Readings for Canazei 2015

My work in recent years has centred around the operationalization of Sen's capabilities approach. The first paper represents an early attempt to measure individual capabilities using data designed to do just this. The edited book provides an overview of the theoretical reasons for wanting to do this and the attached discussion paper represents our latest thinking.

Anand, P., Hunter, G., Carter, I., Dowding, K., Guala, F., & Van Hees, M. (2009). The development of capability indicators. *Journal of Human Development and Capabilities*, *10*(1), 125-152.

Anand, P., Pattanaik, P., & Puppe, C. (Eds.). (2009). *The Handbook of Rational and Social Choice*. Oxford University Press.

The discussion paper below represents some of our latest thinking though I will only give a conceptual overview. Nonetheless comments are very welcome – p.anand@lse.ac.uk or laurence.roope@dph.ox.ac.uk

If you want more, please just google 'capabilities measurement project'.

Multi-dimensional Quality of Life

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Abstract

In recent years, there has emerged an interest in the need to 'go beyond GDP' by assessing progress more directly in terms of the outcomes for human wellbeing. In this paper, therefore, we develop such an analysis, that drawing closely on recent contributions to the foundations of recent developments in welfare economics. Specifically, and with the aid of a new survey instrument designed to reflect key theoretical concepts, we compare wellbeing in the USA and UK using, *inter alia,* stochastic dominance and regression models. The paper discusses empirical findings concerning inequality, life satisfaction, non-cognitive skills, and institutions, and concludes that multi-dimensional measures of human wellbeing offer a feasible complement or alternative to income based assessments.

Keywords: wellbeing, capability, happiness, stochastic dominance, life satisfaction, non-cognitive skill, inequality

JEL Classifications: D60, I31

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Multi-dimensional Quality of Life

1. Introduction

Many policy-makers around the world are now considering how we should assess progress in terms of human outcomes. National income accounting provides an answer based on the prices of market transactions and has a long and successful history recognised, inter alia, by the Nobel prizes awarded to Richard Stone and Simon Kuznets for their contributions to the establishment of national income measurement systems. However, economists have, for a long time, also pointed out that national income is not a measure of human wellbeing - arguably the main intended outcome of economic activity. From this perspective, income is a final output measure for firms but only an input measure for consumers and, as a result, researchers are increasingly turning to alternatives. Within economics especially, two strands of literature stand out; theories of freedom and indices of human development (Sen, 1999) on the one hand, and the economics of happiness (Blanchflower and Oswald, 2002) on the other. Although there is as yet no consensus on how precisely human wellbeing should be measured[1], a few guiding principles are beginning to attain general assent in the field.

For one thing, and as economists from Sen (1985) through to Benjamin et al. (2013) have argued, there is growing recognition of the value of developing a multi-dimensional approach to the assessment of economic progress. To do this in a way that reflects human outcomes, an account of the dimensions that matter for human wellbeing is needed. The Human Development Index added, initially, health and education to income but this is clearly only a start and leaves many high income countries rather close to each other.[2] Secondly, and again as several economists have indicated (e.g. Dolan and Kahneman (2008)), Easterlin (1974), Helliwell (xxxx) and Layard (2005)), there is a need for measures that reflect subjective experience as well as the objective living conditions on which they might be based. Affluence and technological change may be associated with unintended negatives (for example social isolation) and so we cannot always assume that increases in income are necessarily net benefits. Data on subjective experiences may, in some cases, help to identify situations where this is not so. Thirdly, there is an interest in investigating human potential, and its development, particularly in terms of freedoms and opportunities. These have, for a long time, been important in economic thinking but

[1] There is however an important and complementary line of research that shows how evaluations of progress change when the focus starts to move away from consumption and income – see especially Jones and Klenow (2011) - but also Becker et al (2005) and Jones (2013) who notably demonstrates that optimal growth may be lower than would otherwise be the case if the value of life increases faster than the value of consumption. This argument can be extended to multiple dimensions of life quality and therefore illustrates why the kinds of measurements proposed here might be valuable even from a standard consumption perspective.

[2] In 2013, some 16 countries had HDI scores between 0.902 and 0.881 UNDP (2014).

are not always well reflected in theories about consumer behaviour, which tend to focus on optimal bundles of goods and services. Finally, there is growing support, e.g. Ravallion (2011), for the view that given the diversity and nature of human wellbeing, the development of a suite of indicators is arguably more important than the creation of more summary indices. This is not to argue against such summary measures but rather to suggest that much can be learned by analysing the underlying indicators, even before any attempt to aggregate.

In addition to these principles, any approach that seeks to assess progress in terms of human wellbeing is likely to be judged in light of the achievements of national income accounting and needs to reflect similar strengths in its development. National income accounting is consistent with a theory of the determination of income, and any alternative focussing on human wellbeing outcomes should really have a counterpart theory. Moreover, national income statistics have been successful by making themselves useful. Any alternative set of data should ideally sustain both the monitoring and the analysis of wellbeing. In this paper, therefore, we offer an analysis that aims to satisfy these requirements.

At a theoretical level, our approach builds closely on the three simple, but core equations of Sen's (1985, pp. 11-4) approach to welfare economics. The approach was motivated by foundational problems in welfare economics theory and draws on, and reorients, simple and basic tools from neo-classical welfare economics to offer a principled, yet practical, response to some of the well-known difficulties. This heory maintains that there are at least three distinct aspects of human wellbeing that any suite of indicators might monitor, namely, what a person does (or is), their happiness, and what it is they are able or free to do. In this paper we particularly focus our analysis on what people are able to do, in many dimensions of life, as this is one of the more distinctive aspects of the new approach.

