjects who were shown dictionary A only and asked to state their WTP for that dictionary (separate evaluation mode); and iii) subjects who were shown dictionary B only and asked to state their WTP for that dictionary (separate evaluation mode).The mean WTP values for the two dictionaries are shown in the table below.

Preference reversals in joint and separate evaluations

Evaluation Mode	**Dictionary A**	**Dictionary B**
Joint	$19	$27
Separate	$24	$20

Source: Hsee (2000).

Under joint evaluation, people state a higher value for dictionary B. However, under separate valuation, dictionary A attracts the highest stated value. These joint evaluation– separate evaluation preference reversals can be explained by some simple heuristics. In separate evaluation people focus on the categorical attributes of the good, in this case '*whether the dictionary has any defects'.* In joint evaluation, attention is focused on the incremental aspects or differences in the goods, in this case '*the number of additional entries'.*

The study of preference reversals has not been limited to the field of psychology. For example, two economists, Grether and Plott (1979), criticised the previous work by psychologists and replicated the experiments introducing improved incentive compatibility, a wider and more varied range of participants and more information for participants. However, the preference reversal phenomenon did not disappear. Preference reversals have also been found in contingent valuation surveys for environmental goods and amenities (Brown, 1984; Gregory et al., 1993; Irwin et al., 1993).

The anchoring and preference reversal phenomena described above involve people stating or placing monetary valuations on goods. There is some evidence to suggest that part of the problem may be arising when people try to convert a feeling or concept of value into a monetary scale. In this interpretation people could have strong and well-defined preferences, beliefs and feelings for many of the things that are not sold through markets, but these beliefs are not represented monetarily (Gregory et al., 1993). Amir et al. (2008) find a disparity between people's WTP and their predicted experience or utility of goods like music concerts. Kahneman et al (1998) found that in a juror award experiment in which people studied a number of corporate malpractice cases and were asked to rate the defendant's (the corporation) actions on a scales of 'outrage' and 'degree of punishment justified.' There were strong correlations between the level of outrage and punishment across the different jurors, but the dollar awards had very little correlation. This is supported by a study by Malouff and Schutte (1989) who find that juror awards are highly susceptible to the anchoring effect of the plaintiff's initial level of compensatory demand.

The theory of constructed preferences suggests that the preference axioms do not hold. The evidence suggests that preferences and values are constructed on the spot, using a number of heuristics. This would imply that people's preferences are not *complete* and due to preference reversals are often *intransitive*. The above evidence suggests that preferences and valuations are highly dependent on the **framing** of the question, a phenomenon developed in Kahneman and Tversky's (1979) **Prospect Theory**[5]. These findings raise serious doubts about whether stated preference studies obtain meaningful WTP and accept estimates and whether prices at which goods are traded are accurate reflections of the value people place on goods and services. Little is known about the workings and properties of markets where economic agents have inconsistent preferences (Smith and Moore, 2010). In an experimental setting Smith and Moore (2010) find that non-rational agents can adversely impact on the earnings (the attainment of economic surplus) of the group of traders in general in market transactions.

A confounding problem is that people may lack good information about the good (Frey et al., 2004a; Frey and Stutzer, 2005); Robinson and Hammitt, 2011) and, specifically for stated preference, they may not fully understand the details of the payment system (Braga and Starmer, 2005) or could be susceptible to errors (Rashes, 2001). This would question whether, even with stable and well-defined preferences, people could state or reveal accurate values for non-market goods in stated preference and revealed preference contexts.

The theory of preference construction can also help to explain the odd findings that have emerged under the broad title of **embedding effects** in the stated preference literature. There are three types of **embedding effect**:

i) Insensitivity to scope

This refers to when the estimated WTP for a non-market good is insensitive to the size of that good[6]. For instance, Desvousges et al (1992) found no significant difference in the mean levels of WTP to save 2,000, 20,000 or 200,000 migrating birds from death. Scope insensitivity has been discovered in a number of other applications. Schulze et al (1993) discover little difference in the estimated WTP for a partial or complete clean-up of a contaminated area; McFadden and Leonard (1993) find that residents in four western states are willing to pay only 28% more to protect 57 wilderness areas in those states compared to the protection of a single area; Jones-Lee et al (1995) find that reducing the number of non-fatal road injuries by a factor of three only increases the stated WTP for a programme by 29%; and Chilton et al (2004) find insensitivity to WTP for increases in life expectancy in normal health for the respondent and all members of their immediate household. The mean WTP for an extra 6 months was just over 30% higher than an extra 1 month.

Ariely et al. (2003) claim that scope insensitivity is further evidence of coherent arbitrariness because insensitivity to scope is most dramatic in studies that use between-subject designs. Within-subject design studies produce valuations that are far more responsive to scale. Kahneman and Knetsch (1992) argue that insensitivity to scope is explained by respondents putting forward their WTP for the moral satisfaction of contributing to public goods, rather than their true valuation of the good. Another explanation (Kahneman et al., 1999) is that insensitivity to scope reflects respondents expressing an affective valuation of a prototypical exemplar. Here, affective valuation refers to assessments of preference on the basis of "the sign and intensity of the emotional response to objects" (Kahneman et al, 1999, p. 204). In the study by Desvousges et al (1992) discussed above, for example, under this psychological hypothesis respondents would have formed a, "mental representation of a prototypical incident, perhaps an image of an exhausted bird, its feathers soaked in black oil, unable to escape." (Kahneman et

[5] Prospect theory was developed as an alternative model to expected utility theory to describe decision-making under risk. Kahneman and Tversky (1979) show that decisions and valuations are highly dependent on the framing of the question in terms of gains or losses. Tversky and Simonson (2000) discuss further evidence of framing and context effects.

[6] See Kahneman et al (1999) and Loomes (2006) for a more substantial review of scope insensitivity findings in CV studies.

al, 1999, p.213). They would have then responded on the basis of their affective valuation of this image.

ii) Sub-additivity effects

These effects occur when the estimated WTP for one good plus the estimated WTP for another good is greater than the estimated willingness-to-pay when respondents are asked to value both goods together (Kahneman and Knetsch, 1992).

iii) Sequencing effects

These effects have been found when more than one good has been valued in a survey and the estimated value of a good differs according to when in the sequence it is presented to the respondent. The estimated WTP for a good has been found to fall the later in the sequence that it is presented (Tolley et al, 1983; Samples and Hollyer, 1990; Barber and ODwean 2008).

Attempts to explain and find solutions to the preference anomalies

It has been argued that insensitivity to scope findings are idiosyncratic and/or that the studies that have obtained such results are flawed in terms of survey design (Smith, 1992; Carson and Mitchell, 1993; Smith and Osborne, 1996; Carson, 2001). For example, the finding of insensitivity to scope should not be surprising if the description presented is not adequate to enable the respondent to distinguish between the smaller and larger good or if the survey emphasises they symbolic nature of providing the good. Another potential explanation is that individuals are running up against a budget constraint, so that they value the larger good more but they are unable to pay required multiple. However, Loomes (2006) notes that contingent valuation studies formed with WTA questions have also found insensitivity to scope.

Sequencing effects and sub-additivity effects have also been argued to be explainable with reference to income and substitution effects (Hoehn and Randall, 1989; Hanemann 1994; Carson, Flores, and Hanemann, 1998; Carson et al. 2001). Intuitively, each new good obtained reduces the income available for respondents to spend on other goods. Given this, the later in the overall package that a good is offered, the less desirable it will look. There may also be a similar effect if the goods are substitutes for each other.

A number of studies have sought to derive solutions to these preference anomalies and informational problems for contingent valuation. Two editions of the journal 'Environmental and Resources Economics' (in 2005 and 2010) are dedicated to methods that have been developed to deal with preference anomalies in contingent valuation studies. One of the key mechanisms for anomaly reduction in these studies is through learning by repetition and experience. The work is based on Plott's (1996) Discovered Preference Hypothesis (DPH). DPH argues that stable and consistent preferences are the product of experience gained through repetition. There are a number of studies that report reductions in the effects of arbitrary anchors and in the number of preference reversals as people become familiar with the good and the institutional payment arrangements in a contingent valuation context (Bateman et al., 2006; Braga and Starmer, 2005)[7]. Bateman et al. (2006) propose a double-bound dichotomous choice payment format[8] for elciting values. This is contrary to the recommendations set out by the National Oceanic and Atmospheric Administration (NOAA) in 1993[9]. NOAA recommended a single-bound dichotomous choice format in order to mimic a market setting more closely. To allow for

[7] For a review of the literature see Bateman et al. (2006).

[8] See Annex A for details of payment formats in contingent valuation.

[9] In 1993 NOAA appointed a panel of economic experts to consider recommendations for the use of contingent valuation studies (Arrow et al., 1993).

learning and experience Bateman et al. (2006) instead recommend a double-bound format where participants have the opportunity to 'discover' their preferences in the survey.

However, the neurological evidence on the effects of anchoring (Plassman et al., 2008) would suggest that prices should *not* be mentioned in any format during a contingent valuation survey and therefore that the open-ended elicitation format would be most suitable. Under this format, participants are simply asked to state their maximum WTP or minimum WTA, with no mention of a starting price (which would create an anchor). At the same time, however, this format takes the respondents in contingent valuation further away from the type of market institutions with which they are familiar when deciding whether to buy a good.

In addition, it is not clear how applicable these results are for the stated and revealed preference methods because opportunities for learning are often minimal. It is hard to provide repetitive experience for many of the public goods assessed in stated preference (Braga and Starmer, 2005) and revealed preference often relies on markets where transactions are infrequent (eg, housing market) so that few chances for learning exist at the individual level (Genesove and Mayer (2001). To counteract this Bateman et al. (2009) have recently used virtual reality simulators to communicate environmental changes to survey respondents. Some contingent valuation surveys also now employ a workshop format whereby people discuss the valuation issues with others and they can seek further information from moderators and experts (Hanley and Shrogen, 2002).

Alternatively, Gregory et al. (1993), propose a deliberative CV mechanism (multi-attribute utility analysis) in which a group of stakeholders, that includes the affected citizenry and technical experts, assesses the merits of the good under consideration and determines which attributes have the greatest impact on utility and an agreed conversion scale to monetise the 'utils'[10]. They claim that

> "*designers of a CV study should function not as archaeologists, carefully uncovering what is there, but as architects, working to build a defensible expression of value*" Gregory et al. (1993).

There is some recent work on combining stated and revealed preference data. This allows stated preference data to be checked against actual behaviour whilst also extending the range of goods estimable for revealed preference methods. Stated preference data can also help in isolating causal effects in hedonic market approaches, especially in trip cost methods for recreational sites (see Accent, 2010 and Whitehead et al., 2008 for a full discussion).

4.2.2 Whether life satisfaction is a good measure of utility

The subjective well-being approach assesses the impact of non-market goods on people's life satisfaction as reported in surveys such as the ONS's Integrated Household Survey. The approach does not rely on the rationality axioms holding and therefore avoids many of the problems associated with the preference-based approaches that were outlined in section 4.2.1. The approach does, however, rely on stated life satisfaction being an accurate measure of welfare or utility. It is possible to challenge whether this is the case.

Life satisfaction can be seen as being made up of a balance of affect (positive and negative emotions and feelings) together with a cognitive assessment of how well one's life measures up to aspirations and goals (Diener, 1984; Kahneman and Krueger, 2006). A life satisfaction response will incorporate to some extent a retrospective judgement of one's life together with

[10] Multi-attribute utility analysis is a form of Multi-Criteria Analysis. For full details see Department for Communities and Local Government (2009) *Multi-criteria analysis: a manual.*

how one feels now (Kahneman and Krueger, 2006). This can create difficulties as people do not always correctly remember past experience and their present feelings can be influenced by contextual factors present at the time of the interview (Bertrand and Mullainathan, 2001; Kahneman and Krueger, 2006; Schwarz, 2010; Schwarz and Strack, 1999). Biases can also arise in the stage of verbally reporting life satisfaction scores (Schwarz and Strack, 1999).

Below we look at three specific difficulties that have been identified when people respond to life satisfaction surveys:

i. remembering past experiences;
ii. context effects; and
iii. reporting of life satisfaction.

Following this we discuss some of the ways in which psychologists have attempted to overcome these problems by using moment-to-moment measures of well-being and we review evidence that suggests that reported life satisfaction can be an accurate and valid measure of utility.

i) Remembering past experiences

'Remembered utility' refers to people's recollections of the pleasure or displeasure associated with previous experiences or consumption (Kahneman et al., 1997). Experiments have shown that people's remembered utility can be biased due to their tendency to adopt a peak-end rule; in retrospective evaluations people place greatest weight on the peak (more intense part) and the end of an experience. They attach less weight to the the duration of an experience. There is therefore often a mis-match between people's actual experiences at the time and their retrospective evaluations of these experiences (Kahneman et al., 1993; Schwarz, 2010). Wirtz et al. (2003), for example, compare remembered utility with experiences during the event and find that people cannot accurately remember the utility they actually derived from holiday trips.

ii) Context effects

When asked about their well-being individuals tend to base their judgement on information that is most accessible at the time. The accessibility of information depends on the recency and frequency of its use (Schwarz and Strack, 1999). An implication of this is that the research instrument can influence responses to life satisfaction questions. For example, information that was used to answer a preceding question is more likely to come to mind when a respondent comes to answer the life satisfaction question (Bertrand and Mullainathan, 2001). Empirical evidence supports this hypothesis. Strack et al. (1988) find that when a question relating to students' dating frequency came after a life satisfaction question, there was no notable relationship between the question responses. However, reversing the question order resulted in a correlation coefficient of .66. Schwarz et al. (1991) also find different correlation effects when a question relating to marital satisfaction is asked before (.67) or after (.32) a general life satisfaction question. Question order effects, however, may not effect all respondents (Schwarz and Strack, 1999). For example, respondents currently undergoing a divorce are unlikely to be affected by whether they are asked to consider their marriage before or after the general question because this information is frequently used by them (e.g. it relates to their current concerns).

