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Intensity of Time and Income Interdependent Multidimensional Poverty: Well-Being and Minimum 2DGAP – German Evidence

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ABSTRACT

Intensity of Time and Income Interdependent Multidimensional Poverty: Well-Being and Minimum 2DGAP – German Evidence*

Extending the traditional income poverty concept by multidimensional poverty has been of growing interest within the last years. This paper contributes with an analysis of interdependent multidimensional (IMD) poverty intensity of time and income, which in particular restricts social participation. The interdependency of the multiple poverty dimensions under a strong (union approach) and weak focus axiom (compensation approach) are regarded in particular when measuring the intensity of multidimensional poverty. In addition to various poverty gap measures including the multidimensional well-being gap, for the first time we propose a minimum multidimensional poverty gap (2DGAP). To respect Sen's capability approach with its social participation aspects we define the time dimension as genuine personal leisure time. Based on a CES well-being function and a multidimensional poverty line evaluated by the German population (estimated with the German Socio-Economic Panel) the individual poverty intensity of the active population is analysed for various regimes of multiple poverty. For this purpose the German Time Use Surveys 1991/92 and 2001/02 and its time use diary data are used. Analysing the active population this paper contributes too to the poverty situation of the working poor. All the empirical results, including the microeconometric Heckman type estimation of the IMD poverty intensity (2DGAP) and the IMD poverty risk, indicate the overall importance of the time dimension with its social participation aspect incorporated within an interdependent multidimensional time and income poverty approach. An important dimension would be neglected in the poverty analysis and in targeted poverty policies if time additional to income is not respected.

JEL Classification: I32, D31, J22

Keywords: intensity of time and income poverty, interdependent multidimensional time and income poverty, union and compensation approach, minimum multidimensional poverty gap (2DGAP), extended economic well-being, satisfaction/happiness, working poor, CES well-being function, German Socio-Economic Panel, German Time Use Surveys 1991/92 and 2001/02

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Introduction

Extending the traditional income poverty concept by multidimensional poverty has been of growing interest within the last years (see the overview by Kakwani and Silber 2008). Multidimensional poverty in most applications is empirically measured by a list of some activities an individual is excluded from (e.g. Cappellari and Jenkins 2005, Nolan and Whelan 2007). Within the counting approach, the aggregation to a poverty index relies on the number of dimensions[2] in which people are deprived. The European Union Laeken social inclusion indicator set is an example of multiple poverty dimensions with educational disadvantages, health inequalities, unemployment and worklessness as poverty dimensions (Atkinson 2003). Any interdependencies between the dimensions are either neglected or arbitrarily weighted.

Our concern, however, is to take care for the interdependency between multiple poverty dimensions based on a population wide evaluation when analysing the intensity of multidimensional poverty. In particular, we will argue, that beyond income, time as a prominent and basic resource necessary for any activity will be an important well-being and poverty dimension With genuine personal leisure time social participation and social inclusion will be respected, an important poverty aspect following Amartya Sen's capability approach and device: "the role of income and wealth [...] has to be integrated into a broader and fuller picture of success and deprivation" (Sen 1999, p. 20). The interdependency of the multiple deprivation dimensions allows to quantify substitution/compensation between the two dimensions, genuine personal leisure time and income. The evaluation of the degree of substitution then will not be arbitrarily but empirically founded and population based in our poverty intensity analysis for Germany. By analyzing poverty of the active population our paper contributes also to the situation of the 'working poor' a growing group at least in the German Society.

In our paper we focus on the intensity of the interdependent multidimensional time and income poverty. Based on a CES well-being function evaluated by the German population we apply multidimensional Foster-Greer-Thorbecke type poverty measures and present results over a decade for various poverty gap measures. In particular, we propose for the first time a minimum multidimensional poverty gap (2DGAP), an appealing integrated approach which allows to disentangle each individual poverty attribute by ensuring multidimensionality. The 2DGAP, a mapping to the hyperplane of the poverty dimensions, quantifies the minimum efforts to escape multidimensional poverty.

The German Socio-economic Panel (SOEP) serves as the data base for the CES well-being estimation. The German Time Use Studies (GTUS) 1991/92 and 2001/02 are the detailed time use diary data for the further empirical results of uni- and multidimensional time and income poverty. Besides various descriptive intensity results for various poverty regimes and socio-demographic groups, a Heckman type selectivity correction estimates of the IMD poverty risk and the minimum multidimensional 2DGAP mean gaps detects significant multivariate explanation pattern.

[2] Such as a car, tv, washing machine, or whether people can do certain things like going on holidays, having friends, having a substantial meal regularly etc.

This study extends the concept paper of Merz and Rathjen 2009 by its intensity focus including the new 2DGAP, its estimation and the analysis of the two German Time Use Surveys over the decade 1991/92 to 2001/02.

The paper is divided as follows: At first, multidimensional poverty concepts are discussed and the intensity of interdependent multidimensional (IMD) poverty is defined under the strong (union approach) and weak focus axiom (compensation approach). Then CES well-being based multidimensional Foster-Greer-Thorbecke type poverty measures are described. Then the 2DGAP concept is presented and discussed (chapter 2). Chapter 3 justifies and discusses time and income as the multiple poverty dimensions and presents active population CES well-being function estimates using data of the German Socio-Economic Panel for a population wide multiple poverty line evaluation. Chapter 4 informs about the German Time Use Surveys 1991/92 and 2001/2002, the detailed database for all further empirical poverty assignments, and specifies the time and income variables for the empirical analysis. In chapter 5 various time and income unidimensional and interdependent multidimensional descriptive poverty intensity results for the German active population for 1991/92 and 2001/02 are presented. Chapter 6 provides Heckman based microeconometric estimates for the explanation of the minimum IMD poverty gap (2DGAP) and the IMD poverty risk. Chapter 7 concludes.

1 Measuring Multidimensional Poverty

Sen (1976, p. 219) argues that in "the measurement of poverty two distinct problems must be faced, viz., (i) identifying the poor among the total population, and (ii) constructing an index of poverty using the available information on the poor." The first problem covers the identification of poor individuals. For this purpose a poverty threshold has to be defined to assign a person to be poor. The second problem includes the difficulty to choose or construct a poverty index that captures the extent of poverty in a society. These two problems are central for measuring both unidimensional as well as multidimensional poverty.

In the unidimensional context, poverty indices based on certain desirable axioms are discussed and available for long time now (see Zheng 1997, Chakravarty and Muliere 2004), and, there is some consensus about the poverty threshold (as a certain percentage of an equivalized household income, say). In the multidimensional context, axiomatic based poverty indices are more recently developed; see Tsui 2002, Bourguignon and Chakravarty 2003, Chakravarty and Silber 2008 as well as the survey by Chakravarty 2009. Thresholds might be considered for each dimension as well as for its combination (e.g. the sum of deprived dimensions), yet the discussion and empirical application is still at its infancy.

1.1 Multidimensional Poverty Axiomatic

The majority of unidimensional poverty axioms could be conveyed to the multidimensional level: the poverty axioms of symmetry, monotonicity, continuity, principle of population, scale invariance and subgroup decomposability (Bourguignon and Chakravarty 2003, p. 29, Maasoumi and Lugo 2008, p. 5). The focus axiom in the multidimensional context, however, has to be discussed in particular.

In the unidimensional context, the focus axiom claims that a poverty index has to be independent of non-poor persons' quantities. Within the multidimensional context two different approaches are conceivable. On the one hand, the multidimensional focus axiom could demand that the multidimensional poverty index is independent of quantities lying above the

single dimension thresholds. On the other hand, it may only be claimed that the index is independent of non-multidimensional-poor persons' quantities. The former requirement is called the *strong focus axiom*, while the latter is named *weak focus axiom* (Bourguignon and Chakravarty 2003). The consideration of these two axioms corresponds to the question whether a deprivation in one dimension could be compensated by the quantities above dimension threshold in another dimension. The weak focus axiom allows such a substitution while the strong focus axiom does not for all poverty ranges.[3]

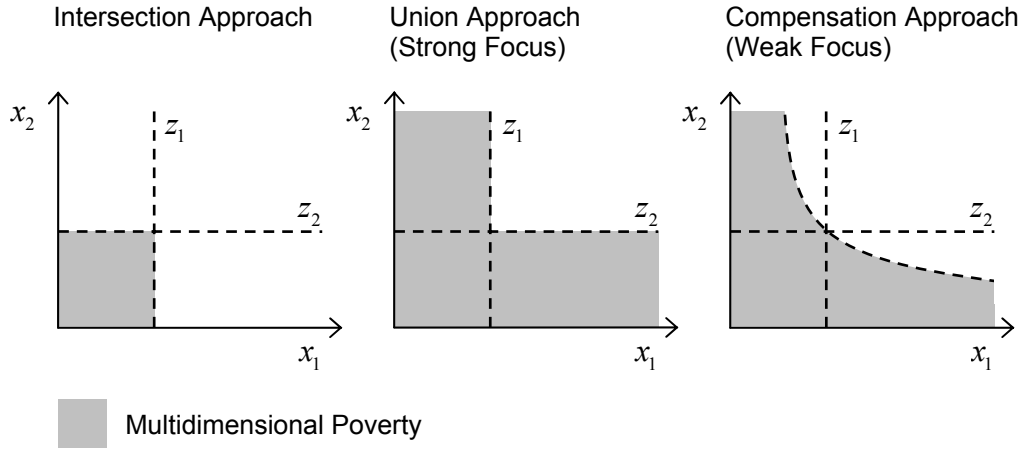
Moreover, in the multidimensional case, it is debatable whether a so called correlation increasing switch should raise or reduce the multidimensional poverty index. A correlation increasing switch is a change of quantities between two multidimensional poor persons in a deprived dimension that increases the correlation between dimensions. After such a switch, strong deprivation in one dimension increasingly is attended by strong deprivation in the other dimension. Depending on the relationship between poverty dimensions, one could expect an increase or a decrease of the multidimensional poverty index. Assuming a substitutive relation between dimensions, one would rather expect an increase, since strong deprivation in one dimension could increasingly not be compensated by the other dimension quantity. The corresponding axiom is named Non-Decreasing Poverty Under Correlation Increasing Switch (Bourguignon and Chakravarty 2003, p. 31). Having a complementary relationship between dimensions, one would rather expect a decrease, since compensation is not possible at all. Accordingly, a decline in one dimension of an individual that is strongly deprived in the other does not worsen the individual situation additionally. Here, the corresponding axiom could be called Non-Increasing Poverty Under Correlation Increasing Switch. Normally, one expects at least a limited substitutional relationship. Therefore, the former axiom is predominantly requested in the scientific literature (e.g. Tsui 2002, p. 78).

1.2 Multidimensional Poverty Concepts: Identification

Multidimensional poverty concepts and axioms require the definition of two kinds of thresholds for the identification of multidimensional poor individuals in principle. On the one hand, poverty thresholds for each poverty dimension are needed to count the number of deprived dimensions for each individual. On the other hand, one has to determine in how many dimensions an individual has to be deprived to be judged multidimensional poor. Here two extreme approaches can be distinguished: Following the so called *union approach*, a person is judged to be multidimensional poor as soon as he or she is deprived in one single dimension (see Figure 1 for the two dimensional case). The *intersection approach*, in contrast, only judges an individual to be multidimensional poor, when she or he is deprived in all dimensions. Intermediate concepts are conceivable as well (see e.g. Alkire and Foster 2007 as well as Atkinson 2003 to mention the case).

[3] For a more detailed description and formal examination see Bourguignon and Chakravarty 2003.

Figure 1: Identification of multidimensional poverty with the intersection, union and compensation approach in the two-dimensional case



Note: x_1 and x_2 are the quantities of the first and second dimension while z_1 and z_2 are the corresponding poverty dimension thresholds.
Source : own figure

The selection of union or intersection approach as the identification strategy depends on the relationship between poverty dimensions. This raises the fundamental question whether a substitution/compensation between poverty dimensions is possible. Having a substitutive situation, the intersection approach seems to be more adequate. There the deficit in one dimension might be compensated by the other. Having a complementary interaction between poverty dimensions, the deprivation in one dimension might not be compensated by the other attribute; then the union approach will be more convenient (see e.g. Atkinson 2003, Leßmann 2007).

Against this background the issue arises whether at least a limited substitution should be considered within the identification of a poor person. In the vast majority of cases, poverty dimensions are neither perfect substitutes nor perfect compliments but something between these two extremes. Accordingly, the deficit in one dimension might be compensated to a limited extent and with diminishing returns by the other attribute. Union and intersection approaches as identification strategies seem to be too rigid for most cases (Bresson 2009, p. 2; Lugo and Maasoumi 2009, p. 25). As an example, an individual lying marginal above the poverty threshold in one dimension and being very strong deprived in the other dimension would not judged to be multidimensional poor following the intersection approach, whereas another individual lying in both dimensions marginal under the poverty line would be affected by multidimensional poverty.

This brings up the question whether and to which extent a poverty gap in one dimension might be compensated by higher quantities in the other dimension. If a gap in one dimension can be compensated by the other dimension quantity above dimension threshold, then a person is off poverty. If such a gap cannot be compensated by another dimension quantity, then the person will be called multidimensional poor. We will call such an approach as the "*compensation approach (CA)*" because substitution/compensation is allowed for all ranges in one dimension given to be poor in the other dimension. With the CA in the following, not only the number of deprived dimensions but also the extent of poverty gaps and the size of quantities above dimension thresholds for the poverty identification and poverty intensity are respected (see the right picture in Figure 1 for the two dimensional case).

