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Measuring Welfare: Latent Variable Models for Happiness and Capabilities in the presence of Unobservable Heterogeneity

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Abstract

The paper contributes to the operationalisation of the capabilities approach to welfare economics by developing and analyzing data on the freedoms of adults in Argentina. Specifically, it reports on the development of a survey instrument for measuring capabilities, calculates for each respondent a Nehring-Puppe type index of their capabilities, and examines the distribution of index scores. The main analytic part of the paper then goes on to develop a generalized linear latent and mixed model (GLLAMM) for assessing the impact of capabilities on life satisfaction, in which allowance is made for (i) unobserved heterogeneity and (ii) possible endogeneity by introducing latent individual effects and by instrumenting capability variables using income and other socio-economic variables. Our empirical results show that empathy, self-worth, goal-autonomy, discrimination, safety and stress are statistically significant determinants of life satisfaction, in a decreasing order of importance. The paper concludes by suggesting that, if replicated, the findings have profound implications for the conceptualisation and evaluation of economic progress.

Keywords: Capabilities, freedoms, GLLAMM, happiness, instrumental variables, multi-dimensionality, unobserved heterogeneity.

JEL classification: C35, I3

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1 Introduction

The Capability Approach is grounded in an attempt to address fundamental theoretical limits that are inevitable in utilitarian approaches to welfare economics (Sen (1979, 1999, 1992, 1993, 1985)), but it can also be seen as a generalisation of the traditional approach to welfare economics. Whilst happiness is important, Sen argues, so are the opportunities to do things that people have reason to value and these capabilities should be integral to the assessment of a person's welfare. The approach is consistent with the emergence of labour policies that emphasised equality of opportunity in the 1970s, evidently, but is widely credited with inspiring the development of the UN's Human Development Index (HDI) which now plays a key role in the assessment of economic development[1].

It has been questioned to what extent the capabilities approach can be broadened beyond HDI given a purported lack of data on opportunities and constraints (particularly non-monetary) though more recent work has suggested some constructive ways forward. Broadly, there are three strands to this emerging literature. Firstly some researchers e.g. Anand et al. (2009); Ramos and Silber (2005) have made the point that with careful inspection, a number of direct capability indicators can be found in standard secondary data sets, like the BHPS - furthermore such variables appear to be on the increase. A second line of research (Krishnakumar (2007, 2008); Krishnakumar and Ballon (2008)) has developed a variety of latent variable structural models that demonstrate how econometric techniques can be used to make inferences about capabilities and their impacts even when direct capability measures are not present in the data. Thirdly, Anand et al. (2009); Anand and Santos (2007) have shown how capability indicators, consistent with theory, can be developed both for a general adult population and for older people across a range of dimensions that impact the quality of their lives.

In this paper, we present work that draws on the latter two traditions. Specifically we develop a data-set of capabilities for Argentina which in effect broadens the potential coverage of capability indexes to many more dimensions than can be found in HDI[2]. In subsequent analysis, we then draw on latent variable structural models to explore whether these capabilities have an impact on happiness, whilst addressing potential problems of endogeneity that might exist in this context. In fact, we shall address three empirical questions: (a) do capabilities have a direct impact on overall life satisfaction, (b) do individual features play a significant role in this self-assessment exercise and finally (c) is there unobservable heterogeneity present in the relationship. Because, capabilities and happiness are both based on self-reports (like most economic data from household surveys), it is possible that personality plays a role in both the evaluations, giving rise to an endogeneity issue. For this reason we shall try to separate out effects of personality on happiness to obtain a 'purer' measure of the influence of capabilities.

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[1]The capabilities approach has influenced economists working in a wide range of fields – see for instance Alkire (2002); Atkinson et al. (2002); Banks (2006); Basu and Kanbur (2009); Bossaert et al. (2007); Bourguignon et al. (2007); Brandolini and D'Alessio (n.d.); Chiappero-Martinetti (2000); Desai and Shah (1988); Duclos et al. (2006); Fleurbaey (2007); Gaertner and Xu (1999); Heckman (2007); Klasen (2000); Klemish-Ahlert (1993); Nehring and Puppe (2009); Offer (2006); Pattanaik and Xu (1990); Ramos and Silber (2005); Schokkaert and van Ootegem (1990); Tonon (2008). This work has in turn started to change significantly the way in which economic progress is being measured – see for instance Stiglitz et al. (2008).

[2]The authors are particularly grateful to Graciela Tonon whose team was responsible for the translation of the OCAP survey instrument into Spanish as well as the collection of data.

The models and estimation methods we propose combine three methodological aspects in order to answer a substantive question about life satisfaction: First, the response variable is of an ordinal nature. Hence, we shall model it in a qualitative response framework (with an underlying continuous latent variable).

Secondly, the responses are elucidated using a set of explanatory factors relating to the individual's choices and achievements in life along with her personality traits. In addition, there may be unobserved effects accounting for similarity of behaviour and perceptions and we would like to account for these specific effects.

A final issue is that of endogeneity. It is true that the choice set should influence 'happiness' but one can also argue that a person who reports being satisfied may generally be of an 'optimistic' nature and hence be able to imagine more opportunities in any given situation compared with a 'pessimist'. This will imply that a happier person is also more likely to report a larger feasible set so the relation between life satisfaction and capabilities may be simultaneous. In this case, capabilities are potentially endogenous in the life satisfaction model and in this paper we estimate a model that allows for this.

We shall therefore specify a *system* of equations for jointly explaining life satisfaction and capabilities but we shall also allow for latent personality features affecting both, to take account of any unobservable heterogeneity. Further, we let the different 'observed' personality measures to partially reflect the latent personality. The complete model consisting of the life satisfaction equation, capability equations and personality measurement equations fits well within the GLLAMM (Generalised linear latent and mixed models) framework. An excellent reference on latent variable models is given by Rabe-Hesketh and Skrondal (2004).

The rest of the paper is structured as follows. Section 2 provides a description of Sen's three equations and indicates how the capabilities happiness relation is derived from two of these relations. Section 3 (together with the Appendix) provides a discussion of the data used with some descriptive statistics. Section 4 then goes on to discuss the modelling approach in greater detail comparing it with other more conventional approaches whilst Section 5 carries an anlysis of the main estimation results. Section 6 provides some summary and concluding remarks.

2 Theoretical setting

Sen (1985)'s formal account of the capabilities approach to welfare economics comprises a set of three related equations. The first, $f_i = f_i(r_i)$, notes that functionings depend on the resources available to a person. People start off with different resource endowments, and they are heterogenous with respect to their abilities to convert those resources into functionings, so this equation encapsulates issues that are central to the analysis of equity. The second equation, $h_i = h(f_i)$, summarises the view that a person's happiness, or utility, depends on the functionings in which an individual partakes. We might see this relation as a plausible first-order approximation, particularly given Sen's wide account of functionings as doings and beings but in any case it provides a direct point of contact between his approach and earlier approaches to welfare economics. Thirdly, and finally, Sen argues

that in addition to a person's chosen functioning bundle, the set of all functioning bundles a person could have chosen given their initial resource endowment, $Q_i \equiv \{f_{i1}, f_{i2}, \dots f_{in}\}$, is also a measure of their advantage. The set Q, referred to as the person's capability set, corresponds to an idea that has a long-standing history in economics (*viz.* the value of freedom) although Sen's approach provides a distinctive grammar for thinking about connections between freedom and concepts of equity, resource endowment and happiness.

