A composite indicator of sustainable well-being: the relative importance of weights in the European Strategy for Sustainable Development

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1. Introduction

As well-being is broadly recognized to be a multidimensional concept, it is difficult to have a unique index to measure it. One of the final recommendations of the Stiglitz's Commission support the use of a dashboard of indicators rather than a composite measure, difficult to synthesize on the various dimension of wellbeing. However the composite indicator has the advantage of expressing with a unique number the multidimensional aspect of wellbeing.

In this paper we aim at exploring the feasibility to developing a composite indicator by using the valuable information provided by data. In particular, we test an approach in which the weights are derived from a regression model linking life satisfaction individual data with the underlying indicators of the institutional set used to monitor the European Strategy for Sustainable Development (EU SDS). We then compare this data-driven composite indicator of sustainable well-being with a traditional one which assumes that all the dimensions of the EU SDS are equally important.

2. Literature review

In the social sciences, quality of life is defined as the overall well-being of individuals in a broad and multidimensional sense (Böhnke, 2005). Moreover, quality of life has been often analysed as a property of society on the whole, using a macro-perspective. But it can also refer to conditions or evaluative judgments from a micro-perspective. Therefore, quality of life should be best conceptualized in terms of individuals' life situations (Vesan et al., 2011). Finally, the notion of quality applies to several domains that may affect human life experience. This implies analysing the different aspects that contribute to individual well-being, both at individual and macro level.

In the economic literature, the growing empirical evidence on subjective life satisfaction has fostered the debate on the dimensions of well-being. Diener and Suh (1997) argue that subjective well-being measures and social indicators are necessary to evaluate a society and add substantial information to the economic indicators. Diener and Seligman (2004) stress some beyond-monetary indicators which influence national well-being: governance, social capital, religion. Helliwell

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(2003) brings arguments in favor of using life satisfaction as a way to evaluate the quality of a society. By using the World Values Survey, he combines individual and societal variables so to assess the effect of individual and national income (GDP), the average level of interpersonal trust, the quality of institutions and life expectancy rate (measuring public health) on citizens' well-being.

A number of papers in this literature have tried to merge the micro perspective of the individual determinants of life satisfaction (as being unemployed) with the macro perspective by including aggregate variables (as the unemployment rate). For instance, Frey and Stutzer (2000) in their study on the influence that institutions of direct democracy have on self-declared life satisfaction of Swiss citizens, differentiate three set of explanatory variables for SWB: *i)* personality and demographic factors; *ii)* micro and macro factors; *iii)* institutional conditions of a society. The micro and macro perspective of well-being is investigated also by Alesina, Di Tella and Mac Culloch (2004). They analyze the influence of inequality over life satisfaction in two "cultural samples" of European and American citizens. Controlling for individual income and other personal characteristics as well as for year and country dummies, they focus on inequality as measured by the Gini coefficient. They find that individuals have a lower tendency to report themselves happy when inequality is high and this is particularly true in Europe. Following this approach, Becchetti, Castriota and Giuntella (2009) test whether the inflation/unemployment trade-off changes according to age and the national degree of employment protection. Using the Eurobarometer survey, they document that the cost of unemployment as perceived by European citizens is markedly higher in central age classes and in countries with lower employment protection with respect to the perceived cost of inflation.

3. The model

Provided that reported subjective wellbeing is a valid and empirically adequate measure for individual wellbeing, it can be modeled in a micro econometric function as follows:

$$Life\ Satifaction_{ijt} = \alpha + \mathrm{X}'_{ijt}\,\beta + \mathrm{Z}_{jt}{}'\gamma + \varepsilon_{ijt}$$

Life satisfaction is a latent variable that is observed by the verbal assessment of people. It is specific to each individual (*i*) living in country (*j*) in a point in time (*t*). Subjective life satisfaction can be explained by observable variables like the socio demographic and economic characteristics both at individual (***X***) and domestic level (***Z***). Among the domestic conditions of life, we highlight unemployment and the level of development of the domestic economy, but also we can go beyond GDP by accounting for the elements relevant to the sustainable and multidimensional development of a society. In order to do this, we take as a reference the European Strategy for Sustainable Development (EU SDS)[1].