From the perspective of data development, we show how a dataset can be constructed that corresponds to all the elements of Sen's theory. The theory proposes that a person's activities depend both on their resources and on individual-specific factors that cause people to convert resources into valuable activities at different rates. At the very least, we shall take it that there is a need, therefore, to develop data on resources and skills. Furthermore, we propose that resources are both financial and social, and that skills, drawing on a distinction popularised by Heckman, are both cognitive and non-cognitive. The simple equations that relate these concepts provide a kind of universal grammar for understanding aspects of what a person's wellbeing is and how, in populations, it is produced and distributed.

The data developed permit, in principle, many kinds of analyses. For the purposes of this paper we highlight four findings. Firstly, we develop an approach to stochastic dominance suitable for use with ordinal data and use it to show evidence of inequalities in a range of domains of life covered by our data. Secondly, we find that after controlling for a range of 'usual suspects' such as income, unemployment, health, age, marital status and personality, multi-dimensional data on what people are able to do adds significantly to the predictive power of life satisfaction models. Thirdly, we find evidence that, out of a number of non-cognitive skills, the ability to plan ahead stands out as appearing to be related to both income and life satisfaction. Finally, on the basis of comparisons between the USA and UK, we observe that multi-dimensional country profiles are rather similar, with the exception of one or two notable differences and suggest that these may reflect the incentives that exist for the promotion of wellbeing.

The rest of the paper is structured as follows. Section two offers a discussion of the theoretical framework and notation used, whilst section three provides an overview of the data generated. Section four develops the first and second order stochastic dominance techniques used to compare our ordinal measures. Empirical analysis, using stochastic dominance and regression models are presented in section five whilst section six offers a further concluding discussion. Descriptive statistics are given in the appendices and some supplementary materials are appended in the online version of the paper.

2. A Framework for Measuring Wellbeing

The framework we employ throughout the paper is essentially that laid out in Sen (1985) as a constructive response to the problems that emerged from the utilitarian approach to welfare economics that, in the 1960s, was implemented through advances in cost-benefit analysis. Bentham's proposal that societies should maximise the happiness of the greatest number was no doubt, at the time, an important democratic corrective but its modern normative interpretation has been taken by philosophers and economists alike as having the unintended consequence of ignoring, for example, claims based on rights (deontological claims)[3]. In this section, we therefore introduce a framework for measuring wellbeing, based on Sen's theory, and some notation that will be helpful in the analysis that follows.

Within the current theoretical approach, there are three aspects (or indicators) of a person's wellbeing - the activities a person undertakes and the states that they inhabit, their experienced utility, as measured by variables such as life satisfaction, and the opportunities to engage in different activities or states, given the resources and personal

[3] See for instance the overview by Sen and Williams (1982) or more recent technical work by Suzumura and Xu (2009).

characteristics with which they are endowed[4]. We therefore assume that there is a finite number $k \in \mathbb{N}$ of types of resources to which an individual might have access. Individual *i* has a vector of resources given by $\mathbf{r}_i^T = (r_{i1}, \ldots, r_{ik}) \in \mathbb{R}^k$. We also suppose that there is a finite number $m \in \mathbb{N}$ of types of personal traits, for example education, soft skills, personality or physical ability, that enable an individual to transform resources into activities and states. Individual *i* has a vector of such characteristics given by $\mathbf{c}_i^T = (c_{i1}, \ldots, c_{im}) \in \mathbb{R}^m$.

This notation allows that some resource and personal characteristic variables may be discrete or binary. It also permits the set of relevant resources and characteristics to differ across individuals, as they are allowed to take zero values.Through various combinations of resources and personal characteristics, individuals produce a variety of activities and states. In what follows, we just refer to activities and assume that there exists some finite number $n \in \mathbb{N}$. Individual *i* has a vector of activities, at a point in time, given by $\mathbf{a}_i^T = (a_{i1}, \ldots, a_{in}) \in \{0,1\}^n$ where $f_{ij} = 1$ if the individual is involved in an activity *j* and $f_{ij} = 0$ otherwise.

We think of the value of a_{ij} as being determined by a production function, where resources and personal characteristics are the arguments, thus:

$$a_{ij} = \theta_j(r_{i1}, \ldots, r_{ik};\ c_{i1}, \ldots, c_{im}) \qquad (1)$$

Individual *i* is assumed to derive utility dependent on the various activities they engage in and also, as before, some traits. This is given by:

$$u_i = \lambda_i(a_{i1}, \ldots, a_{in};\ c_{i1}, \ldots, c_{im}). \qquad (2)$$

This relation also underpins the index of wellbeing proposed by Kahneman et al. (2004/5), in which they develop a utilitarian assessment of wellbeing over the period of a day. So although human development and happiness research have different normative foundations and methodological approaches, they share an interest in the connection between activities and experiential aspects of wellbeing.

