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RECENT EVOLUTION OF POVERTY IN THE EUROPEAN COUNTRIES[1]

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ABSTRACT

The purpose of this paper is to analyse the evolution of poverty in the 15 countries of E.U., whose household income data is available through the information contained in the European Community Household Panel (ECHP).

Several indicators have been proposed in economic literature for measuring poverty, but they may produce different orderings when cases are compared. In this work, a set of poverty one-dimensional indicators are chosen, which best verify some desirable properties. A modification of the Principal Component Analysis (PCA) is proposed to calculate synthetic cross-sectional measures of poverty using this set of indicators.

In order to obtain comparable values throughout time, in addition to cross-sectional sense, joint consideration of single poverty indicators is proposed, independently of their temporary period of reference. Therefore, applying common space analysis to these cross-sectional synthetic measures, a common frame of comparison and a homogeneous weighting structure are obtained, which are stable throughout time.

This powerful tool allows static as well as dynamic comparisons, among the EU countries. Furthermore, the determination of groups of countries according to their characteristics in poverty will be accomplished.

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1. INTRODUCTION.

Social welfare analysis has consistently been one of the main problems in economic science. In this sense, there have been several approaches into this problem, but perhaps the most important one, since the decade of 1960, is that of social indicators. Through this approach, social welfare is decomposed in several components which define social indicators and which, together, will determine social welfare state. This components' selection is also a very interesting issue (Tinbergen, 1991). Further, from an official point of view, this target has conduced to Statistics National Services to create their own social indicators systems. In the European Union, EUROSTAT have been the coordinator of such an objective, and precedents can be found in OCDE (1982).

At this research field, synthetic indicator construction methods become to be especially interesting. These synthetic indicators are designed to merge the isolate information provided by each simple social indicator to give a social welfare indicator as a result. Among such methods, factorial ones (INE, 1991) and Ivanovic-Pena's DP2 distance (Pena, 1977) could be remarkable.

Moreover, from this social indicators' perspective, poverty measures must be considered as one of the most relevant ones, because of the great importance of its social, economic and political consequences. Taking the previous argument into account, poverty measurement has generated a great interest among the researcher community, during the last decades.

Sometimes, poverty has been considered as a multidimensional concept, including monetary and non-monetary elements which could be identified from several social indicators. However, this point of view is difficult to manage because of the lack of disposability of adequate data (Laderchi, 1997). In such circumstances, the most usual option consists of choosing some variable to approximate the household economic position as a summary related to the whole set of aforementioned variables (Sen, 1976). That will be the chosen option in this paper.

Nevertheless, there are another problems related to economic poverty measurement. The most direct one appears when a definition of poor household is involved, because the first issue we need to solve consists of identifying the poor subpopulation, in order to analyse the so-called *poverty incidence.* So, we have to define a minimum income level, in such a manner that if a household falls short of this income, it will be considered poor, and that minimum income will be named the *poverty line* or the *poverty threshold.* But there are so many proposals in the related literature, making difficult its consensus selection, because several ways can be used to define it, depending on its *absolute*, *relative* or *subjective* nature[2]. Obviously, obtained results will be conditioned by such a selection. Because of this argument, we are going to consider relative poverty lines, following well-known recommendations when developed countries are going to be compared (Dagum, 1989), but we propose the use of different relativity degrees, referred to EU as a whole, time-independent and properly relative ones. So, we consider country and time as variables that might be fixed in order to regulate the relative degree incorporated on each poverty threshold.

Another important decision affects to *intensity* measurement. Once more, global curves comparisons can only generate a quasi-order structure among income distributions[3] and poverty intensity quantification has to be evaluated through poverty measures (Sen, 1976). However, there are many possible poverty measures to be used and researchers consensus consists of imposing a minimal set of guarantied properties or *axioms* to be fulfilled (Foster, 1984). But that minimal set of axioms is not able to characterize a unique indicator which could be considered better than others and so there exist some alternative indicators (Foster and Sen, 1997; Zheng, 1997).

The above argumentation may lead us to the consideration of batteries of poverty indicators, avoiding the difficulty of selection among them. That solution might find one precedent in the *intersection quasi-order* issue, proposed by Sen (1973), in an economic inequality environment. But, the similarity relies only on the battery of indicators consideration as a beginning point, because Sen's approximation generates only a quasi order structure again. Instead of looking for global agreement when several

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[2] Further details on this topic can be found in Hagenaars and van Praag (1985) or Hagenaars (1986).

[3] In this sense, we find different poverty ordering (Atkinson, 1987; Foster and Shorrocks, 1988a and b) and TIP curves (Jenkins and Lambert, 1997), applied to Spain by Del Río and Ruiz-Castillo (2001) and Casas, Domínguez and Núñez (2003), among others.

indicators are used to compare two income distributions, our proposal follows the guidelines of García, Núñez, Rivera and Zamora (2002) on an inequality framework, in order to use synthetic indicator construction techniques. Although this original proposal only allows cross-sectional comparisons, we are going to extend this scope so as to find indicators with dynamic comparison capabilities indeed. In order to cover that objective, our conviction points towards more research effort is needed[4], taking into account that when using factorial methods, solutions depend crucially on correlation structure found among initial partial indicators selected to be included in the battery.

