A Multi-dimensional Approach to Subjective Poverty

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Abstract

This paper addresses two key issues in modern policy- oriented poverty research. First, we recognize that poverty is an individual feeling and not an objective status. This leads to an operational definition of subjective poverty as being below a certain degree of satisfaction. Second, we distinguish several domains of life, and consequently, several types of poverty, each pertaining to a specific life domain. It is found that, although the chance on being poor in one domain enhances the chance to be poor in another domain, it is justified to see poverty as a multi-dimensional concept. Poverty 'with life as a whole' may be decomposed into poverty components according to life domains.

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1. Introduction

The concept of poverty is elusive. On one hand poverty is a politically and psychologically loaded concept. It is the subject of novels and the subject of many scientific studies. On the other hand, there is no straightforward definition of the concept and a generally accepted way of measurement. This makes it difficult to use it in the political debate on poverty reduction.

How do we distinguish between the poor and the non-poor and what are the main causes of poverty? These questions are pertinent for societies, which attempt to eliminate poverty by policy measures. Although any society has to cope with poverty, the problem is most pertinent for the poor less- developed countries. For these countries it is hard to get a good idea about the income of households, especially because of the fact that such societies are not completely 'monetarized'. There is a considerable amount of home production and exchange in kind. Moreover, poverty must be seen as a partly relative concept, as the visible circumstances of your reference group and jealousy are taken into account when feeling poor or non-poor. So it might be that in a country with a rural and urban part living next to each other , the city dwellers will consider the rural inhabitants as poor, but the rural inhabitants do not *feel* themselves poor, as they compare their living conditions with those of their neighbours (see e.g. Ferrer-i-Carbonell (2005), Luttmer (2005)).

For long it has been thought that poverty is a condition that may be wholly described in terms of income. If household income falls below a specific income level $y_{\min}$, which is called the poverty line, then the household is called *poor.* In many developed economies

such a poverty line is defined and households are eligible for social assistance, if they earn less than $y_{\min}$. This approach is the cornerstone of the first poverty studies ,started by Rowntree (1901).

Later on it was recognized that income as such is too crude a measure to describe the situation of poverty. Some households are able to spend their income more efficiently than others; there are also substantial differences in price levels between regions within a country or between the city and the countryside. Some households get income in kind, while others do not. One of the first thorough studies was that by Townsend (1979). A rather recent review is given in Citro and Michael (1995).

Sen (1985) pointed out that income or the material consumption level of the household is partly the result of a voluntary decision. Individuals may choose for a leisurely life with not much income or for a heavy workload with a lot of income. Income is an output variable.

This idea triggers the quest for more basic household characteristics. Sen tries to define the *capabilities* of an individual or a household, which determine its *earning potential.* Although Sen's idea is intellectually and intuitively attractive, it turns out that it is very hard to define and measure capabilities empirically (see Cohen, 1993, Deutsch and Silber, 2005). This may be the reason that the capability approach has not been credibly implemented yet[1].

Perhaps the gravest problem of poverty measurement is that for many of the manifestly poor countries the idea of income poverty is not an adequate concept. In those countries a considerable part of consumption does not stem from marketed goods and services but is

[1] See however for a very recent empirical contribution Krishnakumar (2005).

based on home production and exchange in kind. Moreover, for many poor it is rather difficult to determine their money income, as it is highly volatile and the definition of the nuclear household that has to be supported from a specific income is frequently difficult to operationalize.

In the seventies an alternative approach was advocated by Goedhart et al. (1977) and Van Praag et al.(1980). See also Danziger (1984), Pradhan and Ravallion (2000), Ravallion and Lokshin (2002), Van Praag et al. (1982). They argued that poverty was a feeling and that we had to look for the psychological components. The objective approaches have a paternalistic flavor. The government or 'experts' decide which consumption level corresponds to poverty. Such a line is 'objectively' fixed. However, it is by no means clear that the household classified as 'poor' according to the objective definition of poverty recognizes itself as poor, while also households that feel poor are classified as being 'non-poor'. The subjective approach starts by *asking* households how they evaluate their own situation in terms of verbal labels 'bad', 'sufficient', 'good'. By assigning numerical values, e.g. between 0 and 10, to these ordered labels ,one may estimate a function $U = U(y)$, which describes the relationship between household income *y* and the resulting evaluation *U*. Defining a specific evaluation level $U_{\min}$ as the 'beginning of poverty', such that if an individual evaluates his own situation by $U < U_{\min}$ he is feeling himself 'poor', one may calculate the corresponding income level $y_{\min}$ by solving the equation $U(y_{\min}) = U_{\min}$ for $y_{\min}$. This yields the *subjective* poverty line. If we take into account that there are 'intervening variables' like family size, age, health, or in short a vector of variables *x*, we may estimate a function $U = U(y;x)$, yielding an *x*-differentiated poverty line $y_{\min}(x)$. For instance, if *x* is 'family size' we get in this way a

poverty line, differentiated according to family size. A slightly different method is to ask households what income they consider to be their minimum income 'to get along' or 'to make ends meet'. These approaches are sometimes summarized as the 'Leyden approach', named after the Dutch university where the method was first thought out. The basic feature of all those approaches is that poverty is defined as a feeling, which is observable by asking individuals 'how satisfied they feel with their life, their incomes, etc.. We also refer to the thorough study by Hagenaars(1986). There is a voluminous literature on this method with many applications to various countries, but it is as yet nowhere adopted as an 'official' method. See also Garner and Short (2004), Buhmann et al(1988)., Pradhan and Ravallion, (2000), Kapteyn, Kooreman, and Willemse, (1988), Van den Bosch (2001). We refer also to Gustafsson, Shi and Sato (2004) for a first application of the method for urban China.

An other strand of research was triggered by the observation that the household's well-being does not exclusively depend on money income, but also on leisure time, health, etc. We mention Maassoumi(1986), Case and Deaton (2002), Deutsch and Silber (2005), and Slottje (1991), and recently Duclos, Sahn, and Younger (2006). They stress that poverty is a multi-dimensional phenomenon.