Whilst activities and experiences can both provide information about wellbeing, Sen has argued to much effect that what a person *can* do, given their resources and skills, is also

[4] Sen (1985?) actually talks about 'conversion factors' and whilst we shall follow other economists, who have focused particularly on skills and traits (eg Borghans et al (2008)), we note that, in principle, this could include other external factors that help or hinder the person convert resources into activities or states.

an important consideration. For this reason, we introduce a third aspect of wellbeing, namely what a person is capable of doing. Specifically, we suppose that there is a finite number $s \in \mathbb{N}$ of types of abilities to do or achieve things that an individual can have. Individual *i* has a vector of such abilities given by $q_i^T = (q_{i1}, \ldots, q_{is}) \in \mathbb{R}^s$, where the value of q_{ij} is determined by the following production function:

$$q_{ij} = \varphi_j(r_{i1}, \ldots, r_{ik}; c_{i1}, \ldots, c_{im}). \qquad (3)$$

The vector q_i^T describes what person *i* is free or able to do. It therefore describes the collection of situations and states a person could be involved in, given their resources and personal traits. The greater the value of q_{ij}, the greater is individual *i*'s degree of freedom or capability in dimension j. Equation (3) describes the relationship between capabilities and resources and traits. By combining (1) and (2), it follows immediately that utility, our experiential component of wellbeing, can be expressed as follows:

$$u_i = \rho_i(r_{i1}, \ldots, r_{ik}; c_{i1}, \ldots, c_{im}) \qquad (4)$$

We interpret equations (3) and (4) as production functions, analogous to those for firms, where the outputs are aspects of human wellbeing.[5] Finally, since the variables in (3) which produce q_{ij} are the same for all *j*, any simple summary index of individual *i*'s capability based on q_i^T, can be expressed in a similar manner to (3), as a function of resources and traits.

Human wellbeing, then, has different elements and in what follows we focus particularly on multiple dimensions of individual capabilities and experience, as well as their associations with resources and skills. In our empirical analyses, as a key element of our framework, we create summary capability indicescorresponding to individual *i*'s capabilities with respect to Home, Work, Community, Environment and Access to Services. These indices are denoted as Q_{iH}, Q_{iW}, Q_{iC}, Q_{iE} and Q_{iS} and each can be expressed in a similar form to (3).

They are obtained using a threshold plus counting method, similar to that which has become popular in the literature on multi-dimensional measurement (e.g. Alkire and Foster (2011)).[6] To measure individual home-related capabilities, we have seven sub-domain indicators, each of which takes a response on an 11-point scale from '0' to '10'

[5] Note that while in (3) we impose the same functional form φ_j for all individuals, as discussed in Footnote x, in (4) we allow for the possibility that different individuals may have different utility production functions. However, in order to analyse the production of utility econometrically, we will later make the simplifying assumption that $\rho_i = \rho$ for all individuals.

[6] Our approach is also consistent with Nehring and Puppe (2002)'s axiomatic work on measuring the diversity of a set by summing the values of attributes possessed by members of the set.

ranging from 'disagree' to 'strongly agree.' Typically, responses can be conveniently divided into groupings from 0-5 and from 6-10 as , $q_{ij} \in \{0,1\}$, where *i* denotes the individual and $j \in \{1, \cdots, 7\}$ denotes the *j*-th sub-domain. A summary index for this and other domains, for the *i*-th individual, Q_{iH}, is then created by summing over the seven sub-domains, i.e. $Q_{iH}=\sum_{j=1}^{7} q_{ij}$. In principle, these aspects of life quality could be considered to give rise to a total lifetime capability expressed as $\int_{t=0}^{T}(\sum_{l=1}^{5} Q_{il})dt$, where $l \in \{H, W, C, E, S\}$ and t denotes age, from birth $(t = 0)$ through to death $(t = T)$. In the empirical work that follows, however, we choose to focus on life quality as assessed by the five separate capability domains at a single point in time.

We develop data that is consistent with each of these theoretical elements. The resulting dataset is rich and supports, in principle, many kinds of analyses. For the purposes of this paper, we shall be particularly interested in the within-country distributions of these elements of wellbeing, especially those concerned with what people are able to do.

3. Data

The dataset generated in this paper is designed to implement the theoretical framework discussed above. A widely accepted view that capability measurement is either difficult in principle or rare in practice[7] rate has given way in recent years to a more pragmatic concern that there are simply few existing datasets with variables that closely correspond to *all* the elements of Sen's theory. We therefore focus on the construction of a survey instrument which can be used to develop such data. Our surveys are developed for the USA and the UK, to illustrate application of our approach to monitoring wellbeing at a national level. The questions are designed to provide data relating to what people are able to do, their experiences, activity involvement, resources and skills, as well as a range of standard socio-demographic variables

In the empirical analysis that follows in section 5, we make use of data concerning what people are able to do across 29 different dimensions, together with data on activity involvement and measures of experience such as life satisfaction, which is now widely used in empirical work. Question wording draws on previous work (see for example Anand et al (2009)), which in turn was informed by the design of a number of national household surveys, particularly the British Household Panel Survey, the German Socio-Economic Panel Survey and the Panel Survey of Income Dynamics. The dimensions of capability covered owe much to objective list accounts of human flourishing, particularly

[7] See for instance Brandolini and D'Alessio (1998).

a widely discussed list from the political philosophy literature, produced by Nussbaum (2000). Our dimensions also draw on a survey of dimensions proposed by some forty such lists[8], a consultation exercise conducted by the ONS (2011) with over 30,000 members of the UK general public, and the OECD (2011) Better Life Compendium, based on available national data for member states. Our measures of experience include four questions about life satisfaction, happiness yesterday and anxiety yesterday. Different measures of experience respond differently to external changes and there is, as a result, growing interest in a variety of experience indicators beyond questions about life satisfaction or happiness. Measures of activity used here are a slight modification of an account developed by Dolan et al, (2009), which was in turn based on initial work by Kahneman et al. (2005). For present purposes, we use a question based on activity involvement yesterday and record whether yesterday was a normal working day or not. This formulation is, in effect, a short-form version of questions that often appear in time-use research and enables us to ask about activities that might plausibly be remembered with reasonable accuracy without resorting to diary keeping.[9]

Finally, recognising that personal traits such as non-cognitive skills are allowed for in this framework, and are of increasing interest to economists (e.g. Cunha and Heckman (2008), Cunha et al. (2010)), we asked several questions about a range of potentially relevant characteristics in addition to the standard 'big five' personality traits. In his original account, Sen (1985?) discusses what he calls 'conversion factors' that help individuals convert resources into activities and states. In principle, these might include factors such as social norms which apply to particular types of people and might not be classified as non-cognitive skills. Here, we consider skills to do with what might loosely be regarded as 'task completion' or 'social performance.'