Because substitution/compensation is allowed in the compensation approach (weak focus property) as well (but limited) in the union approach we will call this poverty situation *inter-dependent multidimensional poverty* (IMD poverty).

Considering then the multidimensional poverty line (based on two dimensions as in Figure 1) it is little debatable that an individual which is deprived in both dimensions should be judged to be multidimensional poor, while an individual that is not deprived in any dimension should not judged to be multidimensional poor. Accordingly, a multidimensional poverty line that accounts at least for limited substitution and diminishing returns has to run through the intersection of the dimension thresholds (z_1,z_2) in Figure 1.

1.3 Multidimensional Poverty Indices: Intensity – Headcount Ratio and Multidimensional Poverty Gaps

After identifying multidimensional poor individuals in the previous chapter, the question is how to capture the extent of poverty, the intensity of poverty, within an overall multidimensional poverty index. In the unidimensional context the Sen-Shorroks-Thon (SST-Index)[4] or the Foster-Greer-Thorbecke 1984 (FGT) indices are well-known. In the case of the unidimensional FGT index, the individual poverty function is

$$(1) \qquad p_i = \max\left[\frac{z - Y_i}{z}; 0\right]$$

measuring the poverty gap as a relative deviation of the well-being indicator Y_i (income, say) to the defined poverty threshold z. The aggregation over all individuals yields the unidimensional FGT poverty index

$$(2) \qquad P(Y,z) = \frac{1}{n}\sum_{i=1}^{n}(p_i)^{\alpha} = \frac{1}{n}\sum_{i=1}^{n}\left[max\left(\frac{z - Y_i}{z}; 0\right)\right]^{\alpha},$$

where α indicates the poverty risk aversion: the higher the parameter, the more sensitive the index is to strong deprivations. For α = 0, the headcount ratio results, α = 1 correspond to the poverty gap and α = 2 represents the severity of poverty.

In the multidimensional context in particular Lugo and Maasoumi 2009 as well as Bourguignon and Chakravarty 2003 embrace all (two) dimensions in their multidimensional poverty indices. Lugo and Maasoumi 2009 attempt to convey the unidimensional FGT Index to the multidimensional framework. Thereby they classify two aggregation approaches: one by "shortfall of well-being" (aggregate poverty line approach) and one by "well-being of the shortfalls" [5] (component poverty line approach). Both of them might be analyzed under the strong or weak focus poverty axiom. The first one relies on individual well-being compared to well-being at the threshold intersection, where well-being is measured as the output of a production type well-being function with two (or more) input factors allowing substitution. In the second one, the relative differences between the individual dimensional attributes and their thresholds are the respective input factors of the well-being function.

In our empirical application, we first of all will evaluate the individual income and time situation in levels and accordingly concentrate on the first approach, with levels rather than with

[4] See Xu and Osberg 2001 based on Sen 1997, Shorrocks 1997, Thon 1979,1983

[5] Which corresponds to the Bourguignon and Chakravarty 2003 multidimensional poverty index.

relative deviations as arguments in the well-being function. However, with our proposed minimum multidimensional poverty gap indicator (2DGAP, see next section) we also regard the dimensional attributes when we disentangle them within the multidimensional context.

Similar to Lugo and Maasoumi 2009 but with a slightly more flexible function an individual well-being indicator V_i shall evaluate the interdependencies of both poverty dimensions in a CES type well-being function borrowed from production theory.

Well-being function:

$$V_i = \gamma \left[w_1 \left(x_i^1 \right)^{-\rho} + w_2 \left(x_i^2 \right)^{-\rho} \right]^{\frac{\upsilon}{-\rho}} \qquad \textit{weak focus axiom} \tag{3}$$

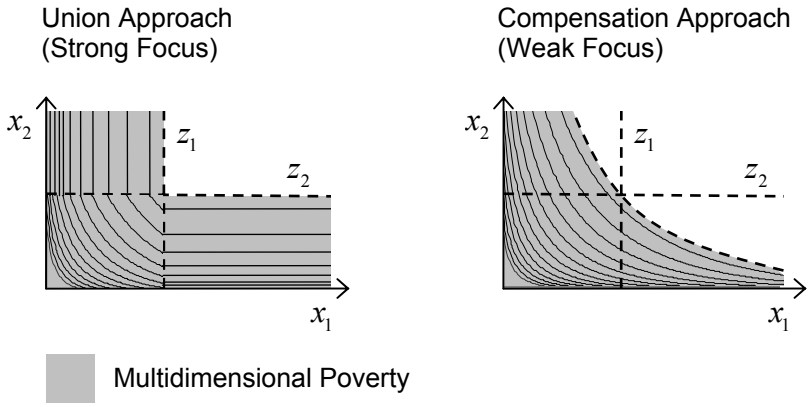
and

$$V_i = \gamma \left[w_1 \left(\min \left[x_i^1, z^1 \right] \right)^{-\rho} + w_2 \left(\min \left[x_i^2, z^2 \right] \right)^{-\rho} \right]^{\frac{\upsilon}{-\rho}} \qquad \textit{strong focus axiom} \tag{4}$$

with the substitution elasticity $\sigma = 1/(1+\rho)$, ρ as a curvature parameter of the isopoverty contours with $\rho \neq 0$, γ as a constant[6], υ as returns to scale, x_i^1 and x_i^2 as the quantities and z^1 and z^2 as the thresholds of the first and second poverty dimension, the input coefficients w_1 and $w_2 = 1 - w_1$ as distribution and weighting parameters describing the skewness of the isopoverty contours.[7]

Note, the min(.) arguments in the strong focus case restrict the input levels to their poverty lines, which is not the case under the weak focus property. Accordingly, under strong focus axiom a substitution between input factors is not possible above the dimension thresholds (see Figure 2). As mentioned, under weak focus however, substitution is possible under all regions below the multidimensional isopoverty threshold.

Figure 2: Interdependent Multidimensional Isopoverty Contours - Union Approach (Strong Focus) and Compensation Approach (Weak Focus) in the Two-Dimensional Case



[6] As some progress indicator like the technical progress in the production function discussion.

[7] See the further CES discussion, interpretation and reasoning in our empirical section.

Note: x_1 and x_2 are the quantities of the first and second dimension while z_1 and z_2 are the corresponding dimension thresholds.
Source: own figure

The *multidimensional poverty line*

$$(5) \qquad V_z = \gamma\left[w_1\left(z^1\right)^{-\rho} + w_2\left(z^2\right)^{-\rho} \right]^{\frac{\upsilon}{-\rho}}$$

is the aggregate poverty line under the weak and strong poverty axiom. It is the isopoverty contour crossing the threshold intersection (see Figure 2).

The *multidimensional poverty function* as a relative gap of individual well-being to the multidimensional threshold well-being is

$$(6) \qquad p_i = \max\left[\frac{V_z - V_i}{V_z}; 0 \right].$$

The aggregated (across individuals) multidimensional FGT poverty measure corresponding to Lugo and Maasoumi 2009 then is

$$(7) \qquad P(V,z) = \frac{1}{n}\sum_{i=1}^{n} p_i = \frac{1}{n}\sum_{i=1}^{n}\left[max\left(\frac{V(z) - V(x_i^1, x_i^2)}{V(z)}, 0 \right)\right]^{\alpha} \quad WF\ axiom$$

and

$$(8) \qquad P(V,z) = \frac{1}{n}\sum_{i=1}^{n}(p_i)^{\alpha} = \frac{1}{n}\sum_{i=1}^{n}\left[max\left(\frac{V(z) - V\left[\min(x_i^1, z^1), \min(x_i^2, z^2)\right]}{V(z)}, 0 \right)\right]^{\alpha} \quad SF\ axiom$$

with $\alpha = 0$ delivering the multidimensional headcount, $\alpha = 1$ an average relative poverty gap in well-being units applied to the total population which measures poverty intensity, and $\alpha > 1$ respecting a higher aversion against strong deprivations.

The multidimensional FGT poverty measures for strong and weak focus as to Lugo and Maasoumi 2009 fulfils the axioms presented with the constraint, of course, that the compensation approach (weak focus) does not satisfy the strong focus axiom. The measure further fulfils Non-Decreasing Poverty Under Correlation Increasing Switch (Bourguignon and Chakravarty 2003, p. 31) if $\alpha \geq -\rho$ (assuming $\upsilon = 1$), respectively, fulfils Non-Increasing Poverty Under Correlation Increasing Switch if $\alpha \leq -\rho$ (assuming $\upsilon = 1$).

1.4 Minimum Multidimensional Poverty Gap (2DGAP) as a Mapping to the Dimensional Hyperplane

The above discussed IMD poverty concept relies on well-being units when comparing the individual situation with the aggregated IMD poverty line evaluated by the population, say. In the weak focus case further regarded, all dimensions are combined and weighted via the respective CES well-being function, say. Figure 3 accordingly describes the two dimensional well-being mountain with V_z as the well-being level at the threshold isopoverty line and V_i an

individual well-being level. The difference between V_z and V_i is the discussed multidimensional poverty well-being gap.

A mapping of the well-being dimension to its (two) dimensional hyperplane allows another appealing integrated approach to describe multidimensional poverty. With this mapping there is an additional straightforward possibility to compactly measure the individual multidimensional poverty situation and to disentangle its single poverty attributes at the same time ensuring that the interdependence of all poverty dimensions is respected.

Consider the two dimensional case by the compensation approach by its attributes space as in Figure 3 and regard the poverty situation at (x_1,x_2) for an individual. With respect to both dimensions there is a fan of pathes from that point (x_1,x_2) to the IMD isopoverty line. However, one path is prominent: it is the *shortest* path between (x_1, x_2) and (p_1,p_2) where (p_1,p_2) is characterized by the orthogonal path from the IMD tangent at (p_1,p_2) to (x_1,x_2).

The respective definite distance path c thus might be called the most efficient way to escape poverty respecting both dimensions based on multidimensional well-being.

We will call this line the minimum multidimensional poverty gap, NDGAP, and with two dimensions the 2DGAP, which is the measurable two dimensional minimum mapping of the well-being distance between the respective well-being contours of the third dimension, the well-being dimension. Since both (all) dimensions are incorporated within the 2DGAP distance c (Figure 3) no direct interpretation in the money or in the time space is given. However, both distances of the rectangular triangle, a and b (Fig. 3) are measurable in their single dimension, say income and time.

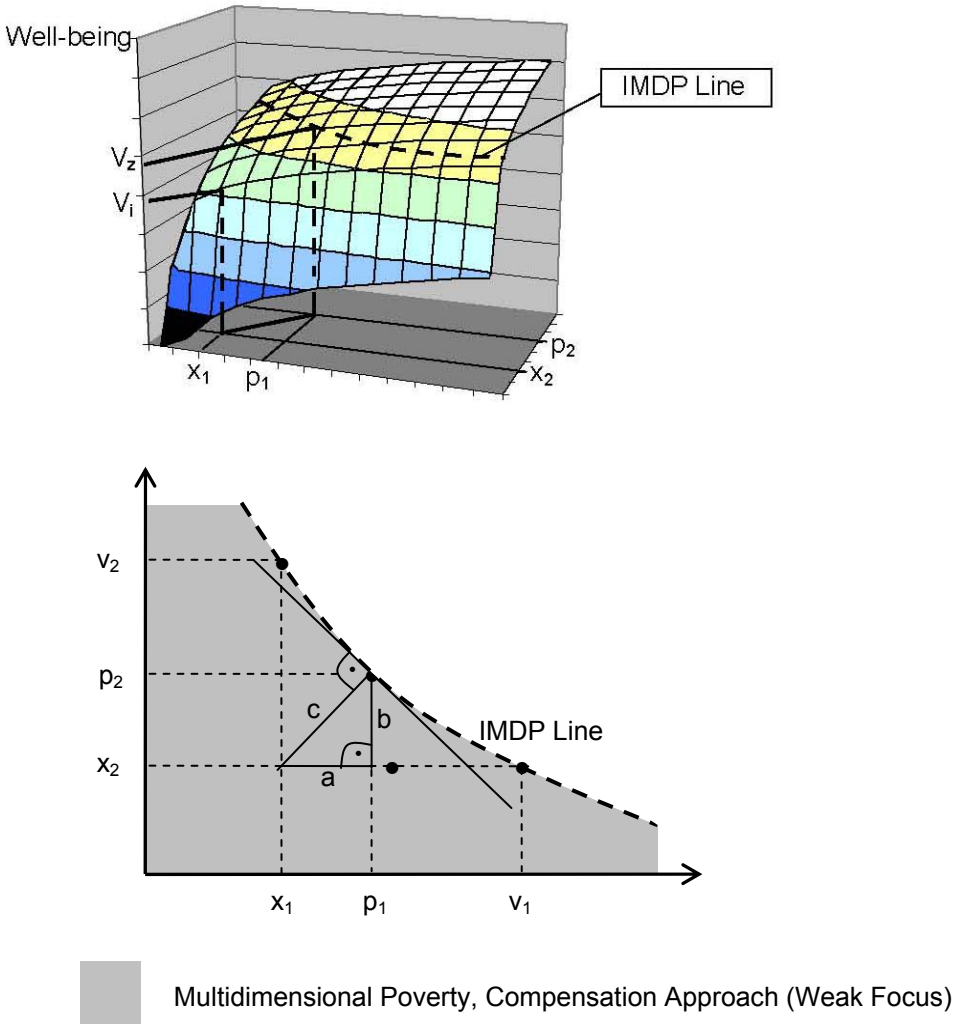
To achieve the 2DGAP distance c, the coordinates (p_1,p_2) at the isopoverty line have to be found fulfilling the condition to be the shortest distance from (x_1,x_2).