A similar process can explain why reports of satisfaction with life have been found to be influenced by the weather, finding a dime on a copying machine, spending time in a pleasant (rather than unpleasant) room and watching a football team win (Schwarz and Strack, 1999). While such factors are likely to influence current mood, they should not have notable effects on true overall life satisfaction. However, current mood could impact on responses to life satisfaction questions in two ways. Thinking about one's life whilst in a good mood may lead to the selective retrieval of positive information relating to their life, leading to a more positive evaluation. People may also take their current mood as a good indicator of their well-being in

life in general (Schwarz and Strack, 1999). Some evidence suggests that the latter explanation may be more accurate and that people use a 'current-mood-heuristic' to judge overall life satisfaction (Ross et al., 1986; Schwarz and Clore, 1996).

iii) Reporting life satisfaction

Individuals may adjust their life satisfaction scores when reporting them in order to give more socially desirable responses. For example, reported well-being is higher in face-to-face surveys than in postal surveys (Smith, 1979). When interviewed by individuals with a disability, respondents have been found to subdue their life satisfaction responses. In contrast, when a disabled person was present in the same room as a respondent completing their own survey, their condition was used as standard of comparison with the result that life satisfaction scores were inflated (Strack et al. 1990). Indeed, more generally, life satisfaction ratings are likely to be determined to some extent by the comparisons people make with their own life at different times and with other people at one point in time (Diener and Suh, 1997; Dolan and White, 2006). The problem with these effects is that respondents may provide assessments of their well-being that do not reflect the true experiences of their lives (Dolan and Kahneman, 2008).

Experienced utility

Kahneman (for example see Dolan and Kahneman, 2008; Kahneman and Krueger, 2006; Kahneman and Sugden, 2005; Kahneman et al., 1997) has been a proponent of using 'experienced utility', defined as the quality and intensity of an hedonic experience[11] as the basis for policymaking. Experienced utility is a sum of the moment-to-moment 'utils' of an experience and can be measured using the Experience Sampling Method (ESM) (Csikszentmihalyi, 1990) or the Day Reconstruction Method (DRM) (Kahneman et al., 2004). The ESM collects information on people's reported feelings in real-time during selected moments of the day using a Personal Digital Assistant (PDA). Respondents report their activity at the time and their subjective experiences, such as anger, happiness and fatigue. This does not involve a cognitive assessment of well-being on behalf of the participant and is therefore a measure of peoples' positive and negative affect (Kahneman and Krueger, 2006).

One criticism of the ESM has been that it is intrusive and can interrupt the flow of people's experiences. As an alternative, the DRM was developed. This method asks people to fill out diaries of their day reporting what they were doing and how they felt during those episodes in terms of positive and negative affect. The DRM is less intrusive than ESM, but does rely, to some extent on remembering utility. As discussed above, recollections of the utility of past events have been shown in a number of contexts to be subject to systematic biases (Kahneman and Krueger, 2006).

Experienced utility methods reduce reliance on remembered utility and are less susceptible to irrelevant contextual factors. ESM is now taken to be the 'gold standard' in well-being evaluation and reporting (Kahneman and Krueger, 2006; Schwarz, 2010). An assessment of how life is going for someone can be gauged from the summation of ESM or DRM reports over a long period of time. However, due to the cost of ESM or DRM methods, the current most viable measure of *overall* well-being for use in non-market good valuation is therefore arguably the type of global life satisfaction question that is included in datasets like the IHS.

Evidence on the validity of life satisfaction responses

There is also a variety of evidence to suggest that overall life satisfaction is a good measure of well-being. Pavot and Diener (1993), Eid and Diener (2004), Fujita and Diener (2005) and Schimmack and Oishi (2005) find mood and contextual effects to be limited. Sandvik et al

[11] (Kahneman and Snell, 1992).

(1993) and Shizgal (1999) demonstrate that there is a strong positive correlation between well-being ratings and emotions such as smiling and frowning. Research shows that Duchenne smiles (i.e. a type of smiling that involves a muscle near the eye called orbicularis oculi, pars laterali, which can distinguish between true and feigned enjoyment) are correlated with subjective well-being (Ekman et al., 1990). Urry et al. (2004) show that reports of life satisfaction are correlated with activity in the left pre-frontal cortex of the brain, which is the area associated with sensations of positive emotions and pleasure. Furthermore, well-being is a good predictor of health, such as heart disease (Sales and House, 1971) and strokes (Huppert, 2006). Cohen et al (2003) find that people who report higher life satisfaction were less likely to catch a cold and would recover quicker if they did. Kiecolt-Glaser et al. (2002) find that people with higher life satisfaction heal more quickly from wounds. Krueger and Schkade (2008) assess the test-retest reliability of life satisfaction responses. They question the same sample of women two weeks apart and find that correlation in life satisfaction responses was about $r = 0.59$, which relates closely to Kammann and Flett's (1983) results. Krueger and Schkade conclude that these levels of test-retest reliability '*are probably sufficiently high to yield informative estimates for……research*'. Finally, it should also be noted that a given person's tendency to over or understate their true well-being scores due to, for example, social desirability reasons could be seen as an underlying time-invariant personality trait. If this is the case, it would mean that using fixed effects estimators would control for this effect in life satisfaction regressions (Powdthavee, 2010; Tella and MacCulloch, 2006).

Interpersonal comparability is an important issue for analysts using cross-sectional or panel datasets on well-being. Sandvik et al (1993) have shown that individuals are able to recognise and predict the satisfaction of others, suggesting that SWB is observable and comparable between individuals. van Praag (1991) and Stutzer and Frey (2003) show that different individuals easily translate verbal labels, e.g. very good, into roughly the same numerical values. Furthermore, Kahneman (2000) suggests that there is considerable interpersonal convergence in the ranking of pleasure and pain.

4.2.3 Setting up the empirical study

All three valuation methods rely on collecting a sample of data from a chosen population in order to derive valuation estimates. Stated preference applications rely on the construction of original questionnaires which are then distributed to members of a target population. Revealed preference and life satisfaction applications typically use secondary data or a combination of both primary and secondary data.

Collecting primary data has the advantage of allowing value estimates to be based on specifically defined populations. For example, the direct users of a good (e.g. people with a licence to fish on a lake) or individuals within a specifically defined geographical area. It can also lead to bias reduction in certain areas. For example, as discussed in 4.2.2 above, Bertrand and Mullainathan (2001) argue that responses to subjective well-being questions are vulnerable to ordering effects. Dolan and Metcalf, (2008) note that this is a problem because many secondary surveys which ask life satisfaction questions, such as the British Household Panel Survey (BHPS), situate the (global) life satisfaction question in the middle of the survey.

However, original data collection is susceptible to problems that are potentially less prevalent in large national surveys, such as non-response bias, interviewer bias, and information bias. Non-response bias can occur when individuals who respond to a survey systematically differ from non-respondents (Champ, 2003). In contingent valuation surveys, for example, individuals with particularly strong feelings toward the good in question may be more willing to commit time to the questionnaire. Interviewer bias occurs when surveys are administered via telephone or face-to-face and the presence of the interviewer influences responses. This effect can be avoided with

well-trained interviewers (Carson, 2000). Information bias occurs if non-neutrality or inaccuracy in what is presented influences responses.

4.2.4 Econometric methodology

All three valuation methods rest on using a sample of data collected from a population in order to draw inferences about that population. However, a number of statistical or econometric issues are specific to the revealed preference and life satisfaction approach. We consider five of these issues below:

i. difficulties in causal analysis;
ii. functional form specification;
iii. the potential for measurement error,
iv. the fact that some values cannot be picked up; and
v. partial values:

i) Difficulties in causal analysis

The most basic econometric approach in revealed preference and life satisfaction applications is the specification of a linear regression model that is then estimated using Ordinary Least Squares. In this setting, valid causal interpretations cannot be attached to parameter estimates if the included covariates are correlated with the disturbance term of the model. This may limit our ability to identify, for example, the causal effect of the non-market good on house prices or wages in a revealed preference model, or the causal impact of income and the non-market good on well-being in a life satisfaction model.

With regard to the revealed preference method specifically, a large number of applications have indeed identified reasons to suggest that the non-market good of interest is correlated with the disturbance term. For example, in travel cost applications a number of cost components are chosen by the individual. Individuals who particularly enjoy the site under consideration are, for example, likely to base their choice of residence with this in mind thereby lowering their travel cost . If so, the partial relationship between individual trip frequency and trip cost will therefore (patially) reflect this unobserved determinant and will not give the true relationship between cost and trip frequency for a randomly selected member of the population (Randall 1994).

In studies valuing environmental amenities using housing markets, the large number of factors that influence the price of a house can lead to omitted variable bias. For example, individuals may accept a longer commute to work in order to live in an area with good air quality. Therefore if commuting time is not controlled for in the hedonic model then the least squares estimated value of the environmental amenity will not capture the true effect. Similarly, in an analysis of the effect of water quality on house prices, Leggett and Bockstael (2000) note that shore-side residential properties nearer to water of higher quality are also likely to be further away from the emitters of pollution. Therefore, if these emitters are undesirable neighbours for reasons distinct from their effect on water quality, then not controlling for a house's proximity to them will bias the estimated effect of water quality on house prices.

It has also been suggested that job risk variables are endogenous in labour market hedonic studies. The main explanation for this is that unobservable individual characteristics determine both specific job assignment and wages. Support for this hypothesis is presented by Black et al (2003). Using the National Longitudinal Survey of Youth they find that test scores from the Armed Forces Qualification Test and self-reported illegal drug use are correlated with their job-risk measures. This suggests that if such individual characteristics are not picked up by observable covariates, then least squares estimates of the implicit price for risk will be biased.

The most obvious solution to derive causal estimates for such non-market goods is the formation and identification of control variables that proxy for the omitted determinants. Other solutions include the use of instrumental variables (Chay and Greenstone, 2005) or using fixed effects models if a time-invariant assumption is reasonable for the unobservables. The *Magenta Book*[12] provides technical guidance on estimating causal impacts.

With regard to life satisfaction applications specifically, there is evidence to suggest that people with higher levels of well-being earn more income, are healthier and are more likely to get married (Diener and Biswas-Diener, 2002; Graham et al., 2004; Lyubomirsky et al., 2005; Stutzer and Frey, 2006). There is likely to be a problem of reverse causality here which will manifest itself by producing a correlation between the error term and such explanatory variables in the life satisfaction regression. To make causal inferences from the life satisfaction regression would require that the variables in which we are interested are determined exogenously. Ideally, to make causal inferences the explanatory variable should be determined through a randomised trial or it should be instrumented with a variable that is not correlated with the error term.

A small number of studies in the well-being literature have used instruments for some of the explanatory variables in the life satisfaction equation. Finding instruments for income is notoriously hard since it is difficult to identify variables that are correlated with income and not the determinants of life satisfaction that rest unobserved in the error term (for further discussion see Dolan and Metcalfe (2008) and Oswald and Powdthavee (2008)). Those studies that use instruments for income find that income has a positive effect on life satisfaction (eg, lottery wins (Gardner and Oswald, 2007; Lindahl, 2002); exogenous pay increases for East Germans after German re-unification (Frijters et al., 2004)). In actuality instrumenting for income generally *increases* the size of the income coefficient. Pischke (2010), Chevalier and Lydon (2002) and Luttmer (2005) use a range of instruments, including average industry wages and wages of the spouse, and find that Ordinary Least Squares estimates of the income coefficient are biased downwards. Instrumenting for income, therefore, should generally *increase* the size of the income coefficient, and therefore reduce the estimated income compensations required for the non-market goods.

Our meta-analysis of the life satisfaction approach literature suggests that very few studies have used exogenous changes in income and the explanatory variables of interest. Ferreira and Moro (2009) (air quality and climate), Luechinger (2009) (air quality), Dolan and Metcalfe (2008) (urban regeneration) and Oswald and Powdthavee (2008) (death of family members) use an instrument for income when deriving income compensations/valuations. As the above discussion would indicate, instrumenting for income reduces the income compensations associated with these non-market goods and 'bads' because the size of the income coefficient increases. Dolan and Metcalfe (2008) and Oswald and Powdthavee (2008) are the only studies in which the explanatory variable of key interest is likely to be exogenous. The urban regeneration project in Dolan and Metcalfe's study was essentially randomly allocated and it can be argued that in Oswald and Powdthavee's study the death of a family member is likely to be an exogenous event (Powdthavee, 2010).

ii) Functional form specification

Most applied hedonic and life satisfaction econometric applications impose an exact functional relationship between the dependent and explanatory variables and statistical inference focuses on the finite number of parameters included in the specified model. Using parametric models can lead to functional form misspecification if the specific functional relationship adopted is incorrect. In some cases, theoretical considerations can be used to develop specifications. For example, in the life satisfaction approach, income usually enters in logarithmic format to account for the diminishing marginal utility of income. However, in most cases theory does not

[12] http://www.hm-treasury.gov.uk/data_magentabook_index.htm

make definitive statements regarding the correct functional form. Taylor (2003) discusses this issue with regard to hedonic price functions.