In 2011, we held a workshop with disciplinary experts from economics, psychology, philosophy and a national statistics office, to finalise a design that was subsequently piloted and delivered by a political polling and market research company. The full survey was conducted in early 2012 with samples from the company's online panels, selected to be roughly representative of working age adults. The analysis in this paper draws mainly

[8] See inter alia Anand (2011).
[9] Whilst not a primary aim, we were concerned with creating a short form survey that might plausibly be incorporated into other surveys, a common approach in psychometric and health research.

on the samples from the USA and the UK and a selection of descriptive statistics are presented in presented in Appendices A and B.[10]

There is considerable interest in the development of dashboards of data for monitoring the human impacts of economic activity and in what follows we illustrate some of the analyses that might be supported by such data. Before…
In the section, that follows we develop the stochastic dominance tests that are suitable for comparing groups, given that the much of our data is ordinal in nature.

4. Stochastic dominance with ordinal variables

Our analysis of empirical results begins with a comparison of within country inequalities, as indicated by differences in the distributions of individual capabilities among different groups. Standard stochastic dominance techniques cannot be applied given the ordinal nature of the data, as the dominance conditions and associated statistical tests are based on a continuity assumption, which does not apply here. However, Yalonetsky (2013) recently developed stochastic dominance results, and associated statistical tests, for multi-dimensional data measured on ordinal scales. However, even in quite large samples and with just a few dimensions, it can be difficult to obtain statistically significant results between groups.[11] Moreover, dominance in a particular given dimension may often be of interest in its own right, regardless of its joint distribution with other dimensions. As a result, we offer an approach to dominance that is suitable for use with ordinal data on a dimension by dimension basis.

Suppose that there are N_g individuals in group $g \in \{A, B\}$. Each individual has an attainment in some common wellbeing domain which lies in one of $S \in \mathbb{N}$ ordinal categories. Let $\boldsymbol{\omega}_g \in \mathbb{N}_{\uparrow}^{N_g}$ for $g \in \{A, B\}$ be a vector of wellbeing scores, where the subscript $\uparrow$ indicates that wellbeing attainments are weakly ordered from lowest to highest. The i'th element of $\boldsymbol{\omega}_g$ is given by $\omega_{ig} \in \{1, \cdots, S\}$. Following Yalonetzky

[10] The workshop was held at Brasenose College in Oxford and the data were collected by YOUGOV. The composition of an Italian sample appears slightly different to that of the USA and UK but some results are given in the supplementary materials.
[11] This is related to the 'curse of dimensionality' that arises when rapidly increasing demands are placed on data when the number of dimensions increase. Intuitively similar points in K-dimensional space become further apart as K increases, density surfaces become flatter, and it becomes harder to distinguish between distributions. In ongoing work, Anderson et al. (2014), develop an approach to creating multi-dimensional deprivation indices that deal with this issue.

(2013), we focus on the class of social wellbeing functions that are additively separable and symmetric with respect to individuals.[12] The class of all such social wellbeing functions Ω, unique up to positive affine transformations, can be defined as

$$\Omega = \left\{ W(\boldsymbol{\omega}_g) : W(\boldsymbol{\omega}_g) = \sum_{i=1}^{N_g} \alpha_i u(\omega_{ig}) \right\},$$

where $\alpha_i \geq 0$ for all $i \in \{1, \cdots, N_g\}$, $\sum_{i=1}^{N_g} \alpha_i = 1$ and the function $u: \mathbb{R} \to \mathbb{R}$ can be interpreted either as an individual-level wellbeing evaluation function (of which a utility function is a special case) or simply as a cardinal scale.

For $k \in \{1, \cdots, S\}$, let us denote the cumulative probability function by $F_g(k) = \Pr(\omega_{ig} \leq k)$. In what follows it will also be convenient to define the differences in wellbeing and cumulative probability functions, respectively, between the two groups as

$$\Delta W = W(\omega_A) - W(\omega_B) \text{ and } \Delta F(\cdot) = F_A(\cdot) - F_B(\cdot).$$

We can now write the following stochastic dominance conditions:

(D1) First Order Stochastic Dominance (FOSD):

$\Delta W \geq 0 \Leftrightarrow \Delta F(k) \leq 0 \; \forall \, k \in \{1, \cdots, S-1\}$ and all $u(\cdot) \in U^1$, where the class U^1 is defined as:

$$U^1 = \{u(\cdot) : u(k+1) - u(k) \geq 0 \; \forall \, k \in \{1, \cdots, S-1\}\}.$$

The only restriction then on the function $u(\cdot)$ is a very mild one of weak monotonicity; ordinal categories are assigned weakly higher cardinal values according to their relative desirability. If group A is found to have FOSD over group B then we can conclude that A is ranked as being preferable to B, with respect to social wellbeing based on our wellbeing domain, by any such function $u(\cdot) \in U^1$.

(D2) Second Order Stochastic Dominance (SOSD):

[12] We use the term 'social wellbeing function' rather than 'social welfare function' simply to emphasise that the function's arguments are variables not typically used in welfare economics. The simplifying assumption of additive separability, though quite restrictive, is widely made and such social welfare functions are well known to have a number of attractive properties, most obviously subgroup consistency.

