

# *Computing multidimensional poverty indices using fuzzy sets theory*

## *(The MPI Program)*

**Maria Noel Pi Alperin\***

CEPS/INSTEAD  
B.P.48, L-4501 Differdange  
Luxembourg

LAMETA Université Montpellier I  
Av. de la Mer - Site de Richter - C.S. 79606,  
34960 Montpellier Cedex 2 France  
E-mail: pialperin@lameta.univ-montp1.fr

**Version 1.0**

**November 2008**

This tutorial presents step-by-step how to use the MPI program. This user-friendly program calculates multidimensional poverty indices based on the fuzzy set approach to the study of deprivation. It also computes all decomposition possibilities in the multidimensional context.

The MPI Program is developed in Visual Basic 6.0, and use Microsoft Access. The source data are imported from an .xls format file, and results are exported to .xls format in order to facilitate later treatment.

## **Installation of the program**

Installation of MPI must be done by means of the package of Distribution ([downloadable at \*\*http://medim.ceps.lu/index?cfm?id=software\*\*](http://medim.ceps.lu/index?cfm?id=software)). The distribution package can be saved anywhere in the hard drive. The feasible program (FP) can be installed in a separate folder. Nevertheless, the input database must be saved in the FP directory folder. Results are automatically saved in the FP directory. Execute MPI (dos) and then setup the program.

---

\* “This work is part of the MeDIM project (Advances in the Measurement of Discrimination, Inequality and Mobility) supported by the Luxembourg ‘Fonds National de la Recherche’ (contract FNR/06/15/08) and by a post-doc grant (“Bourse Formation Recherche” BFR08/019) financed by the Luxembourg Ministère de la Culture, de l’Enseignement Supérieur et de la Recherche, and administered at CEPS/INSTEAD.” The author thanks Silvia Alperin for the Technical Assistance on the construction of this program, and Philippe Van Kerm and Stéphane Mussard for their helpful comments.

## Input Database

The user must construct the input database and save it in .xls format. Table 1 presents an example of database. The first column must be called “**Id**” and contain the rows numbers. The label of the columns called “**D1, ..., D<sub>D</sub>, V1, ..., V<sub>V</sub>, Weight**” can be chosen by the user. Nevertheless, the labels must have less than 20 characters and spaces are not allowed<sup>1</sup>. Columns D1 to D<sub>D</sub> are the selected dimensions to decompose the database, whereas V1 to V<sub>V</sub> are the selected dimensions to study multidimensional poverty. The later variables are quantitative and must be transformed using fuzzy set theory (see Table 2). The last column represents the sample weights, i.e. the number of observations in the total population statistically represented by each sample observation.

**Table 1: The database**

<b>Id</b>	<b>D1</b>	<b>D2</b>	<b>...</b>	<b>D<sub>D</sub></b>	<b>V1</b>	<b>V2</b>	<b>...</b>	<b>V<sub>V</sub></b>	<b>Weight</b>
1	1	MUSULMAN		MALES	0	0		0,4	178,13
2	1	MUSULMAN		FEMALES	0	0,3		0,4	178,13
3	1	CHRISTIAN		FEMALES	0	0,3		0	178,13
4	1	MUSULMAN		MALES	0	0,3		0,4	178,13
5	1	MUSULMAN		MALES	0	0		0,4	178,13
6	1	CHRISTIAN		FEMALES	0	0,3		0,4	178,13

The format of the data and the limitations of the capacity are presented in Table 2:

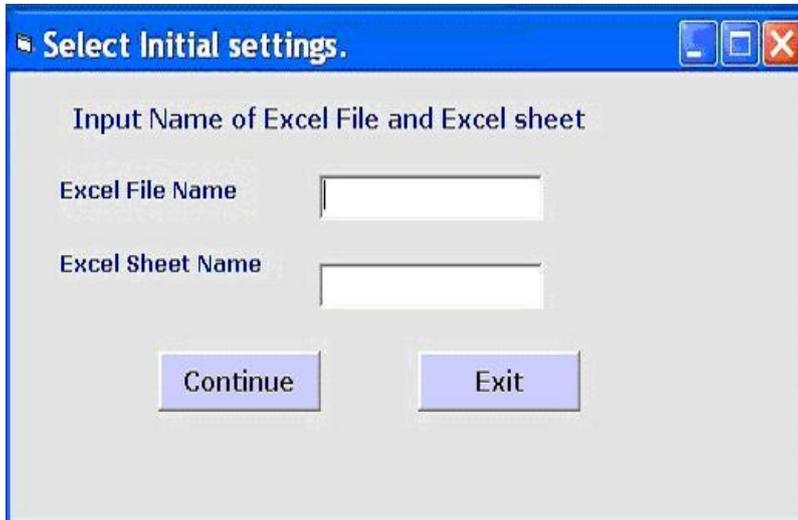
**Table 2: The limitations of the capacities of the database**

<b>Number of columns</b>	<b>Name</b>	<b>Content</b>	<b>Restrictions</b>
<b>First column</b>	<b>Id</b>	<b>Numbers of the rows</b>	Only one column
<b>n<sub>D</sub> columns</b>	<b>The user can choose the column's name</b>	<b>Variables used for decompositions (qualitative or quantitative variables)</b>	n <sub>D</sub> ≤ 68
<b>n<sub>V</sub> columns</b>		<b>Selected variables to study multidimensional poverty (quantitative variables, all belonging to the interval [0,1], transformed using fuzzy set methodology)</b>	n <sub>V</sub> ≤ 30
<b>Last column</b>		<b>Sample weight associated to each observation (quantitative variable)</b>	Only one column
<b>Additional information</b>			n <sub>D</sub> +n <sub>V</sub> +2 ≤ 100

<sup>1</sup> It is also important to avoid names that could be written in the sources of the program, e.g. square.

## Select initial settings

The first screen after starting MPI enables the input file to be selected (Excel File in .xls format). Recall that the input file must be saved in the FP directory. Also in this screen, the name of the sheet that includes the database has to be set. Then, press *Continue* to go to the next step.



**Select Initial settings.**

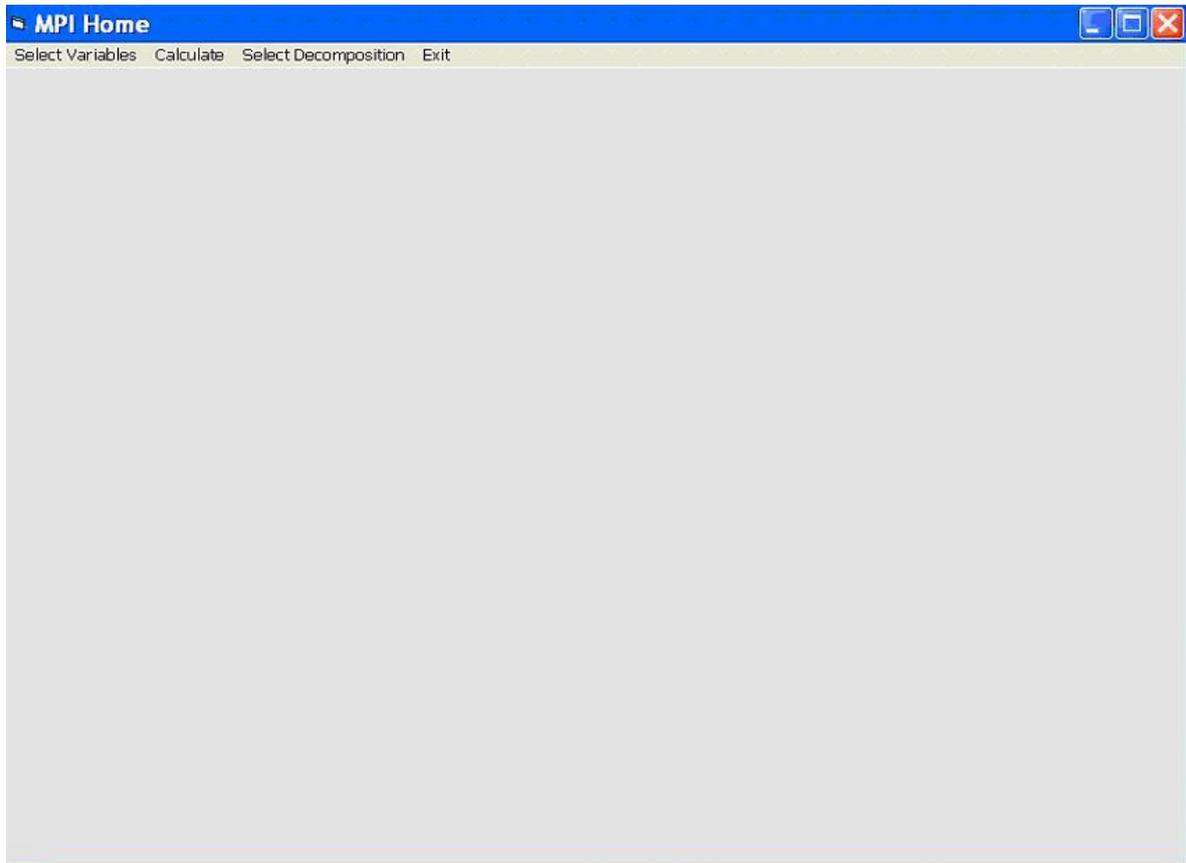
Input Name of Excel File and Excel sheet