Non-parametric and semi-parametric regression models offer an alternative regression approach (see Blundell and Duncan,1998; Yatchew, 1998). In this setting, the exact relationship between the dependent and explanatory variables can be left unspecified. These models have been used in both the hedonic and life satisfaction literature. For example, Layard et al. (2008) estimate the marginal utility of income non-parametrically using life satisfaction from a range of international surveys. Housing market revealed preference applications are also noted by Sheppard (1997).

iii) Measurement error

Measurement error in dependent variables typically results in larger error variances, but does not lead to inconsistent parameter estimates. Measurement errors in one or more of the explanatory variables (i.e., income and the non-market good of interest), on the other hand, is generally more serious as it potentially leads to biased and inconsistent parameter estimates for all the covariates.

In the life satisfaction approach, a natural concern is measurement error in (self-reported) income. Powdthavee (2009) estimates an life satisfaction regression using a sample for which accurate information on income was pertained by the interviewer through the presentation of actual payslips during the survey. This increased the size of the income coefficient. Hedonic price and wage studies have also identified sources of measurement error in non-market goods. Black et al (2003) in an analysis of the implicit price of risk, for example, note a number of likely reasons to suggest that their job-risk variables are mis-measured. Graves et al (1988) present tests of the effect of measurement error in non-market goods (air quality) as well as other covariates in the hedonic price function.

In travel cost applications a primary concern relates to the measurement of an individual's trip cost (see Annex A). Firstly, the estimation of the cost of time foregone is difficult. Freeman (2003, p.285) notes the recreation applications typically use one-third to the full wage, but that neither bound is 'on firm footing'. Secondly, difficulties arise with multiple purpose trips. Methods to get round this problem include checking how results change with alternative travel costs estimates (Carr and Mendelsohn, 2003) or dropping multiple purpose trips from the analysis.

iv) Some values cannot be picked up

Revealed preference methods derive valuations based on observed actions by individuals. Since the non-use value any individual attaches to a non-market good is unrelated to such actions, the methods only measure use-value. For example, an individual who values a cultural monument for its mere existence would not pay a housing premium associated with proximity to its location. Similarly non-use values may not be picked up using the life satisfaction approach because there may be no variation in individual level data for goods and services that are not used.

In addition, because both methods rely on the econometric analysis of existing and available data, they are also unable to value impacts of non-market goods that arise in the future (that have not yet been experienced). For example, if all lakes in a region have contaminated fish then anglers will not have been able to choose an uncontaminated one. Hence, anglers will have not had a chance to reveal their preferences over such a change in water quality (Boyle, 2003) and levels of their well-being with the change will also be unknown. However, pooled stated preference and revealed preference approaches have been attempted in order to overcome this issue (Adamowicz, Louviere, and Williams, 1994)

Related to this, the reliance on market data typically narrows the range or specificity of non-market goods that can be valued. Mostly obviously, the travel cost method is usually only easily applicable to the valuation of recreational sites. The valuation of specific non-fatal risks to health, such as insecticide inhalation, is unlikely to be possible with hedonic regression methods (see Viscusi,1993, p.1939).

Finally, in certain cases more than one revealed preference method may have to be used to estimate the total value of a good. For example, to value the cost of a river becoming polluted the travel cost method may be used to value to loss to those who use the river for recreation and the hedonic pricing method may be used to value the loss to individuals that own houses along the river (Boyle, 2003).

In sum, it is clear that both the revealed preference (for hedonic market studies) and the life satisfaction approaches will work best for policies with significant impacts on market prices (eg, the housing market) or life satisfaction. When this is not the case, stated preference may be the only viable method for valuation of the policy impact.

v) Partial values

People may be compensated for a non-market 'bad' in a number of ways (Stutzer and Frey, 2004). For example, people may be compensated for living in a polluted area with both lower house prices as well as shorter commutes to work. Here, in a hedonic housing price model, the coefficient on the pollution variable would not fully reflect the value that people place on marginal changes in pollution if such marginal changes also, for example, increase the demand to live in their area and consequently their commuting times. Similarly, in the life satisfaction approach when looking at the impact of pollution on life satisfaction, it should be noted that pollution will have an indirect effect on well-being through house prices and time spent commuting.

In such a case in the life satisfaction approach, for example, it would be necessary to also control for house prices and commuting times in the life satisfaction regression. Doing so would allow us to estimate the full (rather than partial) cost of pollution using these approaches.

4.3 Issues specific to each valuation approach

In addition to the issues discussed in section 4.2, which are relevant to the strength of all three valuation methods, there are also some advantages and disadvantages specific to each of the methods. Below we discuss the following issues:

Stated Preference Methods

- Wide application and specific valuations
- Allows one to explore the reasons behind preferences
- Ex-ante application
- Widely used and researched
- Relatively easy to describe and explain
- Hypothetical bias
- Protest valuations
- WTP-WTA disparity
- Costly
- Survey-related biases

Revealed Preference Methods

- Estimates based on real economic choices
- Cost-effective

- Market imperfections
- Measuring WTP for non-marginal changes
- Marshallian versus Hicksian demand

Life Satisfaction Approach

- Cost-effective
- Reasonably wide application
- Fewer survey-related biases
- No market structure assumptions
- Difficulties in estimating the marginal utility of income
- Difficulties in estimating the marginal utility of the non-market good

4.3.1 Stated Preference Methods

Advantages

i) Wide application and specific valuations

Stated preference methods can, in principle, be used to value any specific non-market good. Choice modelling methods can also be used to estimate the value of the attributes of a non-market good. This can be useful if different policy options differ in the attribute levels that they provide (Mourato et al, 2005).

ii) Allows one to explore the reasons behind preferences

Stated preference questionnaires can include questions relating to:

- the respondent's characteristics or attitudes toward the non-market good; and
- the reasons behind the respondent's choices or answers to the WTP/WTA questions.

Exploring the variation in responses is useful for identifying the winners and losers of an intervention. This is useful for stakeholder analysis (Bateman, 2002). It is also helpful that, through the development of a primary questionnaire, groups can be defined by characteristics which are typically unobserved on the conventional datasets used in revealed preference or life satisfaction studies.

Uncovering the reasons behind respondents' answers can also be helpful. For example, in hedonic pricing studies, it is often identified that house prices increase with the air quality in their neighbourhood (Smith and Huang, 1995). The exact reason for this correlation is often not clear. For example, it could be due to lower cleaning bills, the neighbourhood being more aesthetically pleasing, or due to the health damages associated with polluted air (Portney, 1981).

iii) Ex-ante application

The value of any specific policy or intervention can be estimated before it is actually implemented. Therefore stated preference methods can aid decision-making at an early stage of the policy cycle. Other valuation methods can be used ex-ante however they rely on an implicit assumption that the preferences revealed in the past do not change in the future.

iv) Widely used and researched

There have been a large number of applied contingent valuation studies. Carson et al (1995) present a bibliography of over 2000 studies from more than 40 countries and Carson (2004) presents a bibliography that exceeds 5000. In addition to application, the reliability and

credibility of the methods have been widely debated and tested (Arrow et al, 1993; Diamond and Hausman, 1994; Hanemann, 1994; Portney, 1994; Carson, 2001). Best-practice guidance manuals for conducting stated preference studies have also been produced (Carson and Mitchell, 1989; Bateman et al, 2002).[13]

The application of choice modelling methods is, however, relatively newer and a number of challenges have been identified (Hanley et al, 2001).

v) Relatively easy to describe and explain

The general methodological approach of contingent valuation and choice modelling studies is relatively easy to describe to policy-makers. It is arguably more difficult to explain how valuation estimates are derived through revealed preference and life satisfaction approaches.

Disadvantages

Even in cases where people may have stable, well-defined preferences there are some biases that may emerge in a stated preference survey.

i) Hypothetical bias

The hypothetical nature of the good in question and the payment mechanism can lead to inflated values in surveys. It is widely believed that individuals overstate their valuation of a good by a factor of two to three when comparing hypothetical versus actual payments for goods (Murphy et al., 2005). The reasons for hypothetical bias are not fully determined. One reason is attributed to **non-commitment bias;** respondents may overstate their true WTP because they do not face a budget constraint and do not consider substitute goods within the world of the hypothetical scenario. Including simple reminders of substitutes and real world constraints or the adoption of more formal techniques have been suggested as solutions (Kemp and Maxwell, 1993).

Another reason could be due to **strategic bias**: respondents in stated preference surveys may have an incentive to deliberately misrepresent their true preferences in order to achieve a more desirable outcome for themselves. An individual's incentive to behave strategically will be conditional on their beliefs of how their response will affect the price they pay and the provision of the good. For example, individuals may overstate their valuations of the good if they believe their responses influence its provision and are un-related to the price they will be charged for it. Individuals may understate if they believe that their response will not influence their desired outcome but will influence the price they are charged for it (Carson et al., 2001). Mitchell and Carson (1989) argue that true economic preferences are revealed when respondents believe that the non-market goods provision is contingent on their stated values and when they believe that they will have to pay the amount they state.

There is some evidence that the magnitude of hypothetical bias is greater for public goods than for private goods (Murphy et al., 2005). One increasingly popular method of dealing with hypothetical bias is to use a '*cheap talk*' script in which respondents are told about the bias and are essetinally asked to refrain from it (Hanley and Shrogen, 2002). Cheap talk can reduce WTP in hypothetical markets to levels similar to actual payments (Accent, 2010; Murphy et al., 2005).

[13] The National Oceanic and Atmospheric Administration (NOAA) appointed a panel of economic experts to consider the use of contingent valuation studies of non-use value in damage suits (Arrow et al., 1993). The panel's report discusses criticisms of contingent valuation and also presents a set of guidelines for how contingent valuation surveys should be applied (Arrow et al, 1993). These recommendations are summarised by Portney (1994). The panel concluded that contingent valuation studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages including lost non-use value.

See Blumenschein et al. (2008) for a review of the methods developed to tackle hypothetical bias in contingent valuation.

ii) Protest valuations

Respondents with a positive true WTP may put forward a zero stated valuation due to, for example, ethical objections to the idea of paying for the good under consideration. If such respondents are not identified through follow up questions, and their responses consequently excluded from the statistical analysis, then biased estimates of the value of the good will result.

Hanley and Shrogen (2005) suggest that protest values can be reduced by making WTA scenarios more acceptable by specifiying community-level compensation rather than individual compensation "if individuals are adverse to the idea of benefiting personally in money terms" (p.16).

iii) WTP-WTA disparity

All stated preference survey choices and questions can be presented in terms of WTP (to receive a good or prevent a loss) or in terms of WTA (to lose a good or incur a loss). In theory, WTA for most goods evaluated under Stated Preferences should exceed WTP by a few percentage points due to the fact that WTP is constrained by an individual's income (Sugden, 2005). Numerous papers have found, however, that stated WTP is often far below stated WTA for the same good (Shogren et al, 1994; Horowitz and McConnell, 2002). Sugden (2005) argues that the most credible explanations for this relate to the psychological arguments concerning loss aversion and its derivative; the endowment effect (Kahneman and Tversky, 1979; Loewenstein and Adler, 1995; Ariely, 2009).

Some authors argue that the appropriate formation depends on property rights (Carson et al, 2001). That is, if the respondent does not currently have the good and does not have a legal entitlement to it, the WTP formation should be used. On the other hand, if the consumer is being asked to give up a legal entitlement, the WTA formation is appropriate (Carson, 2000). Following this approach means therefore that legal property rights can have a substantial influence on the estimated welfare effects of interventions.

Other authors have argued that the WTP formulation should always be used (Arrow et al., 1993). One reason for this is that CV studies adopting a WTA formulation have often been unsuccessful due to an inability to convince respondents that they have the right to sell a non-market good (Mitchell and Carson, 1989). The WTP-WTA disparity may also be, to some extent, a product of informational constraints and inexperience. Bateman et al.'s (2009) virtual reality survey tool described above reduced the difference between WTP and WTA for environmental goods. List (2003) finds that experienced traders (in a number of different real markets) do not exhibit the endowment effect. The WTP-WTA disparity may be reduced by re-calibrating WTP values into WTA amounts (List and Shrogen, 2002).

iv) Costly

Stated preference studies can be both financially costly and time-consuming. They require focus group and interviews to determine respondents' understanding, and pre-tests (Carson 2000; Mitchell and Carson, 1989; Bateman et al, 2002). DTLR (2002), although noting that it is difficult to generalise, state that, "*it is unlikely that reliable research for a single sample study can be carried out for less than £25-£30,000 (excluding the field survey costs)*".

v) Survey-related biases

All stated preference methods rely on surveys in order to elicit valuations. As such, responses to valuation questions are likely to be influenced by what information is presented (Bergstrom et al, 1990; Whitehead and Bloomquist, 1990). The bias generated by non-neutrality in presentation is termed as information bias.

Face-to-face or telephone surveys also create the potential for interviewer bias if respondents deviate from their true preferences under influence exerted by the interviewer. Of course, this effect should be avoided with well trained interviewers (Carson, 2000).

Non-response bias occurs if individuals who feel strongly for or strongly against a good or issue are more likely to respond, which can lead to either an upward or downward bias.

There is also the potential for fatigue and frustration to set in, especially in iterative bidding formats. In this situation respondents make end up making little effort to provide accurate replies (Accent, 2010).