2DGAP definition: For any point (x_1,x_2) in the two dimensional space under the weak focus CES type isopoverty line, the minimum multidimensional poverty gap with two poverty dimensions, 2DGAP, is defined as the linear distance which is orthogonal to the slope at the respective point (p_1,p_2) at the isopoverty line.

2DGAP calculation: This can be achieved by an iterative procedure to find the shortest distance c in the interval $[x_1,v_1]$.where v_1 is the coordinate of the isopoverty line at x_2. An alternative calculation is an iterative procedure until the slope of of the isopoverty line is equal to the slope of the linear function through (x_1,x_2).

Since our proposed CES well-being function is well behaved, the 2DGAP minimum distance c is always found.

Figure 3: Multidimensional Poverty Well-being Gap and its Mapping into its Dimensions



Source: own figure

The 2DGAP can be extended to an n-dimensional case, called NDGAP, by a a multivariate minimum search where the slopes of the linear distance is subject to the orthogonality of all slopes of the n dimensional tangents to the isopoverty contour. A conceivable 3DGAP e.g. had to consider three dimensional isopoverty contours as a ball and a linear hyperplane within the 3D space.

Beyond the compact interdependent multidimensional poverty description by 2DGAP there is an additional appealing feature of this approach: its single unidimensional attributes are visible by one of the other two sides a and b of the 2DGAP triangle (Figure 3): a as the amount of the first and b as the amount of the second attribute in its genuine dimensions to leave poverty respecting the interdependency and its substitution/compensation.

In our application this would be income in money units (€) for a, and time in time units (minutes) for b as the attributes to escape multidimensional poverty in an efficient manner (if possible by real circumstances).

For aggregation purposes the individual 2DGAPs (NDGAPs) and its single multidimensional attributes might be cumulated and characterized by its means and other statistics. The aggregated respective minimum components to c, and the single dimensional companions a and b then provide a comprehensive multidimensional poverty picture overall and in its disentangled components under interdependency.

2 Application: Intensity of Time and Income Interdependent Multidimensional Poverty – The Case of Germany

Our empirical application of the intensity of interdependent multidimensional poverty in Germany will focus on time and income as prominent poverty attributes. Before the empirical investigation for Germany in 1991/92 and a decade later in 2001/02 we first briefly justify and define the selected two poverty dimensions: income and time.[8]

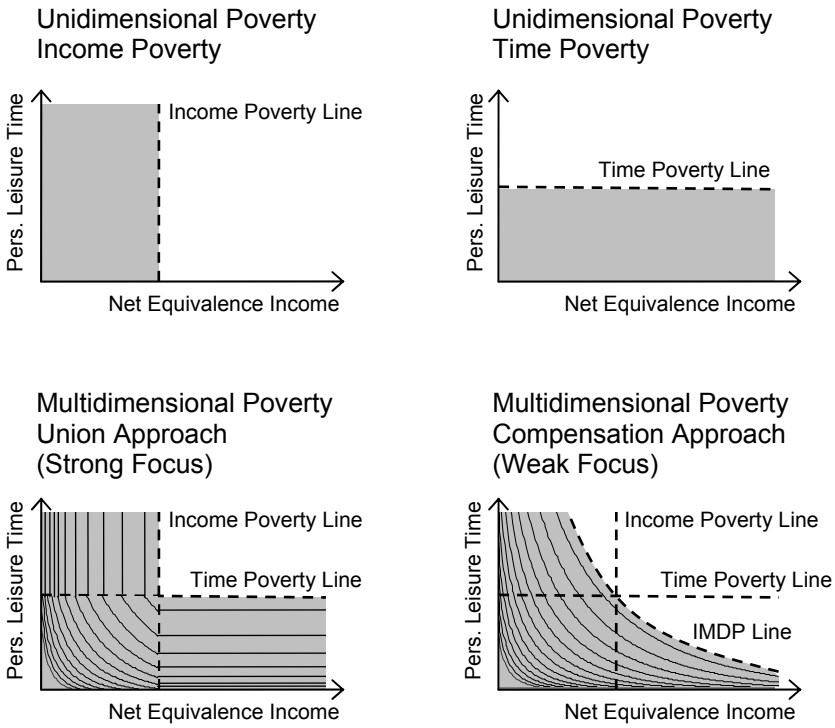
2.1 Applied Income Poverty Concept

Income allows the acquisition and consumption of goods and services and is regarded as a general indicator to describe individual well-being which traditionally is used as a central poverty dimension. Since household members generally share their (net) income with other household members, the unit of observation commonly is the household with household net income as the joint disposable income for consumption activities. To compare various households of different structures with different needs and household size effects, a net equivalence income is regarded within the poverty discussion and in our subsequent analyses. The net equivalence income then equates the household net income divided by the sum of equivalence weights of all household members. Internationally, the new OECD-scale has established. It orders – as we will do – the weight of one to the household head, the weight 0.5 to additional household members with the age of 15 years or older and the weight 0.3 to all others.

Based on such an equivalized income, the majority of conventional income-based poverty concepts in the European Union judge a person as income poor if net equivalence income is below 60% of the median net equivalent income of all individuals (Bundesregierung 2005, XV). This concept is adopted within the present paper. Accordingly, income poverty comes along with a position left of the income poverty line in Figure 4.

[8] Our approach is based on Merz and Rathjen 2009 where a more in-depth reasoning using time as the additional poverty dimension can be found.

Figure 4: Time and Income Unidimensional and Interdependent Multidimensional Poverty Concepts



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2.2 Applied Time Poverty Concept

We intend to embrace the social participation and social inclusion/exclusion aspect by expanding the income poverty dimension by the time dimension. Time is necessary for any activity and is a fundamental prerequisite enabling and restricting the daily living activities.[9] In particular, together with economic and sociological/social perspectives we argue that time (beyond income) is an elementary poverty dimension when an extended poverty concept with social exclusion is accepted, since any social participation requires time. This is in the sense of Sen's (e.g. 1999, 1985) extended perspective on poverty, because time, similar to a commodity, could be seen as a basic to accomplish any functionings to achieve the capability set with its respective freedom of choice.

The link of time and social participation is also expressed e.g. by Bittman 1999: "The ability to participate in [social life] […] is the product of both access to leisure goods and services, and a sufficient quantity of leisure time." In contrast to a total leisure time concept we argue that time poverty is present when the remaining genuine personal leisure time is below a certain level and no or only restricted time is left for social participation. We will define genuine personal leisure time as remaining available time left after all obligations as labour time, household work time, child care, household requirements, sleeping, personal care and health activities. There is no doubt that social participation also is possible in some of these activi-

[9] For a further discussion see Merz and Rathjen 2009.

ties. However, in particular the situation is tight when all the obligations and duties for daily living – enjoyable or not, voluntarily or not – are fulfilled and no time is left anymore for that genuine personal leisure.

Close to our time approach, but still different, is the distinction between free time and discretionary time by Goodin, Rice, Bittman and Saunders, 2005 or Goodin, Rice, Parpo and Eriksson, 2008. Free time there is the actual time left over after carrying out 'obligatory' activities within such as paid work, unpaid work and personal care. Since more than necessary time might be spend for those 'obligatory' activities Goodin and colleagues therefore define "discretionary time" as the residual after the minimum necessary time was spent for paid and unpaid work and personal care (Burchardt 2008, 11). In contrast to the discretionary time approach we prefer to incorporate an appropriate direct time consuming activity describing genuine personal leisure time rather than trying to detect 'necessary time' and in the sequence discretionary time hidden in any single activity which would be hard to measure.

The household situation is the basis for the traditional income orientated poverty analyses. Analogue, the question arises whether time poverty should be considered in the household context as well. We argue that genuine personal leisure time could not or only to a very limited extent be reallocated between household members, and accordingly, is strictly personally linked. Thus, we regard time poverty at the individual level.

For the definition of time poverty Bittman (1999, p. 14) suggests a median concept analogue to the traditional income orientated poverty concepts: "A commonly employed standard used to benchmark [income] poverty [..] is 50 per cent of the median. [..] Applying an analogous standard (50 per cent of the median leisure time) […] we can get some idea of what social situation produces the most severe kinds of time poverty". Adopting this concept but according to EU standards, we refer to the 60% median time poverty line, however, in reference to the individual situation and according to genuine personal leisure. Therefore, time poverty comes along with a position under the time poverty line as in Figure 4.

2.3 Applied Interdependent Multidimensional Time and Income Poverty Concept: CES Well-being

Why should we take care for the interdependency of time and income? The economic perspective pinpoints the central argument: individual well-being is a function of consumption and leisure and their trade-off. The allocation problem there is, given such a well-being (utility) function, how to allocate time in an optimal sense either for more leisure or for more income/consumption. Depending on the well-being function then the degree of the substitution/compensation of time and income is detectable within the optimal solution of the utility maximization. Though in the microeconomic approach time is defined as total leisure we argue, that personal leisure as a subset of total leisure in particular is that time which probably is the first candidate for paid work (income) compensation when all further household obligations still require their time.

When an individual is to be judged as interdependent multidimensional poor? According to the union approach (under the strong focus axiom), an individual is multidimensional poor if their net equivalence income or (logical or) their genuine leisure time is below 60% median of all persons. Here, multidimensional poverty comes along with a position under the time poverty line or left of the income poverty line as in Figure 4. Individuals are judged to be multidimensional poor according to the compensation approach (under the weak focus axiom,

WF), if they have a position below the interdependent multidimensional poverty line (IMDP Line) in Figure 4.

We specify the IMD poverty line (WF) by a CES-type (constant elasticity of substitution) well-being function as in equation (5). In contrast to others (like Bourguignon and Chakravarty 2003 or Lugo and Maasoumi 2009) who arbitrarily choose the dimension weights in their empirical applications, our CES well-being function will be estimated population based. This empirical based estimation – which is described in detail in Merz and Rathjen 2009, 2010[10] – uses individual satisfaction data from the German Socio-Economic Panel (SOEP) in particular.[11]

The evaluation by satisfaction data refers to the recent happiness/satisfaction literature (Frey and Stutzer 2005, 2002, Clark et al. 2008) with its direct measures of satisfaction about quality of life aspects[12]. Van Praag and Ferrer-i-Carbonell 2008 provide arguments for measuring well-being by survey questions about satisfaction. The happiness and capability approaches are dicussed and brought together by Sen 2008 within the respective book by Bruni, Comim and Pugno (2008).

Within the CES well-being function substitution/compensation is possible between all levels of the poverty dimensions. With the constancy assumption any time and income pair sticks together with its degree of substitution regardless the level of well-being. Nevertheless, substitution is different between rays from the origin which allow different substitutions when the relation of time and income is changing.

Specifying our CES relationship of equation (3) with personal genuine leisure time L and net equivalence income I (in prices 2002) as inputs and reported life satisfaction V_i as the proxy for the multidimensional well-being, the CES well-being function for 2002 is estimated for the active population as proposed by Kmenta 1967 with the German Socio-Economic Panel (GSOEP) 2002 and results in:

$$(9) \qquad V_i^{2002} = 3{,}550 \cdot \left(0{,}519 \cdot I_i^{\,0{,}297} + 0{,}481 \cdot L_i^{\,0{,}297}\right)^{\frac{0{,}108}{0{,}297}}$$

with its contours as isopoverty lines as in Figure 5. [13]

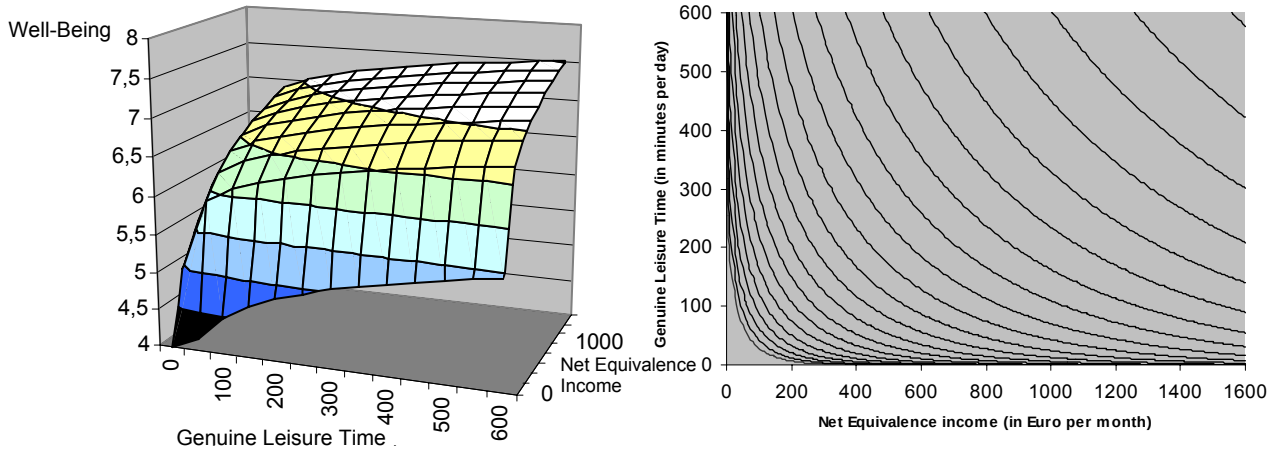
[10] Because only the SOEP provides individual satisfaction data, the CES well-being estimates were based on the SOEP whereas the more detailed German Time Use Survey will be applied for the individual poverty analyses.