[1] The EU SDS is primarily concerned with quality of life, equity between and within the generations. It is the result of the European Council held in 2001 in Göteborg, where the EU Member States gathered to discuss a long-term strategy policy for economically, socially and ecologically sustainable development so to meet its responsibility toward the United Nations declaration on Sustainable Development signed in 1992 in Rio de Janeiro. In 2006 the European Council put forward a Renewed Strategy which set out a more coherent operational strategy meeting the challenges of sustainable development. The overall strategy tackles environmental protection, social equity and cohesion, economic prosperity, external responsibilities. It is articulated around seven key challenges: climate change and clean energy; sustainable transport; sustainable consumption and production; conservation and management of natural resources; public health; social inclusion, demography and migration; global poverty and sustainable development challenges.

The final goal of this paper is to end up with a composite indicator for sustainable well-being. The composite indicator of sustainable well-being for country j at time t, based on the EU SDS headline indicators Z_{jt}, is defined as

$$WB_{jt} = Z_{jt}^{'}\gamma$$

i.e. a linear aggregation, where γ are the estimated weights. We call these weights *objective* because they are obtained using a statistical estimation procedure from given observations, although they derive from subjective evaluation of life satisfaction. The sustainable well-being composite indicator is then calculated at country level for each European Member State surveyed and at a given point in time.

4. Empirical Evidence

Our empirical analysis is based on the Eurobarometer Survey on Western European countries, available from 1975 to 2009. Information on our dependent variable, i.e. self-declared life satisfaction, is drawn from the question "On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead?" (very satisfied=4, down to not at all satisfied=1). Personal information about respondents includes: age, gender, educational attainment, employment status, marital status, family size and household income (which is expressed in terms of classes specific at country-year level). Indeed, this list represents the core set of the explanatory variables for subjective well-being, as widely recognised by the literature (see Dolan et al. 2009).

Macroeconomic controls include unemployment and inflation rates at national level and gross national disposable income (GDI) per capita in purchasing power standards which, according to the OECD, represents a better proxy for the standard of living than gross domestic product. Country and year fixed effects are also included in the model so to capture the life satisfaction commonly shared by EU citizens and due to specific country and time conditions.

We then insert as additional explanatory variable the key challenges of sustainable development as recognized in the EU SD strategy and summarized by the headline indicators of each area. Hence, for the socio economic development challenge we consider the headline indicator of the growth rate of per capita GDP, while for the goal of sustainable consumption and production, we insert the resource productivity. For the social inclusion we consider the total risk of poverty rate. For the demographic changes we consider the employment rate of older worker. For the public health challenge, we consider the healthy life years by gender and life expectancy at birth by gender. For the climate change and energy challenge, the headline indicators are two: the greenhouse gas emissions and the share of renewable in gross inland energy. For the sustainable transport challenge, the headline indicator is the energy consumed by the transportation system relative to GDP. For the natural resources challenge, the headline indicator is the common bird index. Finally, for the global partnership the indicator is the official development assistance (*ODA*). As the variables are expressed in different units of measurement, we apply the standardization.

Unfortunately, our evidence is strongly limited by the EU SDS headline indicators (see Eurostat, 2009) which are not available for all the Eurobarometer waves. In fact, we can carry out our

investigation for the following years: 1998, 1999, 2000, 2001; and on the following countries: France, Belgium, Germany, Italy, Denmark, Ireland, United Kingdom, Spain, Sweden, Austria, Cyprus. We end up with a number of individual observations of 67,077.

The categorical nature of the life satisfaction data is dealt with by an ordered logit with standard errors clustered by country and year. In the first regression we try to disentangle the effects due to individual and macro economic circumstances from those related to the elements of sustainable development selected by the EU SDS. The ordinal regression model is a continuous latent variable model where y* is individual life satisfaction, and the observed response categories are only 4. The probability of and observed outcome (m) for a given value of X is:

$$\Pr(\text{life satisfaction} = m|X) = \Pr(\tau_{m-1} \leq y^* < \tau_m|X) = F(\tau_m - X\beta) - F(\tau_{m-1} - X\beta)$$

Where F is the conditional function for ε , while

$$X\beta = \beta_1 \text{Var Socio Demographic} + \beta_2 \text{Economic Factors} + \beta_3 \text{EU SDS}$$

Our focus is on the highest degree of the subjective life satisfaction, as we want to measure the likelihood of being very satisfied with one's own life (lifeSat = 4) related to a change in the individual situation as well as in the socio economic and environmental conditions.