Excel File Name

Excel Sheet Name

## Menu

Once the database is loaded, the MPI Home menu opens up. A particular order in entering the settings must be followed. Firstly, in the *Select Variables* item, the characteristics of the dataset will be specified. Secondly, in the *Calculate* item, the weighting method will be set to obtain the multidimensional fuzzy poverty index. Finally, in the *Select Decomposition* item the discriminating variables will be chosen to proceed with the decompositions.



## Select Variables

This interface (see the following figure) yields the user the possibility to specify the location of each variable type. The user must introduce the column numbers that correspond to each variable type. Variables of the same type should be in contiguous columns of the dataset. There are four selection types:

1. Id Households: **always** contains numbers From 1 to 1 (the first column).
2. Decompositions: selected variables to make decompositions.
3. Attributes: selected variables to study multidimensional poverty.
4. SNH: the Statistical Number of Households (sample weight).

In the following screen view example, the variables located between columns number 2 and number 8 of the database are specified to be of Decomposition type. Between columns 9 and 20, it is specified that the database contains Attributes type variables (i.e. the selected dimensions to study multidimensional poverty). Finally, the SNH variable type is in column 21.

Once the columns have been recorded, the user can press **Check** to verify if each column has been correctly set. If everything is right, press **Run** in order to get the **Calculate** option of the MPI Home menu.

Database Columns		
Column	Column Name	Type
1	Id	1
2	region	2
3	religion	2
4	etatmat	2
5	tail	2
6	strate	2
7	age	2
8	sexe	2
9	plancher	3
10	toit	3
11	logml	3
12	statoac	3
13	murexter	3
14	typwc	3
15	confo	3
16	activité	3
17	nivinst	3
18	sitprof	3
19	RPerjour	3
20	ipeup	3
21	poids	4