One of the important concerns in this paper is the development of data that will help provide a summary measurement of Q, by asking people a variety of questions about, in the main, their opportunities, abilities and constraints in a wide variety of life domains (dimensions). These questions are relatively distinctive and provide a natural fit for the concept of freedom. The data will be described in more detail subsequently, but theoretically, this amounts to characterising the set Q by eliciting boundary points for the dimensions in which the functionings operate. The approach can be contrasted with the direct enumeration of elements of Q which would instead yield an m-dimensional cuboid estimate of the capability set and would not, in most cases, be practical (see for instance Klemish-Ahlert (1993)). In general, it is not possible to sign the nature of the approximation as there may be reasons to think that some capabilities are jointly constrained (eg choice of career path) whilst others are complements (the opportunity to go to a concert and the ability to hear). So, to create a summary index of a person's capabilities based on observations of *self reported* freedoms, given by the point $\hat{Q} = (q_1, q_2, ...q_m)$ where q_1, represents a person's capability score in life domain 1 and so on, we draw on an idea due to Nehring and Puppe (2002, 2009). Essentially, their axiomatic proposal is to create a measure which moves beyond option counting: by considering the number of dimensions that are realised by the options of a set, they provide a compelling example in the case of measuring species diversity. Carrying this idea into the field of welfare and deprivation assessment, it is natural to ask in how many dimensions a person has freedoms that are above a threshold level and to make this assessment, we therefore construct an index of capabilities which is defined as the count, $\tilde{Q}$, of dimensions, on which the capability score, q is greater than or equal to some threshold level q^*. In short, we develop the summary capability index,

$$\tilde{Q}_i = \sum_{j=1}^{m} I_{ij}$$

where

$$
\begin{aligned}
I_{ij} &= 1 \quad \text{if} \quad q_{ij} \geq q_{ij}^* \\
&= 0 \quad \text{otherwise}
\end{aligned}
\tag{1}
$$

This index provides an intuitive measure of capability, is useful for deprivation assessment, and incorporates a notion of dimensional richness. In addition one could see this as a multi-dimensional measure of deprivation. Furthermore, our index suggests a family of capability measures depending on the specification of thresholds and assumptions about independence between dimensions though in the following section we explore a single implementation.

The main econometric model of this paper draws on Sen's theory by noting that a) happiness depends on functionings, and b) capabilities are defined as the set of functions feasible for a person. Therefore this framework naturally implies a relationship between happiness and capabilities. We exploit this connection to identify robust contributors to quality of

life - a key concern for policy-makers seeking to base social choice on welfare. Within the capabilities approach, the freedoms that matter are those that people have reason to value and these can be identified by a mixture of theory, argument and evidence. Within utilitarianism, freedoms only matter insofar as they yield happiness. So potentially, those freedoms that are significant in econometric models of happiness represent common ground between the two main approaches to welfare economics and can be robust in that sense. Whether such a ground exists is one of the questions that our model helps us to address.

3   Data Description

The data used in our analysis derive from a national sample of 976 adults, in five urban areas of Argentina, who received, in 2007, version of the OCAP survey instrument specifically developed by Anand et al. (2009) to measure capabilities across a wide range of life domains. This version was developed by translating the original OCAP instrument into Spanish and then dropping, or modifying slightly, a small number of questions to reflect the cultural context. This process was led by an Argentinian colleague working closely with the first author and is further discussed in Tonon (2008) - though the key capability questions used are summarized in the body of Table 1 and in Table 4.

The key variable to be explained is self reported life satisfaction which comes as a response to the question *"How satisfied or dissatisfied are you with your life as a whole?"*[3]. The respondents were asked to indicate their degree of life satisfaction on a scale from 1 to 7, where 1 denotes *Completely satisfied* and 7 *Completely dissatisfied*. Hence it is a categorical variable with 7 possible categories. However, some categories only contain a very small percentage of responses and hence we have combined them to obtain 4 groups and inverted the direction so that 1 denotes *Dissatisfied*, 2 *Neither satisfied nor dissatisfied*, 3 *Fairly satisfied* and the last level 4 *Very satisfied*[4].

The set of capability indicators is also composed of self-reported degrees of agreement to different statements related to several aspects. We have constructed ten capability domains as follows: *Health, Freedom of Political Expression, Freedom of Political Participation, Freedom of Religion, Freedom of Thought, Emotional Capabilities, Security, Environment and Social Relations, Discrimination Outside of Work* and finally *Work*. One may observe that we have given slightly different names to some of our domains compared to those in the list found in Nussbaum (2000); Nussbaum and Sen (1993) on which the questionnaire is based. However this is not an issue for the purpose of our paper. Since we are mainly interested in the influence of capabilities on life satisfaction, it does not matter what name is given to each capability domain nor which capability goes into which domain as long as they are all capability indicators entering our model as explanatory (possibly endogenous) variables. Nonetheless, our terminology directly reflects the statements of the questionnaire. So, for example, *Bodily Health* from Nussbaum's list corresponds to our

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[3]Another question related to life satisfaction was asked at the end of the questionnaire. We decided to use only the first question related to the overall life satisfaction as the response variable. Both response variables could be used to test the impact of filling the questionnaire on the self-evaluation of life satisfaction, but that issue goes beyond our present study.

[4]The response categories were originally set up to seven levels with 1: *Completely satisfied*, 2: *Very satisfied*, 3: *Fairly satisfied*, 4: *Neither satisfied nor dissatisfied*, 5: *Fairly dissatisfied*, 6: *Very dissatisfied* and 7: *Completely dissatisfied*. Original categories 1 to 2 are mapped into the new category 4, category 3 is mapped into 3, category 4 is mapped into 2, and finally categories 5 to 7 are mapped into 1.

field *Health*. In the same way, our item *Security* is also part of Nussbaum's *Bodily Health*, and our item *Emotional Capabilities* matches with Nussbaum's *Emotions*. However, our taxonomy contrasts from Nussbaum's list in that we distinguish different forms of freedom which would all be seen as going into Nussbaum's *Senses, Imagination and Thought* group.

The complete list of capabilities along with other variables can be found in Appendix 1. The questions are self explanatory and discussed elsewhere (see Anand et al. (2009)). In addition, the data set includes questions related to past experiences which can be considered as predetermined variables having a definite influence on current capabilities. Not all variables available in the questionnaire have been used in the analysis. Several variables related to work and income have been left aside due to the large number of missing values and some highly correlated variables are dropped to meet the number of instruments required.