In general, findings from lab settings (stated preference surveys are essentially lab experiments) may not reflect behaviour and preferences in the real world (Levitt and List, 2007). Presence of an interviewer and choice-set restriction in the survey setting are likely to be important factors (Carlsson, 2010). In studies by Cook et al. (2007) and Whittington et al.(1992) respondents were given time to think as interviewers left surveys with respondents for one day before collecting responses. During the decision making process interviewers were therefore not present and respondents has time to think about their choice sets more largely and to discuss with friends and family which may replicate more closely actual decision making behaviour. In both studies (for environmental goods) they found that giving people longer time to think reduces people's WTP amounts.

4.3.2 Revealed Preference Methods

Advantages

i) Estimates based on real economic choices

The most notable advantage of the revealed preference approach is that valuation estimates are derived from real economic choices made by individuals in real markets. Revealed preference results are not based on verbal responses in hypothetical markets and are not derived with the use of self-reported life satisfaction variables. Crucially, however, the approach remains based on the fundamental assumption of individual rationality (Viscusi, 1993). As discussed above, this is problematic if people do not in fact have well-defined preferences over goods and cannot forecast changes in their utility due to the consumption of these goods.

ii) Cost-effective

Original surveys are not always used in hedonic pricing studies as suitable secondary data is often available. However, this is not always the case and some hedonic studies and all travel cost applications require some original data to be collected. This cost may be lower, however, than the cost of running stated preference surveys for there is less need to engage in such extensive pre-testing of the survey instrument.

Disadvantages

i) Market imperfections

The hedonic approach rests on the assumption that equilibrium exists in the perfectly competitive market through which valuations are revealed (Freeman, 2003). In housing market applications, this implies a number of criteria. Households must have full information on all house prices and house attributes; there must be zero transaction and moving costs; and market prices must instantly adjust to a new equilibrium after supply and demand change. There are analogous criteria for labour market hedonic wage studies.

However, imperfect information seems likely in a number of cases, including assessments of the probability of risks of injury or death in a job (Viscusi, 1993) and the environmental conditions in housing neighbourhoods (Poor et al, 2001). In addition, Greenwood et al. (1991) and Glaeser et al. (2005) argue that markets may be in disequilibria for some time.

ii) Measuring WTP for non-marginal changes

In the hedonic framework there are challenges associated with estimating the welfare effects of non-marginal changes in the level of a non-market good (Freeman, 2003; Viscusi, 1993; Taylor, 2003). Roughly speaking, a marginal change refers to a slight increase or decrease in a good from the status quo level. Therefore, the introduction of a new park or a policy that leads to signification improvement in air quality would represent non-marginal changes.

Second-stage analyses in the hedonic approach use the estimated implicit prices recovered in the first stage to estimate the entire demand (or marginal WTP) function for the non-market good. The estimated implicit prices represent the dependent variable and are regressed against the observed quantities of the non-market good and other exogenous demand shifters. The econometric challenges and data needs associated with this practice is outlined by Freeman (2003). Due to these complications, most applications stop after estimation of the hedonic wage or price function and assess the value of marginal changes in the nonmarket good or make strong assumptions regarding the form of the marginal WTP function in order to indicatively assess the welfare effects of non-marginal changes (Chay and Greenstone, 2005).

iii) Marshallian versus Hicksian demand

EV and CV are estimates of Hicksian surplus. Hicksian surplus is essentially derived from the substitution effect of a change in prices and is the theoretically appropriate measure for it captures the monetary compensation required to hold each individuals' utility constant. While some applications have made attempts to recover compensated measures, travel cost and hedonic methods typically estimate and report changes in Marshallian surplus. Marshallian surplus differs from Hicksian surplus in that it picks up the income effect as well. For this reason Marshallian surplus is usually smaller than Hicksian surplus (Freeman, 2003; Willig, 1979). However, in practice, income effects are likely to be small in non-market valuation settings.

4.3.3 The Life Satisfaction Approach

Advantages

i) Cost-effective

The life satisfaction approach is highly cost and time-effective.. Most panel datasets which include life satisfaction questions, such as the British Household Panel Survey (Understanding Society), are freely available online. The cost-effective argument would of course not hold if primary survey data collection is required.

ii) Reasonably wide application

There is a rich variety of variables concerning people's lives that national datasets contain. The large number of variables also means that there is scope for analysis of the main drivers behind the valuation results – demographic and geographic factors, for instance.

Given that the life satisfaction approach usually exploits large national datasets, sample sizes tend to be larger than those used in Revealed Preference studies and vastly greater than the sample sizes that are typical of Stated Preference studies. This allows the analyst to derive results for samples that are much more representative of the population in general.

iii) Fewer biases

As discussed above, in the life satisfaction approach well-being data are matched with objective measures of the determinants of well-being and for this reason it is near impossible for respondents to use strategic behaviour to influence analysis results. In addition, the possibility of non-commitment bias and of eliciting protest values is eradicated (Frey et al., 2004a).

iv) No market structure assumptions

A significant advantage over revealed preference approaches is that the life satisfaction approach does not need to make assumptions concerning equilibria in proxy markets. As noted above, however, any potential compensating mechanisms in markets (such as the housing market) must be held constant in the LS model in order to provide full, rather than partial, values of the non-market good. In addition, the approach avoids asymmetric information problems. For example, if there are adverse health affects associated with living in particular areas but people are unaware of the causal link, then their WTP for these effects will not be reflected in house price differentials (Freeman, 2003)

Disadvantages

The life satisfaction approach is relatively new. The number of applications is relatively small and research into understanding and refining the method is still ongoing. A number of studies have generated implausible valuations. For example, the Culture and Sport Evidence Programme (CASE) Technical Report on the value of engagement in culture and sport (2010) reported a life satisfaction valuation estimate for *going to the cinema once a week* of about £85 per visit[14]. While the likely reasons for this high estimate and solutions to correct for the sources of bias are discussed below, caution still must be exercised over the results generated by life satisfaction studies if they have not addressed the concerns discussed in this paper.

i) Difficulties in estimating the marginal utility of income

There are long-standing issues with the estimation of the marginal utility of income in the LS regression. A consistent finding is that the coefficient on income tends to be statistically significant but small, often resulting in implausibly high value estimates for non-market goods (Dolan et al., 2011b). For example, Clark and Oswald (2002) estimate the income compensation required for someone to move from employment to unemployment (i.e. the value of work) to be approximately £23,000 per month in addition to the loss of the wage income from work. Powdthavee (2008) derives large values for social involvement; he finds that life satisfaction is associated with greater frequency of interaction with friends, relatives, and neighbours, and derives a value of £85,000 per year for moving from 'seeing friends or relatives less than once a month' to 'seeing friends or relatives on most days'. Levinson (2009) and Luechinger (2009) both find that values from well-being are orders of magnitude greater than revealed and stated preference values for environmental goods.

[14] Assuming that people who report 'going to the cinema at least once a week' go to the cinema twice a week on average.

As already discussed in section 4.2.4 part of the reason for the high valuations is likely to be that income is often not instrumented. Using an instrumental variable for income tends to increase the income coefficient, thus reducing the income compensation values.

Relative income

There is a theoretical justification for the inclusion of relative income in the utility function to account for reference group effects (Duesenberry, 1949; Frank, 1997). There is empirical evidence that relativities in income matter to well-being (Blanchflower and Oswald, 2004; Easterlin, 1974; Easterlin, 1995, 2001a; Ferrer-i-Carbonell, 2005; Graham and Felton, 2006; Luttmer, 2005; McBride, 2001). Relative income effects can be controlled for by including a measure of the average income for the reference group as an additional explanatory variable. Controlling for relative income in the LS function tends to have the effect of *increasing* the impact (ie, coefficient) of income on LS (eg, Alpizar et al., 2005; Clark et al., 2008; Easterlin, 1995; Frank, 2005). This is because in essence the 'price' of status is held constant as other people's incomes do not change.

There is no consensus on whether relative income should be included when estimating income compensations. In theory Stated Preference techniques implicitly hold others' income constant as people are asked to think about their own finances only. This could be seen as an argument for including relative income in the LS function and this is likely to reduce the levels of income compensation required for non-market goods. However, including relative income in the LS function is not an easy task as assumptions need to be made in the empirical analysis as to what group is used as the reference group (Pischke, 2010). For example is the appropriate reference the incomes of work colleagues, wage levels in the region or GDP per capita? The effect on the income coefficient will vary depending on the reference group used (Dolan and Peasgood, 2006).

Indirect effects of income

As well as affecting our utility directly (for example, the pleasure of having more money in the bank), income affects utility indirectly through the goods and services it allows individuals to purchase (Dolan et al., 2011b; Dolan and Peasgood, 2006). Income may have a positive effect on a number of variables that are held constant in the life satisfaction regression, such as health, social relationships, marital status and place of residence. Controlling for these effects therefore subdues the impact of income on well-being and inflates the monetary values derived (Dolan et al., 2011b). In Stated Preference surveys people are often urged to think about the value of money when stating a WTP figure. In other words, they should consider the opportunity costs or everything else they could do with the money, and so in line with the above argument, in theory, people are asked to think about how income impacts on their health, relationships and place of residence.

The indirect effects of income have generally been ignored by the LS approach literature. One exception is Ferrer-i-Carbonell and van Praag (2002), who model the impacts of income on life satisfaction through its effects on a set of domain satisfactions, including leisure, housing and job satisfaction. A problem with this approach is that the final LS function does not include controls for many of the explanatory variables that have been shown to impact on SWB, such as age and marital status, thus biasing the model. We discuss some solutions to this problem below.

Counter-effects of income

When calculating EV or CV we essentially consider exogenous changes in income required to hold utility constant. For example, if we are interested in estimating the level of compensation that would be required to return people to their original levels of utility after the loss of a good or service (ie, the compensating variation) this compensation is essentially an exogenous increase in income for those affected. However, the income variable used in the life satisfaction function is usually a measure of household income, which is in large part derived from labour income.

Earned labour income incurs costs to the individual, such as loss of leisure time, and thus does not have the required exogenous interpretation.

In the life satisfaction approach it is important to hold constant the determinants of income (Frey and Stutzer, 2004). This would include, for example, time spent commuting and hours at work (in order to earn income people must forego valuable leisure time commuting and at work). If these factors are not held constant the income coefficient will be understated for the purposes of estimating monetary values. Holding constant commuting time and hours at work, should increase the income coefficient and result in a reduction in the values attributed to non-market goods.

ii) Difficulties in estimating the marginal utility of the non-market good

Indirect effects

Welsch (2007, 2008a, 2008b) and Welsch and Kuhling (2009) recognise that the good being valued may also have indirect effects on well-being through some of the other control variables. For example, being employed could impact positively on well-being indirectly through improved health and so if health status is included in the life satisfaction model (as it should be) the impact of employment on well-being is understated.

The issue of indirect effects shares close empirical similarity with the issue of partial values discussed in section 4.2.4. We distinguish between the two issues. The partial values issue refers to changes in realisations on other variables in the life satisfaction regression that emerge because of changes that take place in the economy in response to changes in a non-market good.

Multiple values

On some occasions the value estimate for the good may pick up other unrelated values if in the act of consuming the good, the individual consumes other complementary goods. The valuation estimate for a trip to the cinema reported above (£85) for example, may be picking up additional irrelevant values such as the utility derived from the consumption of popcorn and drinks and from any travel to and from the cinema. Other issues with this study include income not being instrumented and the indirect and counter effects of income not being properly acknowledged. Correcting for all of these factors would considerably reduce the estimated cinema trip value.

Ideally consumption of such complementary goods should be controlled for in the life satisfaction regression, but the data usually do not contain enough detail. As a second best option the price of goods consumed in complement with the good being valued can be subtracted from the overall value estimate. Therefore in the current example a better estimate of the value of a cinema visit can be obtained by subtracting the average expenditure on popcorn and drinks per cinema visit (eg, £4) and the average travel cost to and from cinemas (eg, £3). The problem with this approach is that economic theory suggests that this price will be an underestimate of the utility derived from consumption of these complements.

4.4 Conclusions

This chapter has discussed the strengths and weaknesses, both principled and pragmatic, of the stated and revealed preference and life satisfaction valuation approaches. Arguably the main appeal of the life satisfaction method relates to the fact that it does not rely on people having well-defined pre-existing rational preferences. We presented empirical findings from a number of experimental and contingent valuation studies in different settings that raise doubts as to whether preference-based approaches are measuring the theoretical constructs that they intend to measure. The life satisfaction approach does not require individuals to predict their future utility and values of goods will not be anchored by irrelevant cues or affected by a focusing

illusion. Instead, respondents are simply asked to provide a subjective assessment of their overall well-being which is then matched with objective measures of the determinants of well-being and their exposure to the non-market good. Using panel data we can track the effects of a non-market good over time and therefore fully estimate the degree of adaptation. Furthermore, people are not required to have perfect information about the good being valued and there is no (hypothetical) payment involved and so this solves for the problems related to the payment vehicle in stated preference techniques.

If variables are measured accurately, increased consumption of a non-market good or service should show up in changes in well-being and thus values, therefore reducing the risk of insensitivity to scope. Although it has not been tested empirically, sub-additivity and sequencing effects should also logically disappear. The resulting value estimate will be calculated on the basis of how people are actually affected by the good over time.

Finally, since the analyst in effect calculates the marginal rates of substitution between income and the non-market good there is no potential for errors to occur due to people's inability to convert subjective feelings and beliefs into a monetary scale.

On the other hand, we have highlighted that contextual factors can have large effects on people's reported well-being and there may be biases inherent to the way that people report their well-being to the surveyor. This means that reported measures of well-being may be pick up highly irrelevant factors which would bias any estimated statistical relationship between life satisfaction and the variable of interest, say income or employment.