In this paper we will make an attempt to mix the two approaches, that is the subjective element and the multi-dimensional element. The result will be a subjective multi-dimensional poverty concept. We shall make use of the approach to the measurement of happiness as developed by Van Praag, Frijters, Ferrer-i-Carbonell (2003) and Van Praag and Ferrer-i-Carbonell(2004). This builds also on the work of economists like Easterlin (1974), and Clark and Oswald (1994). See also Blanchflower and Oswald (2004), Di

Tella, MacCulloch and Oswald (2003), and the thorough recent survey by Senik (2005), the monographs by Frey and Stutzer (2002) and Layard (2005) and the monumental handbook by Kahneman, Diener and Schwarz (1999).

In Section 2 we argue that poverty analysis should be considered within the framework of the measurement of happiness and we describe the model, which we shall use. In Section 3 we consider various measures of multidimensional poverty. In Section 4 and 5 we present the empirical results for financial poverty and overall poverty, respectively. Section 6 concludes.

2. Subjective poverty .

When we talk of poverty and consider it as a more general concept than just income poverty, then it is best interpreted as a 'lack of happiness'. Instead of happiness we might also use alternatively the terms well- being, welfare , utility or satisfaction with 'life as a whole'. There will be many who argue that these words do not have the same connotations, but that there are subtle or not so subtle differences between them. However, if those concepts have not been or cannot be operationalized and differentiated from each other by an operational measurement method , it is very hard to say what the differences are. For the sake of this paper we will use the word 'happiness'. Until recently mainstream economists thought that happiness was an unmeasurable concept. In recent years economists are not that sure anymore that satisfactions are empirically unmeasurable, while psychologists have no difficulty at all with the idea of measurability and cardinal comparability (cf. Frey and Stutzer, 2002, Clark and Oswald, 1994; Van

Praag, Ferrer-i-Carbonell, 2004; Layard, 2005). Instead of theorizing about the concept, it has been realized that so-called satisfaction questions may be used to operationalize the happiness concept. In fact, in various German, British and American questionnaires we find question modules[2]., which run as follows (see e.g. GSOEP, 1996):

Satisfaction question module.

How satisfied are you today with the following areas of your life? Please answer using the following scale:
O means totally unhappy
10 means totally happy
How satisfied are you with …

Your household income	*0—1—2—3—4—5—6—7—8—9—10*
Your health	*0—1—2—3—4—5—6—7—8—9—10*
Your leisure time…….	
……..	

By means of this type of questions it is possible to get an idea how satisfied the respondent is with his income, his health, his job, his leisure, etc. This gives us an idea on income satisfaction, health satisfaction, job satisfaction, and so on. Assuming that life has different aspects, which we call *life domains* in conformity with psychological usage, we

[2] Psychologists recently coined the so-called Personal Well-Being Index PWI, that is asked in many psychological health –related surveys, emanating form Australia. The PWI does only marginally differ from the usual satisfaction question modules in GSOEP, BHPS, The PWI is supported by an international network, centered at the AUSTRALIAN CENTER ON QUALITY OF LIFE, headed by the psychologist Bob Cummins. The networks of (happiness) economists and (happiness) psychologists surprisingly do not interact very much.

are able to assess domain satisfactions. Actually, the answer is numerically specified. In the above wording the scaling is between 0 and 10, but sometimes the scale is 1 to 5 or 1 to 7. In all cases we may rescale the answers between 0 and 1.

The fact that thousands of respondents in various countries are responding on those questions shows quite clearly that individuals understand such questions and that they feel able to evaluate their satisfactions with respect to income, health, etc. on a cardinal numerical scale. The fact that individuals in comparable situations give comparable answers makes it plausible that there is a common understanding of verbal or numerical qualifiers between respondents and an approximately common response behaviour. That is, given a scale from 0 to 10 a domain evaluation of '7' for person *A* has the same emotional meaning and significance for person *A* as for person *B*. Obviously, we do not know this for sure, as we do not have other proven calibrated or certified instruments to measure domain satisfactions. However, if it would not be generally felt by psychologists, social scientists and marketeers that there is an approximate comparability between the answers, such questions would be eliminated a long time ago from the hosts of national surveys, where they have been included since long as standard ingredients (see also Van Praag, 1991). Actually, figures for 'average happiness' are reported , and such averaging of indiviudal responses makes only sense if we assume a cardinal comparability between the answers of individuals.

How do we extract information from such questions with the objective of poverty analysis? As an example let us consider *income* or *financial satisfaction*. It may be assumed that the individual's income satisfaction S_1 depends on his income and possibly other variables like family size.

Let us assume that financial satisfaction S_1 is a function[3]

$$S_1 = S_1(x_1; \beta_1) \tag{1}$$

where x_1 stands for personal variables, including income. Here we take resort to a Probit- related method, which we already used on a large scale in Van Praag, Frijters and Ferrer-i-Carbonell (2003), Van Praag and Ferrer-i-Carbonell (2004), and Van Praag and Baarsma (2005). See for methodological expositions also Van Praag (2005) and Van Praag and Ferrer-i-Carbonell (2006). The difference between Probit and our approach is that we make use of the cardinal information in the satisfaction question as well. It is this cardinal information that is neglected by Ordered Probit. If somebody is evaluating his satisfaction level by a 'seven', we assume that this 'seven' has a cardinal significance in the sense that all respondents who are satisfied for a seven feel equally satisfied. Then it lies at hand to specify the function $S_1 = S_1(x_1; \beta_1)$ as a function between 0 and 10 or after normalization between 0 and 1. We assume $S_1 = N(\beta_1' x_1 + \beta_{1,0}; 0, 1)$, where $N(.; 0, 1)$ stands for the normal distribution function with variance 1. We choose the normal distribution function, just because it is a flexible increasing function on $(-\infty, \infty)$ and bounded between 0 and 1. The normalization of σ to one is harmless. If the variance would be σ, we could write $S_1 = N(\beta_1' x_1 + \beta_{1,0}; 0, \sigma) = N(\frac{\beta_1' x_1 + \beta_{1,0}}{\sigma}; 0, 1)$. A similar argument applies for the normalization $\mu = 0$.