Finally, we have some variables on "personality traits". Gosling and Rentfrow (2003) distinguish five major independent personality dimensions: being extravert, agreeable, conscientious, emotionally stable, open to experiences. Our data set contains pairs of individual measures in all these dimensions on a scale one to seven. Thus each pair of indicators measures one particular aspect and its opposite (See Table 6, Appendix 1). These answers are considered as personality trait indicators and can be relevant to disentangle the endogeneity issue, essentially arising out of individual characteristics. For instance, if an individual is assessing herself as "anxious, easily upset", then she may feel constrained in her beings and doings and at the same time not too satisfied with her life. Hence this state of mind and other such personality traits are key factors that simultaneously affect capability answers as well as reported life satisfaction and will thus enable us to deal with the potential endogeneity problem in an adequate manner.

Taking into account all the missing observations, the dataset used in our study comprises 42 variables related to capabilities, 24 socio-demographic variables, 10 personality traits and 12 variables associated with past experience.

Before we formulate the structural model, we briefly examine some descriptive statistics relating to our key variables. Looking at a two-way classification between life satisfaction and some capability variables, we see that the majority of people who are fairly satisfied or very satisfied are in good health, have freedom of expression, political participation, religion and thought. However when it comes to emotional areas there is a substantial percentage that feel difficult to enjoy the love, care and support of their family or to enjoy day-to-day activities. Regarding security/safety there is a slightly higher percentage of people that feels insecure than those feeling secure (leaving out neutral responses) with a 14 to 29% of the 'insecure' in the fairly satisfied or very satisfied category. Similarly a good percentage feel that they are likely to be discriminated against for some reason or another though their life satisfaction response is good.

Turning now to the personality characteristics, there are some clear patterns that emerge from the data: 74% see themselves as critical, 92% as self-disciplined, 75% as anxious, 85% as open to new experiences, 77% as reserved, 86% as sympathetic, 69% as calm, while surprisingly 93% see themselves as not appreciating their natural environment. Only for a few traits, the percentages are lower: 45% claim not to be disorganized, 50% claim not to be conventional. Interestingly, a good 74% claim to have recently been thinking of themselves as worthless either as usual or more than usual.

To conclude our description of the data, we derive two summary figures that describe the extent to which the individuals in our sample enjoy important capabilities, confining ourselves to individuals with no missing data and to the 42 capabilities given in Appendix 1. First we define category 1 (see Table 2, Appendix 1) as the threshold category such that if the answer to a capability question is 1 or higher, then the individual is deemed to possess the capability in question. Then we calculate the percentage of individuals that enjoy each capability and finally we graph these percentages as a bar chart (Figure 1), with each bar corresponding to a capability with the number coded according to Table 4. From Figure 1, we see that there are significant 'deprivations' (more than 50% not enjoying the capability) in certain dimensions : being able to value nature (C8), being discriminated at work except due to age (C20-C23), being discriminated outside of work except due to age (C25-C28), being able to value others (C31), inadequate housing (C35)[5].
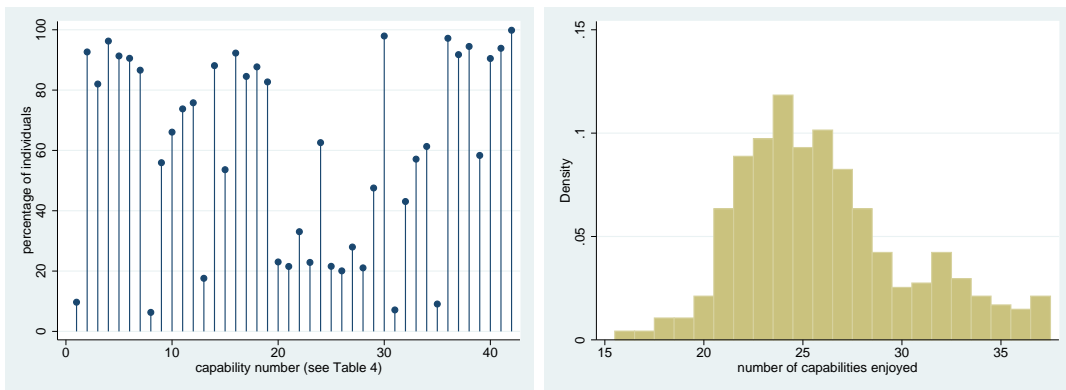

Figure 1: Percentage of individuals having each capability

Figure 2: Distribution of number of capabilities enjoyed (all, n=473)

The next summary representation (Figure 2) relates to the distribution of number of capabilities enjoyed in the population surveyed i.e. the number of capabilities enjoyed plotted against the percentage (or number) in the sample[6] enjoying that many capabilities. We see that the majority of people are in the middle in Figure 2 i.e. they neither possess most of the capabilities nor very few of them. Normality (skewness/kurtosis tests) is rejected for the distribution of capabilities in the whole sample (with a p-value of 0.0083 for the D'Agostino, Balanger and D'Agostino, Jr. (1990) test, a p-value of 0.00056 for the Shapiro-Wilk (1965) W test and a p-value of 0.00123 for the Shapiro-Francia (1972) W' test).

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[5]Note that low values for the two constraint indicators C1 - limitations in health - and C13 - feeling worthless - imply capability enjoyment rather than deprivation.

[6]The sample here only consists of individuals that have no missing observations on any of the capabilities and hence its size (473) is less than the original size.
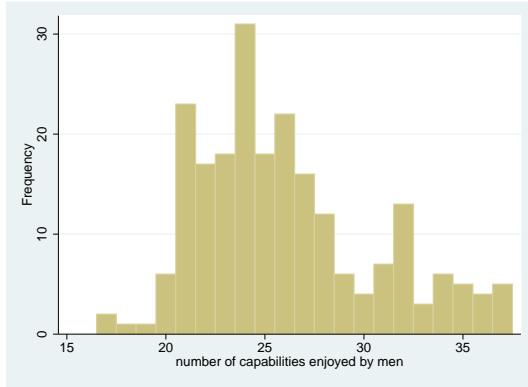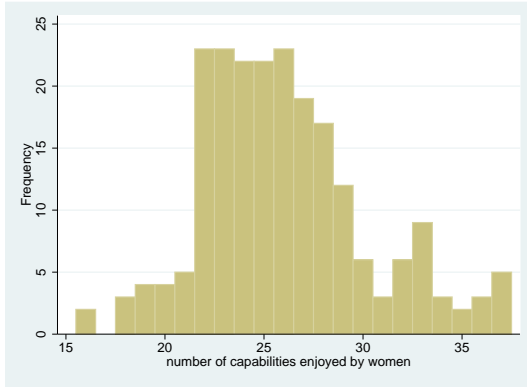
Figure 3: Distribution of number of capabilities enjoyed (women, n=216)

Figure 4: Distribution of number of capabilities enjoyed (men, n=220)

Splitting the sample between women and men, the distributions of the number of capabilities enjoyed by men and women are presented in Figures 3 and 4 respectively. Although no firm statement can be made simply by looking at these graphs, the Kolmogorov-Smirnov distribution equality test strongly accepts that men and women have the same distribution with a p-value of 0.68[7].

4 The Model

As the main aim of the study is to estimate the relationship between capabilities and life satisfaction, more specifically the impact of capabilities on life satisfaction, our key endogenous variable is life satisfaction and the main explanatory variables are the capabilities in various domains. In our data set the answer to the life satisfaction question is an ordinal categorical variable - originally 7 categories regrouped into 4 categories for our analysis[8].

