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ABSTRACT

Beyond GDP and Back: What is the Value-added by Additional Components of Welfare Measurement?*

Building on the Stiglitz report, a growing literature suggests to explore other aspects of human welfare apart from material well-being, such as job security, crime, health, environmental factors and subjective perceptions. To explore the additional information of these indicators, we analyze data on the macro level from the German Federal Statistical Office combined with micro level data from the German SOEP (1991-2008). Much of the variation in many well-being measures can indeed be captured well by GDP and the unemployment rate. These correlations are far from perfect, thus giving considerable hope that there is room for a broader statistical reporting.

JEL Classification: D60, E01 and I30
Keywords: beyond GDP, happiness, Sen, Stiglitz, sustainability and welfare measurement

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1 Introduction

The modern welfare economics literature acknowledges that GDP alone is an inadequate measure of individual well-being and suggests a variety of ways to go "Beyond GDP". Recently, building on the highly polarizing Stiglitz report, a growing literature suggests that statistical offices and applied researchers explore other aspects of human welfare apart from material well-being, such as job security, crime, health, environmental factors and subjective perceptions. The main argumentation behind this recommendation is that there are several factors that increase GDP but might actually have a negative impact on the citizen's well-being. Indeed, to take a simple example, traffic jams may increase the use of gasoline, hence GDP, but not the actual well-being of the people. Furthermore, GDP does not capture sustainability in economic, social and environmental dimensions and this might endanger the long-term functionality of the whole system.

Yet, while it is a conceptionally convincing idea that a broader set of indicators might convey important additional information, it is far from clear that researchers will indeed be able to exploit this theoretical potential in practical work. Not only is the work with real-world data fraught with all sorts of limitations and measurement errors, it very much seems that the further we want to go beyond GDP as *the* measure, the more serious these problems become. On the other hand it has become evident that many alternative indicators covary to a large extent with standard hard indicators. Consequently, the most reliable additional information might be so highly correlated with GDP that it is impossible to justify cost and effort spent.

To explore this issue, this paper analyzes data on the macro and micro level from the German Federal Statistical Office combined with German SOEP data (1991-2008) on the personal work situation and subjective feelings concerning several aspects of life. Our key issue of interest is the extent to which alternative indicators on non-material well-being can indeed offer additional information over and above the standard economic indicators. Germany is a particularly promising case for this analysis since statistical information is arguably among the most reliable in the world. We carry out this analysis using principal component factor analysis at the macro and micro level employing a rich set of indicators suggested by the Stiglitz Report. We find that, even in the case of Germany, with its ample reservoir of candidate indicators, much of the variation in the available well-being measures can indeed be captured well by the hard economic indicators as used in the literature, especially by GDP and the unemployment rate. This suggests that these hard

indicators are still a reasonable and quite robust gauge of the well-being of a country. And yet, we also see that these correlations are far from perfect. Thus, there is considerable hope that there is room for a broader statistical reporting which comprises alternative, non-standard indicators, as long as these are measured reliably and robustly themselves.

Section 2 gives a brief overview of the literature outlining key contributions in the area of subjective well-being and other alternative well-being indicators. Section 3 outlines the data used in the analysis at the macro level for Germany since 1991. It continues on with a similar analysis at the micro level using data from the German Socio-Economic Panel (SOEP). In section 4, the statistical analysis is carried out and the results are outlined and discussed. Section 5 concludes.

2 Literature

When gauging the state of well-being, economists usually focus on hard indicators such as income, GDP or the unemployment rate. They choose these indirect measures, because individuals' welfare or preferences cannot be observed directly. In 2009, a group of leading economists, among them Joseph Stiglitz and Amartya Sen, presented the so-called Stiglitz report commissioned by the French government on ways other than simply using GDP to measure economic progress and social well-being (CMEPSP, 2009). Indeed, the authors explore extensively many other indicators or dimensions of well-being, going far beyond the standard economic measuring concepts of gross domestic product, national unemployment rate or life expectancy. More recently, a joint study by the French Council of Economic Advisors (CAE) and the German Council of Economic Experts (SVR) has developed this theme further and explored the implementation of quality-of-life indicators and of indicators of economic and environmental sustainability into regular statistical reporting (CAE-SVR, 2010).

These reports recommend to improve existing measures of performance (such as GDP) to capture the increasing share of services, changes in the products' qualities, government output (such as education, medical services etc.) and non-market activities (such as services provided within a family or goods produced within the household). Furthermore, leisure as a valuable outcome should be taken into account. Material living standards should be better measured by net national income, real household income, consumption, wealth and their distributions. And yet, "classical" measures of economic performance

are seen still as indispensable elements of comprehensive statistical reporting, for instance for purposes of formulating adequate fiscal and monetary policy.

Regarding subjective well-being, the reports recommend to consider apart from material living standards: health, education, personal activities including work, political voice and governance, social connections and relationships, environment (present and future conditions) and insecurity of an economic as well as a physical nature. Both studies discuss whether and how objective and subjective dimensions of well-being should be considered together and inequality in well-being be compared across socio-economic groups, gender, generations and immigration. Furthermore, the CAE-SVR study emphasizes regular monitoring of the sustainability of private and public sector finances, reflecting the dismal experience of the recent financial and economic crisis. Both studies agree that the monitoring of environmental sustainability should contain quantities and qualities of natural resources, and of human, social and physical capital as well as physical indicators for environmental pressures.

As this paper is mainly concerned with current material and non-material well-being, our discussion of the literature will concentrate on the ample set of recent contributions to the assessment of quality of life. Indeed, both the Stiglitz report and the CAE-SVR study were able to draw on a growing range of papers in this research area. On the macro level, a publication by Easterlin (1974) triggered the interest of economists. He found that happiness and GDP are only weakly positively correlated over time for a country but that within a country people with higher income report higher life satisfaction. Easterlin argues that it is the relative income position that matters (which would stay the same when everyone becomes richer) not the absolute income position. Several papers have critisized the results by providing empirical evidence against this, such as in Oswald (1997), Hagerty and Veenhoven (2003) and Stevenson and Wolfers (2008), arguing that income indeed can buy happiness.