[3] We write S_1 as it refers to the first life domain. In this section we will sometimes drop the index, but we need indexation later on.

If a respondent answers '7', it does not imply that his satisfaction is exactly equal to 7 on a [0,10]-scale. Nevertheless, his satisfaction will be in the range of 7. For instance, the exact evaluation might be 6.75 or 7.25, but due to the necessary discreteness of the responses the observed answer is rounded off at 7. However, it would be very improbable that the exact evaluation would be 7.75, for in that case the respondent would have rounded off to 8. More precisely, we assume that if somebody responds 7 his true evaluation will be in the interval (6.5, 7.5]. A similar reasoning holds for all other response values. For the extremes we use an obvious modification. The observed value 0 corresponds to the interval [0, 0.5] and the value 10 to (9.5, 10]. If we normalize the scale from [0,10] to the [0,1] - interval, the intervals will be [0,0.05] ,…, (0.95, 1]. In order to account for omitted variables, errors and rounding-off we now add a $N(0,\sigma)$-disturbance term ε and we assume

$$S = N(\beta' x + \beta_0 + \varepsilon\ ; 0,1) \tag{2}$$

The parameter σ has to be estimated. As usual, we assume that the distribution of ε does not depend on x. Notice, that this model is an assumption, just as any econometric specification. If another model would fit the data better, we have to replace it. The chance on finding a response '7' is

$$P[0.65 < S \le 0.75] = P[N^{-1}(0.65) < \beta' x + \beta_0 + \varepsilon \le N^{-1}(0.75)]$$

$$= P[N^{-1}(0.65) - \beta' x - \beta_0 < \varepsilon \le N^{-1}(0.75) - \beta' x - \beta_0]$$

$$= N(u_{0.75} - \beta' x - \beta_0; 0, \sigma) - N(u_{0.65} - \beta' x - \beta_0; 0, \sigma)$$

The β 's are estimated by maximizing the log-likelihood. It follows that it is possible to estimate a cardinal satisfaction. This Cardinal Probit (CP) -approach is a special case of what is called in the literature sometimes the Group-wise or Interval Regression Method, where information on the regressand is only available group-wise. This is frequently the case in public statistics, such as with respect to household income, which is only known per income bracket.

Also in this setting we may define the latent satisfaction variable $s = \beta' x + \beta_0 + \varepsilon$ with $N(s) = S$.

It is obvious that satisfaction changes when income changes and similar dependencies hold for the other variables. For instance, let us assume that we found that financial satisfaction depends on income *y* and family size *fs* ; more precisely, the relationship is frequently found[4] to be about

$$s_1 = 0.5 \ln(y) + 0.2 \ln(fs) + \beta_0 \qquad (3)$$

[4] See Van Praag, Ferrer-i-Carbonell (2004).

where we assume $\varepsilon = 0$. If we fix the value for s_1, say at *A*, the equation describes an indifference curve in (*y*,*fs*)- space, corresponding to the satisfaction level *A*. Returning to the satisfaction question, we see that satisfaction may take any of the values 0,1,2,…,10. These values correspond to adjacent ranges of the latent variable s_1. For instance, when we assume that poverty starts if somebody evaluates his income satisfaction by 4, this corresponds with a value of $u_{0.4}$ for the latent variable with $N(u_{0.4}) = 4$. Hence the indifference curve in (*y*,*fs*)- space, corresponding to 'the beginning of poverty', is given by the equation

$$0.5\ln(y) + 0.2\ln(fs) + \beta_0 = u_{0.4} \tag{4}$$

We sketch the map of indifference curves in Fig.1. Here three indifference curves are sketched. The middle one is the 'poverty line' in (*y*,*fs*)- space. It separates the space into an upper region of poverty and a lower region of non-poverty. We see that the childless household *A* (2000,2) is just on the brink of poverty. If it gets 2 children, it is in the situation *C*(2000,4) and it may be classified as 'poor'. If its income is increased from 2000 to 3000 , it shifts to position *B* (3000,4) is again on the brink of poverty. The amount of 1000 would be the family assistance needed to lift the household out of poverty.

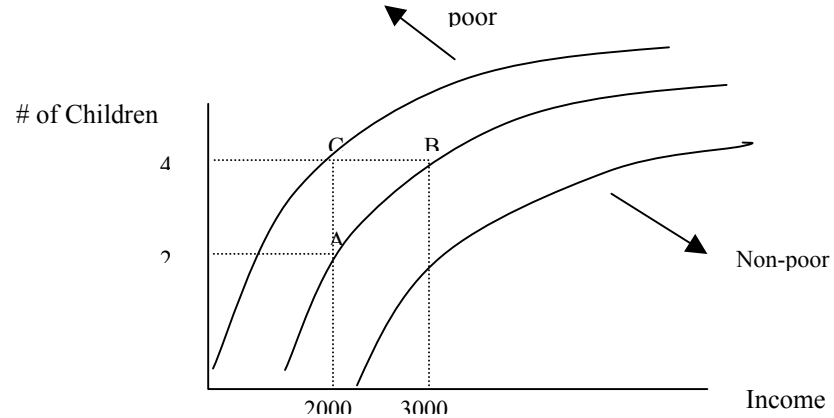

Fig.1. FINSAT- Indifference curves in (fs,income)-space

If the coefficient of *fs* is zero, we find only one solution for y, which we may call *the* poverty line $y_{\min}$. In all other cases we find a *poverty border*. When we distinguish between 'severe poverty', 'poverty', and 'near- poverty' and identify those labels with the satisfaction levels 4, 5, 6 respectively, the corresponding border lines are given by (4), with $u_{0.4}, u_{0.5}, u_{0.6}$[5]. In general, if $s_1(x) = \beta_1' x + C$, the corresponding poverty border corresponding to level *i* becomes

$$0.5\ln(y) + 0.2\ln(fs) + \beta_0 = u_i \tag{5}$$

or equivalently

$$\beta_1' x = u_i - \beta_0 \tag{6}$$

Up to now we have considered only *financial* satisfaction. It is obvious that the same approach may be followed with respect to the other satisfaction types like job

[5] We write for short u_i instead of $u_{i/10}$, as we do not have to fear for confusion.

satisfaction, health satisfaction…., in short with respect to domain satisfactions *2,3,...,j,...,J.*

If those domain satisfactions *j* are explained by latent variables $s_j(x;\beta_j) = \beta_j' x + \beta_{0,j}$, we may also define poverty border-lines for those other life domains.