The explanatory variables of the above relationship are given by indicators relating to people's capabilities in various domains which are either binary or ordered categorical. As the response to life satisfaction question is a subjective evaluation, it is likely to be influenced by an individual's personality. Given the same choice or capability set, two persons can be more or less satisfied with life depending depending on their personality characteristics. A person who always thinks "positively" (say an 'optimistic' person) is likely to take more advantage of the possibilities offered to her than someone who has a more "negative" attitude to life (a 'pessimistic' one). Thus it is important to capture the heterogeneity in individual characteristics in the relationship between capabilities and life satisfaction by including individual personality traits as explanatory variables. Two approaches could be followed in this regard. The first is to assume that the available indicators relating to personality questions are exact measurements of personality and include them directly in our relationship. In this case, the remaining unexplained part (error term) can be assumed to be

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[7]This does not obviously mean that the type of capabilities enjoyed by both are the same.

[8]See Section 3 for an explanation of the new categories.

independent of capabilities. A second approach consists in assuming that the observed indicators are different responses of a latent personality which is included in the unexplained error term of the equation. In this case, capabilities become endogenous as they will also be affected by the same latent factor, being self reported subjective evaluations. Thus we would need to complete the life satisfaction equation with other equations that explain the capabilities themselves using some exogenous factors as well as unobservable individual characteristics which will form part of the unexplained error term, and add a latent factor model for personality using the available personality indicators as its measurements. In our study, we follow both the approaches in our model and compare the results.

Let us now turn to the model specification in more detail. For simplicity of presentation, we present below the modelling approach for continuous dependent variables. Appendix 3 describes the extension for categorical dependent variables.

Let y_i denote the response to the life satisfaction of the i-th individual; Q_i denote the vector of capability indicators of the i-th individual (say $M \times 1$); x_i denote the vector of socio-economic characteristics of the i-th individual (say $K \times 1$); and P_i denote the vector of personality traits of the i-th individual (say $T \times 1$).

Then the relationship to be explored can be written as:

$$y_i = h(Q_i) + \varepsilon_i \tag{2}$$

Because personality influences the answer to life satisfaction and is not among the explanatory variables of equation (2), it is part of the error term. Let us therefore write the error term ε_i as follows:

$$\varepsilon_i = u_i + \epsilon_i \tag{3}$$

where u_i denotes the individual personality effect[9] - which makes it possible for an individual to report a different life satisfaction answer from another, even if both have the same capabilities - and ϵ_i is an idiosyncratic error term.

This yields

$$y_i = h(Q_i) + u_i + \epsilon_i \tag{4}$$

However, as argued above, personality influences the answers to the capability questions as well. That is, if we were to write equations for capabilities, we would have to include these individual effects as part of the explanation:

$$Q_i = c(z_i, x_i) + u_i + v_i \tag{5}$$

where we will denote

$$w_i = u_i + v_i$$

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[9]One could theoretically have a vector of personality dimensions/effects in which case u_i will be replaced by $u_i'\theta$ (see Appendix 3).

z_i denotes exogenous explanatory factors of capabilities (say L in number), x_i are the sociodemographic controls, u_i is our personality effect and v_i the idiosyncratic error term. We assume that the two idiosyncratic error terms ϵ_i and v_i are not correlated (meaning that it is the presence of u_i which accounts for the correlations between the error terms of two equations).

Therefore equations (2) and (5) form a simultaneous equations model with the error terms ε_i and w_i correlated due to the presence of u_i. Thus capabilities are endogenous and need to be instrumented. In our setting, the instruments are given by z_i and x_i (with $L + K \geq M$).

Now, our data set contains information on past experiences of individuals in many capability domains which constitute a natural choice for our z_i variables. Since the questions on these past experiences are very specific to the domain considered, we can exclude a direct relationship with the life satisfaction question. Further, they are 'exogenous' as they concern the past and are factual.

The above specification assumes that personality effects u_i are unobservable. This is the standard way of treating individual effects in economic literature. However if we turn to psychometric literature, personalities can in fact be described using different dimensions. Gosling and Rentfrow (2003) distinguish five major independent personality dimensions: being extravert, agreeable, conscientious, emotionally stable, open to experiences. Our data set contains individual measures in all these dimensions on a scale one to seven which can be used for this purpose. Thus one can add a third set of equations which relate these measures to the latent personality in each of these dimensions.

$$P_i = \pi(u_i) + \xi_i \tag{6}$$

where u_i can potentially contain more than one individual effect (say p latent personality dimensions). The model comprising equations (4),(5), and (6) constitute our main model and will be called variant 1 as defined below.

<u>Variant 1</u> : The latent variable model consisting of equations (4),(5), and (6). The path diagram for this variant is given in Figure 5.

We can explore another possible variant of our model by adding these personality traits measures P_i directly into equation (4) in place of u_i:

$$y_i = h(Q_i, P_i) + \epsilon_i \tag{7}$$

The same can be done for the capability equations (5):

$$Q_i = c(z_i, x_i, P_i) + v_i \tag{8}$$

Recall from Section 3 (Data Description) that we have 10 personality indicators for each individual and they correspond to the five major personality dimensions of Gosling and Rentfrow (2003). Hence the ten indicators are transformed into five personality measures N1,...,N5 for this variant and their definitions are given in Appendix 2.

Since ϵ_i and v_i are not correlated, we have a (block) recursive system and each equation can be estimated separately. Thus a second variant to be explored is:

Variant 2 : Equation (7) with direct measurements of personality traits.

A final variant for comparison purposes could be given by equation (2) without individual personality effects (i.e. ignoring the presence of u_i) i.e. a variant in which neither capabilities are instrumented nor personality traits directly included:

$$y_i = h(Q_i, x_i) + \zeta_i \tag{9}$$

Variant 3: Equation (9) (ordered probit without personality traits).

Recall that our endogenous variable as well as the capability indicators are qualitative in nature (mostly ordered categorical, some binary). All categorical dependent variables are modelled using a corresponding underlying latent response variable for estimation purposes. The detailed model specification is given in Appendix 2.
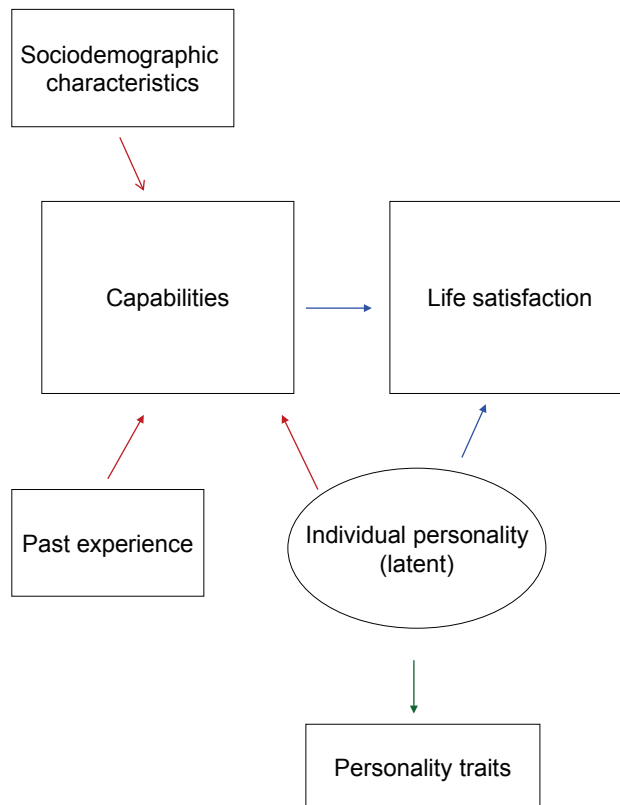