[11] Note, because a poverty line should be evaluated by the total population, the CES well-being function estimates take the active population into account.

[12] For a critical discussion about subjective outcomes in economics and satisfaction as an economic variable see Hamermesh 2004 and Freeman 1978.

[13] The econometric specification of the non-linear CES-function behind is a logarithmic Taylor expansion which overcomes (at least to a certain extent) the limited dependent variable problem given an eleven point life satisfaction scale (see Merz and Rathjen 2009 for details).

Figure 5: Estimated CES Utility Function – Well-Being and Isopoverty Contours



Source: own estimation with GSOEP 2002, daily working hours > 5

Though our further poverty analyses are based on the more detailed German Time Use Surveys (GTUS) we had to use another survey, the German Socio-Economic Panel (SOEP) for the population wide well-being estimation, because no appropriate satisfaction data are available within GTUS.

The econometric specification of the non-linear CES-function behind is a logarithmic Taylor expansion which overcomes (at least to a certain extent) the limited dependent variable problem given an eleven point life satisfaction scale (see Merz and Rathjen 2009 for details).

In general, within a CES function the degree of substitution measured by the substitution elasticity might range from perfect substitution ($\rho = -1, \sigma = \infty$) over a certain degree of substitution (including the Cobb-Douglas case with ($\rho = 0, \sigma = 1$) to no substitution at all (complementary input factors, $\rho = \infty, \sigma = 0$). The estimated and population based evaluated substitution/compensation between genuine time and income of $\sigma = 1,422$ is a bit less distinct than in the Cobb Douglas type ($\sigma = 1$) situation. Thus it is a bit easier to substitute time by income than in the Cobb Douglas case. The returns to scale with $\upsilon = 0,108$ mean that a doubling of the inputs time and income will raise well-being by around 7%. Significant estimated coefficients together with the fulfilment of further consistency rules quantify and support the relevance of the substitution/compensation between time and income (see Figure 5).

The estimated CES well-being function fulfils Non-Decreasing Poverty Under Correlation Increasing Switch for the multidimensional FGT measures with $\alpha = 0$, $\alpha = 1$ and $\alpha = 2$ as well as the further poverty axioms presented in the beginning.

Which isopoverty contour (indifference curve) of Figure 5 should be the *aggregated IMD poverty* line to assign individuals to be multidimensional poor or not to be multidimensional poor? As mentioned, a person who is neither time nor income poor should not be judged multidimensional poor according to both interdependent approaches, the compensation as well as to the union approach. Judging individuals multidimensional poor, who are poor in both dimensions is likewise revealing. Accordingly, interdependent multidimensional poverty line

should run through the intersection (z_1,z_2) of the unidimensional time and income poverty thresholds (see also Figure 4).

A person then is assigned to be *interdependent multidimensional poor* (IMD poor) if its poverty attributes are below the IMD poverty line, the mapping of the well-being mountain at the single poverty thresholds. Note, this is regardless of any voluntary or non-voluntarily individual well-being situation; as in common poverty analyses somebody is counted to be poor if (s)he is just below the poverty line.

In the compensation approach, the IMD poverty line is an isopoverty contour as in Figure 5; in the union approach it is the boundary line of the time and income poverty rectangles as in Figure 4 (left lower picture).

3 The German Time Use Surveys as the Database for Individual Multidimensional Poverty

Selecting individual time and income as central poverty dimensions, a challenging database is needed for the empirical investigation which should include detailed time use as well as detailed income information. The two German Time Use Surveys (GTUS) 1991/92 and 2001/02 of the Federal Statistic Office Germany provide such a database with their more than 35.000 individual time use diaries. As mentioned, because of a lack of individual satisfaction data in the GTUS, the CES well-being function is estimated using the German Socio-Economic Panel.

In the German Time Use Surveys participants were asked to note their daily routines subsequently in diaries in their own words and three times during the week, two working days and a Saturday or Sunday. In addition to the afterwards coded diaries the participants completed a person and household questionnaire. For 1991/92 6,774 households with 15,366 persons and 30,732 diaries are available. In 2001/02 5,144 households with 11,908 persons and 35,685 diaries stand by. For a more detailed description of the German Time Use Surveys see Ehling 1999, Ehling, Holz and Kahle 2001 as well as Ehling 2003.

Income and income poverty is measured as monthly household net equivalence income as described in the previous chapter. This income could be calculated using information from the household questionnaire in GTUS 1991/92 and 2001/02. All subsequent income information for 1991/92 is adjusted to the 2001/02 price situation.

Time and time poverty is measured as personal genuine leisure time. This time information, provided in detail by the individual time use diaries, include activities that are allocated to one of the main categories “Contact, Conversations, Sociality” (Activities 611-640 and 699) and “Media Use, Free-time Activities” (Activities 711-740 and 799) in GTUS 1991/92, respectively the categories “Social Life and Entertainment” (Activities 500-531), “Participation in athletic activities e.g. outdoor activities” (Activities 600-649), “Hobbies and Games“ (Activities 700-739) and “Mass Media“ (Activities 800-849) in GTUS 2001/02.

By incorporating the use of mass media such as watching television into the personal leisure time, a relatively high median for personal genuine leisure time can be expected. However, meanwhile, the use of mass media is an essential part of personal leisure activity and an activity with familial social participation.

4 Time and Income Interdependent Multidimensional Poverty Intensity – The German Case

The following empirical poverty results are based on the above time and income poverty information from the two available German Time Use Surveys (GTUS) 1991/92 and 2001/02 as well as the estimated CES parameters from the German Socio-Economic Panel 2002 (SOEP) for the population based multidimensional poverty line.

4.1 Time, Income and Interdependent Multidimensional Poverty Line

Using both German Time Use Surveys the *median monthly equivalized net household income* is 1109,64 € for 1991/92 and 1322,58 € in 2001/02. The single *income poverty thresholds* thus are 665,78 € for 1991/92 and 793,55 € for 2001/02 (see Table 1 and Figure 6). All income data are adjusted for price inflation by a 19.2% increase within the ten years from 1991/92 to 2001/02.

The *median for personal genuine leisure time* is 265 minutes in 1991/92 and 310 minutes in 2001/02 per day, determining a *time poverty line* (60%) of 159 minutes for 1992/92 and 186 minutes for 2001/02. The increase of personal leisure time as well as the time poverty threshold over the ten years period is 17% and is somewhat lower as the increase in the respective median income by 19,2%.

Table 1: Income, Time and Interdependent Multidimensional Poverty Line

	1991/92	2001/02	Difference %
Median Net Equivalence Income (in € per month and prices 2002)	1109.64	1322.58	19,2
Median Personal Leisure Time (in minutes per day)	265	310	17,0
Income Poverty Line (=60% Median Net Equivalence Income)	665.78	793.55	19,2
Time Poverty Line (=60% Median Personal Leisure Time)	159	186	17,0
$V^{poor} = f(I^{poor}, L^{poor})$	6.704	6.827	1,8

Source: own calculations with GTUS 1991/92 and 2001/02, The time and income poverty lines by GTUS data are calculated for the total population for the median income, and the population available only older 11 years for the median personal leisure time.

The evaluated *IMD poverty* line at the intersection of the unidimensional time and income thresholds is about a well-being level of 6,704 in 1991/92 and 6,827 in 2001/02 based on the estimations of the 2002 SOEP data for both periods (see Table 1 and Figure 6):

$$(10) \qquad V_{1992}^{poor} = f(I^{poor}, L^{poor}) = 3,550 \cdot \left(0,519 \cdot 665,78^{0,297} + 0,481 \cdot 159^{0,297}\right)^{\frac{0,108}{0,297}} = 6,704$$

$$(11) \qquad V_{2002}^{poor} = f(I^{poor}, L^{poor}) = 3,550 \cdot \left(0,519 \cdot 793,55^{0,297} + 0,481 \cdot 186^{0,297}\right)^{\frac{0,108}{-0,297}} = 6,827 .$$

For comparison reasons the 1991/92 well-being function is specified by the same parameters as in 2001/02 suggesting a slight increase in overall well-being within the ten years period. The estimated input coefficients, the weight w for income and $(1-w)$ for personal leisure,

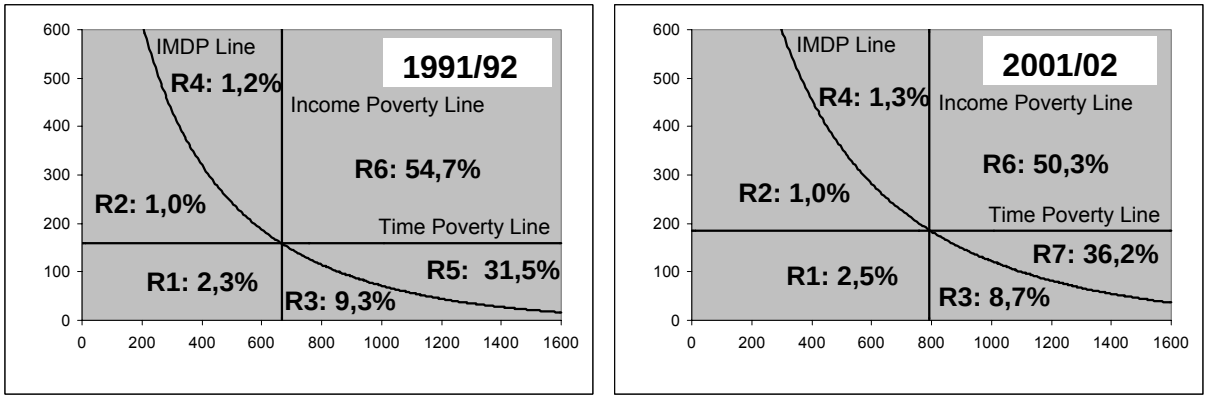
indicate a certain dominance of income, however, the evaluated time contribution is not far away from a balanced 50% situation and refer to the importance of the time dimension.

4.2 Overall Intensity of Uni- and Multidimensional Time and Income Poverty

Given the empirical thresholds, each GTUS sample person then is belonging to one of the six multidimensional poverty regimes out of Figure 6, making descriptive and multivariate analysis of a person's socio-economic background in the various poverty regimes possible. All following poverty intensity analyses concentrate on the active population with more than 5 daily working hours analogue to the SOEP 2002 estimation.[14] With focus on the active population our poverty analyses accentuate the situation of the working poor, a population group of growing interest and importance at least in the German labour market discussion.[15]

Table 2 provides the overall multiple FGT results including their respective standard errors and 95% confidence intervals. Figure 6 illustrates the IMD headcount ratios (FGT with α=0) and different poverty regimes.

Figure 6: Interdependent Multidimensional and Unidimensional Poverty Thresholds and Headcount Ratios in Different Poverty Regimes for Germany 1991/92 and 2001/02



Source: own calculations with GTUS 1991/92 and 2001/02, active population; total population for the calculation of median income, individuals older 11 years for the calculation of median personal leisure time

Intensity of Unidimensional Income Poverty (active population): From 1992 to 2002 the percentage of income poor active individuals (headcount ratio / FGT index (α = 0)) marginal rises from 4,5% to 4,8% (see Table 2 and Figure 6, regimes 1, 2, 4). However, the 2002 headcount ratio of 4,8% is lying within the 95% confidence interval of the 1992 percentage. Accordingly, the not significant difference (α=10%) should be treated with caution. Results for the FGT index with α=1 suggest an increasing poverty gap intensity within the ten years period. The corresponding poverty index – measuring the average (relative) poverty gap – rises

[14] This is a working hour situation with more than 5 hours per day to avoid part-time situations with less restricted total leisure.

[15] The working poor refers (even) to a working poor household where the individual under investigation belongs and not necessary to a working poor person himself.

significantly (α=5%) from 0,00797 to 0,01067.[16] Respecting a larger poverty aversion however results in a non significant increase (FGT, α=2).

Intensity of Unidimensional Time Poverty (active population): From 1992 to 2002 the percentage of time poor active individuals (headcount ratio / FGT index (α = 0)) significantly (α=1%) rises from 43,3% to 47,4% (see Table 2). The relative high time poverty percentage levels are the result of the time poverty line calculation, which encompass the active as well as the non-active population.

The FGT-Index with α = 1 slightly increases from 0,17586 to 0,18522 while the FGT-Index with α = 2 remains relative constant over the ten years period; the one percentage point increase is significant if a α=5,9% significance level is accepted. The higher the poverty aversion, the smaller is the 1992 to 2001 difference of the poverty gaps.