$\Delta W \geq 0 \Leftrightarrow \Delta H(k) = \sum_{i=1}^{k} \Delta F(i) \leq 0 \; \forall \; k \in [1, \cdots, S-1]$ and all $u(\cdot) \in U^2$, where the class U^2 is defined as:

$$U^2 = \left\{ u(\cdot) : u(\cdot) \in U^1 \text{ and } \left[\left(u(k-2) - u(k-1) \right) - \left(u(k+1) - u(k) \right) \right] \leq 0 \; \forall \; k \in [1, \cdots, S-2] \right\}$$

.

Here the form of the function $u(\cdot)$ is further constrained by imposing a concavity restriction.

As with cardinal data, clearly FOSD implies SOSD and is the first condition to check. If FOSD does not hold, the two groups may still be ranked for a broad class of social wellbeing functions if SOSD holds.

Yalonetzky (2013) also provides an ordinal variable extension of Anderson (1996)'s non-parametric statistical tests for stochastic dominance in empirical applications. The univariate versions of these tests for FOSD and SOSD in the present setting are as follows. [13] Let p_{kg} be the probability that a randomly selected individual from $G = \{1, \cdots, N_g\}$ has a capability attainment in category $k \in [1, \cdots S]$ and let $\boldsymbol{p}_g \in [0,1]^S$ be the corresponding vector of probabilities. The empirical estimate of p_{kg} from a random sample of $n_g \leq N_g$ is given by

$$\hat{p}_{kg} = \frac{1}{n_g} \sum_{i=1}^{n_g} I(k_i),$$

where $(k_i) = \begin{cases} 1 \; if \; k_i = k \\ 0 \; otherwise \end{cases}$.

Let $\hat{\boldsymbol{p}}_g$ be the corresponding vector of empirical estimates and let $\boldsymbol{0}$ denote an S-vector of zeros. Using results by Formby, Smith and Zheng (2004), we can then write the asymptotic result:

$$\sqrt{n_g}\left(\hat{\boldsymbol{p}}_g - \boldsymbol{p}_g\right) \xrightarrow{d} N(\boldsymbol{0}, \boldsymbol{\Omega}_g)$$

where the S-dimensional covariance matrix $\boldsymbol{\Omega}_g$ is such that its (k,l)'th element is equal to $p_{kg}(1 - p_{kg})$ whenever $k = l$ and $-p_{kg}p_{lg}$ otherwise. Now denote $v = (\hat{p}_A - \hat{p}_B)$. Under the null hypothesis that groups A and B are identically distributed,

[13] Yalonetzky (2013) provides only multivariate results, for two or more variables. The univariate results provided here are very closely related and more easily derived.

$$v \xrightarrow{d} N\left(\mathbf{0}, \frac{n_A + n_B}{n_A n_B}\boldsymbol{\Omega}\right).$$

where $\boldsymbol{\Omega} = \boldsymbol{\Omega}_g$ for any $g \in \{A, B\}$.

Some further notation is helpful at this point. Let $\boldsymbol{\Delta}\mathbf{F}$ and $\boldsymbol{\Delta}\boldsymbol{\Pi}$ denote the S-vectors with k'th elements $\Delta F(k)$ and $\Delta\Pi(k)$, respectively, and let the corresponding test statistic vectors be denoted by $\widehat{\boldsymbol{\Delta}}\mathbf{F}$ and $\widehat{\boldsymbol{\Delta}}\boldsymbol{\Pi}$. Let $\hat{\boldsymbol{\Omega}}_g$ be the estimate of the covariance matrix $\boldsymbol{\Omega}_g$, with (k,l)'th element equal to $\hat{p}_{kg}(1 - \hat{p}_{kg})$ whenever $k = l$ and $-\hat{p}_{kg}\hat{p}_{lg}$ otherwise. We also define $\mathbf{L}$ as an S-dimensional lower triangular matrix of ones.

We can now write the statistical tests for FOSD and SOSD.

(S1) The k'th element of the test statistic for $\boldsymbol{\Delta}\mathbf{F}$ is given by

$\widehat{\Delta F}(k) = \sum_{j=1}^{k} v_j = \sum_{j=1}^{k}(\hat{p}_{jA} - \hat{p}_{jB})$.

Now, under the assumption that the samples from A and B are independent,

$$var\left(\widehat{\boldsymbol{\Delta}}\mathbf{F}\right) = \mathbf{L}\left(\frac{1}{n_A}\hat{\boldsymbol{\Omega}}_A + \frac{1}{n_B}\hat{\boldsymbol{\Omega}}_B\right)\mathbf{L}'.$$

For each $k \in \{1, \cdots, S\}$, the corresponding z-statistic Z_k^1 is obtained by dividing $\widehat{\Delta F}(k)$ by its standard error (S.E), which is given by the square root of the k'th diagonal element of $var\left(\widehat{\boldsymbol{\Delta}}\mathbf{F}\right)$. Thus,

$$Z_k^1 = \frac{\sum_{j=1}^{k}(\hat{p}_{jA} - \hat{p}_{jB})}{S.E.\left(\widehat{\Delta F}(k)\right)}$$

where $S.E.\left(\widehat{\Delta F}(k)\right)$

$$= \sqrt{\sum_{j=1}^{k}\left(\frac{\hat{p}_{jA}}{n_A}\left(1 - \hat{p}_{jA} - 2\sum_{l=j+1}^{k}\hat{p}_{lA}\right) + \frac{\hat{p}_{jB}}{n_B}\left(1 - \hat{p}_{jB} - 2\sum_{l=j-1}^{k}\hat{p}_{lB}\right)\right)}$$

We now consider the null hypothesis that A does not FOSD B.

H_0: $\Delta F(k) > 0$ for some $k \in \{1, \cdots, S-1\}$.