Starting in the mid 1990's economists became increasingly aware of the additional value of subjective indicators to extend their standard economic analyses, with the aim of identifying otherwise unknown behaviour or parameters. For instance, Winkelmann and Winkelmann (1998) try to identify the "true" costs of unemployment by focusing on the impact of unemployment on survey measures of life satisfaction. Similarly papers following the more sociologically-oriented concept of social exclusion use indicators for health, access to educational institutions, intergenerational mobility, social relations etc. (see for

example Papadopoulos and Tsakloglu, 2002; D'Ambrosio et al., 2002; Mickelwright, 2002; Eurostat, 1998 and Dekkers, 2002).

When it comes to regular statistical reporting, there exist several approaches and a rising literature on alternative measures to GDP in order to measure well-being. One of the most prominent approaches to capture more than GDP is the Human Development Index (HDI) which has been constructed once a year since 1990 by the United Nations Development Programme and ranks countries according to their human development. The HDI consists of a weighted average of GDP, life expectancy and education measures (adult literacy rate and school entry rates). Similar approaches are undertaken for the Living Planet Report published by the World Wide Fund for Nature (WWF) and the Happy Planet Index provided by the New Economics Foundation (NEF).

Other indicators that were developed focused on sustainability, such as the one developed in 1989 by Daly and Cobb (1989) on the basis of Nordhaus and Tobin (1972) which was later revised and named the Genuine Progress Indicator (GPI). Its was to reflect consumption that is sustainable in the future. Therefore information was added on income distribution, unpaid household labor, health expenditures, education and environmental damage. Hence the ISEW is roughly calculated by subtracting the unsustainable components from economic welfare (consumption). Several papers have applied and also slightly modified the index of sustainable economic welfare (ISEW), such as Stockhammer et al. (1997) who applied a modified version to Austria and conclude that GDP has overestimated economic welfare since the 1980s because since then, the ISEW has stagnated.[2] However there is a strong debate on the speculative assumptions behind the ISEW (England, 1998) and on its theoretical and methodical foundations (Neumayer, 1999).

Osberg and Sharp (2002) create an index of economic well-being (IEWB) by including information on effective per capita consumption flows, net societal accumulation of stocks of productive resources, income distribution and economic insecurity. They show for the

[2]Other papers applying the method to other countries derive similar results, namely that the ISEW has been stagnating or falling since the 1980s (for Germany: Diefenbacher, 1994; for the UK: Jackson and Marks, 1994 and Jackson et al., 1997; for Sweden: Jackson and Styme, 1994 as mentioned in Neumayer, 1999). Closely related to the ISEW is the concept Green GDP, correcting GDP for environmental consequences of growth, which was implemented in China for only two years because of politically unacceptable levels of environmental consequences. Similarly, other countries also failed to advocate regular calculations. An idea similar to ISEW and Green GDP lies behind the concept of Genuine Savings developed by the World Bank.

US, the UK, Canada, Australia, Norway and Sweden for 1980 to 1999, similar to the papers dealing with the ISEW index, that economic well-being has increased at a much lower rate than GDP. In another study by Osberg and Sharp (2005), the IEWB and its components are compared to GDP and HDI over time for the US, the UK and Norway, showing that the IEWB exhibits lower levels and a flatter trend than GDP.
Yet another indicator is the National Footprint Accounts provided by the Global Footprint Network. It does not rely on GDP at all. The basic methodology behind the ecological footprint is to compare the annual supply of and demand for ecosystem products and services of a country depending on its activities and production of goods (Ewing et al., 2008).

For Germany, Van Suntum et al. (2010) develop a "Glücks-BIP" (Happiness GDP) based on ordered logit model regarding the determinants of life satisfaction at the person level, using the SOEP from 1991 to 2007. The variables that are found to have a significant influence on life satisfaction are averaged over each year and equally weighted to calculate the average over all variables. Graphs are provided to show that this Happiness GDP and GDP display a diverging pattern over time, while Happiness GDP and life satisfaction show a similar trend, with Happiness GDP lagging one year behind. This study follows Haisken-DeNew and Sinning (2007) who analyze the factors influencing life satisfaction for migrants, but who, by contrast, weigh these factors according to their impacts on life satisfaction to calculate a weighted aggregate measure of social exclusion.

Several other researchers support the concept of Gross National Happiness such as Diener (2000), Kahneman et al. (2004) and Layard (2005) while others have expressed doubts whether life satisfaction is comparable across individuals and countries (Burchardt, 2006; Frey and Stutzer, 2007; Nussbaum, 2009). Different cultural norms might hinder comparisons and the scaling of life satisfaction might vary according to personality traits, current moods, adaptation to certain situations and the phenomenon that individuals might mostly remember peaks and the last moments of a certain time period. Furthermore, doubts remain if answers to life satisfaction questions represent the objective situation of one's well-being. If Gross National Happiness would really be used to measure well-being, citizens could strategically dramatically drop their life satisfaction responses on a very

low level in order to change policies they are not so fond of.[3]

Boarini et al. (2006) investigate empirically how different measures of well-being correlate with GDP across countries. They find that alternative hard measures, such as net national product and net income, are highly correlated with each other and with GDP and result in the same ranking of countries with respect to GDP. Also the modification of measures of economic resources by including leisure time, sharing of income within households and distributional aspects leads to a similar ranking. The levels of social indicators are highly correlated to GDP, while changes over time are not. The authors also compare life satisfaction across OECD countries and find it to be correlated with GDP as well.