Table 2: Interdependent Multidimensional and Unidimensional Time and Income Poverty 1991/92 and 2001/02, Germany

		1991/92				2001/02				
		Index	Std. Err.	95% Conf. Interval		Index	Std. Err.	95% Conf. Interval		Dif. Test[1] p-values
FGT[2] (α=0)	Unidimensional									
	Income	0.04523	0.00262	0.04010	0.05036	0.04816	0.00342	0.04145	0.05487	0.49648
	Time	0.43338	0.00614	0.42133	0.44542	0.47357	0.00721	0.45943	0.48771	0.00002***
	Multidimensional									
	Union (SF)	0.45193	0.00650	0.43920	0.46466	0.49702	0.00745	0.48241	0.51163	0.00001***
	Compensation (WF)	0.12588	0.00421	0.11764	0.13413	0.12159	0.00459	0.11260	0.13058	0.49099
FGT (α=1)	Unidimensional									
	Income	0.00797	0.00063	0.00674	0.00921	0.01067	0.00092	0.00885	0.01248	0.01548**
	Time	0.17586	0.00329	0.16941	0.18230	0.18522	0.00371	0.17795	0.19248	0.05911*
	Multidimensional									
	Union (SF)	0.01264	0.00033	0.01198	0.01329	0.01254	0.00032	0.01191	0.01317	0.82780
	Compensation (WF)	0.00406	0.00020	0.00367	0.00445	0.00378	0.00021	0.00336	0.00419	0.33433
FGT (α=2)	Unidimensional									
	Income	0.00290	0.00030	0.00231	0.00349	0.00352	0.00038	0.00277	0.00427	0.20038
	Time	0.10501	0.00261	0.09989	0.11013	0.10434	0.00273	0.09898	0.10970	0.85921
	Multidimensional									
	Union (SF)	0.00088	0.00004	0.00079	0.00097	0.00073	0.00004	0.00065	0.00081	0.00802***
	Compensation (WF)	0.00029	0.00002	0.00025	0.00034	0.00027	0.00002	0.00022	0.00032	0.47953

[1] Two sample difference in means test with variance inhomogeneity and unequal variances; *** = significant on the 1% level; ** = significant on the 5% level; * = significant on the 10% level.

[2] FGT = Forster-Greer-Thorbecke-Measure

Source: own calculations with GTUS 1991/92 and 2001/02, active population

Intensity of Multidimensional Poverty (Union Approach, SF): According to the *union approach (strong focus axiom)*, the percentage of multidimensional poor individuals significantly increases from 45,2% in 1992 to 49,7% in 2002 (see Table 2). Note, the relative high levels depend on incorporating all regions under both dimensional thresholds (in particular inclusive region 5, a compensation region under weak focus). The gap intensity indices of

[16] Note, small figures are due to the FGT type division by the total population number and not by the number of poor people.

FGT with $\alpha = 1$ (FGT1) are constant over the ten years period (no significant difference), while the FGT index with $\alpha = 2$ (FGT2) significantly decreases (α=1%). In 2002 more individuals are affected by multidimensional poverty (union approach), however, multidimensional poor individuals (Union Approach, Weak Focus) suffer higher multidimensional deprivations in 1992.

Intensity of Multidimensional Poverty (Compensation Approach, WF): According to the *compensation approach (weak focus axiom)* with allowing a substitution between poverty dimensions also above dimension thresholds, the headcount ratio of multidimensional poor individuals slightly reduces from 12,6% in 1992 to 12,2% in 2002. The FGT1 as well as the FGT2 index slightly decreases as well. However, for all FGT indices the ten years slight decrease is not significant (α=10%).

To summarize the overall picture: unidimensional income and time poverty show an increase in Germany within the considered decade. This holds for the headcount ratio (not significant for income but for time) as well as the mean relative poverty gap measured by FGT1 (income and time significant). Multidimensional poverty under strong focus (union approach) also significantly increased with regard to the headcount ratio but decreases significantly with regard to the intensity gap when poverty aversion is higher (FGT2). Multidimensional poverty under weak focus, however, shows a slightly decreasing poverty picture with regard to the headcount ratio as well as to both gaps; the decade differences however are not significant.

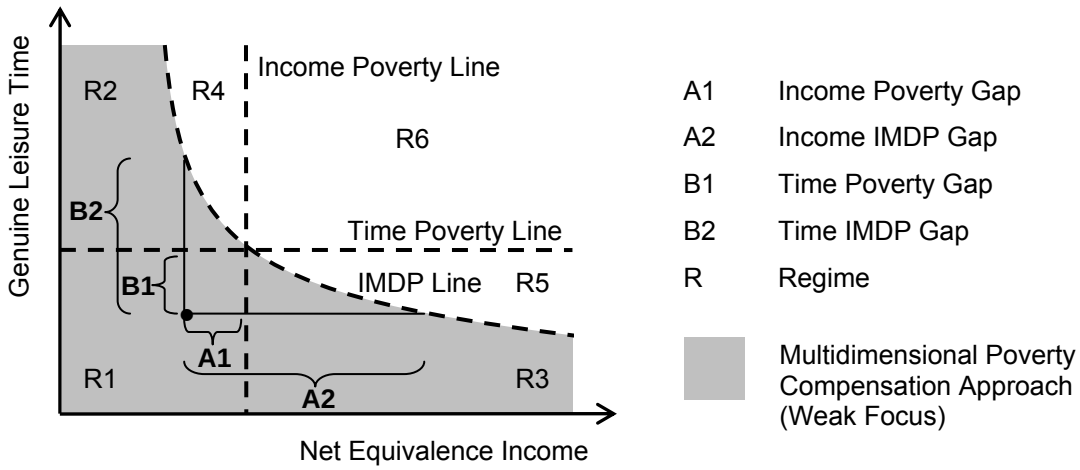
The reason behind: If compensation is not allowed above dimension thresholds (union approach, strong focus), then regime 5 affect a relative high headcount ratio which increased form 1991 to 2001 because of a relative strong increase of just this regime. However, if compensation is allowed (compensation approach, weak focus), then regime 5, with time deficit assigned to be compensated, is therefore no more a multidimensional poverty regime and the relative strong increase of regime 5 is not relevant any more. This results even in a slight not significant decrease of the multidimensional IMD headcount ratio.

4.3 Mean Interdependent Multidimensional and Unidimensional Time and Income Poverty Gaps

Though the above overall poverty development measured by the multidimensional FGT indices is an important information, other approaches for the gap intensity promise a better interpretability and some new results. We will focus on various mean gaps in the single attributes' dimensions, in € and minutes, in the following and in the next section for our proposed mean minimum 2DGAP.

Figure 7 illustrates the various unidimensional and multidimensional gaps in the case of the compensation approach (week focus). As an example, for an individual being time, income and multidimensional poor (regime 1), four poverty gaps can be calculated: the unidimensional income poverty gap (A1), the income gap to the Interdependent Multidimensional Poverty Line (IMDP Line) (A2), the unidimensional time poverty gap (B1) and the time gap to the Interdependent Multidimensional Poverty Line (IMDP Line) (B2). All of them depict one poverty but under weak focus IMD poverty.

Figure 7: Poverty Gaps for an Individual Situated in Multidimensional Poverty Regime 1



Source: own figure

5.3.1 Mean Poverty Gaps

The FGT index has the advantage to incorporate headcount ratio as well as relative poverty gap information according to different poverty aversions. Those gaps are the result of dividing the respective sum of gaps by the total number of the population. This yields small numbers and mean values which are not directly drawn to the poor and their subgroups within different poverty regions.

To get a more interpretable impression of the poverty intensity in what follows we show respective mean poverty intensity measures drawn only to the poor population, where a gap here is defined not in relative but in absolute differences. In Tables 3a and 3b the means of the above five poverty gaps are presented for each of the six poverty regimes of Figure 7 as well as for the overall income (regime 1, 2, 4), overall time (regime 1, 3, 5) and multidimensional (regime 1, 2, 3) poor individuals (compensation approach).

Unidimensional Income Poverty: Unidimensional income findings for the FGT index with $\alpha = 0$ and $\alpha = 1$ in principle are confirmed by the results for the mean income poverty gap of income poor individuals. In 1992, income poor persons have an average gap to the income poverty line of 117,37 € net equivalence income per month in prices 2002 (see A1 in Table 3a). In 2002, this average increases to 176,25 € by remarkably 50%. Although some of the increase could be traced back to a higher income poverty line in 2002, the findings underline a remarkable rise in the intensity of unidimensional income poverty within the ten years period.

Unidimensional Time Poverty: The mean time poverty gap of time poor individuals increases as well (see B1 in Table 3) from 64 to 73 minutes genuine leisure time per day. An increase by 14%, remarkable less than the income gap increase.

Multidimensional Poverty (Compensation Approach (WF): The mean gap in well-being measuring multidimensional poverty by the compensation approach (weak focus axiom) slightly decreases from 0,21601 in 1992 to 0,21207 well-being units in 2002 (see C in Table 3b).

In 2002, multidimensional poor individuals have an average income gap to the IMDP Line of 517,77 € net equivalence income (see A2 in Table 3a). Thus multidimensional poor individuals need on average an increase of monthly net equivalence income by 517,77 € to negotiate

multidimensional poverty (weak focus) in the income dimension. Furthermore, they have an average gap to the IMDP Line on the time dimension of 79,01 minutes genuine personal leisure time to negotiate their multidimensional poverty (weak focus) in the time dimension. Though these gaps consider the IMD poverty line (weak focus) they still measure the respective unidimensional gap when describing an average way out of multidimensional poverty.

Time & income poor, regime 1: Regime 1 characterises the 'hard core' poor, so to say: they are poor under the income as well as under the time dimension. This group increase slightly over the decade inspected to 2,5% of all active Germans in 2002. And, all of their measured mean gaps according to income and time (A1, A2, B1, B2) increased as well. Thus this particular group faces even a stronger depriviation after those ten years.

Not compensable time deficits, regime 3: Regime 3 is another region of particular interest: it is the poverty regime where time poverty – even by an above poverty income – is assigned not to be compensated by income. This (regime 3) poverty group shows a slightly decreasing poverty headcount ratio of 9,3% compared to 8,7% 2002 for total IMD poverty (compensation approach, see Table 3b) but an increasing mean time poverty gap (from 35 to 45 minutes) within the analysed decade. This poverty group, which are assigned not to compensate their time deficit so far is not judged to be poor by the traditional income orientated

Table 3a: Mean Poverty Gaps of Unidimensional and Interdependent Multidimensional Time and Income Poverty 1991/92 and 2001/02, Germany

			Unidimensional Poverty Gaps							
	Headcount ratio (FGT index (α = 0))		A1 Mean Income Poverty Gap (in € per month and prices 2002)		A2 Mean Income IMDP Gap (in € per month and prices 2002)		B1 Mean Time Poverty Gap (in minutes per day)		B2 Mean Time IMDP Gap (in minutes per day)	
	1991/92	2001/02	1991/92	2001/02	1991/92	2001/02	1991/92	2001/02	1991/92	2001/02
R1	0.0228	0.0246	109.7708 (6.67089)	171.2731 (8.28929)	405.9142 (23.66317)	659.5577 (47.20821)	62.98561 (2.34581)	85.60554 (3.521794)	130.4852 (6.15031)	184.3046 (7.93540)
R2	0.0104	0.0102	202.8682 (11.19503)	253.1557 (14.00744)	102.9651 (8.23453)	140.89 (12.30728)	-	-	80.30216 (7.89591)	106.9007 (11.61167)
R3	0.0927	0.0869	-	-	572.9093 (22.76929)	522.317 (26.24093)	112.5947 (1.21941)	122.2176 (1.51315)	35.61066 (0.98866)	45.94135 (1.39903)
R4	0.0120	0.0134	57.69079 (5.51410)	126.4468 (8.41722)	-	-	-	-	-	-
R5	0.3151	0.3620	-	-	-	-	49.97887 (0.61559)	59.71008 (0.75451)	-	-
R6	0.5469	0.5030	-	-	-	-	-	-	-	-
Income Poverty (R1+R2+R4)	0.04523	0.04816	117.3688 (4.94651)	176.2503 (6.11281)	310.687 (18.04617)	506.4486 (35.9125)	62.98561 (2.34581)	85.60554 (3.52179)	114.711 (5.03161)	161.4552 (6.85080)
Time Poverty (R1+R3+R5)	0.43338	0.47357	109.7708 (6.67089)	171.2731 (8.28929)	539.9997 (18.63329)	552.5648 (23.01937)	64.18741 (0.65337)	72.52032 (0.76894)	54.30753 (1.84542)	76.43649 (2.71459)
IMD Poverty, Compensation (WF) (R1+R2+R3)	0.12588	0.12159	139.0345 (6.09401)	195.4446 (7.46209)	503.7879 (17.36705)	517.7742 (21.38315)	102.8183 (1.20609)	114.1484 (1.48663)	56.46139 (1.82437)	79.01102 (2.68174)

Note: Only Poverty gaps > 0 are considered for the calculation of mean gaps.

Source: own calculations with GTUS 1991/92 and 2001/02, active population, standard errors in parentheses

Table 3b: Mean IMD Poverty Gaps and Minimum Multidimensional Poverty Gap (2DGAP) of Interdependent Multidimensional Time and Income Poverty 1991/92 and 2001/02, Germany

	Multidimensional Poverty Gaps							
	C Mean Well-being Gap (WF)		2DGAP: c Mean Minimum 2DGAP		2DGAP: a Mean Minimum Income 2DGAP) (in €)		2DGAP: b Mean Minimum Time 2DGAP) (in minutes per day)	
	1991/92	2001/02	1991/92	2001/02	1991/92	2001/02	1991/92	2001/02
R1	0.25971	0.34405	106.7176	152.5694	50.63491	72.17527	93.06684	133.5011
	(0.01276)	(0.01898)	(4.11026)	(5.19315)	(2.57724)	(3.31472)	(3.28085)	(4.13939)
R2	0.09365	0.10920	56.35211	75.12522	35.51656	46.75295	43.23462	58.26131
	(0.00826)	(0.01051)	(4.73298)	(7.16912)	(3.33438)	(5.01437)	(3.41206)	(5.19218)
R3	0.21905	0.18695	34.56861	44.34332	7.754112	10.81547	33.59079	42.87851
	(0.00780)	(0.00797)	(0.94883)	(1.33200)	(0.26549)	(0.40425)	(0.91438)	(1.27449)
R4	-	-	-	-	-	-	-	-
R5	-	-	-	-	-	-	-	-
R6	-	-	-	-	-	-	-	-
Income Poverty	0.20751	0.27472	90.886	129.8773	45.8827	64.72621	77.40289	111.4549
(R1+R2+R4)	(0.00997)	(0.01497)	(3.39270)	(4.68024)	(2.08738)	(2.83976)	(2.74252)	(3.83196)
Time Poverty	0.22706	0.22157	48.78697	68.19626	16.20461	24.33912	45.3117	62.85166
(R1+R3+R5)	(0.00672)	(0.00774)	(1.39421)	(2.08027)	(0.75241)	(1.11727)	(1.19384)	(1.78489)
IMD Poverty, Compensation (WF) (R1+R2+R3)	0.21601	0.21207	49.4138	68.77621	17.80475	26.21514	45.1396	62.46745
	(0.00626)	(0.00721)	(1.33817)	(1.99812)	(0.75626)	(1.12071)	(1.13031)	(1.69233)

Note: Only Poverty gaps > 0 are considered for the calculation of mean gaps.