We would have a system of *J* equations

$$\begin{aligned} & s_1(x;\beta_1) = \beta_1' x + \beta_{0,1} + \varepsilon_1 \\ & ..... \\ & s_j(x;\beta_j) = \beta_j' x + \beta_{0,j} + \varepsilon_j \\ & ..... \\ & s_J(x;\beta_J) = \beta_J' x + \beta_{0,J} + \varepsilon_J \end{aligned} \tag{7}$$

It is obvious that the error terms of such domain satisfactions might be correlated, as we cannot assume for two domains 1 and 2 that $\text{cov}(\varepsilon_1, \varepsilon_2) = 0$. It is a Seemingly Unrelated Equation sytems. However, due to the discrete observation of the s_j's, a ML-solution would involve likelihoods that are a *J*-variate normal integrals. If we distinguish six domains the likelihood might be a six-dimensional integral. Although it is possible to estimate this system by simulated moments methods, in pracitce this is a hell of a job and unnecessary. In Van Praag and Ferrer-i-Carbonell (2004,2006) we developed an alternative method, the so-called Cardinal Ordinary Least-Squares (COLS) method, which works as follows[6].

We evaluate for each response i the latent satisfaction *s* by its conditional expectation

$$\overline{S}_i = E(S \mid u_{i-1} < S \le u_i) = \frac{n(u_{i-1}) - n(u_i)}{N(u_i) - N(u_{i-1})} \tag{8}$$

Notice that we do not condition on x_n and that σ is set at one. We use here a formula, known in normal distribution function theory (see e.g. Maddala(1983,p.366).

Then we formulate for domain j (j =1,…, J) and respondent n the regression equation

$$\overline{S}_{j,n} = \beta'_{j,COLS}\, x_n + \beta_{j,0,COLS} + \varepsilon_n + \eta_{jn} \tag{9}$$

The first error term is an individual fixed random effect, while the second stands for white noise. The usual independency between errors and x, and between the errors ε_n, η_{jn} themselves is assumed.

For the six domains to be considered in the next section we have now a system of six Seemingly Unrelated Regression equations. The covariance matrix is estimated simultaneously.

We called this the COLS-approach. For a more extensive treatment we refer to Van Praag and Ferrer-i-Carbonell (2004,2006)

3. Empirical results

In order to see how this works we borrow the specification presented in Van Praag and Ferrer-i-Carbonell (2004). There the GSOEP sample was divided into four different sub-samples according to whether the household lives in former East- or West-Germany and

[6] Although the intuition behind it will be clear, it is out of the scope of this paper to dwell on the

whether the respondent works or not. This distinction was made as we assumed that the four subgroups would have different attitudes with respect to satisfaction (questions). In the present paper we will only present as an illustration of the methodology the results for the West-workers sample. The data set we will use is the wave 1996 of the German Socio-Economic Panel (GSOEP). In Van Praag and Ferrer-i-Carbonell (2004) we use the waves 1992 to 1997. Given that the main objective of the present paper is to discuss the subjective poverty method, we keep the empirical analysis simple by only using one wave and avoiding the introduction of time and individual effects.

For the present paper we are especially interested in the satisfaction questions, which are worded like the one, quoted earlier.

A simple count for the GSOEP 1996 wave yields the following results for domain poverties, that is, the individuals in the level groups 0,1,…,4 taken together. We see that financial poverty is 6.8% but that with respect to health the poverty is 11.3%, while job scores 10.3%.

Table 1a. A simple count of domain poverties for GSOEP 1996, West-workers

Level	Life as a whole	Financial Situation	Health	Job	Leisure time	Environ-ment	Housing
Poor ≤ 4	0.054	0.068	0.113	0.103	0.177	0.146	0.089
Non-poor > 4	0.947	0.932	0.886	0.896	0.823	0.854	0.912

equivalence between the method involving integrals and the COLS-method.

It is also interesting to consider in how far poverty feelings in one domain are correlated with poverty feelings in a second domain. If we define for each domain a dummy variable D_j which equals zero if (Poor ≤ 4) and equals one otherwise, we may calculate the overlap of domain poverties. We see from Table 1b that 31% of the individuals who are dissatisfied with their financial situation are also dissatisfied by their life as a whole. Of those who are dissatisfied with their life as a whole, 97% are also dissatisfied with their financial situation. From Table 1.b it is clear that most individuals who are dissatisfied with their life as a whole are also dissatisfied with all the other domains, while the opposite is not true. This seems to indicate that individuals who are dissatisfied with their life as a whole are also dissatisfied with many domain satisfactions. In contrast, being dissatisfied with one domain satisfaction does not necessarily mean that individuals are dissatisfied with their life as a whole (first column).

Table 1b. Overlap of domain poverties

	Life as a whole	Financial Situation	Health	Job	Leisure time	Environ-ment	Housing
Life as a whole		0.975	0.978	0.469	0.935	0.956	0.975
Financial Situation	0.311		0.337	0.340	0.491	0.423	0.363
Health	0.219	0.201		0.342	0.330	0.308	0.194
Job	0.242	0.224	0.378		0.374	0.325	0.235
Leisure time	0.142	0.187	0.211	0.217		0.276	0.200
Environ-ment	0.132	0.195	0.238	0.228	0.333		0.204
Housing	0.175	0.275	0.247	0.271	0.398	0.335	

Table 1.b also shows that 'non-financial' poverty is a very realistic phenomenon, especially because it is frequently hard or even impossible to compensate the lack of satisfaction by giving more money to the individual. Apart from the fact that enormous money amounts may be needed

for those compensations (see Ferrer-i-Carbonell and Van Praag, 2002), money is not a determinant of some domain satisfactions.