The paper by Constanza et al. (2009) provides a review of the different attempts to measure well-being and economic growth, as does Fleurbaey (2009) who also provides thorough details on theoretical background information and critically evaluates the different approaches. Summarizing the literature, the common opinion is that while income as an indicator might be very useful on the whole for economic analyses, it might not reflect the "true" overall picture. There have been several approaches of incorporating more than GDP in the analysis of human welfare on the macro level. The approaches consist of 3 types: (i) those that modify GDP, (ii) those that augment GDP by alternative measures and (iii) those that completely depart from GDP.

Because it is unclear until now what additional information the extra measures actually bring to the analysis of welfare, we will investigate in our analysis how much of the variation of these extra measures can simply be explained by GDP. This is even more important since any composite measures are usually aggregated using equal or other arbitrarily chosen weights for all their constituent components. By applying factor analysis to the variables recommended by the Stiglitz commission, we can identify variables that explain the same underlying constructs. This allows us to detect those variables that load highly on these factors, thereby reducing the dimensionality of the data significantly; we might even construct weights which lead to a maximization of the observed variance - a much more justifiable approach than assigning each variable an arbitrary weight. The next section will describe the data that was used for the analysis.

[3]In 2009, the social network platform Facebook has launched a statistic tool Gross National Happiness that calculates Happiness for each country and day via the status updates of the people. This tool made evident, that South Africans seem to be happier on Fridays than on Saturdays, while most other nations are the happiest on Saturdays.

3 Data

The data used in this paper have been taken from standard macro indicators and derived from micro panel data sets. As the data derive from many different sources, it is important to document their origin and generation at this point. We perform the analysis on the macro and on the micro level. On the macro level, we investigate correlation patterns over different years, on the micro level we want to detect correlation patterns within a cross-section.

3.1 Macro data

Focusing first on data taken from sources at the macro level, we include: (a) life expectancy at birth measured in years from the World Bank[4], (b) an air pollution index (1990=100) [5], (c) German real gross domestic product per capita (2005=100)[6], (d) military expenditures as percent of GDP[7], and (e) the unemployment rate of all dependent employable persons[8].

We additionally use data from the German Socio-Economic Panel (see Haisken-DeNew and Frick, 2005) for the years 1991-2008, aggregated to the representative German nation-wide level. Using SOEP design weights[9], the following nationally representative indicators were generated. In addition to objective indicators such as (a) average overtime hours per week and (b) generated real (2005=100) current net labour income measured in Euro, and (c) the Gini coefficient, many subjective indicators were also generated. They include (a) "worried about economic development" (1 high - 3 low), (b) "worried about own economic situation" (1 high - 3 low), (c) "satisfaction: job" (0 low - 10 high), (d) "satisfaction: health" (0 low - 10 high) ,(e) "satisfaction: life" (0 low - 10 high), (e) "worries: world peace" (0 low - 10 high), (f) "worries: job security" (1 high - 3 low) and (g) "worries: environmental protection" (1 high - 3 low). We calculate yearly averages of these variables

[4]World Bank, http://data.worldbank.org.

[5]German Federal Statistical Office, Umweltbundesamt, averaged index of SO2, NOX, NH3 and NMVOC, https://www-genesis.destatis.de/genesis/online.

[6]GDP/capita.

[7]http://www.worldbank.org.

[8]Bundesagentur für Arbeit, Eckdaten Arbeitsmarkt ZR 1998-2007.

[9]"Altogether, the SOEP consists of 40 strata: one stratum in sample A, twenty-seven in sample B, one in sample C, three in sample D, one in sample E, two in sample F, four in sample G, and one in sample H. Unique inclusion probabilities pertain to each of these strata. The variable `DESIGN` contains the inverse of this probability, i.e., the design weight." (Spiess and Kroh, 2007).

across respondents, thereby assuming cardinal comparability of the three point scale and eleven point scale, respectively.

Thus, we are able to combine standard objective indicators with nationally representative subjective indicators in line with the new "Beyond GDP" literature in order to compare the contribution of these new indicators. The dimensions of well-being which the Stiglitz Commission recommended to take into account are therefore almost completely covered by our dataset as can be seen in Table 1. Information on university entry is only available since 1993 and number of burglaries only from 1994; therefore we will not include them in our main analysis.

Table 1: Data used and Recommended Data by Stiglitz Report

Stiglitz Report	**Data used**
Material living standards	GDP, Labour Income, Gini Coefficient
Health	Life Expectancy, Satisfaction: Health
Education	University Entry Rate *(will not be used in the analysis because it is only available since 1993)*
Personal activities including work	Unemployment Rate, Overtime, "worried about Job Security", "worried about Own Economic Situation"
Political voice and governanve	*No variable available for a sufficiently long time period*
Social connections and relationships	*No variable available for a sufficiently long time period*
Environment	Pollution, "worried about Environmental Protection"
Insecurity, Economic and physical nature	Military Spending, "worried about World Peace", "worried about Economic Development", Number of burglaries *(will not be used in the analysis because it is only available since 1994)*

Table 2 provides the summary statistics for the macro level indicators showing the mean over the time period 1991 to 2008, the standard deviation, minimum and maximum. Our data collection provides us with observations over 18 years for 15 variables. For purpose of presentation, the variables are not standardized, but in our further analysis

this will be automatically taken into account by the correlation matrix which we use for the factor analysis, since the correlation is calculated by dividing the covariances by respective standard deviations.