Source: own calculations with GTUS 1991/92 and 2001/02, active population

poverty concepts. However, still 9% of all 2002 IMD poor individuals under the multidimensional perspective in regime 3 with an increased poverty gap stress the importance of the time dimension when poverty is inspected.

Further results for all described regimes can be found in Table 3a where the not discussed IMD headcount ratios of other regimes are of minor magnitude around 1%.

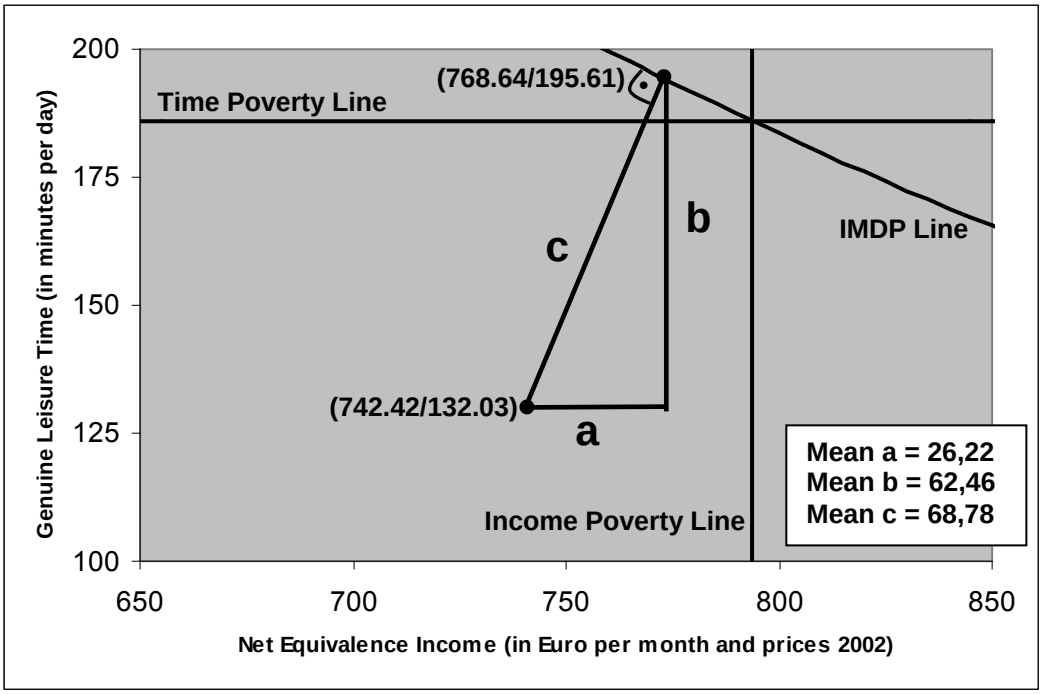
5.3.2 2DGAP: Minimum Multidimensional Poverty Gap

So far a multidimensional poverty gap with its single dimensions but respecting the multidimensionality is not directly visible in the two-dimensional space of time and income because the gap is the well-being distance between an individual's well-being to the overall IMD poverty well-being threshold (WF). However, our proposed multidimensional poverty 2DGAP provides such a 2D description in the time and income space and disentangles the interdependent poverty dimensions respecting substitution/compensation. The minimum 2DGAP offers an effective way out of multidimensional poverty with its single dimensions under IMD poverty.

To accompany the above result of the multidimensional mean well-being gap (WF) of 0,21207 in 2002 (Table 3b) measured in well-being units therefore we now consider the minimum 2DGAP (WF) as the most effective path to leave poverty when considering all poverty dimensions together.

Figure 8 will illustrate the situation for the mean multidimensional poverty situation in Germany. We depict the centre of IMD poverty (compensation approach, weak focus), as the overall mean of all individual minimum 2DGAP lines c. To fix this line within the income and time space, one need to know, where this line will cross/touch the IMD poverty contour for each poor individual.

Figure 8: Mean Minimum Multidimensional 2DGAP Poverty



Source: own figure

With the help of mean a, the two-dimensional respective mean minimum income gap, and its respective angle α between c and a, the orthogonal to c slope at that crossing point has to be cot(α+90) which by iteration delivers (p_1,p_2) for measuring the length of c..

The result for Germany (Figure 8 and Tables 3b,c): The mean most effective way out of multidimensional poverty respecting time and income is the distance c with 68,78 units (11,42%) in 2002 which is larger than in 1992 with 49,41 (8,20%) units. In other words: the multidimensional poverty gap increased from 8,20% to 11,42% that decade.

The mean minimum IMD poverty situation is characterized by 742,42 € income and 132,03 minutes and respective 768,64 € and 195,61 minutes at its IMD poverty threshold.

The mean minimum 2DGAP with regard to the income dimension (a) is 26,22 € (6,04%) and with respect to the time dimension (b) about 62,46 minutes (14,96%). Thus, on average it is about 26 € of income and a bit more than one additional hour of genuine personal leisure time to escape the assigned compensation between time and income within the multidimensional poverty (WF) situation.

Table 3c: Mean Minimum Multidimensional Poverty Gap (2DGAP) of Interdependent Multidimensional Time and Income Poverty 1991/92 and 2001/02, Germany

2DGAP	1991/921		2001/02		
		%		%	max
a Income [€]	17,80	4,10	26,22	6,04	434,4
b Time {minutes]	45,14	10,81	62,46	14,96	417,51
c min 2DGAP	49,41	8,20	68,78	11,42	602,51

The mean minimum 2DGAP has its starting point in the hard core time as well income poverty region pinpointing its empirical importance in Germany. In addition, with a relative longer time distance b than the income distance a, the importance of time poverty is emphasized.

Further 2DGAP results for all single poverty regimes are provided in Table 3b.

4.4 Multidimensional and Unidimensional Time and Income Poverty by Subgroups

Next to the overall poverty situation, the situation for different socio-demographic subgroups is of further major interest in poverty analyses. Table 4 presents for various subgroups the headcount ratios (FGT index with $\alpha = 0$) of income, time and multidimensional poverty (compensation approach, weak focus) as well as for the different poverty regimes. Table 5 includes respective intensity gap indices (FGT index with $\alpha = 1$ and $\alpha = 2$, Mean Well-Being Gap and mean minimum 2DGAP). We will restrict the presentation to the 2001/02 situation and only will highlight in the following some remarkable descriptive findings.

Table 4: Time, Income and Interdependent Multidimensional Poverty Headcount Ratios for Socio-demographic Groups (FGT index with α = 0) 2001/02, Germany

	Income Poverty	Time Poverty	Comp. (WF)	R1	R2	R3	R4	R5	R6
Gender									
Male	0.04564	0.45348	0.11898	0.0248	0.0116	0.0826	0.0093	0.3485	0.5232
Female	0.05249	0.50882	0.12608	0.0242	0.0077	0.0942	0.0206	0.3852	0.4681
Age									
12-17	0.13681	0.31628	0.16497	0.0364	0.0237	0.1048	0.0767	0.1895	0.5688
18-24	0.05422	0.33595	0.10920	0.0193	0.0215	0.0683	0.0133	0.2489	0.6285
25-44	0.05243	0.49883	0.13892	0.0265	0.0100	0.1024	0.0159	0.3692	0.4760
45-64	0.03584	0.48861	0.09782	0.0228	0.0056	0.0694	0.0075	0.3967	0.4980
> 65	0.11374	0.59487	0.18506	0.0454	0.0264	0.1133	0.0419	0.4296	0.3434
Education									
A-Level	0.03755	0.52051	0.08894	0.0227	0.0055	0.0608	0.0094	0.4313	0.4704
Vocational Dipl.	0.03639	0.45774	0.11883	0.0153	0.0179	0.0856	0.0032	0.3561	0.5219
Second. School II	0.05597	0.47283	0.14321	0.0289	0.0148	0.0996	0.0123	0.3476	0.4969
Secondary School I	0.04698	0.44040	0.12222	0.0203	0.0064	0.0955	0.0203	0.3266	0.5309
No certificate	0.08013	0.47260	0.15790	0.0368	0.0053	0.1158	0.0380	0.3237	0.4804
Occupation									
Self-employed	0.12019	0.57371	0.22106	0.0885	0.0170	0.1156	0.0147	0.3788	0.3854
Liberal. Prof.	0.07238	0.50395	0.11327	0.0463	0.0045	0.0625	0.0216	0.3759	0.4892
Entrepreneur	0.15269	0.62150	0.29431	0.1172	0.0255	0.1516	0.0100	0.3809	0.3148
Civil Servant	0.00317	0.45243	0.04275	0.0002	0.0016	0.0410	0.0014	0.4117	0.5441
White-Collar	0.01593	0.49032	0.07911	0.0075	0.0037	0.0679	0.0047	0.4143	0.5018
Blue-Collar	0.05310	0.45430	0.13989	0.0219	0.0105	0.1075	0.0207	0.3202	0.5192
Other occupation	0.09013	0.34670	0.16419	0.0541	0.0114	0.0987	0.0246	0.2259	0.5853
Nationality									
German	0.04599	0.47449	0.12043	0.0235	0.0094	0.0875	0.0131	0.3632	0.5033
Not German	0.16360	0.42143	0.18306	0.0798	0.0526	0.0507	0.0312	0.2975	0.4883
HH-Structure									
Single-HH	0.04539	0.48233	0.10266	0.0187	0.0083	0.0757	0.0184	0.3877	0.4912
Couple 0 Kids	0.01409	0.46454	0.04247	0.0051	0.0027	0.0347	0.0063	0.4198	0.5314
Couple 1 kid	0.03917	0.46186	0.09930	0.0238	0.0055	0.0700	0.0099	0.3650	0.5258
Couple 2 kids	0.03171	0.47845	0.15094	0.0178	0.0088	0.1243	0.0051	0.3387	0.5053
Couple > 2 kids	0.15001	0.53168	0.31550	0.0934	0.0382	0.1839	0.0184	0.2763	0.3898
Single par. 1 kid	0.14481	0.39444	0.19194	0.0416	0.0347	0.1157	0.0685	0.2335	0.5061
Single par. > 1 kid	0.11187	0.47125	0.16802	0.0521	0.0174	0.0985	0.0423	0.3281	0.4616
Other structure	0.05747	0.50493	0.16601	0.0461	0.0095	0.1104	0.0019	0.3423	0.4897
Region									
West-Germany	0.04024	0.45086	0.10051	0.0180	0.0091	0.0734	0.0132	0.3569	0.5295
East-Germany	0.08315	0.57456	0.21471	0.0537	0.0149	0.1462	0.0146	0.3847	0.3860
Overall	0.04816	0.47357	0.12159	0.0246	0.0102	0.0869	0.0134	0.3620	0.5030

Source: own calculations with GTUS 2001/02, active population

Gender: Females are more often affected by income (5,2%), time (50,9%) and multidimensional poverty (weak focus) (12,6%) than men (4,6%, 45,3% and 11,9%) (see Table 4 headcount ratios). According to this, the proportion of time poor males and females that are not able to compensate their time deficit by income above income poverty line (regime 3) is respectively higher for females with 9,4% in comparison to 8,3% for males. Nevertheless, if males are affected by multidimensional poverty (weak focus), they are more deprived than females according to the Mean Well-Being Gap 0,22178 for males and 0,19641 for females (see Table 5). This finding is confirmed by an gap analysis with FGT indices with $\alpha = 1$ and $\alpha = 2$ for multidimensional poverty (weak focus) as well as the higher minimum 2DGAP for males. Thus and, all over: uni- and multidimensional poverty is more frequent for females;

their single dimensional gap intensities are higher than for men. However, the multidimensional IMD poverty measures show an inverse picture

Table 5: Poverty Gaps of Time, Income and Interdependent Multidimensional Poverty for Socio-demographic Groups 2001/02, Germany