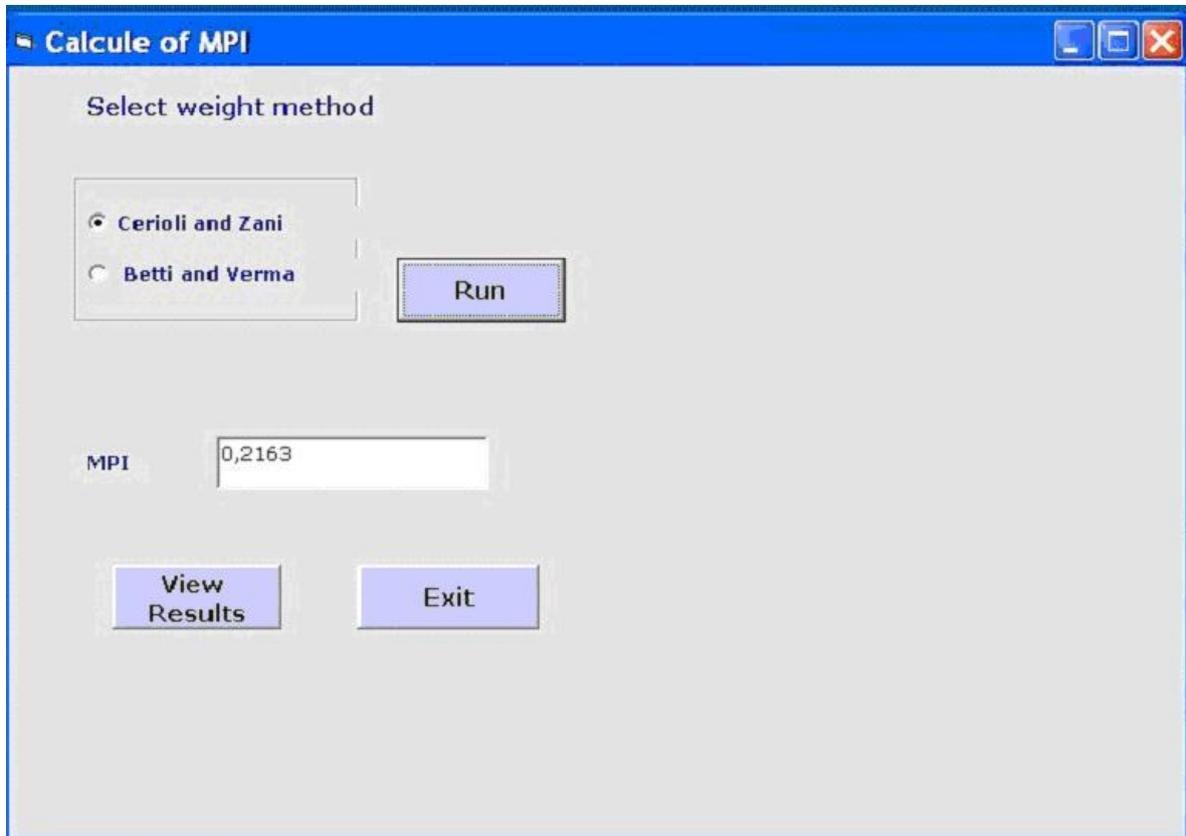
  

Select Columns Types	
From	To
1 :IdHouseholds	1 1
2: Decompositions	2 8
3: Attributes	9 20
4: SNH	21 21

Check Run Exit

## Calculate

In this interface, the user must select the weight method. Two possibilities are available: the weight system proposed by Cerioli and Zani (1990)<sup>2</sup> and the one developed by Betti and Verma (1999)<sup>3</sup>. Press **Run** in order to calculate the global multidimensional poverty index.



The screenshot shows a software window titled "Calculate of MPI". Inside the window, there is a section titled "Select weight method" with two radio button options: "Cerioli and Zani" (which is selected) and "Betti and Verma". To the right of these options is a "Run" button. Below this section, the label "MPI" is followed by a text input field containing the value "0,2163". At the bottom of the window, there are two buttons: "View Results" and "Exit".

Once the calculation process is completed, **View Results** provides the results which are presented in the following screen. Press **Exit** to come back to the MPI Home menu.

---

<sup>2</sup> The weight attached to each attribute of poverty attribute, and proposed by Cerioli and Zani (1990), stands for the intensity of deprivation of this attribute. It is an inverse function of the degree of deprivation of this attribute by the population of households.

<sup>3</sup> The weight proposed by Betti and Verma (1999), not only takes into account the intensity of deprivation of each attribute but also limits the influence of those indicators that are highly correlated.

In this interface the user can visualize all the results and export them to .xls format. Until this step, the MPI Program output consists in:

- The multidimensional poverty index for the entire population.
- The unidimensional poverty indexes for each attribute and for the entire population.
- The relative contribution of each dimension to global poverty.