Table 2: Descriptive Statistics: Macro Level (N=18)

Variable	mean	sd	min	max
GDP per capita (annual)	26660.0556	1001.5923	25056	28464
Labour Income (monthly)	1456.6185	54.9008	1318	1549
Life expectancy at birth	77.7346	1.4820	75.32	80.09
Gini coefficient	0.3464	0.0355	.3028	.389
Satisfaction: Health	7.0684	0.1092	6.922	7.245
Unemployment Rate	10.8889	1.2714	8.7	13
Overtime Hours (weekly)	2.0542	0.1566	1.838	2.505
Satisfaction: Job	7.0986	0.1072	6.992	7.291
Worry: Job Security	2.3340	0.0707	2.201	2.455
Worry: Own Economic Situation	2.0777	0.0724	1.963	2.176
Satisfaction: Life	7.1318	0.1136	6.942	7.327
Military Expenditures (% of GDP)	1.5566	0.2502	1.281	2.185
Worry: World Peace	1.7667	0.1139	1.467	1.943
Worry: Economic Development	1.7350	0.1666	1.475	1.973
Air Pollution	59.3611	15.7431	43.88	100
Worry: Environment	1.7708	0.1723	1.422	1.962

3.2 Micro data

For the analysis regarding only the micro level, all data is taken directly from the German Socio-Economic Panel (see Haisken-DeNew and Frick, 2005) for the years 1991-2008. All male and female adult respondents are included in the dataset. Thus, all corresponding SOEP-derived macro generated variables mentioned in the macro data description are used here at the micro level[10]. Since GDP now cannot be included directly, we use labor income on the micro level to capture material living standards. Instead of the university entry rate (which we did not include in the final macro model, because we did not have data for all years), we can now use the education level of the respondents. Instead of the unemployment rate, at the micro level we use a dummy variable capturing whether the respondent is registered unemployed or not. We now cannot include the

[10]The analysis was run for (a) all years 1991-2008, (b) just 1991 and (c) just 2008 to compare the stability of the results. We later present the results only from 2008, as the other results lead to qualitatively identical interpretations.

macro level indicators for life expectancy, military spending and pollution, since there is no discernable variation across individuals in each panel wave. The data were extracted using PanelWhiz[11].

Table 3 provides the summary statistics for the micro level indicators for 2008. We can include 8840 individuals who have no missing values for the variables used.

Table 3: Descriptive Statistics: Micro Level (N=8840)

Variable	mean	sd	min	max
Labour Income (monthly)	1540.4515	1019.7256	0	18000
Education (years)	12.5872	2.6129	7	18
Unemployed	0.0154	0.1230	0	1
Overtime Hours (weekly)	2.1865	3.4863	0	23.1
Worry: Job Security	2.3383	0.7103	1	3
Worry: Own Economic Situation	2.0844	0.6643	1	3
Satisfaction: Health	6.9597	1.9222	0	10
Satisfaction: Job	6.9641	1.9498	0	10
Satisfaction: Life	7.1641	1.5440	0	10
Worry: World Peace	1.8944	0.6612	1	3
Worry: Economic Development	1.8779	0.5782	1	3
Worry: Environment	1.8796	0.6137	1	3

4 Analysis

4.1 Factor Analysis and Rotation

We use factor analysis in order to detect patterns in our data structure. The aim of this tool is to reduce the dimensionality of the data. Factor analysis allows describing the covariance structure of many variables in terms of few underlying unobservable factors to be extracted which represent each group of interrelated variables. The variables in each group should be highly correlated among themselves and with the corresponding factor, but should have only small correlations with variables of any other group (Eckey et al., 2002).

Since we are interested in whether certain indicators suggested by the Stiglitz report are highly correlated, factor analysis can help us to identify groups of correlated variables and their relationship to an underlying unobservable construct. Yet, factor analysis does not

[11]See Haisken-DeNew and Hahn (2006).

allow us to draw conclusions whether certain indicators reflect the welfare of a country or well-being of a person better than others. It merely serves to identify those factors that might be redundant because the additional information they provide is negligible.

In this procedure, the p observed variables $X_1, ..., X_p$ are explained by a linear combination of the q common factors $F_1, ..., F_q$ (with q<p):

$$\mathrm{X}_j = \mathrm{F}_1\alpha_{1j} + \mathrm{F}_2\alpha_{2j} + ... + \mathrm{F}_q\alpha_{1q} + e_j$$

where the coefficients α_{qj} are called factor loadings. The error term e_j represents the unique part of the variable X_j that is not accounted for by the common factors. The commmon factors F_q are unobserved and have to be estimated, as have to be the factor loadings. This means that the model is only uniquely identified if certain constraints are imposed on the model, such as that the unique factors are uncorrelated with the common factors (Backhaus et al., 2000).

In practice, there are many ways of extracting the common factors. Here, we use the principal component factor method which minimizes the total variance accounted for by the specific factors summed across all variables. With this method, the correlation matrix is analysed and the communalities (the proportion of variation in the variable explained by the factor model, which is calculated by summing up the squared factor loadings for each variable) are estimated from the correlation matrix under the assumption that they sum up to 1. The principal component method is then applied to the reduced correlation matrix (correlation matrix minus the unexplained part of the variance of the standardized observed variables). This means that eigenvalues and the correspondng eigenvectors with norm 1 are determined. The main q eigenvectors corresponding to the q largest eigenvalues of the correlation matrix then determine the factor loadings. The factor loadings tell us which variables are highly correlated with each of the factors and thus can justifiably be grouped together (Hartung and Elpelt, 2007).

Since we would like to find the factor model that allows the easiest interpretation of the factors, we rotate the factor loadings. The idea behind this is that the factor loadings of each variable can be visualized in a coordination system with two axes for the two factor loadings for each variable (for the two dimensional factor model). If we draw a line from the point of origin to each variable point, the Pythagorean theorem tells us that the square over this line equals the sum of the squares over the factor loadings. The line from the origin represents the multiple correlation coefficient of the variable and the two

common factors. Hence, the square over the line from the origin equals the communality. Thus by rotating the axes while holding the line of the origin constant, we do not change the communality, the explained part of the variance of the variable by the factors. Here we use the varimax method which aims at having factor loadings close to 0 or close to 1. This is done by chosing the rotation angle such that the variance of the loadings is maximized. The varimax method is a right-angle rotation method, consequently the axes of the coordination system remain right-angled and thus the factors can be interpreted independently from each other (Eckey et al., 2002).