The life satisfaction approach typically involves conducting econometric analysis in order to estimate the true causal effect of both income and the non-market good of interest on reported life satisfaction. For a number of reasons outlined above this is extremely challenging and often requires rich data sets and careful econometric analysis. Many of the valuations which have been generated so far are implausibly high. Most of the reasons for this are likely to have been addressed in this chapter. The approach is still very much in development in the academic literature.

The robustness of a valuation generated by a given study using any of the three valuation methods, and therefore the appropriateness of including it in Social Cost-Benefit Analysis, should always be assessed on a case-by-case basis. However, given the relative infancy of approaches that utilise reports of life satisfaction to derive valuations, we suggest relatively more caution be exercised regarding this method. Instead, we recommend that the life satisfaction approach to valuation be currently regarded as a *complement* to the more standard preference-based approaches, especially where good data on life satisfaction are available.

Nevertheless, even when the valuations derived from a specific life satisfaction study cannot be considered robust enough for Social Cost-Benefit Analysis due to the reasons outlined here, the valuations and their description can still be of value. It is likely that the study may still be able to indicate the approximate magnitude of an impact thereby allowing decision makers to refine the values that they may otherwise place implicitly on these impacts.

5 Practical Application of the Life Satisfaction Approach

Although we have not gone so far as to recommend, for the immediate future, the straightforward and automatic inclusion of new subjective well-being measures in Social Cost-Benefit Analysis, we have made it clear that subjective well-being measurement is a live research issue, and one which Departments should be challenged to pursue further. A number of valuations so far generated by the life satisfaction approach are implausibly high. The most important reasons for this are likely to have been covered in Chapter 4.

In this chapter we:

- discuss the datasets and variables that have been most commonly used in the life satisfaction approach to valuation;
- present some recent methodological developments to the approach; and
- present ten applied econometric recommendations or guidelines, based on research so far, that we believe should be followed when employing the life satisfaction approach,
- present a worked example of the approach.

This chapter is written in order to help Departments pursue this research agenda further.

5.1 Setting up the model

Variables

It is important to include all determinants of well-being in the model. There is no consensus on these variables, but Dolan et al. (2008) provide a list of the main determinants of life satisfaction found in the literature to date:

- Income
- Age
- Gender
- Marital status
- Educational status
- Employment status
- Health status
- Social relations
- Religious affiliation
- Housing and environmental conditions and crime levels in the vicinity
- Number of children and other dependents (including caring duties)
- Geographic region
- Non-market good being valued
- Personality traits (such as extroversion)

Data

The British Household Panel Survey (BHPS) is a nationally representative sample of British households, conducted on 10,000 individuals each year. Since 1997 [1] individuals have been asked "How dissatisfied or satisfied are you with your life overall?" and then asked to score their level of satisfaction on a scale of 1 (not satisfied at all) to 7 (completely satisfied).

The BHPS has a rich list of variables so it is possible to analyse the value of a wide range of non-market goods and control for a wide range of other influences on well-being[2].

From April 2011, the Office for National Statistics (ONS) will include four questions on subjective well-being in the *Integrated Household Survey* (IHS). The IHS is a composite household survey combining the answers from a number of ONS household surveys to produce a dataset of core variables. The well-being module will include a question on overall life satisfaction rated on an 11 point scale (0 - 10). With approximately 200,000 people interviewed each year, this will be the largest regular survey on well-being in the UK and it provides an opportunity for analysts to use the Life Satisfaction Method on a much larger dataset.

Where there are variables that we are interested in valuing which do not feature in the BHPS or IHS, it may be possible to derive a value estimate using other national panel datasets, for example:

- *Household, Income and Labour Dynamics in Australia* (HILDA)
- *German Socio-Economic Panel* (GSOEP)
- *Eurobarometer* (Europe-wide)
- *US General Social Survey* (GSS)
- *Gallup* (Worldwide)

Alternatively, it is possible to administer a well-being survey on the target population of interest. Dolan and Metcalfe (2008) is an example of this. They collect data on the life satisfaction (and other determinants of well-being) for a sample that experienced an urban regeneration project in their neighbourhood. Data was also collected from a similar neighbourhood, which did not benefit from the intervention to use as a control group.

5.2 Recent methodological developments

Dolan et al. (2011b) develop a method for accounting for the indirect effects of income. Groot and van den Brink (2006) and Welsch (2007, 2008b) develop methods for accounting for the indirect effects of non-market goods and 'bads', including health, air pollution and public sector corruption.

These methods are only required when the explanatory variables are not exogenously determined through either an instrumental variable or randomisation. Thus for example if the health variable is exogenous then income cannot have an indirect effect through health in the model. If *all* explanatory variables are exogenously determined in the life satisfaction model then it is not necessary to use methods to account for indirect effects (Dolan et al., 2011b).

Dolan et al. (2011b) and Groot and van den Brink (2006) assess the indirect effects of income and health on well-being by dropping in piece-wise fashion variables from the model that are

[1] 2001 did not include the life satisfaction question and so this year is usually dropped in the analysis.

[2] A list of all variables included in the BHPS can be found here: http://www.iser.essex.ac.uk/survey/bhps/documentation/volume-b-codebooks/thesaurus

determined by income and health. Dolan et al.'s (2011b) *Step Approach* employs a statistical test to check whether other explanatory variables in the model are likely to be determined by income.

For example, in equation (19) if X_2 is determined to some extent by income (M_{it}), we could estimate the full impact of income (both direct and indirect) on life satisfaction by estimating equation (20) (which drops X_2):

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{1it} + \beta_4 X_{2it} + .\beta_5 X_{3it} + ...\beta_k X_{kit} + \lambda_i + \varepsilon_{it} \quad (19)$$

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{1it} + \beta_4 X_{3it} + ...\beta_k X_{kit} + \lambda_i + \varepsilon_{it} \quad (20)$$

This can have considerable effects on the value estimates. By including the indirect effects of income the size of the coefficient on income increases by 40 per cent. For example, using the *Step Approach* the value of 'living in a safe area' falls from £2,200 per month to £1,400 per month and the costs of 'being burdened with serious debt' falls from £36,500 per month to £14,000 per month (Dolan et al, 2011b).

Welsch (2007, 2008b) estimates the indirect effects of the non-market 'bads' off-model. His application is concerned with the indirect effect of non-market 'bads' on income. This approach involves estimating a subsidiary income model. For example, assume, that in equation (21) income (M_{it}) is not exogenously determined and depends to some extent on the non-market 'bad' (Q).

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{it} + \lambda_i + \varepsilon_{it} \quad (21)$$

To account for the impact of Q on life satisfaction via income we can estimate equation (22):

$$M_{it} = \alpha + \beta_4 Q_{it} + \beta_5 Z_{it} + \lambda_i + \varepsilon_{it} \quad (22)$$

where Z_{it} is a vector of determinants of M_{it}.

In this system of equations the cost or income compensation of the non-market 'bad' is

$$IC = \frac{\beta_2 + (\beta_1 * \beta_4)}{\beta_1} \quad (23)$$

Using this technique can have a significant impact, increasing the valuations of the costs of corruption and pollution (Welsch, 2007, 2008a, 2008b).

5.3. Applied recommendations

In this section we present ten broad key recommendations that we believe should be followed, where possible, when using the life satisfaction approach. These recommendations emerge from the discussion in Chapter 4.

1. Endogenous explanatory variables should be identified and steps should be taken to correct for the correlation with the disturbance term

This will give the model's coefficient estimates a causal interpretation. If some explanatory variables cannot be assumed to be determined exogenously then the indirect effects of income and the good being valued (through the un-instrumented variables) should be estimated using

either Dolan et al.'s (2011b) *Step Approach* or Welsch's (2007, 2008b) methodology outlined in section 5.2.

2. Where possible align the sample and variables with the policy question.

Whether EV or CV is the appropriate theoretical measure of value will depend on the policy intervention and property rights. If, for example, we are interested in understanding the WTA a loss in community centre services, where possible the sample should be focused on those members of the population that have experienced losing a similar service. The sample used should be similar to the target group of the policy intervention in question.

It should be noted that the effects of non-market good on life satisfaction may be heterogeneous across the population. Therefore, when using instrumental variable techniques, the estimator retrieves the **Local Average Treatment Effect** (LATE). This is the average causal effect for the group that is affected by the instrument. In the example below (Table 2) income was instrumented using the earnings of the spouse and so the causal effect of income on life satisfaction is only applicable to this sample. This should be considered and discussed when estimating values using the life satisfaction approach[3].

3. Correctly specify the relationship between the dependent and explanatory variables in the life satisfaction regression model

Non-parametric and semi-parametric models significantly reduce the chance of functional form mis-specification, but at the cost of computational complexity and less desirable estimator properties. Consideration of the regression models adopted in the existing LS applications forms a good starting point and aids in result comparability. Goodness-of-fit tests should also be employed in order to find the models with the best fit [4].

4. Relative income should be controlled for.

Relative income can be controlled for by including a measure of average income for a suitable reference group.

5. Compensatory market mechanisms should be controlled for in the model.

This will provide full, rather than partial, values of non-market goods and 'bads'. See the part on partial values in section 4.2.4.

6. Counter-effects of income should be accounted for in the model.

If earned income is being used as the income variable, the number of work hours and time spent commuting should be held constant. See the part on counter-effects of income in section 4.3.3.

7. Where multiple values may be relevant the analysis should clearly explain what the value estimate is composed of.

[3] For more details on these issues the reader is referred to Angrist and Pischke (2009) and Gangl (2010).

[4] See Fox (1997) for a review of goodness-of-fit tests.

As a minimum value estimates should be fully explained to acknowledge the utility derived from the consumption of complementary goods. A preferred approach (if possible) would be to control for the consumption of complementary goods or to subtract the market price of the complementary goods from the overall value estimate.

8. Time-invariant factors such as personality traits should be controlled for (panel data estimation only).

In practice, the life satisfaction regression is estimated assuming the existence of time-invariant unobserved determinants (λ_i) of well-being. The life satisfaction variable is ordinal in nature but Ferrer-i-Carbonell and Frijters (2004) show that assuming cardinality as opposed to ordinality in the LS function makes no difference to estimation results. For ease of estimation and exposition, the preferred model has therefore become an OLS regression with fixed effects to control for λ_i:

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{it} + \lambda_i + \varepsilon_{it} \qquad (24)$$

Fixed effects models work by using the longitudinal nature of the data to control for determinants of life satisfaction which do not change over time (λ_i). This might include characteristics such as extroversion and introversion which are strongly associated with well-being or factors such as an innate tendency / ability to be happy or satisfied. Because these factors do not change over time they can be controlled for using a separate intercept for every individual in a fixed effects model.

Random effects models can also control for λ_i but it makes the assumption that the individual effect λ_i is uncorrelated with the other regressors in the model (X_{it}).This assumption is not likely to hold in the life satisfaction function as we would expect factors such as extroversion to be strongly correlated with some of the covariates included in the model.

9. Adaptation effects

Evidence suggests that many people adapt quickly to many positive and negative life events, including marriage, divorce, disability, pay rises and unemployment (Brickman et al. ; Larsen and Prizmic, 2008 (Eid and Larsen eds); Frijters et al, 2008). Adaptation effects can be estimated using panel data and by including time-lagged explanatory variables for the good being valued. For example, the life satisfaction of individual *i* in period *t* could be written as:

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 Q_{it-1} + \beta_4 X_{it} + \lambda_i + \varepsilon_{it} \qquad (25)$$

The time-path effect of the non-market good (*Q*) is captured by parameters β_2 and β_3. Here, the good (*Q*) occurred or was consumed in the previous period (*t-1*) and so Q_t picks up any adaptation effects. If there is adaptation to *Q*, then $\beta_2 < \beta_3$ [5]. Of course, specifications can be adopted with further lags into past periods. The value of the good should be estimated for the good's entire time-path as follows:

$$WTP(years:\ t-1+t) = \frac{\beta_2 + \beta_3}{\beta_1} \qquad (26)$$

[5] If there is adaptation to a non-market 'bad' then $|\beta_2 < \beta_3|$.

Without a lagged model that accounts for adaptation (so that $\beta_2 \neq \beta_3$), WTP for *Q* over the two years would be mis-estimated using the standard method of:

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{it} + \lambda_i + \varepsilon_{it} \quad (27)$$

and

$$WTP(years: t-1+t) = \frac{2(\beta_2)}{\beta_1} \quad (28)$$

10. Sub-group valuations can be investigated

Although the focus of a valuation exercise is usually to recover estimates for the typical member of the population under consideration, it is also possible to assess how valuation estimates differ by gender, age, or other characteristics by, for example, estimating the life satisfaction regression on sub-samples (Powdthavee and van den Berg, 2011). Sufficient sample size is a pre-requisite and there should be an ex-ante reason to suspect differences across the characteristics. Restrictions on the regression model parameters should be applied and tested in these cases to assess whether differences are statistically significant.

5.4 Worked Example

5.4.1 The life satisfaction regression

As an example we use a study by Luttmer (2005) and provide an estimate of the costs of unemployment. This study was chosen because it adheres to most of the recommendations set out in 5.3 above. Luttmer uses two waves of the American National Survey of Families and Households. Income is instrumented by predicted in household earnings where predicted earnings are based on the industry x occupation of the respondent and his or her spouse (**Recommendation 1 – for income only**). Relative income, hours worked and fixed effects are controlled for in the model (**Recommendations 4, 6 & 8**). Table 3 below is an excerpt from Luttmer's (2005) Table 1.