	FGT (α=1)			FGT (α=2)			C Mean Well-being Gap (WF)	2DGAP Mean Minmum Gap
	Income Poverty	Time Poverty	Comp. (WF)	Income Poverty	Time Poverty	Comp. (WF)		
Gender								
Male	0.01028	0.17761	0.00386	0.00338	0.10117	0.00027	0.22178	71.40362
Female	0.01133	0.19856	0.00363	0.00376	0.10991	0.00026	0.19641	64.50722
Age								
12-17	0.02657	0.13752	0.00566	0.00925	0.08360	0.00044	0.23445	77.27355
18-24	0.01283	0.12977	0.00324	0.00456	0.07460	0.00020	0.20274	64.90478
25-44	0.01159	0.19719	0.00429	0.00398	0.11123	0.00031	0.21081	70.23994
45-64	0.00764	0.18841	0.00315	0.00211	0.10536	0.00023	0.21989	66.80318
> 65	0.03338	0.21553	0.00388	0.01451	0.11157	0.00015	0.14310	69.8673
Education								
A-Level	0.00730	0.20676	0.00302	0.00195	0.11764	0.00022	0.23220	70.87143
Vocational Dipl.	0.01048	0.18020	0.00324	0.00388	0.10475	0.00023	0.18626	63.98772
Second. School II	0.01326	0.18306	0.00447	0.00475	0.10133	0.00032	0.21311	71.48291
Secondary School I	0.00960	0.17047	0.00367	0.00298	0.09613	0.00025	0.20527	62.68555
No certificate	0.01015	0.16669	0.00420	0.00201	0.09028	0.00035	0.18150	57.40273
Occupation								
Self-employed	0.03068	0.26142	0.00961	0.01018	0.16079	0.00073	0.29694	108.5462
Liberal. Prof.	0.01642	0.21138	0.00427	0.00483	0.12895	0.00029	0.25713	88.68941
Entrepreneur	0.04037	0.29571	0.01325	0.01382	0.18261	0.00103	0.30735	113.7393
Civil Servant	0.00044	0.18302	0.00118	0.00006	0.10868	0.00007	0.18788	24.17239
White-Collar	0.00276	0.18659	0.00218	0.00069	0.10246	0.00014	0.18791	48.56657
Blue-Collar	0.00937	0.16955	0.00345	0.00237	0.09237	0.00021	0.16840	54.03878
Other occupation	0.02270	0.14038	0.00723	0.01032	0.08425	0.00076	0.30078	98.25826
Nationality								
German	0.01020	0.18600	0.00378	0.00340	0.10505	0.00027	0.21402	68.53742
Not German	0.03518	0.14106	0.00390	0.01023	0.06461	0.00013	0.14548	77.12722
HH-Structure								
Single-HH	0.01134	0.18789	0.00256	0.00327	0.10150	0.00015	0.17024	62.47346
Couple 0 Kids	0.00217	0.17239	0.00125	0.00066	0.09501	0.00008	0.20066	50.11732
Couple 1 kid	0.00517	0.17572	0.00307	0.00109	0.09818	0.00020	0.21130	58.93923
Couple 2 kids	0.00830	0.19341	0.00478	0.00329	0.11158	0.00039	0.21640	64.37021
Couple > 2 kids	0.03511	0.23006	0.01074	0.01181	0.13854	0.00072	0.23241	83.49092
Single par. 1 kid	0.03846	0.16368	0.01074	0.01429	0.09569	0.00033	0.20308	84.13602
Single par. > 1 kid	0.02146	0.15823	0.00458	0.00673	0.08176	0.00024	0.18604	77.22169
Other structure	0.01553	0.21463	0.00761	0.00627	0.12953	0.00077	0.31291	96.70768
Region								
West-Germany	0.00882	0.17477	0.00298	0.00299	0.09840	0.00021	0.20271	64.26773
East-Germany	0.01882	0.23169	0.00728	0.00589	0.13078	0.00053	0.23157	78.10043
overall	0.01067	0.18522	0.00378	0.00352	0.10434	0.00027	0.21207	68.77621

Source: own calculations with GTUS 2001/02, active population

Occupation: Self-employed are remarkable more often affected by income (12,0%), time (57,4%) and multidimensional (22,1%) poverty (weak focus) than the overall active population (4,8%, 47,4% and 12,2%) and any other occupational group (see Table 4). Dividing further the Self-employed into the Liberal Professions ("Freie Berufe") and Entrepreneurs, reveals that the high percentages should be first and foremost traced back to the high percentages of the Entrepreneurs: 15,3% of the Entrepreneurs against 7,2% of the Liberal Professions

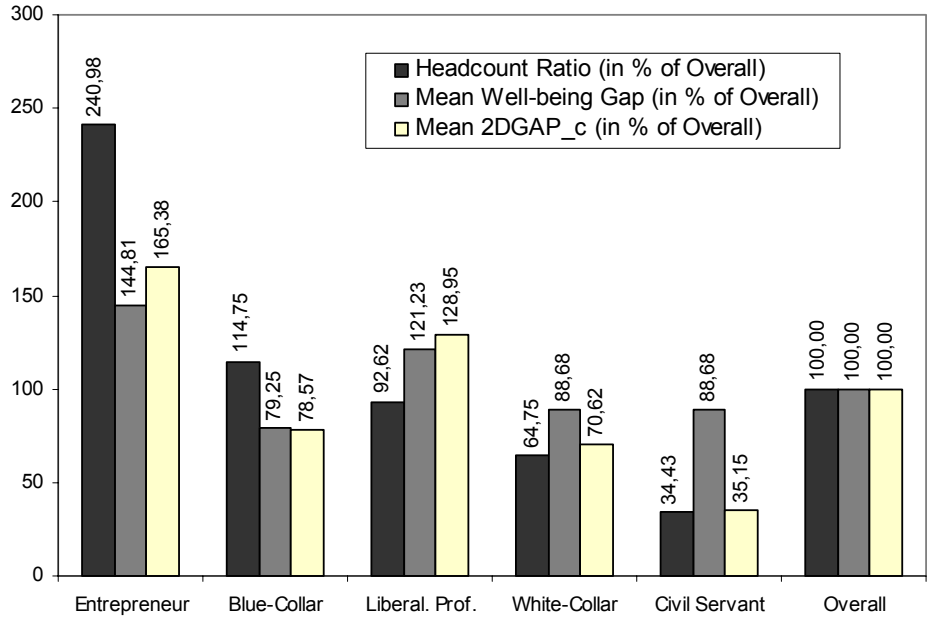
are income poor, 62,2% respectively 50,4% are time poor and 29,4% respectively 11,3% are multidimensional poor according to the compensation approach (weak focus).

This picture is confirmed by the regime 3 percentages: 15,2% of the Entrepreneurs and 6,3% of the Liberal Professions are not able to compensate their time deficit by income above the income poverty line. Nevertheless, Liberal Professions are more often affected by income (7,2%) and time (50,4%) poverty than the overall active population (4,8% respectively 47,4%). Furthermore, self-employed are more deprived than overall according to the Mean Well-Being Gap of 0,29694 in comparison to the overall-mean of 0,21207 (see Table 5). Again, entrepreneurs suffer higher deprivations (0,30735) than liberal professions (0,25713) confirmed by the 2DGAP results.

Household/Family Structure: The number of children in a household seems to be a mayor cause for time and multidimensional poverty (compensation approach (weak focus). The headcount ratios for multidimensional poverty increases from 4,2% for couples without children, over 9,9% for couples with one child, and 15,1% for couples with two children, to 31,6% for couples with more than two children (see Table 4). And, poverty gaps increases by increasing number of children in a similar fashion. The Mean Multidimensional Well-being Gap also increases from 0,20066 of couple without children to 0,23241 for couples with more than two kids, confirmed by the 2DGAP results (see Table 5).

Figure 9 combines central IMD poverty intensity indicators in descending order of the headcount ratios and illustrates the outstanding IMD poverty situation of the self-employed, in particular for entrepreneurs and liberal professions.

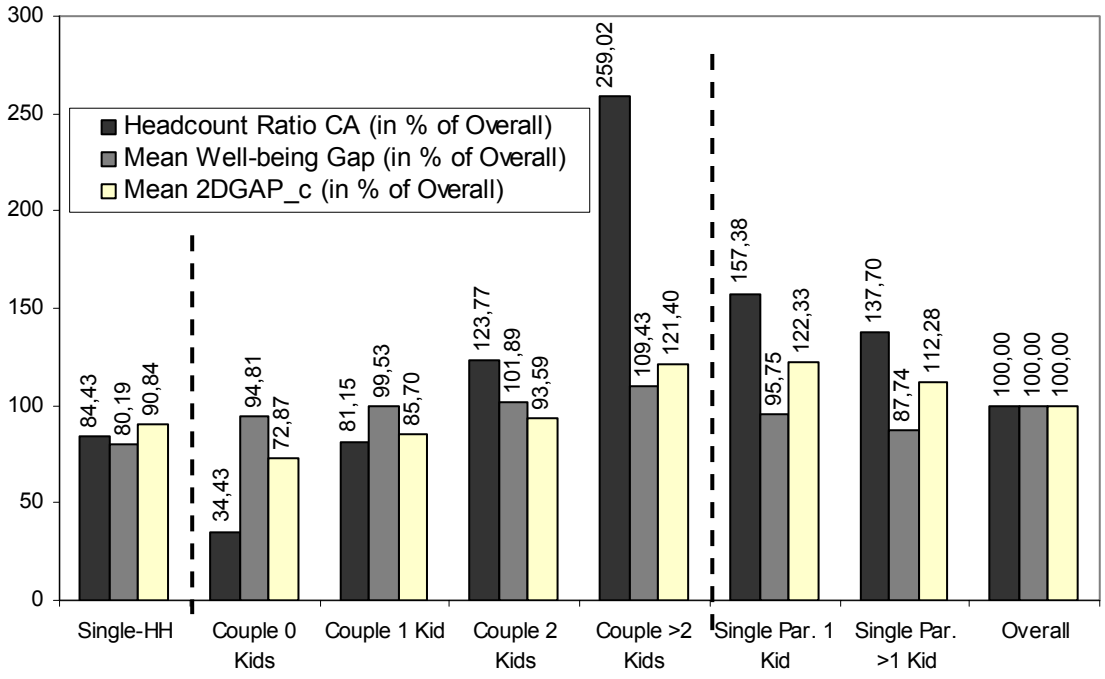
Figure 9: Interdependent Multidimensional Time and Income Poverty: Headcount ratio, Mean Well-Being Gap and 2DGAP – Subgroup Occupation



Source: own calculations with GTUS 2001/02, active population

Figure 10 illustrates the increasing IMD poverty by all poverty intensity measure for couples with children and pinpoints the above overall IMD poverty situation of single parents.

Figure 10: Interdependent Multidimensional Time and Income Poverty: Headcount ratio, Mean Well-Being Gap and 2DGAP – Subgroup Household Structure



Source: own calculations with GTUS 2001/02, active population

Altogether and as expected, there are remarkable differences of unidimensional and multidimensional time and income poverty ratios and poverty gap intensities between various and important socio-demographic groups in the German society. In particular gender, the occupational status with its principal time sovereignty of the self-employed, the family situation with its children shows remarkable differences and indicate the overall importance to incorporate time with its social participation aspect within an interdependent multiple time and income poverty approach.

5 Explaining Intensity of Multidimensional Poverty - 2DGAP and IMD Poverty Risk Microeconometric Estimation

The final microeconometric estimation focuses on the minimum IMD poverty gap (2DGAP), our comprehensive indicator of the individual multidimensional poverty intensity/severity being multidimensional poor (WF), providing multivariate results of an extended set of concurrent explanatory variables. In conjunction with the 2DGAP, IMD poverty risk estimates as the selection rule are discussed, too.

Microeconometric Model

Since the poor are expected not to be a random subgroup of the entire population, respectively of the working population, we apply the Heckman (1976) approach to account for the expected selectivity. As known, the two step procedure with

Step1: PROBIT-estimation for the probability to be IMD poor

$$z_i^* = \alpha' v_i + u_i$$

$$z_i = \begin{cases} 1 & if \quad IMD\ poor \\ 0 & else \end{cases}$$

with $PROB(z_i = 1) = \Phi\left(\alpha' v_i / \sigma_u\right)$ and z* as the latent indicator function with a normal distributed error term u_i

Step 2 : Selectivity corrected estimation

$$y_i \left| z_i^* > 0 = \beta' x_i + \beta_\lambda \lambda_i + \varepsilon_i \right.$$

with $\beta_\lambda = \rho\sigma_\varepsilon$, ρ = correlation coefficient between u_i and ε_i

σ_ε = standard error of normal distributed error term ε

With the selectivity correction by the Mills' ratio (hazard rate)

$$\lambda_i = \phi\left(\alpha' v_i / \sigma_u\right) / \Phi\left(\alpha' v_i / \sigma_u\right)$$

allows to separately estimate and explain the probability of being selected, that is to be IMD poor, and the amount of the variable of interest, the minimum IMD poverty gap.

Estimation Results

Explaining poverty intensity by our proposed 2DGAP can borrow from theoretical and empirical results concerning the topics behind. As obvious, the explanation of the 2DGAP has to account for both dimensions: time and income. As to income (respectively wage), including income based poverty studies with focus on the poverty risk, a human capital specification proved to be a well suited approach for explanation in numerous empirical investigations. In addition, many studies proved the importance also of the household and family situation explaining labour supply.[17] As to time, the focus of the microeconometric estimation is still on labour supply, on time spent for paid work. However, with the extended household production approach, the household and family situation forms the background for the explanation of time use for unpaid work and other household/family/personal activities. This holds for time spent for various leisure activities which corresponds to a certain extent to our personal genuine leisure time concept.[18] Note, we analyse the working population, thus experienced poverty results from a total population will not necessarily be the same.

Thus, our model specification will test the explanatory power of those and further variables of that kind, of course under the restriction and possibilities of the available data, the mentioned German Time Use Study (GTUS) 2001/2002.

The overall specification strategy for the explanation of the IMD poverty risk concentrates rather on market oriented variables, whereas more personal and family related economic and time use variables, which might help to diminish the poverty gap respectively will add to, will be tested for the multidimensional poverty gap. In addition, for an easier interpretation our respective reference category will be a person expected not to be poor.