In many applications it makes sense to test whether a variable should be included in the analysis or not, because its correlation with other variables cannot be ascribed to common factors. For these applications the Kaiser-Meyer-Olkin criterion might help which is based on the idea that on the one hand there has to be a close relationship to the other variables (this is reflected by a high multiple correlations coefficient) and on the other hand that this close relationship should not only depend on the influence of one variable but preferably on many other variables (which is reflected by a small partial correlation coefficient). This is summed up by the following KMO criterion for each factor model (Eckey et al., 2002):

$$\begin{aligned} \text{KMO} &= \frac{\sum_{j=1}^{m}\sum_{k=1}^{m} r_{j,k}^2}{\sum_{j=1}^{m}\sum_{k=1}^{m} r_{j,k}^2 + \sum_{j=1}^{m}\sum_{k=1}^{m} r_{j,k-1,2,\ldots(j),(k)\ldots m}^2} \text{ with} \\ r_{j,k-1,2,\ldots(j),(k)\ldots m}^2 &= \text{partial coefficient of determination} \\ (j)\,(k) &= \text{exclusion of variables j and k} \end{aligned}$$

One advantage is that this criterion can also be applied to each variable which is expressed by the following *kmo* (measuring of sampling adequacy) as in Eckey et al. (2002):

$$\text{kmo}_\text{j} = \frac{\sum_{k=1}^{m} r_{j,k}^2}{\sum_{k=1}^{m} r_{j,k}^2 + \sum_{k=1}^{m} r_{j,k-1,2,\ldots(j),(k)\ldots m}^2} \text{ for all k} \neq \text{j}$$

In general, a *kmo* bigger than 0.6 is seen to be acceptable in the literature. We will report KMO for every model and *kmo* for each variable, although their interpretation for our application should be different from their general interpretation in terms of acceptability. The lower case *kmo* is simply an additional check for us whether a variable is unique or simply highly correlated with the other variables. Small *kmo*'s are not an indicator of misspecification, small realizations of *kmo* simply show us which variables are more unique

than others in terms of correlations. It can also be expected that the more variables we add to the analysis, the smaller the *kmo*'s will be, because it becomes less likely that there is a strong correlation to all the other variables.

Because we have several variables potentially measuring similar underlying concepts, we group the variables that we expect to be related and feed the groups step by step to the factor model to understand the behavior of the model and the data. Model 1 is assumed to reflect on the macro-level objective material living standards and includes GDP (macro), life expectancy (macro), labor income (micro) and the Gini coefficient (micro). For Model 2, we include all variables from Model 1 and add variables which we expect to reflect job security: unemployment rate (macro), average overtime hours (SOEP), worries with job security (SOEP) and worries with own situation (SOEP). Model 3 is Model 2 plus subjective satisfaction measures: health satisfaction, job satisfaction and overall life satisfaction. Finally, Model 4 augments Model 3 with variables reflecting general insecurity and environmental conditions: military expenditures (macro), air pollution (macro) and worries with world peace (SOEP), the economic development (SOEP) and the environment (SOEP).

This estimation strategy allows us to see immediate changes when including further variables and also to detect those variables that load the highest on each factor. Model 5 combines the variables with the highest factor loadings from Model 4. Through this strategy, we should be able to determine the variables that can explain most of the variation in the data. The various models for the macro level are described in Table 4. On the micro level, the same strategy is applied, leaving the variables which are only available on the macro level out of the analysis, and adding the micro variables described in the data section instead.

4.2 Macro Analysis

The analysis is performed using factor analysis in Stata using the principal-component factors method for the 18 years available: 1991-2008. The factor loadings are first rotated using the *varimax* procedure, for easier interpretation and to ensure orthogonal loadings between the factors. The variables having the highest factor loadings are underlined. These represent the variables that are correlated the most with the unobserved latent factors.

Table 4: Models estimated

Model	Variables included
[Model 1]	**Objective Material Living Standards** Real GDP/capita (macro), life expectancy (macro), Real Labour Income (SOEP), Gini coefficient (SOEP)
[Model 2]	**is Model 1 and Job insecurity** Unemployment rate (macro), average overtime hours (SOEP), worries with job security (SOEP) and worries with own situation (SOEP)
[Model 3]	**is Model 2 and Subjective satisfaction measures** health satisfaction, job satisfaction, life satisfaction
[Model 4]	**is Model 3 and General insecurity and environmental conditions** military spending as a share of GDP, worries about world peace, worries about economic development, pollution, worries about environmental protection.
[Model 5]	**combines variables from the most important factor loadings over Models 1-4.**

Table 5: Macro Model 1

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.357	–	0.839	0.839

Variables	Factor1	Uniqueness	kmo
GDP per capita	0.959	0.081	0.716
Labour Income	0.833	0.306	0.909
Life expectancy at birth	0.972	0.055	0.692
Gini	0.894	0.200	0.969

Note: N=18, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.969.

Table 5 summarizes the results from Model 1, exclusively focusing objective material living standards. The four variables compress to one single unobserved latent factor, accounting for 84% of the variation amongst them. Examining the factor loadings, one can ascertain the contribution of each individual variable to the latent factor. Thus "life expectancy" is correlated with the latent Factor1 at the level $\rho = 0.97$, a particularly high level. Slightly less correlated with the latent Factor1 is the measure of GDP at $\rho = 0.96$. Nonetheless, the strong correlation between all variables and the latent factor indicates the possibility of focusing simply on *only one* of the variables as opposed to using all three. The uniqueness (the variance of the variable that is not shared by the other variables) of the variable "labour income" is highest; still the *kmo* criterion for this variable is pretty high in comparison to life expectancy at birth which has a very small uniqueness value but loads very highly on the factor. This indicates that although labour income has a relatively high uniqueness, it is closely related to many other other variables and not only to one single variable as is most likely the case with life expectancy at birth (very small uniqueness but also small *kmo*).