Figure 5: Path Diagram for Variant 1

5 Results

Table 1 reports the results for the equation that explains happiness in terms of capabilities (equation (4) of variant 1 extended for the qualitative response case i.e. equation (11), Appendix 2). These results essentially correspond to the middle part of Figure 5 i.e. the relation mapping the box of capabilities and the ellipse of latent individual personality to that of life satisfaction[10]. The table thus focuses on the model which allows for endogeneity and latent individual effects as discussed above. The two versions of variant 1, 1a and 1b, reflect the fact that we estimated a number of models with instruments to determine the stability of our estimates with respect to sign and significance. In the main the results appear robust and so for presentational purposes we show two versions: version 1a in which there are as many instruments as capabilities, and version 1b in which there are fewer instruments[11].

Turning to variant 1a, our results show that happiness often depends on capabilities in the direction that one might expect. Being able to imagine the situation of others (C18, say empathy for short), being able to have a concept of a good life based on one's own judgement (C5, say life-autonomy), thinking of oneself as worthless (C13, say self-worth), and losing sleep over worry (C32, say stress) stand out as being statistically significant at or near the 10% level or lower. The coefficients of the former two capabilities are positive while the latter two have a negative coefficient. These results are robust across other possible specifications of variant 1.

In variant 1b we see two additional significant variables, namely possible future discrimination and safety. Future possible discrimination on race grounds outside employment (C20) has a negative impact which tends to be significant at low p-values. This would be true for any other discrimination response as answers to questions about discrimination were strongly correlated and hence only one form of discrimination is used in these results. Although the analysis cannot exactly identify the forms of discrimination that matter, it does suggest that discrimination is an important source of unhappiness - and for this reason, the capabilities approach and happiness perspectives might agree that discrimination should be a target for policy-interventions albeit for different reasons. The second additional variable, feeling safe while walking alone in day-time (C14, say safety), has the right positive impact (significant at 10%), once again with a strong policy implication that providing a secure environment is a means of making people more satisfied with life.

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[10]We do not report the results of the first stage instrumentation equations (the arrows from sociodemographics and past experience to capabilities) nor the results of the personality measurement equations (the arrows from the latent individual personality to the box of observed personality traits capabilities) as it would make the paper too long.

[11]Recall that the capabilities-happiness model also includes equations explaining capabilities using past experiences and socio-demographic controls that serve as instruments. To ensure there are enough instruments, it is impossible to include all capability indicators in the happiness equation. In some cases it was possible to drop capability indicators on the grounds they were strongly correlated with other indicators. In some other cases, capability indicators were dropped on the grounds that their coefficients in capability-happiness equations were not significantly different from zero.

	Models	
Variables	Variant 1a	Variant 1b

Health

Does your health in any way limit your daily activities compared to most people of your age? (C1)	0.166 (0.696)	- -
Have you recently lost much sleep over worry? (C32)	-0.160 (-1.947)	-0.177 (-1.294)
Have you recently felt constantly under strain? (C33)	-0.116 (-1.408)	-0.178 (-1.339)

Freedom of political expression

| I am free to participate in political activities that affect my life if I want to. (C3) | 0.122 (1.463) | - - |

Freedom of religion

| I am free to practice my religion as I want to. (C4) | 0.121 (0.830) | 0.233 (0.954) |

Freedom of imagination and thought

My idea of a good life is based on my own judgement. (C5)	0.252 (2.513)	0.515 (3.005)
How often do you use your imagination and or reasoning in your day to day life? (C36)	-	-
I have a clear plan of how I would like my life to be. (C37)	0.025 (0.239)	0.104 (0.584)

Emotional capabilities

| At present, how easy or difficult do you find it to enjoy the love care and support of your immediate family? (C6) | 0.135 (1.427) | 0.241 (1.489) |

*t-stats in brackets

Table 1 Life satisfaction equation estimates* (cont'd)

| | Models | |
Variables	Variant 1a	Variant 1b
Do you find it easy or difficult to express feelings of love, grief, longing, gratitude and anger compared to most people of your age? (C7)	-	-0.020 (-0.125)
Have you recently been able to enjoy your normal day to day activities? (C10)	0.013 (0.136)	-
Do you tend to find it easy or difficult to imagine the situation of other people (ie to put yourself in others shoes)? (C18)	0.369 (4.118)	0.694 (4.472)
Security		
Please indicate how safe you feel walking alone in the area near your home during the daytime? (C14)	- -	0.286 (1.833)
Please indicate how safe you feel walking alone in the area near your home after dark? (C15)	-0.011 (-0.157)	- -
Please indicate how vulnerable you feel to domestic violence in the future. (C16)	-0.051 (-0.432)	-
How likely do you think it is that you will be a victim of violent assault or attack in the future? (C17)	-	-
Environment and social relations		
I appreciate and value plants, animals and the world of nature (C8)	-	0.419 (1.027)
How difficult do you find it to make friendships which last with people outside work? (C9)	-0.139 (-1.878)	-0.253 (-1.978)
At work, have you recently felt that you were playing a useful part in things? (C11)	0.048 (0.538)	- -

*t-stats in brackets   Continued on next page

Table 1 Life satisfaction equation estimates* (cont'd)

Variables	Models	
	Variant 1a	Variant 1b
Outside of work, have you recently felt that you were playing a useful part in things? (C12)	-	0.089 (0.585)
Have you recently been thinking of yourself as a worthless person? (C13)	-0.364 (-2.774)	-0.608 (-2.811)
I respect, value and appreciate other people. (C31)	-0.181 (-1.163)	-0.357 (-1.318)
Do you normally have at least one week's (seven days) annual holiday away from home? (C39)	0.136 (1.036)	0.334 (1.500)
Do you normally meet up with friends or family for a drink or a meal at least once a month? (C40)	-0.084 (-0.360)	-
Housing		
Is your current accommodation adequate or inadequate for your current needs? (C35)	-0.306 (-1.538)	-0.551 (-1.575)
Work		
Have you ever sought employment? (C19)	-0.347 (-0.898)	-
To what extent does your work make use of your skills and talents? (C41)	-	-
At work, are you treated with respect? (C42)	-0.381 (-1.243)	-
Discrimination		
While seeking work in the future, do you think is it that in the future you will be discriminated against because of your race? (C20)	-	-0.446 (-2.055)

*t-stats in brackets   Continued on next page

Table 1 Life satisfaction equation estimates* (cont'd)