H_1: $\Delta F(k) \leq 0$ for all $k \in \{1, \cdots, S-1\}$.

H_0 is rejected if and only if $Z_k^{FF} \leq -Z^* < 0$ for all $k \in [1, \cdots, S-1]$, where $-Z^*$ is the left-tail critical value for a desired level of statistical significance.[14]

(S2)The k'th element of the test statistic for $\Delta\boldsymbol{\Pi}$ is given by $\Delta\hat{\Pi}(k) = \sum_{j=1}^{k} \Delta\hat{F}(j)$.

Similarly to above, under the assumption that the samples from A and B are independent,

$$var(\Delta\hat{\boldsymbol{\Pi}}) = \mathbf{L}^2 \left(\frac{1}{n_A}\boldsymbol{\Omega}_A + \frac{1}{n_B}\boldsymbol{\Omega}_B\right)\mathbf{L}'^2.$$

For each $k \in [1, \cdots, S-1]$, the corresponding z-statistic Z_k^{FF} is obtained by dividing $\Delta\hat{\Pi}(k)$ by its standard error, which is given by the square root of the k'th diagonal element of $var(\Delta\hat{\boldsymbol{\Pi}})$. Thus,

$$Z_k^{FF} = \frac{\sum_{j=1}^{k} \Delta\hat{F}(j)}{S.E.\left(\Delta\hat{\Pi}(k)\right)}$$

where $S.E.\left(\Delta\hat{\Pi}(k)\right)$

$$= \sqrt{\sum_{g \in G} \frac{1}{n_g}\left(\begin{array}{c}\sum_{j=1}^{k}(k-j+1)^2 \hat{p}_{jg}(1-\hat{p}_{jg}) - \\ 2\sum_{j=1}^{k-1}(k-j+1)\,\hat{p}_{jg}\sum_{l=j+1}^{k}(k-l+1)\hat{p}_{lg}\end{array}\right)}$$

We now consider the null hypothesis that A does not SOSD B. The test is similar to the first-order test.

H_0: $\Delta\hat{\Pi}(k) > 0$ for some $k \in [1, \cdots, S-1]$.

H_1: $\Delta\hat{\Pi}(k) \leq 0$ for all $k \in [1, \cdots, S-1]$.

H_0 is rejected if and only if $Z_k^{FF} \leq -Z^* < 0$ for all $k \in [1, \cdots, S-1]$, where $-Z^*$ is the left-tail critical value for a desired level of statistical significance. In the following section, we use these results to make within country comparisons of wellbeing by race and gender.

5. Empirical Findings

To begin, we use the FOSD and SOSD tests derived above to make some intra-country comparisons on multiple dimensions of wellbeing. In principle, many such comparisons are possible with this dataset. For tractability, we restrict our focus in this section to

[14] Other rejection rules are possible; this rather strict rejection rule is from Howes (1996).

capabilities in the home, at work and in the physical environment. In the USA sample, comparing whites with non-whites, the former are found to dominate non-whites at second order, at least, in all domains analysed (see Table 1(a)), and to FOSD non-whites in the physical environment domain, at the 1% significance level. The results also suggest that whites in the UK have higher levels of wellbeing than non-whites across each domain though the results are not statistically significant. The proportion of non-whites in the UK is considerably smaller in the UK than in the US and may contribute to lack of statistical significance. Nonetheless, taken together, the results suggest that racial disparities are found in a number of important areas of life in both countries.

Comparing men and women in the USA, the former FOSD the latter in all three domains, though the results are only (marginally) statistically significant in the Environment domain.. Males SOSD females in the home domain at the 5% significance level. Overall, the results indicate significant gender disparities, favouring males, in a number of domains in the USA. Analysis of gender disparities in the UK provides inconclusive results[15]

Taken together, these findings suggest that well-known race and gender inequalities found in income are evident also in a variety of other domains. They are more evident in the USA than in the UK, andinequalities related to the physical environment are perhaps the most clear-cut. Understandably, there is considerable interest in the growth of income inequality, but this evidence suggests that inequalities with respect to environmental externalities may also be a cause for concern.

Another way to compare multi-dimensional wellbeing between countries is to look at the respective within-country rankings of capabilities. That is, within a country, on average, which dimensions do people feel they have relatively high levels of capability, and are such rankings consistent across countries. Without any strong priors about the differences that might emerge, the results in Table 2 suggest a perhaps surprising degree of similarity between the two countries, albeit with a couple of notable exceptions. For the most part, the extent to which people are able to perform tasks or access and receive services are within one or two ranks of each of other. That said, there are a couple of rather larger

[15] However, in unreported results for income, males FOSD females in our sample at the 10% level, and SOSD females at the 5% level.

differences for dimensions related to criminal justice and health, differences that might be at least partially attributed to institutional differences in the supply of these services.

In the UK, people rank their ability to be treated by a doctor or nurse higher, relative to other capacities, than is the case in the USA. This suggests that the universal system of public finance that accounts for roughly nine-tenths of health care in the UK is providing greater effective access to those who would otherwise find access to health-care difficult – i.e. those on low incomes.

There are also differences with respect to criminal justice. In the USA, respondents rank higher their ability to be helped by the police, but rank lower their ability to get help from a legal representative, compared with counterpart rankings in the UK. Legal representation is generally financed through private sector market mechanisms in both countries, though the UK also has a reasonably well developed system of legal aid which could contribute to a higher within-country ranking. By contrast, police services in both countries, as in most around the world, are generally provided as a publicly financed service, so it is possible that the higher internal ranking reflects some other cultural difference, perhaps, for example, a more developed sense of customer ethos, though it is impossible to ascertain from the data.