We augment the analysis to Model 2 as displayed in Table 6, now also including job insecurity measures. We see that all eight variables compress into 2 latent factors explaining 78% of the variation. Latent Factor 1 accounts for 45% of the variation in the eight variables and Factor 2 accounts for an additional 31%. GDP again loads highly on Factor 1 again with a correlation of $\rho = 0.97$, slightly outstripping life expectancy at $\rho = 0.94$. The job insecurity/job situation variables now generate a second factor on which they load highly, except for overtime which seems to be more closely related to Factor 1. The unemployment rate is the variable that loads the highest on Factor 2 at $\rho = 0.90$. Very similar loadings are found for job security worries and worries about own economic development. The values for *kmo* now drop significantly compared to model 1. This is expected, because we measure now two different underlying concepts as expressed by the two factors that are extracted.

Further augmenting the analysis to form Model 3 as displayed in Table 7, we now account for various domains of satisfaction. As a result we still find GDP to load highly ($\rho = 0.97$) on Factor 1, the most important factor, explaining 34% of the variance of all variables. However, now health satisfaction loads highly on Factor 2 ($\rho = 0.97$), with a similar behavior for job satisfaction and overall life satisfaction. Now, the official unemployment rate together with the other job situation variables loads highly on the third most im-

Table 6: Macro Model 2

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.606	1.102	0.451	0.451
Factor2	2.504	–	0.313	0.764

Variables	Factor1	Factor2	Uniqueness	kmo
GDP per capita	0.971	0.123	0.043	0.593
Labour Income	0.763	0.256	0.352	0.863
Life expectancy at birth	0.944	0.280	0.031	0.660
Gini	0.835	0.218	0.255	0.881
.....				
Unemployment Rate	-0.010	0.900	0.190	0.448
Overtime	0.501	0.017	0.749	0.498
Worry: Job Security	-0.388	-0.856	0.117	0.589
Worry: Own Economic Situation	-0.302	-0.869	0.154	0.619

Note: N=18, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.619.

portant Factor 3 ($\rho = -0.94$). The variable overtime has a high uniqueness value and therefore does not load highly on only one factor but loads on several factors. The *kmo* criteria drop for all variables when we are including the additional satisfaction variables. We conduct the last model augmentation to specify Model 4 by adding variables for general insecurity and environmental conditions, as displayed in Table 8. Factor 1 is still dominated by the hard indicators GDP and life expectancy ($\rho = 0.96$). Factor 2 is dominated by the objective unemployment rate ($\rho = -0.94$) and also the other job situation variables (except for overtime which loads highly on the fourth factor). Factor 3 is strongly correlated with the subjective measures, especially health satisfaction ($\rho = 0.96$), while the new Factor 4 is dominated by the subjective general insecurity measure, worries for world peace. From the last added group of variables, this is the only one loading highly on the fourth factor. Worries about economic development loads on the same factor as unemployment; air pollution, worries about the environment, and military expenditures load highly on the first factor, together with GDP.

The rankings of the factors are given at the top of each table. Factor 1 explains about 3.5 times the variance compared to Factor 4. Thus very clearly, the objective measures GDP and the unemployment rate dominate Factors 1 and 2, explaining about 58% of the variation of all variables under consideration.

In a final step we create a parsimonious Model 5 in which we retain those variables which display the highest factor loadings for each of the four factors in Model 4 (Table 9).

Table 7: Macro Model 3

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.736	0.945	0.340	0.340
Factor2	2.790	0.378	0.254	0.593
Factor3	2.413	–	0.219	0.813

Variables	Factor1	Factor2	Factor3	Uniqueness	kmo
GDP per capita	0.965	0.139	-0.106	0.037	0.588
Labour Income	0.776	-0.008	-0.215	0.351	0.567
Life expectancy at birth	0.948	0.081	-0.257	0.028	0.611
Gini	0.871	-0.083	-0.146	0.213	0.464
Unemployment Rate	-0.002	0.053	-0.936	0.122	0.356
Overtime	0.412	0.364	-0.136	0.680	0.347
Worry: Job Security	-0.424	0.059	0.827	0.132	0.536
Worry: Own Economic Situation	-0.362	0.300	0.813	0.118	0.549
Satisfaction: Health	0.069	0.953	-0.028	0.087	0.353
Satisfaction: Job	-0.118	0.919	0.114	0.128	0.362
Satisfaction: Life	0.210	0.881	0.123	0.165	0.403

Note: N=18, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.403.

The four variables, GDP, unemployment rate, health satisfaction and worries for world peace collapse into two factors, in which the highest loadings are claimed by the objective indicators GDP and unemployment rate ($\rho = 0.78$ and $\rho = 0.87$ respectively), explaining 60% of the variation in all four variables. It should be noted that all four variables have a high uniqueness contribution, indicating the extent to which the variables contribute additional information. Although the loading of worries for world peace is similar to the factor loading of GDP, it also loads on Factor 2. Health satisfaction is split between Factor 1 and 2.

Thus, if we are interested in compressing the model to include only variables with a high informational value-added, we see that the variables GDP and the unemployment rate are correlated highly with the key factors. Thus, we can already explain a substantial portion by simply looking at these two key variables for measures of well-being, without gaining a lot more additional variation by including more indicators. This conclusion is confirmed by looking at the correlations of the predictions of the two factors extracted by this model with the predictions of the factors of a principal component analysis where all variables are included and thus the maximal variance of all the variables is captured by the principal component factors. The correlations are significant and range from 0.6 to

Table 8: Macro Model 4

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	6.226	3.126	0.389	0.389
Factor2	3.100	0.284	0.194	0.583
Factor3	2.816	1.006	0.176	0.759
Factor4	1.810	–	0.113	0.872