As an example we reproduce the estimation result for financial satisfaction in Table 2. The other satisfaction - equations are presented in the Appendix *A*. We see that financial satisfaction depends on household net income and on a set of additional variables like age, number of children and education.

Table 2. Financial Satisfaction GSOEP, 1996, west-workers, COLS

	Estim.	t-value
Constant	3.556	3.280
Ln(age)	-2.740	-4.470
Ln(age) ^ 2	0.365	4.270
Min. Age	43	
Ln(household income)	0.164	6.910
Ln(years of education)	0.191	4.310
Ln(adults)	-0.056	-2.540
Ln(children+1)	-0.032	-1.750
Male	-0.050	-2.790
Ln(Savings)	0.077	5.940
Living together?	0.132	4.590
2nd Earner	-0.061	-2.470
Self-employed	-0.027	-0.870
Number Observations	5179	
R^2	0.069	

Dummies for missing variables are not included in the table.

Age has a log - parabolic influence where the individual becomes less satisfied with his financial situation when growing older until the age of 43. After that age satisfaction grows under *ceteris paribus* conditions. Males are slightly less content than females. Financial satisfaction is strongly dependent on the number of adults (16 years and older) in the household and the number of children. If individuals have savings, it is a strong signal of satisfaction. Individuals who live together with a partner are more content and the same holds for individuals with a job. Individuals whose partner has a job are less

satisfied than those who live in a household in which only one adult works. 'Missing'-dummies are included to account for the relatively few incomplete observations.

4. Is poverty really multi-dimensional?

An interesting question is in how far these one-dimensional types of poverty are related to each other? Is it not very probable that someone with a low income, and consequently in financial poverty, will also suffer from bad health, and hence be 'health- poor' as well? In how far are the different types of poverty really different or are they heavily correlated indicators of the same underlying status? If that would be the case, there would be no room nor need for a concept of multi-dimensional poverty, because a one-dimensional concept would do. In order to get a clearer look, let us consider two domains *1,2* with

$$\begin{aligned} s_1(x;\beta_1) &= \beta_1' x_n + C_1 + \varepsilon_{1n} \\ s_2(x;\beta_2) &= \beta_2' x_n + C_2 + \varepsilon_{2n} \end{aligned} \tag{10}$$

We are interested in the covariance or rather the correlation of the two poverty indicators. This correlation may be split up into an explained or structural part and a residual part. We have

$$\operatorname{cov}(s_1, s_2) = \operatorname{cov}(\beta_1' x + \beta_{01}, \beta_2' x + \beta_{02}) + \operatorname{cov}(\varepsilon_1, \varepsilon_2) \tag{11}$$

The covariance between the two domain satisfactions can be split up into two parts. First, a *structural* covariance caused by the fact that both satisfactions partly depend on the

same explanatory variables. Second, a *residual* covariance because the error terms are correlated. Given the hypothesized independence between $\boldsymbol{x}$ and the residual error this decomposition is additive. Now the latent variables are discretely observed, as we do not know the exact value of *s*, but we know only that for *s* holds $u_{i-1} < s(x_n, \varepsilon_n) \leq u_i$, where the *u* 's for the two domains may differ if the response categorizations differ. Assessing the first term at the right-hand side by means of the corresponding sample moment is no problem. The second term is assessed by the covariance matrix of the residuals of the SUR-system. Actually, we observe the satisfactions bracket-wise. This implies that the residuals are 'between- group errors' . Consequently, the covariance matrrix of the calculated residuals is a 'between-' covariance matrix. It underestimates (in absolute value) the real covariance matrix.

Notice that we may group either with respect to the categories 0,1,…,10 or that we may group still further in line with the poverty concept into 'poor' (1,2,3,4) and 'non-poor' (response 5 or higher). We present the variance-covariance matrices as given for the first more refined type of categorization. In Table 3 we present instead of the correlation matrices the so-called *variance-correlation* matrices. These are correlation matrices where the trivial diagonal elements, equal to 1 by definition, are replaced by the corresponding variances[7].

We see that in general there is a significant positive correlation between the domain satisfactions. However, there are some exceptions in the structural part. For instance, older people live in better houses or at least enjoy more housing satisfaction, while at the same time their health is worse than that of younger people. This may explain the

negative correlation between health and housing. A similar explanation may hold for the low correlation between health and environment and leisure satisfactions.

Table 3. Domain Variance/Correlation Matrix; GSOEP 1996 West-workers

	Job Satisf.	Financial Satisf.	Health Satisf.	House Satisf.	Leisure Satisf.	Environ. Satisf.
			TOTAL VARIANCE			
Job Sat.	0.509					
Financial Sat.	0.180	0.383				
Health Sat.	0.221	0.152	0.526			
House Sat.	0.158	0.231	0.120	0.621		
Leisure Sat.	0.160	0.194	0.147	0.221	0.614	
Environm. Sat.	0.124	0.148	0.116	0.144	0.130	0.406
			STRUCTURAL PART			
Job Sat.	0.013					
Financial Sat.	0.008	0.026				
Health Sat.	0.013	0.010	0.039			
House Sat.	0.004	0.014	-0.012	0.024		
Leisure Sat.	0.004	0.004	0.002	0.005	0.045	
Environm. Sat.	0.003	0.006	0.001	0.005	0.007	0.006
			RESIDUAL			
Job Sat.	0.496					
Financial Sat.	0.167	0.356				
Health Sat.	0.205	0.143	0.487			
House Sat.	0.152	0.211	0.131	0.598		
Leisure Sat.	0.153	0.186	0.145	0.214	0.570	
Environm. Sat.	0.120	0.140	0.115	0.139	0.125	0.400

The sizeable correlations between domains imply that the domain satisfactions cannot be seen as independent of each other. There is a considerable linear dependency. A high satisfaction in domain *A* predicts a high satisfaction in *B*, and consequently a strong inequality in domain *A* entails a strong inequality in domain *B* as well. This picture does not change very much when we take account of the fact that the structural variables *X*, which play a role in one domain satisfaction, play also a role in another domain, as is found by looking at the error matrices.