Another finding worth noting is that ability to get rubbish cleared is ranked highest by US respondents. It is also very highly ranked by respondents from the UK, which suggests that this is not an artefact. From the data we can only speculate but it seems that a constellation of factors might be important here. Clearing waste is essential but not very complicated; by contrast, if not cleared, it can give rise to a salient problem. In such a case, it would not be difficult to identify the local political representatives responsible in either country. In their overview of the economics of service provision, Keefer and Khemanai (2005) demonstrate that effective political competition can play a major role in the provision of services for the electorate and we suggest that this finding reflects their insight; in both countries the nature of the service is such that political competition is indeed relatively effective.
STATISTISTICAL TEST?/FIGURE

We now turn to consider possible implications for economic models of happiness. It is generally found that income, unemployment, ill-health, age, marriage or partnership,

personality and health are related to life satisfaction, and that measures of negative affect, such as anxiety, behave slightly differently and are not merely the inverse of positive affect measures. We therefore examine what happens in models of life satisfaction where the 'usual suspects' known to affect experiential measures are used as controls, and capabilities are brought into the equation. According to our framework in section 2, a positive expansion of the *i*th individual's capability set, $Q_{it} \rightarrow Q_{it} + \varepsilon \cup \Delta\delta Q_i$, should be experience enhancing if preferred activities or states now become feasible (providing negative factors, such as regret, do not arise as a result of the newly possible opportunities). Our results, in Table 3, are consistent with this hypothesis and show that capabilities associated with the home and work domains add significantly to the explained variation in the USA and UK, compared with models based only on the usual suspects (i.e. columns 2 and 5 in Table 3). These results confirm only, of course, the predictive power of certain capabilities in life satisfaction regressions, but this in itself is of some interest. To the extent that we might be interested in, or concerned about, experienced utility, these findings provide clues about where to look – the home, the work-place and (from results not reported here) the interface between the two, as indicated by our work-life balance variable.

What an individual is able to do is a function not just of their resources, in our framework, but also of a variety of personal attributes, including non-cognitive skills, and we therefore estimate such models, using both ordered probit and OLS models. A variety of results are reported in Table 4. We expected the role of non-cognitive skills to be relatively similar between countries and, broadly speaking, find this to be the case. Treating income, for these purposes, as an indicator of consumer welfare, we find that the ability to plan ahead, controlling for education, is the only such skill that is statistically significant. However, in models of life satisfaction, a number of variables appear to be significant, including ability to take guidance, knowing what one likes and being good at sports. It is quite possible, of course, that the significance of the non-cognitive skill variables in the life satisfaction regressions is driven by endogeneities due to reporting styles or reverse causality; this is not necessarily a story of causality. Our observation is simply that it is interesting that inclusion of these variables enhances the predictive power of the life satisfaction regressions.– a difference that could clearly be driven by endogeneities due to reporting styles or reverse causality. In an effort to address this issue, we created an index NC from binary variables s_i constructed from our non-

cognitive skills data, so that $NC = \sum_{i=1}^{i=13} s_i$. This variable was them instrumented for using data on whether or not individuals were engaged in particular activities yesterday (see footnote to Table 4 for further details).. In the resulting 2SLS regressions, the non-cognitive skills index was found to be statistically significant at the 1% level in the USA. In the UK, the instruments were found to rather weak and though the non-cognitive skills index coefficient remained positive after instrumentation, it was no longer statistically significant.
[16]

6. Concluding Discussion

Whilst income measures the opportunities people have to consume and save, there is a growing consensus both within and outside economics that the effects of economic activity on human wellbeing should be directly monitored. Various initiatives and commissions (e.g. Stiglitz, Sen and Fitoussi (2009)) have drawn on developments in welfare and behavioural economics but implementation has been limited by the availability of data. In this paper, we developed a framework for understanding wellbeing, drawing closely on Sen's seminal contributions to welfare economics, and on the economic life satisfaction literature, and used it to generate novel data consistent with all the components of his theory. The approach in practice naturally gives rise to a number of ordinal measures and, to compare these, we also developed an approach to first and second order stochastic dominance that is suitable for such variables, on a dimension by dimension basis. This was then used to identify gender and racial differences on multiple dimensions concerning what people are able to. Following this, we presented analysis to shed light, *inter alia*, on dimensions associated with life satisfaction, including

[16] It is difficult to adequately explore causal relations such as this in our cross-sectional pilot data, but should be relatively straightforward if data such as that proposed here were rolled out in a panel setting. That said, we did find some very tentative evidence to support causality here. We created an index NC from binary variables s_i constructed from our non-cognitive skills data, so that $NC = \sum_{i=1}^{i=13} s_i$. This variable was then instrumented for using data on whether or not individuals were engaged in particular activities yesterday (see footnote to Table 4 for further details). In the resulting 2SLS regressions, the non-cognitive skills index was found to be statistically significant at the 1% level in the USA. In the UK, the instruments were found to rather weak and though the non-cognitive skills index coefficient remained positive after instrumentation, it was no longer statistically significant.

capabilities and non-cognitive skills, and the relative ranking of various capabilities within the USA and UK

Our primary aim has been to show that it is possible to 'go beyond GDP' in a manner consistent with economic theory. In principle, the resulting measures could be used to illuminate the distribution and production of wellbeing. As with any approach, our focus on the kind of data that is used in household survey design has its pros and cons but we believe that this exercise demonstrates that Sen's theory is empirically operational and that early concerns about the lack of data can be overcome. In addition, we believe our estimation of his equations indicates that they can support analysis which incorporates aspects of wellbeing that are not so evident from a focus on resources alone.