Table 3. Example Life satisfaction regression

Dependent variable: Life Satisfaction	Coefficient	Standard error
ln Household income	0.361**	0.10
Relative income	0.296**	0.08
Working hours	-0.138**	0.05
Unemployed	-0.355**	0.15
Age	-0.038**	0.01
Black	-0.025	0.07
Hispanic	0.297**	0.07
Asian	-0.011	0.12
Years of education	-0.006	0.01
ln Household size	-0.188**	0.04
No religion	-0.162**	0.06
Live in a metropolitan area	-0.007	0.01
Nonmetropolitan area	-0.047	0.04
Number of observations	8944	

*Note: For illustrative purposes this is just a selection of the variables used in Luttmer's (2005) study. Significance levels: *: 10 percent; **: 5 percent. Relative income is the average income in the locality. Average (mean) income = $18,000 p.a.*

5.4.2 Estimating the monetary value

In Table 3 Both income and unemployment are significant at the 5 per cent level. Since income is in logarithmic format it requires the following formula to calculate the income compensation or cost of unemployment to the individual:

$$WTP \quad or \quad WTA \quad = e^{[\ln(\overline{M})-(\beta_2/\beta_1)^*-1]} - \overline{M} \qquad (29)$$

where $\overline{M}$ = average income in the sample; β_1 = the income coefficient; β_2 = the coefficient on the good being valued (in this example unemployment).

Using (29), the cost of unemployment to the individual is around **$30,000 per year** or **$2,500 per month**. Converting to UK pounds this is about **£18,000 per year** or **£1,500 per month**[6].

5.4.3 Explaining the results

Income is included in the life satisfaction regression and therefore the coefficient on unemployment is the impact on well-being over and above (or in addition to) the loss of wage income that comes with unemployment. The full cost of unemployment to the individual is therefore $30,000 (well-being cost) + $18,000 (loss of wage) = $48,000 or £29,000 per year.

The well-being cost of $30,000 per year picks up the loss of the non-wage benefits of employment. These benefits are mainly comprised of structured time use, activity, social contact, collective purpose and status, which impact positively on people's health and well-being (Jahoda, 1982; Fujiwara, 2010). A loss in these benefits shows up as a reduction in life satisfaction for the sample in Luttmer's (2005) study. The figure of $30,000 seems high; it is

[6] Converted using 1 June 2011 exchange rate of £1 = $1.64.

nearly twice the size of average income ($18,000), but it is significantly lower than the unemployment cost estimates made by Powdthavee (2008) (£74,000), Blanchflower and Oswald (2004) ($60,000) and Clark and Oswald (2002) (£276,000). The estimate presented here is likely to be lower because Luttmer's study adheres to many more of the recommendations set out above.

This estimate has a number of caveats. First, the unemployment variable is not instrumented and so it is likely to be *biased upwards* (too negative in this context). This is because people who are less satisfied with their lives in the first place are more likely to become and stay unemployed. The cost of unemployment is therefore overstated in this respect.

Second, only the income variable is instrumented in the regression and indirect effects are not taken into account (violation of recommendation 1). This has two implications. (i) The indirect effects of unemployment are not accounted for, which leads to a *downward bias* in the coefficient on unemployment. (ii) The indirect effects of income are not accounted for, which leads to a *downward bias* in the income coefficient. There are therefore two opposing biases in the unemployment coefficient and it is hard to stipulate the net effect. We can, however, say something about the indirect effects of income. Dolan et al. (2011b) find that accounting for the indirect effects of income increases the coefficient on income by about 40 per cent. This would increase Luttmer's income coefficient from 0.361 to 0.5054. The corresponding cost of unemployment would be about $18,000 (£11,000) per year or $1,500 (£900) per month, which is equal to average income for the sample.

Third, Luttmer looks at unemployment rather than employment. There is evidence to suggest that the absolute impact on well-being is greater for unemployment than for employment (Fujiwara, 2010). The figures quoted above therefore should not been seen as the *'value of employment'*, but rather strictly only as the *'cost of unemployment'*.

Fourth, adaptation effects are not taken into account (violation of recommendation 9). Therefore the coefficient on unemployment represents the average effect of unemployment on life satisfaction for all people who were unemployed in the sample at that time (regardless of their past employment history). To get a more accurate estimate of the individual costs of unemployment adaptation should be accounted for.

Fifth, Luttmer restricts his sample to people who are married or co-habiting. If there are heterogeneous impacts of income on life satisfaction throughout the population, then the income coefficient in Table 3 represents the LATE for this sample and the unemployment coefficient is also only relevant to this sample.

5.4.4 Incorporating the results into cost-benefit analysis

The value estimates derived above for unemployment would be relevant for policy interventions that improve job retention. A benefit of programmes that help to keep people in work would be the avoidance of these costs of unemployment. For each person successfully treated by the programme the benefits would be the avoidance of the loss in wage income for that person and the avoidance of the individual costs of unemployment. Aggregating these values across all affected groups would provide an estimate of the WTP for the programme and this can be compared to the programme's operating costs in cost-benefit analysis.

6 Future Areas of Research

6.1 Valuation with Experienced Utility

The econometric recommendations set out in this paper will significantly improve the accuracy of the value estimates derived from the life satisfaction approach. The Worked Example has shown that value estimates come down to much more reasonable and plausible figures when adhering to most of these recommendations. No study to date however has met these criteria and thus we advise that value estimates from the life satisfaction literature be used with a lot of caution in any policy analysis.

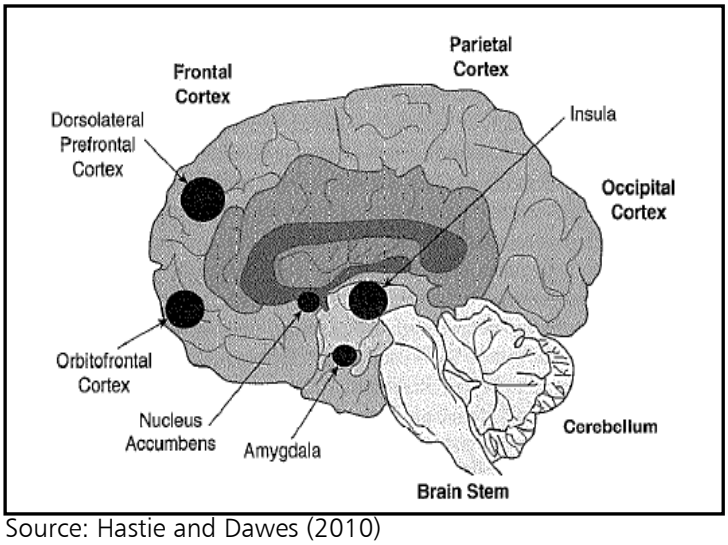
These recommendations, however, do not provide solutions to any possible measurement error issues concerning life satisfaction. We have seen that context effects and difficulties in remembering past experiences and in reporting well-being in an unbiased way can impact on the robustness of life satisfaction data. In response to this we saw that experienced utility or moment-to-moment well-being, measured with the Experience Sampling Method (or potentially the Day Reconstruction Method), represents the *gold standard* in well-being measurement. Going forward, therefore, this report recommends that methods are also developed to derive monetary value estimates from experienced utility and many of the recommendations set out in this report will be relevant for the development of this approach. This will be costly exercise given the nature of the data collection techniques and there will be concerns about how representative an ESM or DRM sample can be of the general population. In the meantime, we propose that the life satisfaction approach be pursued as a complementary method to the more traditional preference-based valuation approaches, especially where well-being data already exist.

6.2 The Role of Neuroscience

Neuroscientists are now starting to collaborate with economists and psychologists and a new field of Neuroeconomics has developed. Much of the work in this field is complementary to the research in behavioural economics, in that the rationality of people's preferences and choices is now being assessed with neurological data. The field essentially attempts to monitor activity in brain cells (neurons) under different conditions and experiences. Much of the relevant research uses functional magnetic resonance imaging (fMRI) scans to assess brain activity in humans and primates during decision tasks. fMRI picks up blood oxygen level dependency (BOLD) in the brain regions of interest (see Figure 1), which is an indirect measure of activity in the brain. fMRI does not pick up the actual electrical stimulation in neurons during their activation (like Electroencephalography (EEG) does), but rather the levels of oxygenated blood that converge on the activated areas (to supply neurons with oxygen and glucose). fMRI is popular because it allows for full spatial imaging across the brain, whereas EEG can only pick up activity in the cortex (ie, the upper layer of the brain). For example, fMRI allows us to monitor activity in areas such as the *insula* and *amygdala*, which are areas, situated deep in the core of the brain structure, that are key to processing subjective values. The trade-off is that there is a lag of about 4-6 seconds between activation of neurons (brain activity) and a BOLD signal and therefore it is sometimes difficult to infer causality between experience/action and brain activity with fMRI.

Here we discuss some of the interesting findings in relation to valuation techniques.

Figure 1. Major brain regions associated with cognitive functions involved in the decision-making process



Source: Hastie and Dawes (2010)

Cognitive processes involving consideration of gambles and consumer products seem to use the *dorsolateral prefrontal cortex.* Valuation processes of hedonic experiences are associated with activity in the central area of the brain (including the *amygdala* and *insula.* The *orbitofrontal cortex* plays a crucial role in integrating cognitive information and emotional valuation (Hastie and Dawes, 2010). Many studies (eg, Plassmann et al. 2007; Paulus and Frank, 2003; Roesch and Olson, 2004) have highlighted that activity (BOLD) in the medial orbitofrontal cortex (mOFC) plays a critical role in the evaluation of choices and decision making. Levy et al. (2011) find that activation in the *medial prefrontal cortex* and *striatum* predict subsequent choice, suggesting that these areas represent value.

In section 4.2.1 we discussed evidence of price anchors in brain activity. Plassmann et al. (2007) find that computation of WTP amounts take place in the mOFC. For different food snacks WTP was positively correlated with activity in the mOFC. Participants showed significantly greater activity in the mOFC when stating higher WTP values for the snacks. Participants used their own money and actually made the purchases.

There is evidence that qualitively different rewards and experiences are represented in the same areas of the brain and on a common scale (Hare et. al., 2010; Chib et. al., 2009; Camerer et. al., 2005). Grabenhorst et al. (2010) find that the subjective pleasantness of temperature and taste are represented on a common scale of neural activity and Hare et al. (2011) find that for a sample of dieters the experience (or utility) derived from consuming food and the dis-utility felt from having not abstained from eating both activate the same area of the brain. Kang et al. (2011) find that the same areas of the brain (including the OFC) are active in both real and hypothetical decision and valuation exercises. These findings have implications for the understanding of how people derive stated preference responses.

fMRI data can be used to determine 'true' preferences and values and correct bias in reported WTP and valuation statements (Krajbich et al., 2009). Bossaerts et al. (2009) discuss evidence to show that values are computed on the spot, rather than being retrieved from memory.

An interesting result is that brains seem to be responsive to relative (rather than absolute) changes as predicted by prospect theory (Hastie and Dawes, 2010), and that agreement with the opinion of others (especially experts) triggers activity in the same area of the brain that responds to receiving a valued object (Campbell-Meiklejohn et al. 2010). This implies that the

opinion of others can affect our individual perceptions of the value of different objects, which has implications for the contingent valuation workshop approach suggested by Hanley and Shrogen, (2002) (see section 4.2 of this paper).

This research is still very much in its early stages, but neuroeconomics has the potential to provide scientifically-grounded evidence on how and if preferences are constructed and the mechanisms involved in how people perceive and state value. It is also possible for example to assess the role of attention and the framing of questions in neural determinants of choice and value (Kahneman and Frederick, 2007; De Martino, et al., 2006). There is belief that findings from neuroscience and neuroeconomics "will soon play a large role in shaping the concepts and theories of behavioural research" (Kahneman, 2009); research that is central to properly understanding how people make valuations.

For further sources and discussion on the role of neuroscience in economics and valuation the reader is directed to Glimcher et al. (2009), Kenning and Plassman (2005), Camerer et. al. (2005) and Braeutigam (2005).

7 Conclusion

This paper serves as a response to a growing appetite in Government for well-being and social impacts to be properly incorporated in to policy decisions. We have looked at three different approaches to valuing important policy impacts. These approaches can be useful for measuring values such as impacts on health, family and community stability, educational success, and environmental assets. This is important because these types of impacts do not have a readily available financial price, and can therefore be in danger of neglect in policy analysis.

The paper has discussed the main issues associated with the application of each approach. In doing so it draws heavily on and provides a concise overview of the evidence from behavioural economics and psychology. This complements the Green Book and other Government guides on stated and revealed preference techniques. The paper also discusses the main challenges associated with the implementation of the life satisfaction approach to valuation.

Traditional preference-based approaches have provided us with many valuations over the past few decades which we have been able to use in policy analysis. They have also frequently provided us with implausible estimates. The newer life satisfaction approach is, at the moment, providing us with valuations which look implausibly high, but we are also in the process of discovering more about what might be driving these implausible estimates and adjusting the methodology as appropriate. This paper discusses the current evidence relating to the approach.

We have highlighted throughout, though, that even when valuations (and specifically those being generated currently by the life satisfaction approach) fail to meet the standards for direct inclusion in Social Cost-Benefit Analysis, they may still be useful in challenging decision makers to think more carefully about the full range of impacts of their proposed policies. And they may help decision makers to question the values that they may otherwise place implicitly on these impacts. Even where we cannot robustly place these absolute valuations for non-market goods alongside market valuations, they may still enable comparison of the relative value of different non-market goods.