[7] Notice that this may imply that diagonal elements are smaller than non-diagonal entries. Covariances are found by the formula $\sigma_{ij} = \rho_{ij}\sigma_{ii}\sigma_{jj}$.

Our conclusion is that although there is linear correlation, it is not perfect at all. It follows *that it is justified to distinguish between different types of poverty and to see poverty as a multi-dimensional concept. This is our first major result.*

5. Overall poverty

However plausible a multi-dimensional poverty vector concept is, it is obvious that some type of poverty may be more life- destroying than another type of poverty. The first question is then whether there is a trade-off between domain poverties or rather between domain satisfactions? And second, is there a natural aggregate of domain poverties, which may be interpreted as an aggregate poverty concept, 'overall poverty'?

The answer may be found in the survey questionnaire. In many questionnaires that carry domain satisfaction questions we also find a question about General Satisfaction (GS). The only difference is that there is asked for *'satisfaction with life as a whole'* instead for *'satisfaction with a particular domain of life'*. Hence we may define a s_{GS} and explain it by the domain satisfactions $s_1,\ldots,s_k$. Graphically we assume a two-layer- model structure, as pictured in fig.1. (see also Van Praag, Frijters, Ferrer-i-Carbonell, 2003).

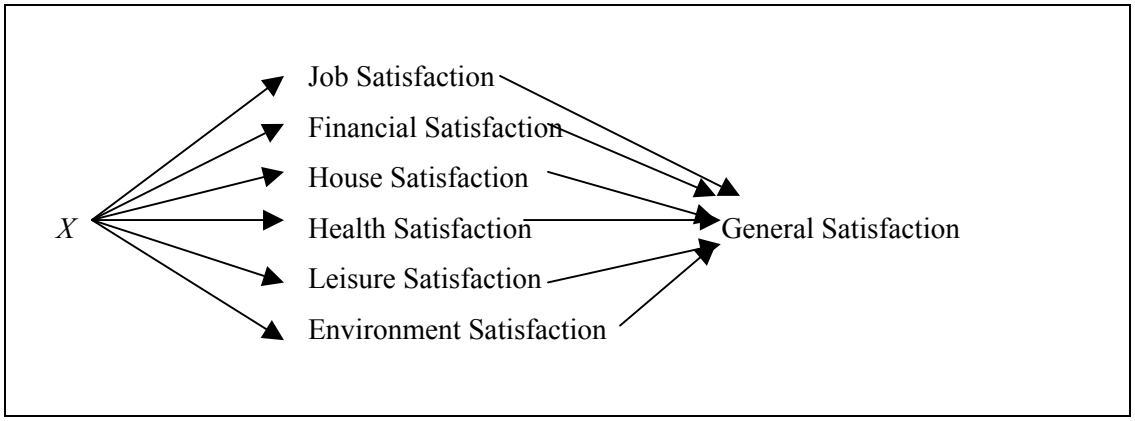

Figure 2: The two layer satisfaction model

Doing this we may analyse the following equation

$$s_{GS} = \mathrm{s}_{GS}(\mathrm{s}_1 \ , \ldots , \ \mathrm{s}_\mathrm{k} \ ) \tag{12}$$

We refer to Van Praag, Frijters, Ferrer-i-Carbonell (2003) and Van Praag, Ferrer-i-Carbonell (2005) for a detailed description of this analysis.

We assume a linear aggregate:

$$s_{GS} = \alpha_1 s_1 + \ \ldots + \alpha_\mathrm{k} s_\mathrm{k} + \beta_{GS} x + \gamma z + \varepsilon_{GS} . \tag{13}$$

We operationalize the s_j variables ($j=1 , , , k$) by their conditional expectations $\overline{s}_{j,i_n}$

$$\overline{s}_{j,i_n} = E(s_j \left| u_{j,i_n-1} < s_j \le u_{j,in}) = \frac{n(u_{j,i_n-1}) - n(u_{j,i_n})}{N(u_{j,i_n}) - N(u_{j,i_n-1})} . \tag{14}$$

and $\overline{s}_{GS}$ likewise. Notice that we do *not* use the *x-corrected* structural predictions but the real 'observations'. Those observations are not exact, but the best estimate we can get[8]. The vector *x* stands for a vector of 'other' variables.

It may well be that the error term ε_{GS} is correlated with the explanatory variables $\overline{s}_j$. For instance, the satisfaction response of an optimist will be structurally higher than that of a pessimist. Hence, if this psychological trait is not explicitly included as an explanatory variable the effect will pop up in the error term. As this psychological trait will affect all satisfaction responses we may expect positive correlation between the error terms of the $\overline{s}_j$-equations. However, we may expect the same effect for satisfaction with life as a whole, that is for $\overline{s}_{GS}$. It follows that estimation of (13) may suffer from an endogeneity bias, as the error term ε_{GS} is correlated with the explanatory variables $\overline{s}_j$. Hence, we attempt to assess this common hidden effect by the first principal component of the domain error matrix. We denote it by *Z*. Hence we estimate the equation

$$\overline{s}_{GS,n} = \alpha_1 \overline{s}_{1,n} + \ \ldots + \alpha_k \overline{s}_{k,n} + \beta_{GS} x_n + \gamma Z_n + \varepsilon_{GS,n} \qquad (15)$$

The estimation results are presented in Table 4. We see that the variable Z in this example is not significant.

[8] If we would attempt to use *x-corrected* structural predictions, we would be caught in a vicious circle, as we are out to estimate such relationships and the ensuing x-corrections.