Variables	Factor1	Factor2	Factor3	Factor4	Uniqueness	kmo
GDP per capita	0.959	0.051	0.075	0.190	0.035	0.419
Labour Income	0.834	-0.206	-0.002	-0.049	0.259	0.509
Life expectancy at birth	0.955	-0.120	0.021	0.180	0.041	0.404
Gini	0.887	-0.018	-0.063	-0.242	0.150	0.293
.....						
Unemployment Rate	0.126	-0.935	0.058	0.161	0.081	0.398
Overtime	0.349	-0.076	0.204	0.782	0.219	0.180
Worry: Job Security	-0.525	0.700	0.046	0.034	0.231	0.328
Worry: Own Economic Situation	-0.427	0.758	0.295	0.065	0.152	0.299
.....						
Satisfaction: Health	0.100	0.026	0.964	-0.005	0.059	0.235
Satisfaction: Job	-0.094	0.103	0.934	0.014	0.109	0.261
Satisfaction: Life	0.221	0.183	0.853	0.172	0.160	0.202
.....						
Military Expenditures	-0.868	0.312	-0.018	-0.300	0.059	0.404
Worry: World Peace	0.134	0.160	-0.023	0.867	0.203	0.396
Worry: Economic Development	-0.051	0.856	0.272	0.303	0.099	0.257
Air Pollution	-0.881	0.319	-0.107	-0.250	0.047	0.414
Worry: Environment	0.835	-0.305	0.237	0.105	0.143	0.360

Note: N=18, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.360.

Table 9: Macro Model 5

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.346	0.304	0.337	0.337
Factor2	1.042	–	0.261	0.597

Variables	Factor1	Factor2	Uniqueness	kmo
GDP per capita	0.784	0.218	0.339	0.499
Unemployment Rate	-0.033	0.870	0.241	0.474
Satisfaction: Health	0.349	0.427	0.695	0.511
Worry: World Peace	0.780	-0.234	0.336	0.495

Note: N=18, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.495.

0.7, indicating that we have successfully reduced the dimensionality of the data without much loss of information.

Finally, Table 10 shows the correlation amongst the key variables and the corresponding p-values. Since they are all greater than 0.1, the null hypotheses of no correlation are not rejected. This indicates that all four variables add informational content to the determination of the level of welfare of Germany, assuming that these are correlated with the true level of welfare for Germany.

Table 10: Correlation Matrix of the Key Variables

Variables	GDP	Unemployment Rate	Satisfaction: Health	Worry: World Peace
GDP	1.000			
Unemployment Rate	0.098	1.000		
	(0.700)			
Satisfaction: Health	0.185	0.026	1.000	
	(0.463)	(0.918)		
Worry: World Peace	0.299	-0.004	0.030	1.000
	(0.228)	(0.987)	(0.907)	

Note: Significance levels in brackets.

4.3 Micro Analysis

We check the robustness of these results at the micro level. Although we have information from 1991 to 2008, we focus here on the 8840 observations for the last year 2008; qualitatively, there is very little difference, whether one uses only 1991, only 2008, or 1991-2008. Using a single survey wave, we eliminate the potentially problematic issue of repeated observations for each individual. In any case, the different time periods produce almost identical factor structures and loadings.

Table 11: Micro Model 1

Factors	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	1.385	–	0.692	0.692

Variables	**Factor1**	**Uniqueness**	**kmo**
Labour Income	0.832	0.308	0.500
Education	0.832	0.308	0.500

Note: N=8840, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.500.

Examining Table 11, we compare labour income and education and see almost identical factor loadings. Each component variable is correlated with the latent Factor 1 with a $\rho = 0.83$. As in the macro analysis, we augment the model with additional variables from the area of job insecurity in Table 12. Here worries about job security loads highest on Factor 1 and labour income loads highest on Factor 2. However in this case, Factor 1 and Factor 2 are indistinguishable in size, each contributing to 26% of the variance explained in Model 2 variables.

Table 12: Micro Model 2

Factors	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	1.575	0.011	0.263	0.263
Factor2	1.564	–	0.261	0.523

Variables	**Factor1**	**Factor2**	**Uniqueness**	**kmo**
Labour Income	0.179	0.787	0.349	0.613
Education	0.258	0.614	0.556	0.661
.....				
Unemployed	-0.188	-0.270	0.892	0.758
Overtime	-0.161	0.688	0.501	0.616
Worry: Job Security	0.853	0.004	0.272	0.567
Worry: Own Economic Situation	0.829	0.150	0.290	0.590

Note: N=8840, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.590.

We now add the satisfaction variables, overall satisfaction and contentment in the domains health and job satisfaction in Table 13. Health satisfaction loads highest on Factor 1, although all satisfaction measures behave very similarly with respect to Factor 1. Job security worries loads highest on Factor 2 and labour income now loads highest on Factor 3. However, one must keep in mind that the relative contributions of the three factors are almost identical, each contributing around 20% of the total variation in the variables. Remarkably, the *kmo*'s are in general higher than in the corresponding macro model in Table 7 where there were several variables with *kmo*'s smaller than 0.4, whereas in this table no *kmo* is smaller than 0.6. This indicates that the variables on the micro level in general seem to be more interrelated than on the macro level.

We extend the model in Table 14 even further with worries about peace, development and the environment. Now there are four factors, each contributing from 13-16% (almost identical contributions), with health satisfaction loading highest on Factor 1, worries about one's own economic situation loading highest on Factor 2, worries about the environment

Table 13: Micro Model 3

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.894	0.293	0.210	0.210
Factor2	1.601	0.029	0.178	0.388
Factor3	1.572	–	0.175	0.563

Variables	Factor1	Factor2	Factor3	Uniqueness	kmo
Labour Income	0.023	0.187	0.782	0.353	0.624
Education	-0.009	0.298	0.600	0.551	0.677
.....					
Unemployed	-0.154	-0.066	-0.313	0.874	0.799
Overtime	0.010	-0.179	0.689	0.494	0.610
Worry: Job Security	0.093	0.852	0.011	0.266	0.683
Worry: Own Economic Situation	0.223	0.785	0.159	0.309	0.703
.....					
Satisfaction: Health	0.814	-0.001	0.014	0.337	0.715
Satisfaction: Job	0.737	0.178	-0.023	0.425	0.769
Satisfaction: Life	0.778	0.258	0.046	0.326	0.717

Note: N=8840, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.717.

on Factor 3 and labour income highest on Factor 4. Again the *kmo*'s are pretty high in comparison to the corresponding macro model presented in Table 8.