The screenshot shows a software window titled 'UPI'. Inside the window, there is a table with the following data:

Attributs	IUP	Relative C.
plancher	0,3939	12,93
toit	0,5005	12
logml	0,4844	12,37
statoac	0,1599	10,33
murexter	0,2017	11,38
typwc	0,7111	8,54
confo	0,9686	1,08
activité	0,0696	6,53
nivinst	0,8869	3,75
sitprof	0,0971	7,98
RPerjour	0,9336	2,25
lmeun	0,1694	10,67

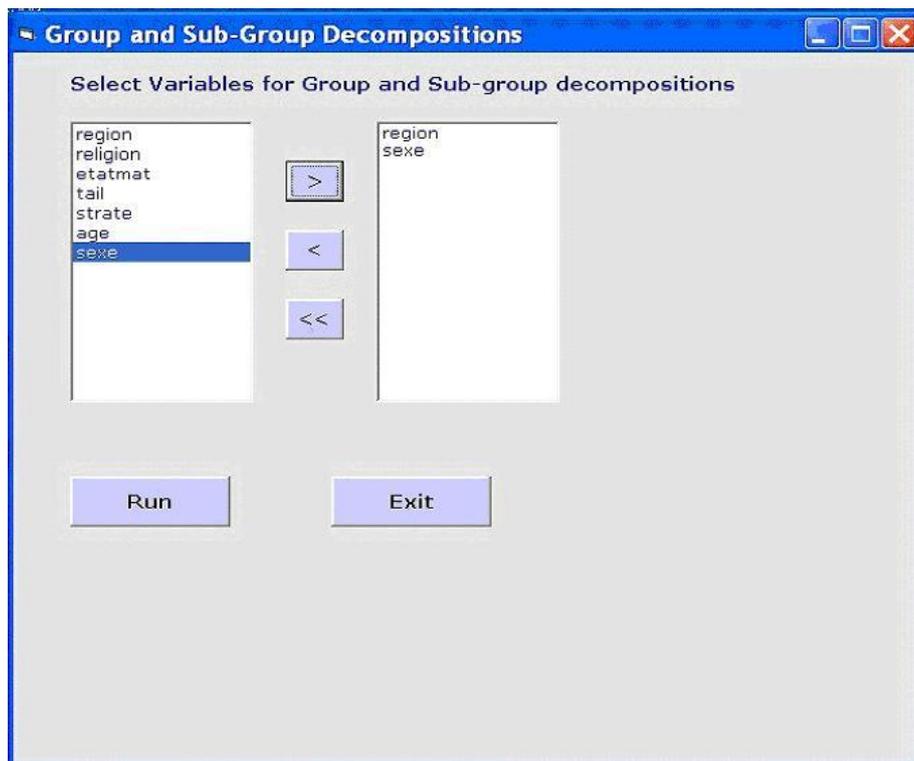
Below the table, there is a label 'MPI' followed by a text box containing the value '0,2163'. At the bottom of the window, there are two buttons: 'Export to excel' and 'Exit'.

## Select variables for group and sub-group decompositions

Once the fuzzy indexes have been computed, in the MPI Home menu the user can enter in the Select Decomposition item. The Group and Sub-Group Decompositions interface allows the user to choose, among variables of type 2 (i.e. Decomposition types), those who will participate in the decomposition.

For each multi-level decomposition, the maximal number of variables must be  $\leq 4$ , and the number of resulting sub-groups must be  $\leq 50$ .

Press **Run** to get the requested decomposition. The result can be visualized and exported. The user can then enjoy additional decompositions.



To visualize all the results, it is necessary to export them into .xls format (press **Export to Excel**).

The user can access to the following results:

- The multidimensional poverty indexes for each sub-group after the partition of the population.
- The relative contribution of each sub-group to the global poverty level.
- The unidimensional poverty indexes for each attribute and for each sub-population.
- The relative contribution of each dimension to global poverty for the entire population.
- The relative contribution of each dimension to the poverty level of each sub-population.