The estimation results of the IMD poverty risk (step 1) and of the minimum IMD poverty gap (2DGAP) are given in Table 6. The overall goodness of fit is highly significant; the significant selectivity bias coefficient (λ) supports our modelling strategy.

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[17] e.g. Polachek and Siebert (1999), Merz, Böhm and Burgert (2009) and the references cited there

[18] See the results in various scientific Journals about Leisure, e.g. Leisure Studies and e.g. Merz (1996, 1989) for market and non-market behavioural response of tax reform policies

Table 6: Minimum IMD Poverty Gap (2DGAP) and IMD Poverty Risk, Two-step Heckman Estimation Results, 2001/02, Germany

	IMD Poverty Risk Probit estimates		2DGAP (c) Selectivity corrected OLS	
2DGAP (c)	Coeff.	p-values	Coeff.	p-values
Personal				
Female	-0.0513	0.391	-2.977	0.637
Age	0.0992***	0.000	23.45	0.763
Age**2	-0.00122***	0.000	-0.0697	0.304
Married	-	-	11,3	0.197
Active help	-	-	-0.0541	0.687
Not German	0.445*	0.033	24.56	0.181
Human Capital				
School years	-	-	-15.81	0.837
Experience	-	-	-21.01	0.786
Experience**2	-	-	0.0728	0.258
Education				
A-Level (Ref.)				
Second. School II	-0.00428	0.943	-	-
Second. School I	0.0489	0.522	-	-
Still schooling	-0.335	0.546	-	-
Occupation				
Civil Servant (Ref.)				
Liberal Profession	0.186	0.203	34.98**	0.009
Entrepreneur	0.499***	0.000	38.23**	0.001
Blue -Collar	0.306**	0.007	9.144	0.254
White-collar	0.138	0.160	4.951	0.475
Other occupation	0.215	0.192	28.80	0.246
Job				
Wage	-0.0724***	0.000	-3.074***	0.000
Weekly working hours	-0.00226	0.454	-0.353	0.371
core/fragmented	0.112*	0.036	1.954	0.664
non core/not fragmented	0.487***	0.000	-5.007	0.515
non core/fragmented	0.486***	0.000	3.121	0.738
Family/Household				
Couple 0 kids (Ref.)				
Couple 1 kid	0.221*	0.021	-2.731	0.757
Couple 2 kids	0.456***	0.000	0.868	0.920
Couple >2 kids	1.016***	0.000	3.352	0.785
Single	0.321**	0.005	20.93	0.079
Single 1 kid	0.788***	0.000	23,1	0.078
Single > 1 kids	0.989***	0.000	39.39**	0.008
Other structure	0.470**	0.001	27.69	0.169
Housework hours	-	-	0.420	0.833
Child care hours	-	-	-0.836	0.826
Youngest kid <7 years	-	-	28.80**	0.003
Getting help	-	-	-0.00257	0.986
Branch				
Service				
Agriculture	0.265*	0.039	-	-

Industry	-0.111	0.066	-	-
Region				
East Germany	0.263***	0.000	2.002	0.780
Constant	-3.057***	0.000	-112.9	0.813
Lambda	-	-	-21.226**	0.004
n	7354			
Uncensored (IMD poor)	946			
Wald chi2(31)	83,67***			
Log Pseudo Likelihood	-7.580.038			

Std. errors adjusted for 2877 clusters

Source: own calculations with GTUS 2001/02, active population

IMD poverty poverty risk, selection equation: the variables and hypotheses analyzed will be blocked in the personal situation, education, occupation, job characteristics, family situation, branch and the East-/West German situation.

Personal situation: The allover concurrent explanation wipes out significant gender differences. One reason: though each person in a household is considered as a single observation, nevertheless, being poor in the income dimension is depending on an equivalized household net income regardless of the single gender. An increased age increases the probability to be IMD poor. Though there is a significant negative quadratic term, however, its amount is too small to show an important diminishing economic effect. To be a foreigner increases the risk of being poor.

Education: Compared to an A-level (Abitur) education, there is no significant difference to other educational levels. With respect to the income literature, human capital proved to be important to be active in the labour force, but once being active other variables seems to be more important for explaining poverty.

Occupation: Compared to the reference as a civil servant, a blue collar worker has a significant higher risk to poverty. As it was visible in the single variable description there is a significant risk of being poor for self-employed in particular as an entrepreneur. This is a remarkable result since common sense tells that (liberal) professions (Freie Berufe) and entrepreneurs (tradesmen) as self-employed are rich by money and, because of their independence and time sovereignty, are rich by time, too. We refer here for a further in-depth analysis of self-employed poverty to Merz and Rathjen (2010, 2011).

Job: As expected, a higher individual wage diminishes the poverty risk significantly, and it is rather the wage than the size of the weekly working hours which is the driving factor behind the income situation. However, the daily working hour arrangement is important for the poverty risk situation: Compared to a normal not fragmented full time job, flexible working hours significantly rise the poverty risk. In particular, fragmentation and a job outside core hours (7 am to 5 pm) increase the risk to poverty. For a further in-depth discussion of flexible daily working hours according to the timing and fragmentation and its significant influence on the income distribution see Merz, Böhm and Burgert 2009.

Family/Household: The descriptive results pinpoints the importance of children when poverty is analyzed; the multivariate estimates even emphasize their influence highly significant: An increasing number of children for couples and for lone education parents rises significantly IMD poverty compared to the more well situated couples with no children. Thus, any anti poverty policy has to take into account particularly child targeted issues.

Branch: One available indicator describing the labour market situation with its different labour conditions is the economic branch of the individual worker. Compared to the most prevalent service industry an agricultural work rises significantly the IMD risk for time and income poverty. However, working in the industrial sector yields a better situation but only significant at the 6,6% level.

Region: Finally, even more than ten years after the German reunification, living in East Germany overall increases the risk to be IMD poor highly significant.

To summarize: Personal (but not gender) and the family situation together with education, occupation and in particular the job situation with its daily working hour arrangements including the branch and regional characteristics proved to play an important role in explaining the IMD poverty risk for multidimensional (IMD) time and income poverty.

IMD poverty intensity - Minimum IMD poverty gap (2DGAP)

The specification strategy for the explanation of the IMD poverty intensity, the multidimensional poverty gap (2DGAP), in particular asks for human capital factors as well as concurrent household time use and further household indicators to explain individual poverty severity and the family situation to escape IMD poverty.

One overall result: Compared to the explanatory power of our specification of the IMD poverty risk, a relative small number of significant coefficients are detected to explain the minimum IMD poverty gap (2DGAP) (Table 6).

Personal and human capital: No visible gender differences at the one hand might be attributed to the household based poverty line definition, and at the other hand, to lesser individual genuine leisure time differences between males and females. An engagement for others measured as time spent for active help is not significant. Age influences additional to the human capital years of schooling and working experiences are not significant. Again, though human capital in many studies is detected to be an important indicator to explain labour supply, however, it turns out that once being working poor, the multiple poverty gap at the risk to be IMD poor, is not affected thereby.

Occupation: Not only the risk to be IMD poor but also its poverty intensity is in particular driven by the self-employed as liberal professions and entrepreneurs. The labour market situation with outsourced small businesses, hard situations for many freelancers, increasing time stress in particular for the self-employed seems to be remarkably strong to overstrike the prosperous self-employed. As further results support the findings, the higher income inequality among the self-employed in Germany is not driven only by the very rich, but also by a relatively large group of low income self-employed. So, based on German individual tax data, e.g. the median income of the self-employed is significantly below the median income of the employees at the time of our analysis (see Merz 2007, 2004, Merz and Zwick 2005).

Job: Beyond the significant wage, IMD poverty intensity is not further influenced significantly by further working hour arrangements. Though the IMD poverty risk depends on those paid work time variables, the resulting poverty gap, however, will not.

Family/household: Being a lone parent with more than one child significantly rises the poverty gap; the remaining family/child situations also increase the poverty gap but not at a 5% level of significance. We also test the influence of the concurring time absorbing household activities, like for housework and child care hours, and the specific situation to care for young kids. The result: Only a young child (not yet in school) bonding possible paid working activi-

ties deepens the IMD poverty gap. Help from outside the household (measured in hours), which could change IMD poverty intensity, is not significant,

Region: Though the risk to poverty is significantly higher in East Germany than in West Germany, no such differences can be found in the IMD poverty intensity.

To summarize: Whereas a profound set of explanatory market oriented and non-market household/family factors could be detected for the multidimensional risk to time and income poverty, the set of significant explanatory variables for the multidimensional poverty intensity is remarkably smaller. Many personal (but not gender) and human capital variables, daily working hour arrangements, the children situation (to a certain extent) and the region are no more significant. However, further time sensitive activities with caring a young child, the individual wage and again the self-employed situation do have a significant influence in explaining the multidimensional time and income poverty intensity.

6 Concluding Remarks

This study analyses time and income interdependent multidimensional (IMD) poverty. Based on disentangling the interdependency between time and income with respect to the union approach with its strong focus axiom and the compensation approach with its weak focus axiom allowing compensation between the dimensions over their whole ranges, the unidimensional and the interdependent multidimensional (IMD) poverty situation in Germany is investigated. To incorporate Sen's capability approach with its social participation aspects we define the time dimension as genuine personal leisure time and argue that when this personal time, which remains after all obligations (paid work or within the family/household etc.), is restricted then a person should be called poor in the time dimension because of limited possibilities for social participation.

The IMD poverty line in this study is evaluated by the total population and estimated by a CES well-being function with individual satisfaction information of the German Socio-Economic Panel evaluating the substitution/compensation trade-off between time and income. The more detailed German Time Use Surveys (GTUS) available for 1991/92 and 2001/02 with its time use diaries then serve to assign the individual situation to be poor or not for diverse poverty regimes over a ten years period.

IMD time and income poverty is measured by a multidimensional Foster-Greer-Thorbecke (FGT) approach which considers multidimensional well-being units delivering headcount ratios and information about the intensity of the poverty gaps. In addition we propose for the first time the minimum multidimensional poverty gap, the 2DGAP, an interdependent multidimensional measure of well-being units projected to the two dimensional time and income space, which allows to disentangle the intensity of IMD poverty to its single dimensions but with respect to its interdependence. The minimum 2DGAP at the same time shows an effective way out of IMD poverty. The analysis is extended by mean time, income and IMD poverty gap measures for different IMD poverty regions and overall characterizes the situation of the active population and its working poor for Germany.

The overall result: Unidimensional income poverty remains relatively constant over the investigated decade in Germany, while time poverty remarkably increased for the active population within the ten years period. Unidimensional gap intensity indices in addition suggest a stronger deprivation in 2002. Interdependent multidimensional poverty (union approach, strong focus) also indicates more frequent IMD poverty in 2002 however with relative small changes over time. IMD poverty according to the compensation approach (weak focus), how-

ever, indicate some IMD poverty decrease but not significantly compared to the other developments. One reason behind the compensation situation is a diminishing but still important group of those time poor, who are assigned *not to compensate* their time deficit by above threshold income (regime 3). In addition, the group *with compensation* of the time deficit by above threshold income in particular increased, regime 5, resulting in a lower IMD poverty headcount ratio in 2001/02.

The relative large amount of the average poverty gaps to the unidimensional poverty lines and to the IMD poverty line (compensation approach) shows the importance and wide range of accepted compensation evaluated by the German society as a whole. And, it emphasizes the importance of the time dimension when individual well-being is analyzed.

One poverty regime is of particular interest: it is the poverty regime where time poverty cannot be compensated even by an above poverty income. This (regime 3) group, with a poverty headcount ratio of still 8,7% in 2001/02 is not judged to be poor by the traditional income orientated poverty concepts. However, as this remarkable result indicates, before the background of increasing time squeeze and time stress, the society assigns a relatively high value to the time dimension and in particular to personal genuine leisure time with its social participation aspects.

With regard to socio-economic groups there are remarkable differences of unidimensional and multidimensional time and income poverty ratios and poverty gap intensities in the German society. In particular, differences were detected according to gender (with higher depriviation for females), the occupational status with its principal time sovereignty of the self-employed (remarkable high IMD poverty ratios of entrepreneurs as well of liberal professions), the family situation with their children (more kids result in remarkable higher IMD headcount ratios), and the situation for single parents with poverty above the average.

The microeconometric multivariate two step Heckman estimates of the IMD poverty risk and the 2DGAP IMD poverty intensity detected a broad set of personal, human capital, occupational, job, family/household and regional characteristics for its explanation. Though many market and non-market economic and time use variables could be tested, the set of significant variables for explaining the IMD poverty risk is broader than the set to explain the IMD poverty intensity. Further research is necessary to go forward in explaining the fascinating field of multidimensional time and income poverty.

All these empirical based results indicate the overall importance of the time dimension with its social participation aspect to be incorporated within an interdependent multiple time and income poverty approach. As the results based on the German population evaluation have shown, time is going to be so valid that a remarkable proportion of the working population are assigned not to compensate their time deficit even by above poverty income.

Any targeted policy to reduce poverty, or more general, for a better coordination of the daily life – with respect to the labour market, the child care situation, public goods etc. – would ignore an important dimension when time with its social exclusion aspects would be neglected. Beyond income policies for the working poor (like a minimum wage etc.) also particular time policies are asked for a better and more efficient synchronization of the working and non-working time consuming activities (flexible working hours, commuting and public transport, child care support, public services...) in general and in particular to reduce multidimensional poverty allowing social participation.

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