Table 4. German General Satisfaction explained (GSOEP, 1996 west-workers), method: COLS

	West Workers	
	Estim.	**t-value**
Constant	0.151	3.710
Job Satisfaction	0.157	10.790
Financial Satisfaction	0.275	16.770
House Satisfaction	0.057	4.070
Health Satisfaction	0.190	13.910
Leis. Satisfaction	0.087	6.570
Environmental Satisfaction	0.006	0.410
First-Component *Z*	-0.025	-0.940
Number Observations	5062	
R^2:	0.421	

It is obvious that we can now define an overall- poverty border line on the space of domains by the equation

$$s_{GS}(s,x) = \alpha'_{GS}s + \beta'_1 x + C = u_{GS,i} \tag{16}$$

where s stands for the vector of domain satisfactions and where $u_{GS,i}$ stands for the quantile of General Satisfaction , corresponding to the poverty level (e.g.0.4). Equation (16) again may be interpreted as an indifference curve. The coefficients presented in Table 4 make it possible to interpret overall-poverty as a weighted sum of domain poverties. It makes also clear that there is a trade-off between the domains. For instance less job satisfaction may be compensated by a higher financial satisfaction. Notice that (16) describes an indifference curve on *s*-space, that is R^k . It is more interesting to look

at the corresponding curve on the satisfaction *S*- space, that is the unit cube I^k. Here we have $S = N(s)$. For *k=2* we have for the poverty level 0.4, $\mathrm{N}(S_2 = N(u_{0.4} - \frac{\alpha_1}{\alpha_2}.\mathrm{N}^{-1}(S_1)))$.

For the couple (health, job) we present the indifference curves for the levels *GS = 0.2,0.4,0.6* in Figure 3.

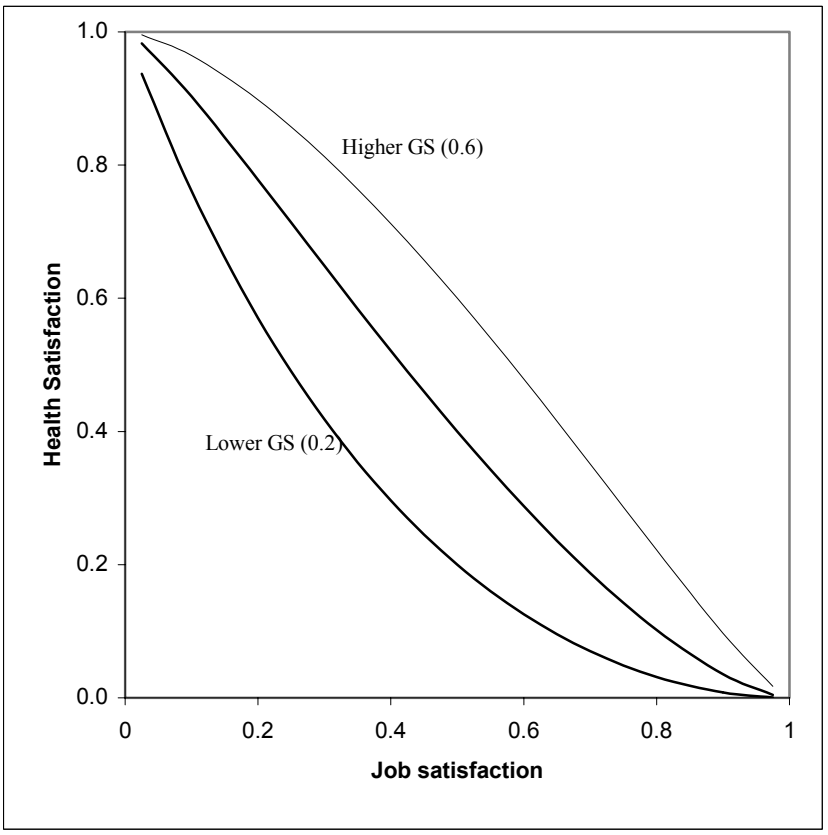

Figure 3. Indifference curves on the domain space.

In a certain sense these domain satisfaction variables are not tangible. However, we may replace the *s* – variables in (16) by their conditional expectations, being the structural parts in (15).

Then we may write (16) as

$$s_{GS}(s_n, x_n) = \alpha'_{GS} B X_n + \beta'_1 x_n + \beta_0 = u_{GS,i} \qquad (17)$$

where the (J x q) – matrix B is

$$B = \begin{bmatrix} \beta'_1 \\ . \\ . \\ . \\ . \\ \beta'_6 \end{bmatrix}$$

where q equals the number of all explanatory variables used and X the corresponding (q x J)- matrix of explanatory variables that are used in the J domain satisfaction equations. Equation (17) is the border- line of overall-poverty.

Especially interesting is of course the trade-off with money. Let us assume that ln(*income*) appears only in the financial satisfaction equation with coefficient $\beta_{1,y}$. Then a change in variables X, say by ΔX, has to be compensated by a (relative) income change $\Delta \ln(y)$ where

$$\beta_{1,y} \Delta \ln(y) + \tilde{B}.\Delta X = 0 \qquad (18)$$

where $\tilde{B}$ is the matrix B except for the column pertaining to $\ln(y)$, where we assume that income has only effect on financial satisfaction. If income has also an effect on other domains (like health), it is obvious how things have to be changed.

6. Conclusion

In this paper we extended and generalized the subjective poverty concept as originally introduced by Goedhart et al. (1977) to a multi-dimensional context. In accordance with the ideas on poverty up till recently, there it was assumed that poverty could stand only for *financial* poverty. Using the life domain concept in this paper we may define any kind of subjective poverty, as soon as we have a corresponding satisfaction question. We saw that we can define various degrees of poverty, ranging from 'severe' to 'hardly'.

Moreover, the method can also include intangibles determinants of poverty, like perceived political freedom, democracy, and environmental factors[9]. It is also usable for non-monetary economies and for aspects of poverty, other than financial poverty.