Variables	Models	
	Variant 1a	Variant 1b
Outside of any employment or work situation, do you think is it that in the future you will be discriminated against because of your gender? (C27)	-	- -

Overall

How often, if at all, do you evaluate how you lead your life and where you are going in life? (C38)	0.113 (0.970)	0.147 (0.740)

Personality traits

Personality: Agreeable	0.016 (0.183)	-0.041 (-0.282)
Personality: Conscientious	-0.069 (-0.883)	-0.058 (-0.418)
Personality: Emotionally Stable	0.098 (1.395)	0.228 (1.897)
Personality: Extravert	-0.070 (-0.862)	-0.120 (-0.865)
Personality: Open to Experiences	0.197 (2.574)	0.354 (2.770)
Log-likelihood	-4996.485	-4424.16

*t-stats in brackets

It is also possible to make some quantitative comparisons among the different (significant) impacts as all these capability variables are categorial with the same number of categories. Thus we see, from variant 1b which has more significant impacts, that the biggest (absolute) impact on life satisfaction, of going from a lower level of 'capability' to a higher one, occurs for empathy (-0.69), closely followed by self-worth with a coefficient of -0.61. Using the highest coefficient, i.e. that of empathy, as a benchmark (100%), the next important factors are life autonomy (whose coefficient is 75% of that of empathy) and (absence of) discrimination (64%). Then come safety (during day-time) (about 41% of the highest), and finally we have mental stress (25%). In variant 1a where discrimination and safety are absent, the order of impact magnitude - empathy, self-worth, life autonomy, mental stress - and their relative importance are almost the same if we only consider the included variables.

Many other capabilities in the area of political freedom and participation, family support, and housing, are not significant for our sample but come close to being so.

One anomaly worth noting is a slightly negative relation between socialising capabilities and life satisfaction. In Table 3 this relates to being able to make lasting friendships (C9) though other regressions with slightly different variables suggest a similar issue. Given that we have, in effect, a relatively large number of controls or variables in our equations, it is difficult for us to rationalise this result and it remains open to further investigation.

Among the five different personality traits that were included in the capability-happiness equation, being open to experiences and being emotionally stable have significant impacts on life satisfaction. This suggests that while the five different traits do describe distinct dimensions of personality, it is not necessary that all of them play an important role in life satisfaction.

What we can say from variants 1a and 1b, in line with previous recent research but this time addressing endogeneity, is that happiness (life satisfaction) is highly multi-dimensional, clearly depends on various aspects of autonomy and is strongly associated with social aspects of life.

Turning to variants 2 and 3, there is a striking similarity between the results of these two models - both in terms of their coefficients and in terms of their significance. Thus one can conclude that even though some personality traits are significant in capability-happiness equations, their direct in- or ex- clusion has little impact on the remaining coefficients.

If we compare variant 1 with the other two (which ignore endogeneity), we find a mixture of differences and similarities. For example, the impact of having lost sleep is negative in variant 1 but not significant in variants 2 and 3. Similarly, being able to put oneself in the shoes of others has a strongly positive impact in variant 1 but is insignificant in variants 2 and 3. Conversely, enjoying family support is significant and positive in variants 2 and 3 but not significant in variant 1. The same is true for being able to express feelings and having a week's holiday. However, despite the variability in terms of statistical significance the coefficients normally have the sign that might be expected.

Thus we do see a notable difference in estimation results between treating capabilities as endogenous or not. More specifically, the former approach stresses more on capability indicators that relate to general aspects of life - not having any serious worry, empathising with others, being able to make own judgments in life, not feeling worthless, not suffering discrimination - for leading a happy life whereas the latter leaves out some of these general features but brings out some particular aspects such as having a week's holiday or enjoying family support etc.

Finally, the results of the capability equations[12] show that all the capabilities are significantly affected by at least one or two personality traits. This finding emphasizes the endogenous nature of capabilities in our life satisfaction model.

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[12]These results are not reported here but are available with the authors upon request.

6   Concluding Remarks

In this paper, we report the development of a survey instrument to measure individual freedoms of adults and its application in Argentina to create a unique dataset for adult capabilities. The paper then uses this data to generate an index of capabilities, across a wide range of life domains, and develops a generalized latent variable framework to estimate the impact of capabilities on life satisfaction, whilst allowing for unobserved heterogeneity and potential endogeneity. Substantively, we find that empathy and self-esteem are the biggest relative contributors to happiness in our sample. These are closely followed by life autonomy (with an impact of about 75% of the first factor). Potential future discrimination seems to be the next important consideration (64%) for Argentineans . Finally, our study points out that safety and stress also matter significantly for life satisfaction though the magnitude of their impact is less than half of 'empathy'. Broadly speaking, these results are robust both in models presented as in others that are available in a longer version of the paper - and they help to identify perhaps for the first time a range of determinants of happiness that add to what we know about the role of relative income and unemployment. However, it is also worth noting that none of these, with the exception of stress, yield a statistically significant relation with income in the process of instrumentation indicating that not all aspects of the welfare outcome can be assumed to be positively and closely related to financial income.

These results, if replicated, are interesting because they identify some important common ground between the capabilities approach to welfare economics which emphasizes the value of positive freedoms and the utilitarian approach which advocates maximizing the sum of individual happiness. Both approaches can advocate developing policies that prioritise the six aspects of a person's freedom mentioned above - albeit for different reasons. From a capabilities perspective, value would derive from the fact these are freedoms a person has reason to value whereas from a utilitarian perspective, these are freedoms that make people happy. This particular list is not obvious *a priori* and raises questions about the promotion of policies that focus solely on monetary indicators of welfare. There is already some consensus that economic growth should be sensitive to distributional concerns (pro poor) as well as environmental impacts (green) but findings such as ours underline a third issue, namely that we should check that *growth is delivering the welfare outcome (quality-of-life) improvements* that most expect.

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Appendix 1

Table 2: Response categories description

Type of response	Response categories	Description
A	0	Dissatisfied[a]
	1	Neither satisfied nor dissatisfied
	2	Fairly satisfied
	3	Very satisfied[b]
B	0	Disagree[c]
	1	Neither agree nor disagree
	2	Agree[d]
C[e]	0	Difficult/unlikely/insecure[f]
	1	Neither easy/likely/secure nor difficult/unlikely/insecure
	2	Easy/likely/secure[g]
D	0	No
	1	Yes
E	0	Less than usual[h]
	1	As usual
	2	More than usual[i]
F[j]	0	Rarely[k]
	1	Occasionally
	2	Often[l]

[a]This response category encompasses the original categories 'Completely dissatisfied', 'Very dissatisfied' and 'Fairly dissatisfied'.

[b]This response category encompasses the original categories 'Completely satisfied' and 'Very satisfied'.

[c]This response category encompasses the original categories 'Disagree strongly' and 'Disagree moderately'.

[d]This response category encompasses the original categories 'Agree strongly' and 'Agree moderately'.

[e]The response category "I prefer not to answer", originally in the questionnaire, has been collapsed with the missing data since it does not provide any qualitative information for our study.