Whilst our particular empirical results are in a sense secondary to this aim they nonetheless illustrate some potentially important issues. If we look at inequality from a multi-dimensional perspective, the evidence from comparisons by sex and race suggests that inequalities to do with environment may be as marked as those to do with income, at least in the USA. Our multi-dimensional indicators of what people are able to do, their capabilities and constraints, add significant predictive power to models of experienced utility. We suggest that to the list of usual suspects that go into life satisfaction equations should therefore be added salient constraints. Where constraints are not salient, they may not show up in such equations but a social planner might still want to take them into account. However, from a behavioural perspective we think that salient constraints offer a promising line for future research in the economic analysis of experiential measures of wellbeing.

Our results here do also suggest some important limitations (again consistent with Sen's theory) of experience as a measure of value. Access to services, for example, does not show up in models of life satisfaction as one might perhaps expect, but this does not mean such services are not important – clearly they are. Perhaps therefore we should see 'measures' such as life satisfaction as economic tools for diagnosing potential risks to wellbeing rather than as definitive measures. (Evaluations of the US Moving to Opportunity programme suggest, to give just one example, that whilst 'hard' economic outcomes of the most deprived may not always be alleviated by such programmes, there can be significant benefits in terms of experience (Ludwig et al (2013)). However, as our evidence suggest not all things that matter to people, or help life to go well, are necessarily detected in the commonly used life satisfaction and happiness measures.

Turning to the limitations of our study, perhaps the most significant are problems to do with the cross-sectional nature of the data. Our main aim has to be develop data consistent with a theoretical framework and this gives rise to standard econometric issues but we believe they could be addressed simply with panel surveys of the kind used to generate household data or possibly by building in the gathering of variables for instrumentation. We have also sought to avoid direct country comparisons here and have confined ourselves to international comparisons based on intra-country analyses. In principle, the problems of direct international comparisons have been addressed for income using the concept of purchasing power parity, and for life satisfaction through the use of vignettes, but the question remains open for multi-dimensional indicators based on household survey type questions. These caveats notwithstanding, we believe this paper offers a useful blueprint for policy-makers wanting to go 'beyond GDP' by demonstrating how they might go about building and analysing theory based multi-dimensional data of life quality to complement the inevitable gaps by national income accounting.

Appendix - Descriptive Statistics for USA and UK

Supplementary Materials

Appendix D1 Data

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Tables and Figures

Table 1(a) First and Second Order Dominance Test Results: Whites compared with Non-Whites

	USA Home		UK Home		USA Work		UK Work		USA Environment	
k	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$
0	-0.0761	-0.0761	-0.0068	-0.0068	-0.0554	-0.0554	-0.053	-0.053	-0.0681	-0.0681
1	-0.0833	-0.1594	-0.0811	-0.0879	-0.0524	-0.1078	-0.0582	-0.1112	-0.0945	-0.1626
2	-0.0532	-0.2126	-0.0486	-0.1365	-0.0101	-0.1179	-0.0975	-0.2087	-0.1145	-0.2771
3	-0.0289	-0.2415	-0.0748	-0.2113	0.0013	-0.1166	-0.1701	-0.3788	-0.0978	-0.3749
4	0.0004	-0.2411	-0.0973	-0.3086	0.0575	-0.0591	-0.1082	-0.487	-0.1185	-0.4934
5	0.0394	-0.2017	-0.1216	-0.4302	0.0485	-0.0106	-0.0438	-0.5308		
6	0.031	-0.1707	-0.0365	-0.4667						
7										
Test Result	NR	Whites SOSD	Whites FOSD	Whites SOSD	NR	Whites SOSD	Whites FOSD	Whites SOSD	Whites FOSD***	Whites SOSD***

Notes:
1. US: n=845 for whites & 214 for non-whites for Home and Environment; n=586 for whites & 137 for non-whites for Work. UK: n=1,599 for whites & 64 for non-whites for Home and Environment; n=1,177 for whites & 47 for non-whites for Work.
2. Here, and throughout the paper, *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.
3. NR=inconclusive result, here and in Table 1(b).

Table 1(b) First and Second Order Dominance Test Results: Males compared with Females

	USA Home		UK Home		USA Work		UK Work		USA Environment	
k	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$	$\hat{\Delta}\hat{F}(k)$	$\hat{\Delta}\hat{H}(k)$
0	-0.036	-0.036	0.0066	0.0066	-0.0163	-0.0163	0.0029	0.0029	-0.0284	-0.0284
1	-0.0437	-0.0797	-0.0067	-0.0001	-0.0413	-0.0576	-0.0061	-0.0032	-0.0511	-0.0795
2	-0.0439	-0.1236	-0.001	-0.0011	-0.0428	-0.1004	-0.0008	-0.004	-0.0682	-0.1477
3	-0.0459	-0.1695	-0.0048	-0.0059	-0.048	-0.1484	0.0082	0.0042	-0.0665	-0.2142
4	-0.0574	-0.2269	0.0055	-0.0004	-0.0401	-0.1885	0.0294	0.0336	-0.099	-0.3132
5	-0.0557	-0.2826	-0.0091	-0.0095	-0.0503	-0.2388	0.0438	0.0774		
6	-0.0503	-0.3329	-0.0285	-0.038						
7										
Test Result	Males FOSD	Males SOSD**	NR	NR	Males FOSD	Males SOSD	NR	NR	Whites FOSD*	Whites SOSD*

Notes:
1. US: n=530 for males & 529 for females for Home and Environment; n=402 for males & 321 for females for Work. UK: n=846 for males & 843 for females for Home and Environment; n=656 for males & 587 for females for Work.