Table 1 shows the marginal effects of selected variables in increasing the probability of people declaring to be very satisfied of their lives. The effects of the socio demographic and socio economic characteristics at individual levels (i.e. ***X*** variables) are stylized facts[2]. We rather focus on the headline indicators of the EU SDS. By changing the number of the macro variables, we obtain different estimation models, so to measure the relevance of single indicators[3]. We find that the most statistical significant elements for our EU SDS indicators come out from model D. In that model, four indicators (i.e. risk of poverty, employment rate of elders, green house gas emissions, life expectancy) have a strong magnitude. While two indicators are not statistically significant (i.e. sustainable consumption and use of renewable energy). Hence, we choose these coefficients to be the weights of our *objective* composite indicator.

Table 1. Subjective life satisfaction and EU SDS indicators, Eurobarometer (1998 - 2001).

Variables *selection*	**A**	**B**	**C**	**D**	**E**
Household Income	0.0175***	0.0176***			
Unemployment rate	-0.0257***	-0.0129	-0.0238**	-0.00847	
Inflation rate	-0.00475***	0.00144	-0.00275	0.00408**	
Gross Disposable Income	0.0625***		0.0723***		
Risk of Poverty	-0.0695***	-0.138***	-0.0952***	-0.169***	-0.0970**
Biodiversity	0.0114	-0.0532***	0.0128	-0.0623***	-0.0403***
Employment rate of elders	-0.0843	0.181***	-0.0459	0.253***	0.198***
Energy consumption in transport	-0.0280***	-0.0256***	-0.0266***	-0.0238***	-0.0272***

[2] For reason of space we omit the results, but they are available upon the authors.

[3] In A we estimate the full model; in B we do not include the GDI; in C we did not include the household income; in D we do not include the household income and the GDI (so that the only economic variable remains the unemployment rate, the inflation rate and the rate of growth of the economy); in E we did not include the economic variables at all. A further reason to insert separately the macro variables is that there are still doubts on the reliability of these coefficients due to the collinearity within Z and between X and Z.

Green-house Gas emissions	0.0423	0.151***	0.0847*	0.212***	0.179***
Official Development Aid	-0.0464**	-0.0954***	-0.0698***	-0.120***	-0.0844***
Sustainable consumption	-0.00668	-0.0227	0.0267	0.00375	-0.0572
Use of renewable energy	-0.0744*	-0.00535	-0.0326	0.0517	-0.0309
Life expectancy	0.207***	0.495***	0.287***	0.624***	0.516***
GDP growth rate	0.0269***	0.0247*	0.0208**	0.0238	0.0418**

Legend: * p<0.05; ** p<0.01; *** p<0.001; Standard Errors adjusted for clusters in year – country groups. Dummy for year and country fixed effect are among the controls.

The second step of our analysis is to use the odds ratio for the EU SDS headline indicators and to compute the weight of a composite indicator. The computed indicator is a linear aggregation of coefficients which are data driven. In other words, the coefficients estimated from the life satisfaction regression have been converted to weights. The coefficients are taken in absolute value and normalized to sum to one. Moreover, when there is a negative sign, we swap the direction of the indicators before the aggregation. The components of our objective composite indicators are listed in Table 2.