[f]This response category encompasses the original categories 'Extremely difficult/unlikely/ insecure' and 'Very difficult/unlikely/insecure'.

[g]This response category encompasses the original categories 'Extremely easy/likely/secure' and 'Very easy/likely/secure'.

[h]This response category encompasses the original categories 'not at all' and 'no more than usual'.

[i]This response category encompasses the original categories 'rather more than usual' and 'much more than usual'.

[j]The response category "I prefer not to answer", originally in the questionnaire, has been collapsed with the missing data since it does not provide any qualitative information for our study.

[k]This response category encompasses the original categories 'rarely', 'very rarely' and 'never'.

[l]This response category encompasses the original categories 'all the time', 'very often' and 'fairly often'.

Table 3: Response categories description (continued)

Type of response	Response categories	Description
SD1	0	Working[a]
(Working status)	1	Not working[b]
SD2	0	Married or living as married[c]
(Marital status)	1	Separated/divorced/Widow/Never been married[d]
SD3	0	No Children
(Children)	1	Children[e]
SD4	0	Christian[f]
(Religion)	1	Not Christian[g]
SD5	0	0 - 25 years
(Age)	1	26 - 45 years[h]
	2	More than 46[i]
SD6	0	Male
(Gender)	1	Female
SD7	0	0-999
(Personal Income in AR$)	1	1000-1999
	2	2000-2999

[a]This category encompasses the original categories 'Full time work', i.e 30 or more hours per week (54.98%), 'Part time of less than 8 hours a week' (3.99%) and 'Part time of 8 to 29 hours per week' (18.47%).

[b]This category encompasses the original categories 'Student', i.e full time student (5.25%), 'Retired' (4.62%) and 'Unemployed' (9.86%)

[c]This category encompasses the original categories 'Married' (34.20%) and 'Living as married' (13.62%).

[d]This category encompasses the original categories 'Separated' (5.41%),'Divorced' (2.29%),'Widow' and 'Never been married' (40.23%)

[e]This category encompasses the original categories 'One child' (16.02%), 'Two children' (10.47%),'Three children' (5.76%), 'Four children' (1.47%) and 'More than four children' (0.94%.)

[f]This category encompasses the original categories 'Catholic' (70.42%) and 'Other Christian' (5%).

[g]This category encompasses the original categories 'Judaism' (1.67%), 'Islam' (1.04%), 'Other religion' (2.81%) and 'None' (19.06%)

[h]This category encompasses the original categories '26 - 35 years' (34.16%) and '36-45 years' (16.14%).

[i]This category encompasses the original categories '46 - 55 years' (11.07%), ' 56 - 65 years' (9.07%) and 'more than 65 years' (5.18%).

Variable name	Statement	Response Categories
Health		
[C1]	Does your health in any way limit your daily activities compared to most people of your age?	D
[C32]	Have you recently lost much sleep over worry?	E
[C33]	Have you recently felt constantly under strain?	E
Freedom of political expression		
[C2]	I am free to express my political views.	B
Freedom of political participation		
[C3]	I am able to participate in the political activities that affect my life if I want to.	B
Freedom of religion		
[C4]	I am free to practice my religion as I want to.	B
Freedom of imagination and thought		
[C5]	My idea of a good life is based on my own judgement.	B
[C36]	How often do you use your imagination and or reasoning in your day to day life?	F
[C37]	I have a clear plan of how I would like my life to be.	B
Emotional capabilities		
[C6]	At present, how easy or difficult do you find it to enjoy the love care and support of your immediate family?	C
[C7]	Do you find it easy or difficult to express feelings of love, grief, longing, gratitude and anger compared to most people of your age?	C
[C10]	Have you recently been able to enjoy your normal day to day activities?	E
[C18]	Do you tend to find it easy or difficult to imagine the situation of other people (i.e. to put yourself in others shoes)?	C
[C34]	Have you recently been enjoying your recreational activities?	E
Security		
[C14]	Please indicate how safe you feel walking alone in the area near your home during the daytime?	C

Variable name	Statement	Response Categories
[C15]	Please indicate how safe you feel walking alone in the area near your home after dark.	C
[C16]	Please indicate how vulnerable you feel to domestic violence in the future.	C
[C17]	How likely do you think it is that you will be a victim of violent assault or attack in the future?	C

Environment and social relations

[C8]	I appreciate and value plants, animals and the world of nature.	B
[C9]	How difficult do you find it to make friendships which last with people outside work?	C
[C12]	Outside of work, have you recently felt that you were playing a useful part in things?	E
[C13]	Have you recently been thinking of yourself as a worthless person?	E
[C31]	I respect, value and appreciate other people.	B
[C39]	Do you normally have at least one week's (seven days) annual holiday away from home?	D
[C40]	Do you normally meet up with friends or family for a drink or a meal at least once a month?	D

Housing

[C35]	Is your current accommodation adequate or inadequate for your current needs?	D

Work

[C11]	At work, have you recently felt that you were playing a useful part in things?	E
[C19]	Have you ever sought employment?	D
[C30]	Do you tend to find it easy or difficult to relate to your colleagues at work?	C
[C41]	To what extent does your work make use of your skills and talents?	F
[C42]	At work, are you treated with respect?	F

Discrimination at work

[C20]	When seeking work in the future, how likely do think it is that you will experience discrimination because of your race?	C
[C21]	When seeking work in the future, how likely do think it is that you will experience discrimination because of your sexual orientation?	C

Table 4: Variables related to Capabilities (cont'd)

Variable name	Statement	Response Categories
[C22]	When seeking work in the future, how likely do think it is that you will experience discrimination because of your gender?	C
[C23]	When seeking work in the future, how likely do think it is that you will experience discrimination because of your religion?	C
[C24]	When seeking work in the future, how likely do think it is that you will experience discrimination because of your age?	C

Discrimination outside of work

[C25]	Outside of any employment or work situation, do you think that in the future you will be discriminated against because of your race?	C
[C26]	Outside of any employment or work situation, do you think that in the future you will be discriminated against because of your sexual orientation?	C
[C27]	Outside of any employment or work situation, do you think that in the future you will be discriminated against because of your gender?	C
[C28]	Outside of any employment or work situation, do you think that in the future you will be discriminated against because of your religion?	C
[C29]	Outside of any employment or work situation, do you think that in the future you will be discriminated against because of your age?	C

Overall

[C38]	How often, if at all, do you evaluate how you lead your life and where you are going in life?	F

Table 5: Variables related to Past experiences

Variable name	Statement	Response Categories
[Pp1]	Have you ever been a victim of domestic violence?	D
[Pp2]	Have you ever been the victim of some other form of violent assault or attack?	D
[Pp3]	When seeking work in the past, have you ever experienced discrimination because of your race?	D
[Pp4]	When seeking work in the past, have you ever experienced discrimination because of your sexual orientation?	D
[Pp5]	When seeking work in the past, have you ever experienced discrimination because of your gender?	D
[Pp6]	When seeking work in the past, have you ever experienced discrimination because of your religion?	D
[Pp7]	When seeking work in the past, have you ever experienced discrimination because of your age?	D
[Pp8]	Outside of any employment or work situation, have you ever experienced discrimination because of your race?	D
[Pp9]	Outside of any employment or work situation, have you ever experienced discrimination because of your sexual orientation	D
[Pp10]	Outside of any employment or work situation, have you ever experienced discrimination because of your gender?	D
[Pp11]	Outside of any employment or work situation, have you ever experienced discrimination because of your religion?	D
[Pp12]	Outside of any employment or work situation, have you ever experienced discrimination because of your age?	D