We now encourage departments to pursue further research relating to the valuation of non-market goods, and specifically subjective well-being measurement in order to deliver a step change in the way that previously "hard to value" impacts of policy are accounted for.

A An Introduction to Stated and Revealed Preference Methods

This annex serves as a concise and intuitive primer to the main issues involved in the application of stated and revealed preference methods of valuation. It is targeted at those who are new to this area of literature or as a refresher for those more familiar. This background knowledge complements the discussion in the main body of the text. Throughout the Annex the reader is directed to sources that present a more comprehensive coverage of the different issues.

Applying Stated Preference Methods

A more extensive introduction to stated preference application is given by DTLR (2002) *'Economic Valuation with Stated Preference Techniques: Summary Guide'*. Associated with this introduction is a companion manual by Bateman et al (2002) *'Economic Valuation with Stated Preference Techniques: A Manual'*. The manual is more detailed and would be useful for those actually undertaking a stated preference study. The summary is useful for those who need to commission or manage stated preference valuation studies. Boyle (2003) *' Contingent Valuation in Practice'* and Holmes and Adamowicz (2003) *' Attribute-Based Methods'* are also excellent introductions to the key practical issues involved.

More general reviews of stated preference methods and the key areas attracting academic research within this field are presented in Chapters 8 (contingent valuation) and 9 (choice modelling) by Pearce et al (2006) *'Cost-Benefit Analysis and the Environment: Recent Developments.'* and Chapter 14 of Boardman et al (2005) *'Cost-Benefit Analysis: Concepts and Practice'.*

Identification of Population, Choice of Sample, and Survey Method

As choice modelling and contingent valuation are survey-based approaches to valuation, both require:

- a target population to be chosen; and
- data to be collected from a representative sample of this population..

The chosen target population is determined by:

- the specific good in question; and
- the *type* of value that is being measured.

The direct 'users' of non-market goods are the most obvious group that would attach value to them. However, individuals may also value the existence of some non-market good even if they do not use the good in any direct way. The **total economic value** of a non-market good is the sum of all **use and non-use values**. For example, the economic value of the countryside will be determined not just by the values of countryside residents and by visitors but also by individuals who remain in urban areas but simply want the country-side to exist (DTLR, 2002, Chapter 3). Likewise, improvements to the water quality of ponds to enable their use for fishing will be associated with use value and nonuse value. The later relating to individual deriving satisfaction

from the knowledge that the points are clean enough for fishing use by other people and future generations (Kaoru, 1993).

The implication of non-use value is that it extends the size population that has to be considered when estimating the total value of a good. If the good is nationally or locally unique then the target non-user population may be the entire nation or entire local area. Bateman et al (2002, p.91) recommend geographical sampling if the estimation of total non-use value of a good is an objective. This is because individual non-use value may decline with distance from the site.

Another choice in determining the target population is the **geographic boundary** of the analysis. If the proposed or existing good is to be paid for by UK residents, then policy markers may only be interested in estimating the values that UK residents attach to it. In some cases, however, legal grounds can be used to justify an extension to the boundaries. For example, there are international agreements relating to global warming and pollution and other nations can claim property rights over world heritage sites (Bateman et al, 2002, p.93).

The most common approach to sampling is **simple random sampling**. With this method, each member of the sample frame representing the population has the same probability of selection. Other methods, and the reasons for their adoption, are discussed by Bateman et al 2002 p.96-99 and DTLR, 2002, p.44 and Champ (2003)).

Surveys can be administered via mail, by telephone, face-to-face, or over the internet. Each survey mode has its pros and cons over factors such as cost, response rates, and the complexity of the information that can be presented (see table 7.1 on p.42 of DTLR (2002) and table 14-1 on p.375 of Boardman et al (2006)). Bateman et al (2002) p. 101-107 and Champ (2003) p. 69-80 present a more substantial discussion.

The Design of Contingent Valuation Questionnaires

Contingent valuation studies construct and present a hypothetical market to questionnaire respondents. Their responses in this hypothetical market are then taken to represent what their actions would be if the market was in fact real. Most contingent valuation questionnaires contain:

1) An introductory session and initial set of questions relating to the respondent's attitudes towards, and specific use of, the good in question.
2) The valuation scenario:
    - A detailed description of the good that is to be valued.
    - A description of any currently available substitutes or complements for the good.
    - Which institution will provide the good (e.g. the Government, a local council, a charity)
    - When, and for how long, the good will be provided.
    - How the good will be paid for (i.e. through changes in taxes, rates, fees, charges, or prices.)
    - How frequently payments are to be made (one-off, yearly, monthly, per visit). If repeated payments are used, then a time frame also needs to be specified (e.g. yearly payments for the next five years)
3) Questions to elicit monetary valuations with reminders of budget constraints.
4) Follow-up questions to the valuation responses and questions relating to the respondent's socioeconomic and demographic characteristics.

The institute providing the good, the payment vehicle, and the payment frequency should be specified, since these characteristics may have influence on an individual's valuation (Arrow et al, 1993). For example, respondents may hold options over different institutions' effectiveness (Bateman et al, 2002, p.127).

It is usually recommended that the specified institution, payment vehicle, and payment frequency should be those that would be most likely to be employed if the good were indeed supplied. For example, Tuan and Navrud (2007) estimate the value of a proposed preservation plan for a complex of religious temples in central Vietnam. They ask foreign visitors whether they would pay an increase in entrance fee for this plan, while they ask local residents whether they would bear an increase in local tax for it. Likewise, a one-time payment will be appropriate, for example, in cases when the good is a one-time event (Carson, 2000). However, problems can arise if respondents refuse to answer or submit protest values as an objection to paying through some mechanism (e.g. council taxes). In such cases, adopting vaguer payment vehicle descriptions may be justified (see Bateman et al, 2002, p.131-133).

Follow-up questions are useful for understanding the reasons behind respondents' valuations and for identifying respondents who are not responding with their true WTP in mind. For example (in an open ended contingent valuation format), some respondents may give a valuation of zero. This may be a protest response or it may represent their true WTP (see Bateman et al, 2002, p.145-147; or DTLR, 2002, p. 52-53).

Questions on respondents' characteristics (e.g., age, income, education) are useful for assessing the representativeness of the sample and for providing variables to model the determinants of WTP. The later is done to test for theoretical consistency (i.e. does WTP increase with income) or to facilitate benefits transfer techniques (when valuation estimates from one study are applied to a different context (see Rosenberger and Loomis; 2003 for an introduction to benefit transfer techniques).

A key design choice in contingent valuation questionnaires is how to present the valuation question(s). The most widely used elicitation formats are:[1]

- open ended;
- bidding game;
- payment card; and
- and dichotomous choice.

The **open-ended format** is the most direct approach to valuation estimation. Respondents are simply asked their maximum WTP for the good under consideration. The question formulation is along the lines of: 'what is the maximum amount you would be prepared to pay (every period) through (payment vehicle) to receive the good just described?'

The **bidding game format** proceeds by asking respondents whether they would pay a given discrete amount for a good per period. If they respond 'yes' ('no'), a series of higher (lower) bids are offered until they respond 'no' ('yes'). An open-ended WTP question is then offered. The closed-ended bidding game format is a variant. This format does not finish with an open-ended WTP question.

The **payment card method** presents respondents with a range of different listed monetary amounts. Respondent tick amounts they are willing to pay and put a cross next to amounts that they are not willing to pay.

The **dichotomous choice** (or **referendum method**) gives respondents the chance to respond 'yes' or 'no' to a single randomly drawn bid amount. Therefore, the format offers respondents a binary choice between not having the good or having the good but giving up the offered price. The double-bounded dichotomous choice method is a variant. An additional higher (lower) offer is made if the respondent responds 'yes' ('no') to the first offer.

[1] Applied examples of each format, as well at the pros and cons of each, are given in tables 9.2 to 9.6 in DTLR (2002).

Regardless of the elicitation format adopted, respondents should always be reminded of their **budget constraint** (Bateman et al, 2002, p.143). This is to help ensure that respondents perceive the questions as real economic choices.

The Design of Choice Modelling Questionnaires

Choice modelling questionnaires are typically structured in much the same way as contingent valuation questionnaires (see, for example, Tuan and Navrud, 2006). The difference between the two methods is that choice modelling focuses on the attributes of a non-market good (and the valuation of these attributes) instead of the whole good. By valuing attributes, choice modelling can also value the good as a whole.

Most non-market goods can be described by their **attributes** and the **levels that these attributes take**. For example, Mourato et al (2005) estimate the value of different schemes to reduce the amount of sewage overflows that end up in the River Themes. Such schemes or 'goods' can be described more specifically in terms of their underlying attributes. In this study, these attributes include how much the sewage reducing proposal costs (COST), the reduction in fish deaths it causes (FISH), the reduction in number of days when exposure to river quality is a health risk (HEALTH), and the reduction in visual disamenity it causes (SEWAGE). Similarly, a wetland can be described by its bird population, water quality, diversity of animal life, etc. Therefore the value that individuals attach to the wetland's existence is determined by the values attached to the elements that describe it as a whole.

All CM methods:

- present respondents with alternative descriptions of a good, differentiated by different levels of its attributes; then
- ask respondents to either rank, rate, or chose.

For the latter task there are four main choice modelling methods [2]:

- choice experiments ('chose');
- contingent ranking ('rank');
- contingent rating ('rate'); and
- paired comparisons ('chose then rate').

Choice experiments present respondents with a series of choices between the status quo or 'do nothing' option and an alternative option or options. The 'do nothing' option in Mourato et al (2005) is to pay nothing annually and to bear the expected annual negative side effects (FISH, HEALTH, and SEWAGE) if no actions are taken to counter the sewage overflows. The alternative options refer to alternative descriptions of the good in question. One option may be costly but results in a large reduction in the negative sewage side effects; another may be cheap but result in a modest reduction in the negative sewage side effects.

The **contingent ranking** approach asks respondents to rank the 'do nothing' and alternative options from most to least preferred.

The **contingent rating** approach presents respondents with a series of *single* alternative descriptions of the good. The respondent then has to rate the strength of their preference for each description on a semantic or numeric scale.

[2] (Hanley, 2001).

Finally, a **paired comparison** exercise involves respondents choosing their favourite alternative out of a set of two and then indicating the strength of their preference on a numeric or semantic scale.

The key questionnaire design stages that are specific to choice modelling studies are:

- selecting the attributes of the good;
- assigning levels to the attributes;
- creating the alternative descriptions of the good; and then
- constructing the specific choices that are presented to respondents.

Attributes are typically chosen through literature reviews, focus groups, and interviews with policy makers. The attributes of the good that people attach value to and the attributes that may be affected by any policy are those that are relevant. As noted above, a monetary cost (price) must be one of the attributes in order to derive WTP estimates. The **levels** that the attributes take should be realistic and span a sensible range. The **total** possible number of alternative **descriptions** of the good is determined by the chosen number of attributes and the chosen number of levels that each attribute can take. Finally, a number of **specific choices** (choice sets) are constructed.

Applying Revealed Preference Methods

A number of papers provide a more detailed introductory treatment of a number of areas covered here. Parsons (2003) provides a detailed practical overview of the key steps involved in applying the travel cost method. Taylor (2003) focuses on the practicalities associated with the valuation of environmental amenities using housing markets. Sheppard (1997) also presents a useful primer on the theoretical foundations and implementation of the hedonic analysis of housing markets. The main issues arising with the use of labour markets to estimate the statistical value of a life is covered by Viscusi (1993) and Viscusi and Aldi (2002).

The Hedonic Pricing Method

The hedonic pricing method derives estimates of the value of a non-market good through observations on real choices made in actual markets. Housing and labour markets are the most common applications. In the former, the intuition is that the price differential between otherwise identical houses that differ in their exposure levels to non-market goods and 'bads' such as pollution, noise, crime or education facilities reveals information regarding individuals' WTP for such goods. Labour market applications follow a similar logic, though the focus is typically on the compensating wage differentials that are paid in relation to job characteristics such as health and safety risks or job security.

Theoretical Foundations

Viscusi (1993) presents a useful overview of the main elements of the basic theory for labour market applications. This is captured here in order to provide a basis for understanding issues related to the methods application. In brief, the model relates to the trade-off that the supply and demand side of the labour market makes over wage (w) and job-characteristic (r) combinations. For example, for any given firm to offer less injury risk to its workers while maintaining the same level of profits, it will have to offer a lower wage rate. Each firm has therefore has a wage-risk offer curve. Since any worker will select the highest possible wage for a given level of risk, the outer envelope of each firm's offer curve gives the market opportunities locus. On the supply side, each worker will have their own preferences over risk/wage trade-offs. However, all will be willing to give up some wages for some reduction in risk probability. The

market clears with each worker selecting employment at the firm that offers them the highest expected utility. Hence, in equilibrium, all observed risk/wage outcomes give represent the set of points of tangency between workers' constant expected utility loci and the market opportunities locus.

Therefore, the observed relationship between wages and the level of a job characteristic $\partial w_i / \partial r_i$ gives the market opportunities locus. Moreover, since each worker's constant expected utility locus is tangent to this market wage opportunities curve, $\partial w_i / \partial r_i$ is also equal to the slope of worker i's constant expected utility locus and therefore gives their WTP for marginal changes in the job characteristic.

Importantly, however, knowledge of market opportunities locus (the set of tangencies between firms' offer curves and workers' constant expected utility loci) does not allow for assessments a worker's WTP for non-marginal changes in the job characteristic. This is because the pertinent trade off is given by the movement across their constant expected utility locus and not across the market opportunity curve.