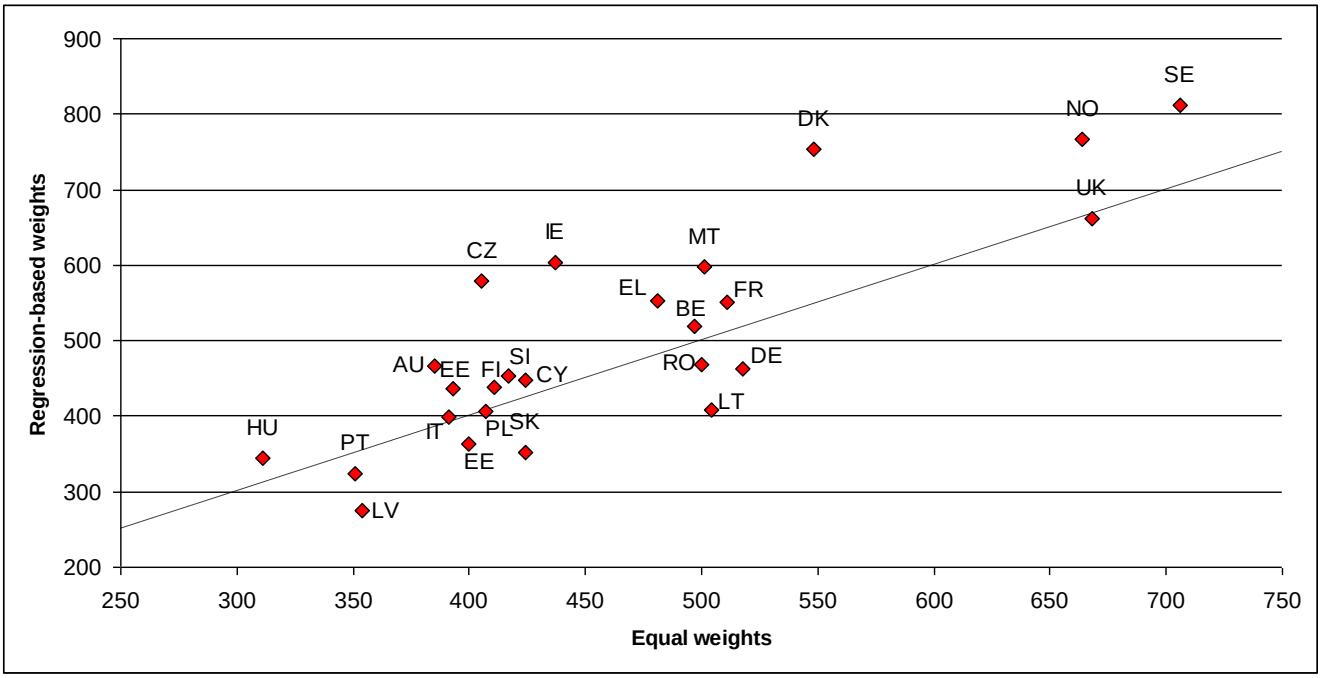
Table 2. Weights of the EU SDS indicators computed from the subjective well being estimation's coefficients.

EU SDS indicators	weights
Risk of Poverty	0.12
Biodiversity	0.04
Employment rate of elders	0.17
Energy consumption in transport	0.01
Green-house Gas emissions	0.14
Official Development Aid	0.08
Sustainable consumption	0
Use of renewable energy	0
Life expectancy	0.42
GDP growth rate	0.01

The last step of our analysis is a comparison between the composite indicator created using the empirical weights derived by estimating the life satisfaction regression (called objective) and the composite indicator computed with a linear aggregation of EU SDS headline indicators each of them equally weighted (i.e. using weight given from experts). This second indicator is called "subjective" as it relies on experts judging all the EU SDS dimensions being equally important.

In Figure 1 we plot these two composite indicators and the total score finalized by each EU countries investigated in the empirical analysis. The composite indicators scores (on a range 0 – 1,000) are generally higher for regression-based weights. For some countries the ranking can change considerably, for instance Ireland and CZ. While, other countries ends up to be neutral to change of weights.

Figure 1. Comparison between objective and subjective composite indicators for the sustainable development well-being.



5. Conclusions

This paper investigates the relation between the headline indicators of the EU SDS and subjective well-being in several European countries. In particular, by using the Eurobarometer Survey we try to estimate whether citizens' s life satisfaction is related to the priorities set by the European Council in 2001 at Goteborg. In a preliminary analysis, we found that people are concerned by life expectancy, risk of poverty, employment rate of elders, and green house gas emissions. After having estimated the coefficients of the EU SDS headline indicators, we make an attempt to aggregate those variables in a unique composite indicator for *sustainable well-being*. We called this indicator an "objective" one as it is based on weights derived directly from data estimation. This objective composite indicator is then compared to a "subjective" composite indicator which aggregates the elements of the EU SDS with equal weights, as it relies on the assumption that all the EU SDS dimensions have equal importance in determining sustainable well-being. We then check the different rankings obtained by European countries. The country scores are generally higher when using the objective composite indicator. For some countries the ranking can change considerably, while other countries are neutral to the change of weights.

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