Table 6: Socio-demographic indicators

Variable name	Statement	Response Categories
[SD1]	Which of these best applies to you ..(working status)?	SD1
[SD2]	What is your marital status?	SD2
[SD3]	How many dependent children do you have – that is children dependent on your income?	SD3
[SD4]	Which religion, religious denomination or religious body, if any, do you belong to?	SD4
[SD5]	Age	SD5
[SD6]	Sex	SD6
[SD7]	Gross personal income is an individual's total income received from all sources, including wages, salaries, or rents and BEFORE tax and contributions to national insurance are deducted. What is your gross personal income?	SD7

Table 7: Personality Traits indicators

Variable name	Statement	Response Categories
[PT1]	I see myself as extravert	B
[PT2]	I see myself as critical, quarrelsome	B
[PT3]	I see myself as dependable, self-disciplined	B
[PT4]	I see myself as anxious, easily upset	B
[PT5]	I see myself as open to new experience, complex	B
[PT6]	I see myself as reserved, quiet	B
[PT7]	I see myself as sympathetic, warm	B
[PT8]	I see myself as disorganized, careless	B
[PT9]	I see myself as calm, emotionally stable	B
[PT10]	I see myself as conventional, uncreative	B

Appendix 2

Variant 1 for categorical variables

As the life satisfaction variable is categorical, equation (4) has two parts as follows. Our response variable y_i takes four values 0,1,2,3 corresponding respectively to four categories - dissatisfied, neither satisfied nor dissatisfied, fairly satisfied, very satisfied. Thus we have

$$y_i = c \quad \text{if} \quad \tau_c < y_i^* < \tau_{c+1} \tag{10}$$

for $c = 0, 1, 2, 3$ where $\tau_c, c = 0, 1, 2, 3$ are endogenous thresholds with $\tau_0 = -\infty$ and $\tau_4 = \infty$ and where y_i^* represents the underlying continuous response variable explained by capabilities as follows:

$$y_i^* = Q_i'\gamma + u_i'\theta + e_i \tag{11}$$

where u_i is the vector of individual effects and e_i is assumed to follow a normal distribution (probit link) of unit variance. Then we can write:

$$p(y_i = c | Q_i, u_i) = p(\tau_c < y_i^* < \tau_{c+1}) \tag{12}$$

Next our capability measures. Each capability is either a binary response variable or an ordered categorical variable. For the categorical variable the procedure is the same as for the life satisfaction response variable. Denoting it as $Q_{j,i}$, we have:

$$p(Q_{j,i} = c | z_i, x_i, u_{j,i}) = p(\tau_{j,c} < Q_{j,i}^* < \tau_{j,c+1}) \tag{13}$$

where $Q_{j,i}^*$ is a latent capability variable such that:

$$Q_{j,i}^* = z_i'\delta_j + x_i'\beta_j + u_i'\theta_j + e_{j,i} \tag{14}$$

for $j = 1, ..., M$. We assume that $e_{j,i}$ are independent across dimensions and individuals and independent of e_i.

For a binary capability variable, the latent model is even simpler. We have:

$$p(Q_{j,i} = 1 | z_i, x_i, u_{j,i}) = p(Q_{j,i}^* > 0) = \Phi(z_i'\delta_j + x_i'\beta_j + u_i'\theta_j) \tag{15}$$

and

$$p(Q_{j,i} = 0 | z_i, x_i, u_i) = 1 - p(Q_{j,i} = 1 | z_i, x_i, u_i) \tag{16}$$

Finally the measurement model for personality dimensions. There are ten personality traits ($T = 10$) which can be divided into five pairs corresponding to five different aspects of an individual's personality ($p = 5$) according to Gosling and Rentfrow (2003). Each pair consists of answers to a particular aspect and its opposite. All answers are scaled from 1 to 7 with 1 indicating 'strongly disagree' and 7 'strongly agree'. These pairs are as follows:

Pair 1 : Being extravert: I see myself as extravert (PT1) and see myself as reserved, quiet (PT6)

Pair 2: Being agreeable: I see myself as critical, quarrelsome (PT2) and I see myself as sympathetic and warm (PT7)

Pair 3: Being conscientious: I see myself as dependable, self-disciplined (PT3) and I see myself as disorganised, careless (PT8)

Pair 4: Being emotionally stable: I see myself as anxious, easily upset (PT4) and I see myself as calm, emotionally stable (PT9)

Pair 5 : Being open to experiences: I see myself as open to new experiences, complex (PT5) and I see myself as conventional, uncreative (PT10)

For our variant 1, we have five latent factors u_1 to u_5 corresponding to each personality dimension and each latent factor $u_{ji}, j = 1, ..., 5$ is measured by the corresponding pair of personality indicators say PTm_{ji} and PTn_{ji}. Thus our measurement model is given by:

$$
\begin{aligned}
PTm_{ji} &= \lambda_{jm}u_{ji} + \xi_{m,ji} \\
PTn_{ji} &= \lambda_{jn}u_{ji} + \xi_{n,ji}
\end{aligned}
\tag{17}
$$

The complete model comprising (11), (12), (14), (13), (15), (16) and (17) is estimated by maximum likelihood (ML). Due to its computational complexity and because independence is assumed between $\xi_{jm,i}$ and $\xi_{jn,i}$, $j = 1, ..., 5$ and $(e_i, e_{j,i}, j = 1, ..., M)$ $\forall j, i$, the ML procedure can be implemented in two stages. In a first stage factor analysis is performed for equations (17) in order to obtain estimates of individual scores $\hat{u}_{j,i}, j = 1, ..., 5$. In a second stage the individual effects u_{ji} are replaced by their estimates in equations (11), (12), (14), (13), (15), (16) and these equations estimated by ML.

Variant 2 : Definition of personality variables

In variant 2 the personality dimension indicators are directly introduced into the life satisfaction equation. For this purpose, we construct five new personality variables N1, N2, N3, N4, N5 corresponding to the five personality dimensions:

N1 = Being extravert = PT1 - PT6 (both values taken in the scale 1 to 7)

N2 = Being agreeable = PT7 - PT2 (both values in the scale 1 to 7)

N3 = Being conscientious = PT3 - PT8 (both values in the scale 1 to 7)

N4 = Being emotionally stable = PT9 - PT4 (both values in the scale 1 to 7)

N5 = Being open to experiences = PT5 - PT10 (both values in the scale 1 to 7)

These new variables N1,...N5 can theoretically range from -6 to 6 which are directly included in equation (7) and the equation is estimated by ordered probit.

Variant 3

This is a reduced version of variant 2 without personality traits and hence also estimated by ordered probit.