The screenshot shows a software window titled "Indices Unidimensionnels par attribut". It contains two data tables side-by-side. The left table is titled "Multidimensional Poverty Index of the K group" and the right table is titled "Contribution of the K group to the MPI". Both tables have columns for "region", "sexe", and a numerical value. A dialog box titled "Input Name for Excel Export File" is overlaid on the tables, with a text input field and a "Continue" button. At the bottom left of the main window, there is a button labeled "Export to excel".

Multidimensional Poverty Index of the K group			Contribution of the K group to the MPI		
region	sexe	G_MubXJ	region	sexe	ContRelG
0	FEMININ	0,1967	0	FEMININ	0,0053
0	MASCULIN	0,1573	0	MASCULIN	0,0596
1	FEMININ	0,2439	1	FEMININ	0,0795
1	MASCULIN	0,2414	1	MASCULIN	0,2493
2	FEMININ	0,2152	2	FEMININ	0,0148
2	MASCULIN	0,1808	2	MASCULIN	0,0445
3	FEMININ	0,455	3	FEMININ	0,0707
3	MASCULIN	0,1686	3	MASCULIN	0,0696
4	FEMININ	0,1113	4	FEMININ	0,0171
4	MASCULIN	0,1559	4	MASCULIN	0,065
5	FEMININ	0,273	5	FEMININ	0,0054
5	MASCULIN	0,19	5	MASCULIN	0,0524
6	FEMININ				0,0139
6	MASCULIN				0,0634
7	FEMININ				0,0219
7	MASCULIN				0,0726
8	FEMININ				0,0084
8	MASCULIN				0,0355
9	FEMININ				0,0114
9	MASCULIN				0,0398

## References

- Betti G. et Verma V., (1999)**, « Measuring the Degree of Poverty in a Dynamic and Comparative Context: a Multidimensional Approach Using Fuzzy Set Theory », *Proceedings of the Sixth Islamic Countries Conference on Statistical Science ICCS-VI*, Lahore (Pakistan), August 27-31, 1999, pp. 289-301.
- Ceroli A. et Zani S., (1990)**, « A Fuzzy Approach to the Measurement of Poverty », in Dagum C. and Zenga M. (eds.), *Income and Wealth Distribution, Inequality and Poverty*, Springer Verlag, Berlin, pp. 272-284.
- Mussard S. and Pi Alperin M.N. (2007)**, « Multidimensional Poverty Decomposition: A Fuzzy Set Approach », *Statistica & Applicazioni*, Vol. V, n. 1, pp. 29-52.
- Pi Alperin M.N., (2007)**, « Décomposition Multidimensionnelle d'un Indice de Pauvreté Basé sur la Théorie des Ensembles Flous. Le Cas de l'Argentine de 1974 à 2003 », *Ph.D.*, University of Montpellier 1, France.

## Citation

MPI is a free contribution to the research community. Citation is therefore appreciated when used for published research. Please make reference to this document:

Pi Alperin, M. N. (2008), "Computing multidimensional poverty indices using fuzzy set theory. v1.0", CEPS/INSTEAD, Differdange, Luxembourg.

## Liability waiver

The program should work as advertised, but it is freely offered 'as-is' to the research community and may contain bugs. Use at your own risk! Bug reports, as well as comments and suggestions are welcome (pialperin@lameta.univ-montp1.fr).

THIS PRODUCT IS PROVIDED FOR FREE ON AN 'AS IS' BASIS, WITHOUT ANY WARRANTIES OR CONDITIONS. NEITHER MARIA NOEL PI ALPERIN NOR CEPS/INSTEAD OR UNIVERSTE MONTPELLIER 1 SHALL HAVE ANY LIABILITY FOR ANY INDIRECT, INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES WHATSOEVER, INCLUDING, BUT NOT LIMITED TO, LOSS OF REVENUE OR PROFIT, LOST OR DAMAGED DATA OR OTHER COMMERCIAL OR ECONOMIC LOSS.