The theoretical framework underlying the use of housing markets largely parallels the above (see Taylor, 2003). In brief, the price of a differentiated good such as house will be a function of the characteristics of that good. Such characteristics will include non-market goods such as air quality in the neighbourhood. The observed relationship between house prices and air quality will reflect the equilibrium interactions between sellers and buyers. The first differential of this relationship will give consumers' WTP for marginal changes in the characteristic.

Application

Most hedonic method applications broadly consist of four steps:

- Gathering a representative sample from chosen population with data to measure the variables thought to influence house prices or wages;
- Forming the hedonic price or wage function as a regression model;
- Using econometric techniques to recover an estimate of the causal effect of the non-market good on prices or wages; then
- Using the estimates to derive estimates of the value associated with changes in the non-market good.

Either individual-level or aggregated level house data could be used in hedonic analysis of housing markets. The latter approach utilises data on average sales prices and average housing characteristics across different geographic areas. However, individual level data is generally preferred (Schultz and Kling, 2001). The most costly approach to form a sample is through conducting a survey of homeowners asking them the price that they paid and the purchase year as well as the housing characteristics of interest. However, secondary data sources are typically used (Taylor, 2003, p.340-346).

Taylor (2003) notes that the determinants of house sales price will typically include variables relating to: the house and the lot (e.g. number of bedrooms, the size of garden); features of the neighbourhood (e.g. quality of schools, air quality); and the property location (e.g. commuting distance to nearby cities). When modelling wages, most applications exploit variables measuring personal characteristics, job characteristics, and location of employment.

The majority of labour markets applications adopt a hedonic regression model of the general parametric form:

$$\ln(W_{it}) = \alpha + \beta_1 X_{it} + \beta_2 r_{it} + \varepsilon_{it} \qquad \text{(A1)}$$

where w_{it} represents the wage of individual *i* at time t, r_{it} is a measure of the non-market characteristic of interest and x_{it} is a vector of other determinants of wages. The partial derivative of the hedonic model with respect to a characteristic is called the marginal implicit price of that characteristic. As noted above, this also captures the marginal WTP for worker i for changes in the characteristic.

While attempts have been made to identify demand functions in a second stage analysis aimed at deriving welfare estimates for non-marginal changes, most applications stop after the first stage due to data demands, modelling complexity associated with the second stage, and also because the insights gained from the first stage are often sufficient (Viscusi and Aldi, 2002; Taylor, 2003).

The Travel Cost Method

The travel cost method has most predominantly been used to estimate values associated with recreational sites. A site can be, for example, a river, a park, a trail, or a beach (Parsons, 2003). The method can be used to:

- estimate the total use (or 'access') value of a site; and
- estimate the surplus changes associated with changes to characteristics of a site (e.g. entrance fee, an improvement in water quality, easier access, site amenities).

The former application assesses the welfare effects of site closure (e.g. a beach closure due to an oil spill or a residential property development over a public park). The later can be used to estimate the value of implementing changes to a site.

Sites can be used for more than one type of recreation use. For example, a river might be used for swimming, kayaking, or fishing. Although aggregating highly dissimilar recreation types (e.g. motor-boating and swimming) can be problematic, the method can be generally be used to estimate the recreation value of the site as a whole or the value of the site for a specific activity (Parsons, 2003, p.275). The policy change in question dictates whether focusing on a specific recreation use is the most appropriate approach.

Single-Site Travel Cost Models

The number of visits (q_i) to a site by an individual *i* over, say, a year is likely to be related to the cost of visiting the site (p_i), the cost of substitute sites available to them (ps_i), and their income (m_i). It might also be suspected that visit frequency will vary across other variables, such as age, gender, and occupation (X_i) [3]. A simple model to explain visit frequency is given by

$$q_i = f(p_i, ps_i, m_i, x_i) \qquad \text{(A2)}$$

From (20), the total access value that each individual *i* derives from the site over a year (CS_i) is given by

$$CS_i = \int_{p_i}^{p_{choke}} f(p_i, ps_i, m_i, x_i)\, dp_i \qquad \text{(A3)}$$

(A3) is the area under their demand curve between the cost (or "price") of their visits (p_i) and their choke price (p_{choke}).[4] In other words, (A3) is the sum of the surpluses (WTP minus price) that they gain from each trip they make over the period.

[3] Common covariates to be included in X_i are discussed by Parsons (2003, p. 278-279)

[4] An individual's choke price is the price at which their number of visits to a site falls to zero.

Single-site travel cost model applications consist of:

- collecting data from a sample in order to measure the variables in (20);
- specifying (20) as a regression model and deriving parameter estimates; and
- deriving welfare estimates from the regression estimates.

Primary data can be collected by surveying on or off-site. Off site surveying can be targeted (e.g. a sample of everyone with a fishing permit) or determined by making assumptions regarding the geographic area that the user population occupies. Off-site sampling generally requires more contacts in order to get a reasonable number of users.

Data is collected to help measure the variables that are specified to enter (20). The cost (p) of the visit to a recreation site under consideration (and the cost of any alternative sites) should measure the full opportunity cost of the visit. Given this, an individual or household's trip cost can include:

- the direct expenditures incurred travelling to and from the site;
- the direct expenditures incurred at the site;
- the cost of the time spent travelling; and
- the cost of the time spent at the site.

Direct travel costs can be measured by asking questions relating to travel distance or by asking for the respondent's post-code or hometown.[5] This is then combined with estimates of average vehicle operating costs per mile travelled. Direct on-site expenses can include entrance fees or rental (e.g. boat rental) costs. Equipment costs related to the activity or activities undertaken on are often omitted if they are negligible per visit.

Estimating the opportunity cost (i.e. the value of what they give up) of a respondent's time spent travelling and their time at the site is more difficult. Parsons (2003, p. 285) notes that the recreation literature typically uses one-third of the (estimated or actual) wage rate as a lower bound and the full wage as an upper bound.

Since the dependent variable in (20) is a count (the number of visits to a site over a given period), count data regression models (such as Poisson regression) are typically used for single-site models. The estimated parameters from these regression models are then used to derive value estimates (see Parsons, 2003, p. 289-292).[6]

Random Utility Models

The random utility model can be considered as an extension of the single-site travel cost model. Instead of focussing on the visit frequency to a single given site, the focus is on the individual and *which,* if any, site they chose to visit. To accommodate this, the price and the characteristics of different sites are incorporated into the framework.[7] The extension leads to more analytical complexity. For example, each individual's site choice set must be defined (usually done by the number of related sites in a given geographic distance from their residence) and the site characteristic variables need to be defined and measured (which may necessitate identifying and using other data sources). However, the range of impacts that the random utility model can consider is much broader since the overall welfare effects of the closure, opening, or characteristic changes at one or more sites can be estimated.

[5] To shorten the length of the survey, questions are normally asked in relation to the respondent's most recent trip

[6] For illustrative purposes, a 'demand' curve of a typical visitor can be estimated by fixed all the variables, other than p and q, at their mean sample values in the estimated regression equation. This curve will show estimates of how much a typical visitor would be willing-to-pay for each successive visit to the site.

[7] While the characteristics that influence an individual's site choice will differ depending on the type of recreation under consideration, some examples may include the size of the site, its scenic beauty, catch rate of fish, site amenities, water quality, diversity of the animal population, and how easy the site is to access (Smith and Devousges, 1986).

B Meta-Analysis of Life Satisfaction Approach Papers

Author(s)	Country	Good evaluated	Income Compensation value
Blanchflower and Oswald (2004)	USA and UK	Various	For example, Cost of unemployment: -$60,000 p.a (in addition to the loss in the wage)
Carroll et al. (2009)	Australia	Droughts and some other life events	Drought (in Spring time): -A$18,000; Marriage: A$67,000 p.a.; Employment: A$72,000 p.a. (in addition to the gain in the wage)
CASE (2010)	UK	Culture and Sport	Engagement in sport (£11,000 p.a.), attending a concert (£9,000 p.a.), attending a cinema (£9,000 p.a.). All values for engagement 'at least once a week'.
Clark and Oswald (2002)	UK	Various	Employment to unemployment: -£15,000 p.m. (GHQ) and -£23,000 p.m. (SWB) (in addition to the loss in the wage); Health excellent to good health: -£10,000 p.m. (GHQ), -£12,000 p.m. (SWB); Health excellent to fair health: -£32,000 p.m. (GHQ), -£41,000 p.m. (SWB).
Cohen (2008)	USA	Crime and Health	Crime: -$49 p.a. for 10% increase in crime rates. Health: Good health to fair health: -$161,060 pa.; Good health to poor health: -$276,624 p.a.
DCLG (2010)	UK	Urban regeneration	£59, 600 p.a. for transition from being 'not satisfied' to 'satisfied' with the local area. Values also listed for other outcomes of regeneration.
Deaton et al. (2008)	Africa	Value of life	Small estimates for the value of life by Africans.
Tella et al (2003)	USA and Europe	Various	Values estimated for macro-level unemployment rates and inflation rates.
Dolan and Metcalfe (2008)	UK	Urban regeneration	Regeneration of local area: £19,000. £6,400 when income is instrumented.
Ferrer-i-Carbonell and van Praag (2002)	Germany	Chronic diseases	For example, cost of diabetes: 59% of income; cost of arthritis: 43% of income; cost of hearing problems: 18% of income.
Ferriera and Moro (2009)	Ireland	Air quality and climate	Reduction in air pollution: €945 per microgram per cubic meter of PM10 (5% improvement from average). Climate: €15,585 for 1c temperature increase in January and €5,759 for 1c temperature increase in July (increase in temperature valued positively).
Frey et al (2004b)	Paris, London, Northern Ireland	Terrorism	Value of reducing terrorist activity to lower levels (as experienced in other parts of the country): 14% - 41% of income per capita.
Groot et al (2004)	Holland	Cardiovascular disease	€12,000 – €25,000 p.a. for 25 year olds. Valuations decrease with age. Based on an approach using measures of income satisfaction and not life satisfaction.
Groot and van den Brink (2006)	UK	Cardiovascular disease	Cost of heart disease: -£49,564 (men) and -£17,503 (women). -£93,532 for 25 year old man and -£1,808 for 75 year old man.
Helliwell and Huang (2005)	USA	Non-financial job characteristics	1 point fall in job satisfaction (on a 10 point scale) has a cost of -$30,000 to -$55,000 p.a.
Levinson (2009)	USA	Air quality	Cost of -$464 p.a. per microgram per cubic meter of PM10 (notes that this is larger than revealed preference values).

Luechinger (2009)	Germany	Air quality	Value of €183 to €313 for a 1 microgram per cubic meter reduction in SO2 (compared to €6-€34 using a revealed preference method).
Luechinger and Raschky (2009)	Europe	Flooding	Value of prevention of flood: $6,500; Value of decrease in annual flood probability by its mean: $190 (note that this is similar to compensation found in hedonic markets).
Mackerron and Mourato (2009)	UK	Air quality in London	Cost of 1% increase in NO2 levels: 5.3% of income (note that this is deemed unrealistically high compared to stated and revealed preference studies).
Oswald and Powdthavee (2008)	UK	Death of family members	Loss of mother: -£20,000 p.a. (-£10,000 with income instrumented); Loss of child: -£41,000 p.a. (-£34,000 with income instrumented); Loss of partner: -£64,000 p.a. (-£36,000 with income instrumented).
Powdthavee (2008)	UK	Social relationships	Cost of moving from state of seeing friends and relatives less than once a month to never: -£63,000 p.a.; Marriage: £68,000 p.a.; Value of move from very poor health to excellent health £300,000; Cost of unemployment: -£74,000 p.a. (in addition to the loss in the wage).
Powdthavee and van den Berg (2011)	UK	Health Conditions	Costs of problems connected with arms, legs, hand, feet, back, etc. (£7,000 p.a.), Diabetes (£6,000 p.a.), Heart or Blood pressure or blood circulation problems (£8,000 p.a.). Many other estimates reported. A number of well-being measures used - results reported here from life satisfaction measure only.
Rehdanz and Maddison (2005)	Multi-country panel	Climate	Large range of values estimated for 67 countries.
Stutzer and Frey(2004)	Germany	Commuting	Cost of work commute of 23 minutes per day (sample mean): -€242 p.m. (19% of the average monthly wage).
van den Berg and Ferrer-i-Carbonell (2007)	Holland	Informal care	Cost of caring: -€8 to -€9 per hour if recipient is family member. -€7 to -€9 per hour if recipient is not family member.
van Praag and Baarsma (2005)	Holland	Airport noise	Cost of noise generated per flight: -€253.
Welsch (2002)	Cross-country	Air pollution	Cost of $70 p.a. per kiloton of nitrogen dioxide per capita.
Welsch (2006)	10 European countries	Air pollution	Reduction in total suspended particles valued at $13-$211 p.a. per microgram (per cubic meter) (notes that this is comparable to values obtained from US hedonic models).
Welsch (2007)	International - 54 countries	Air pollution	Cost in range of 'few hundred US dollars' per ton of nitrogen dioxide for the direct effect. The indirect effect of air pollution on SWB is positive as it is an input to production, but it is smaller than the direct effect in absolute terms.
Welsch (2008a)	International - 21 countries with history of conflict	Civil conflict	Cost of one fatality due to conflict: -$108,000
Welsch (2008b)	International	Corruption	1 index point increase in corruption on the Transparency International 1-10 point scale (a relatively large change) has a cost of -$900 per capita p.a. (including indirect effects).

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