Including the four variables that loaded highest on each of the factors in the most comprehensive model, we examine the results in Table 15. Only two factors are drawn from the four variables, with labour income loading highest on Factor 1 and worries about the environment loading highest on Factor 2. Each factor contributes an almost identical amount of 30% of the total variation. Hence, this result is similar to the macro model where we identified GDP per capita (which corresponds to labour income) and the unemployment rate (which corresponds to worried abut economic development) as the most important factors.

At the micro level, there is a clear sign that hard indicators like labour income still have a particularly strong role to play in explaining overall variance. However, three of the four strongest variables are subjective indicators: health satisfaction, economic worries and environmental worries.

Table 14: Micro Model 4

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.919	0.076	0.160	0.160
Factor2	1.843	0.207	0.154	0.314
Factor3	1.636	0.053	0.136	0.450
Factor4	1.582	–	0.132	0.582

Variables	Factor1	Factor2	Factor3	Factor4	Uniqueness	kmo
Labour Income	0.033	0.164	0.000	0.788	0.351	0.624
Education	-0.008	0.330	-0.162	0.593	0.514	0.673
. . . . .						
Unemployed	-0.170	-0.018	-0.119	-0.329	0.849	0.817
Overtime	-0.007	-0.169	0.112	0.679	0.498	0.614
Worry: Job Security	0.137	0.756	0.010	0.050	0.407	0.753
Worry: Own Economic Situation	0.228	0.777	0.104	0.160	0.308	0.730
. . . . .						
Satisfaction: Health	0.799	0.009	0.098	0.004	0.352	0.722
Satisfaction: Job	0.749	0.149	-0.006	-0.013	0.416	0.777
Satisfaction: Life	0.783	0.249	-0.035	0.047	0.321	0.726
. . . . .						
Worry: World Peace	-0.001	0.160	0.829	0.074	0.282	0.608
Worry: Economic Development	0.055	0.627	0.356	-0.045	0.475	0.775
Worry: Environment	0.039	0.018	0.865	-0.051	0.247	0.569

Note: N=8840, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.569.

Table 15: Micro Model 5

Factors	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.225	0.057	0.306	0.306
Factor2	1.168	–	0.292	0.598

Variables	Factor1	Factor2	Uniqueness	kmo
Satisfaction: Health	0.188	0.650	0.542	0.540
Worry: Own Economic Situation	0.677	0.411	0.374	0.512
Labour Income	0.843	-0.153	0.266	0.496
Worry: Environment	-0.146	0.744	0.425	0.560

Note: N=8840, FA by principal-component factors with varimax.
Overall Kaiser-Meyer-Olkin measure of sampling adequacy is 0.560.

5 Conclusions

This study has examined the potential role of alternative well-being indicators, over and above standard hard indicators such as income, unemployment and working hours. Alternative measures also include indicators for satisfaction or worries in various domains. The study uses the principel components factors method rotated with the *varimax* option to investigate the additional information provided by the alternative well-being indicators.

After grouping variables into logical co-related units, we have let the factor analysis show us which particular variables tend to provide additional information and which are simply correlated with other indicators. We have systematically augmented our analysis models to include more and more domains and ultimately focus on the variables correlated most with the underlying latent factors. At the macro level, we focus on GDP, the unemployment rate, health satisfaction and worries about world peace. At the micro level we focus on labour income, health satisfaction, economic worries and environmental worries. Comparing the macro to the micro level, we see very similar patters of variables explaining overall variation, with slightly more room for subjective variables at the micro level.

Naturally, with this analysis we cannot say much about which factors reflect the true well-being of a person or a country, but we can reduce all the suggestions by the Stiglitz Commission and other researchers to those variables that offer *additional* information in the sense of additional variation. This enables us to reduce the dimensionality of the data without loosing significant information. While we cannot make any strong statements about which of the remaining variables are more important in determining the level of well-being of a person or a country, this was not the intent of the study. Furthermore, our results are specific to Germany and therefore one should not overly emphasize the empirical implications for rich countries with completely different economic systems or for less developed countries.

Nevertheless, our results suggest three closely related conclusions. First, when gauging the well-being of a society comprehensively under the condition that the statistical reporting (i) should be provided timely, (ii) using a stable set of indicators which are measured regularly and reliably, and (iii) requiring that results should not be fragile with respect to slight changes in the concrete indicators employed, then this reporting unavoidably depends on the quality of statistical information which is available on a timely and regular basis. Second, when we follow the conceptual reasoning offered by the Stiglitz report and

other contributions and, for the case of Germany, utilize all currently available information provided by aggregate sources and micro data, we see that the value added to the assessment of well-being is quite limited. At the present time, relying on hard indicators such as GDP, labour income and unemployment goes a long way in gauging the current state of human welfare.

Third, our analysis still gives considerable credence to efforts augmenting traditional statistical reporting by non-standard indicators, since it reveals that the correlation of alternative indicators suggested by the quality-of-life literature with monetary measures is not at all perfect. And yet, our results lead to the conclusion that this is anything else than an easily winning proposition, as many of the available alternative indicators - although they seem attractive at the level of theoretical reasoning - do not provide important additional information in a statistical sense. Thus, collecting more and better data is a prerequisite for better, i.e. more comprehensive, statistical reporting, but is is not a sufficient condition. Here, as with most other good conceptual ideas, it pays to retain a healthy degree of skepticism when it comes to actual practical implementation.

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