In this paper we then asked the question whether those types of domain poverty are heavily correlated, in the sense that somebody who may be called poor with respect to one domain *A* is almost automatically also poor with respect to another domain *B*. If this would be the case there is no room for two or more distinct domain poverty concepts, but one would suffice. In this paper it is demonstrated, at least for a German data base, that poverties for the main domains are correlated, but not to such an extent, that poverty with

respect to domain *A* almost implies poverty with respect to *B* or vice versa. In other words, there is room and need for a multi-dimensional poverty concept.

We explained poverty with respect to six domains. So it became possible to explain the subjective *feelings* of poverty by measurable objective variables.

Third, we defined an overall poverty concept as an amalgam of domain poverties and we derived trade-off coefficients between various objective explanatory variables. We notice that it is not essential in this analysis to *explain* poverty. If we do not introduce explanatory variables *x*, we can still measure poverty as such. However, in that case we cannot look for objective causes of poverty and from those findings develop instruments to alleviate poverty.

Fourth, we notice that the satisfaction questions can be answered by (almost) any individual, irrespective of whether he or she is living in a developed or an underdeveloped country and irrespective of whether the household lives in a monetarized environment or not.

In this paper we did not attempt to measure poverty for a specific country, although we tabulated in Table 1 some simple subjective poverty counts for Germany. We reported on the estimation results for one poverty equation. The corresponding equations for the other domains can be found in Van Praag, Frijters, Ferrer-i-Carbonell (2003) or in Van Praag, Ferrer-i-Carbonell (2004).

Finally, the question arises how this new apparatus has to be placed in the present framework of poverty analysis. In our view poverty is a subjective feeling of individuals. Hence, any knowledge and any poverty policy has to rely in the last instance on the

[9] See the work of Frey and Stutzer (2002) for the effect of democracy and Van Praag and Baarsma (2005) for the effect of air traffic pollution.

gauging of those feelings in the population. If specific objective variables explain the feelings of poverty very well, there is of course no problem to replace the outcomes of surveys by some synthetic index, but still we should periodically check if that index still represents that what it is assumed to do. In our view it is natural to base any political poverty measures on subjective data.

It is sometimes thought that subjective indicators are themselves subjective and therefore non-scientific. This idea is based on confusion and not true. As we hope this paper demonstrates, analysis of subjective data can be done in the most objective way. We use a calibrated questionnaire and a sample, representative for the population we are interested in, and we apply the method described above. Such a method should be clearly described, and it should be repeatable. It should lack subjective choices by researchers, or if they are unavoidable, they should be well-documented by the researchers.

The main test for a poverty index is whether it reflects reality. That is, whether the index classifies those individuals or households as poor who perceive themselves as poor and the same for the non-poor. In that respect the subjective measures do not score very highly thus far. This is so, because the error term rules mightily. Partly, this is caused by the fact that the analysis still has to be refined by choosing better functional specifications and better explanatory variables. But partly it is also due to the fact that there is and there will remain always a large element of randomness involved. In terms of significance of the effects we see that the quality of the estimates is very good. This points to the fact that the structural relations underneath are well-estimated, but that there are random components and/or an unobservable components involved, which we cannot catch (yet), but which have rather significant effects on poverty feelings. Nevertheless, what is the

performance of so-called objective measures, like half-median income or the U.S.A. food based poverty index (see Orshansky (1965)) in this respect of individual predictions? There have been only a few attempts to compare those objective measures with the underlying poverty feelings (see e.g. Hagenaars, 1986 and Van Praag, Flik, and Stam, 1997). Those partial comparisons suggest that such measures shoot structurally beyond the mark as well. This is especially due to the fact that they not use subjective household equivalence scales, but objective definitions like that of the OECD, which are based on the intuition of some nutritional experts and/or politicians instead of on subjective data analysis (see Garner and Short (2005)).

Summarizing, we believe that the subjective multi-dimensional concept is a needed instrument. It is needed for scientific analysis and socio-economic policy.

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Appendix *A*.

	Job Satisfaction		House Satisfaction		Health Satisfaction		Leisure Satisfaction		Environmental Satisfaction	
Constant	7.706	5.420	5.709	4.280	4.187	3.320	12.585	9.480	2.982	2.810
Ln(age)	-4.146	-5.310	-4.104	-5.380	-1.870	-2.630	-6.253	-8.400	-1.987	-3.310
Ln(age) ^ 2	0.565	5.110	0.606	5.670	0.174	1.750	0.876	8.390	0.280	3.340
Min Age	*39*		*29*		*214*		*35*		*34*	
Male	-0.128	-1.680	-0.106	-4.770	0.022	1.080	0.113	1.330	0.085	4.730
Ln(household income)	0.078	3.100	0.249	9.520	0.032	1.330	0.047	0.950	0.102	5.440
Ln(years education)	-0.080	-0.410	0.027	0.490	0.206	4.040	0.053	-2.620	0.005	0.100
Ln(adults)	0.049	1.840	-0.092	-3.250	0.026	1.250	-0.072	-3.980		
Ln(children+1)	0.078	3.580	-0.031	-1.350			-0.089	4.800		
Living together?	-0.025	-0.920						-9.910		
Ln(working income)	0.049	0.580			0.007	0.270		-10.280		
Ln(working inc.)* Ln(age)	-0.016	-1.090						0.330		
Ln(work.inc.)*Ln(YrsEdu)	0.020	0.840						0.130		
Ln(working income)*male	0.009	0.940						-8.700		
Self-employed	0.080	1.550	0.031	0.790	0.002	0.060	-0.414		-0.059	-1.810
Ln(working hours)	-0.066	-2.080				1.300	-0.266			
Ln(extra money)	0.014	2.550				0.770				
Ln(extra hours)	-0.004	-0.440								
Ln(Savings)					0.020					
Ln(leisure time)							0.035		0.012	2.300
Ln(leis.time)*ln(hous.inc.)							0.002			
Observ	5098		5171		5185		5177		5179	
R2	0.025		0.039		0.073		0.073		0.015	

Dummies for non-missing variables are not included