The structure of this paper is as follows. Section 2 deals with involved methodology and decisions we have taken about poverty measurement, and the construction of cross-sectional and dynamic synthetic indicators. Section 3 describes data used. In section 4, empirical results are presented and commented, using several poverty lines, as mentioned above. Finally, main conclusions are enlightened in last section.

2. METHODOLOGY.

First of all, we need to construct the space of incomes as a useful background to all the next developments, keeping in mind that the economic position of the households has been selected through its global income[5].

Let x be a vector of non-negative incomes, whose dimension should be determined by the population size. Thus, the space of incomes, D, can be defined as:

$$D = \bigcup_{N=2}^{\infty} D_N = \bigcup_{N=2}^{\infty} \left\{ (x_1,...,x_N) : x_i \geq 0, i = 1...N; \sum_{i=1}^{N} x_i > 0 \right\}$$

Obviously, the remainder definitions about poverty measures, which are real-valued functions, must be understood over the above set.

[4] Some results can be found in Domínguez, Núñez and Rivera (2003a and b).

[5] The subsequent construction would be valid if the household economic position measurement is changed, using any other option, like expenditures, earnings or disposable incomes.

2.1. Poverty lines.

One of the basic problems we found when dealing with economic poverty analysis is the identification of poor elements (individuals or households, as in this case) inside the population, through the poverty threshold or poverty line definition. Dagum (1989) argues that poverty line in a poor and less-developed country should be determined from basic needs, whereas for developed countries, relative poverty lines should be used.

The relative poverty threshold is related to any indicator of the quality of living of society, what Thurow (1969) calls the *adequate living standard* as it is perceived by the majority of society. In this paper, we use different relative poverty lines, defined by the 50% of the mean per capita total net household income for each case considered. In cases we decide to use time-fixed poverty lines, we extend them using the corresponding Harmonised Consumer Price Index to complete the period considered, avoiding the change of price level influence. In doing so, we intend to avoid the excessively relative impact of choosing different poverty lines defined at each year of the period, allowing us longitudinal comparisons with the same poverty level in each country. So, three different relative poverty lines have been considered:

1. A common European poverty line fixed in 1995. All countries are compared with EU poverty line.

2. A time-fixed poverty line for each country. 1996 is the first year when data of the fifteen countries are available (1997 wave). So, each country's poverty line was fixed in 1996, and then extended using the corresponding values of their own harmonized consumer price index.

3. The poverty line is computed each year and for each country. These are totally relative poverty lines, thus having a different poverty line for each country in each wave.

2.2. Selection of a set of poverty indicators.

As discussed in the Introduction, there are a great number of poverty measures proposed in the literature (see for example Foster and Sen, 1997) and there is no agreement about which one could perform the best. However, it is usual to establish a minimal set of properties to limit the scope. In such a case, the selection process could lead to the following simple poverty indicators[6], whose expressions are given in descriptive mode over a general income vector $x \in D$, taking into account that z is the poverty line considered, n is the number of households in each sample unit and q identifies the number of poor households (those in which per capita income is under the poverty line):

1. Measure of Sen:

$$SEN(x, z) = \frac{2}{(q+1)\, nz} \sum_{i=1}^{q} (z - x_i)(q + 1 - i).$$

2. Measure of Thon:

$$THON(x, z) = \frac{2}{(n+1)\, nz} \sum_{i=1}^{q} (z - x_i)(n + 1 - i).$$

3. Measure of Foster, Greer and Thorbecke of order 2:

$$FGT2(x, z) = \frac{1}{nz^2} \sum_{i=1}^{q} (z - x_i)^2 \ .$$

4. Measure of Foster, Greer and Thorbecke of order 3:

$$FGT3(x, z) = \frac{1}{nz^3} \sum_{i=1}^{q} (z - x_i)^3 \ .$$

5. Exponential Measure[7]:

$$E(x, z) = \frac{1}{n} \sum_{i=1}^{q} \left(1 - \frac{x_i}{z}\right) \exp\left(-\frac{x_i}{z}\right).$$

6. Measure of Chackravarty of order 0.75:

$$CHACK0.75(x, z) = \frac{1}{n} \sum_{i=1}^{q} \left[1 - \left(\frac{x_i}{z}\right)^{0.75}\right] \ .$$

The headcount ratio index ($H=q/n$) has been used to analyse the evolution of poverty incidence in the European Countries throughout time. To study poverty intensity, the simple indicators that have been previously presented have been used.

[6] The selected indicators verify the axioms usually imposed in literature. See Domínguez (2003), for further details.
[7] Further details on this measure can be found in Domínguez (2003).

2.3. Construction of the cross-section synthetic poverty indicators.

Let us begin with the presentation of the data structure where this methodology works. Consider a set of p simple poverty indicators $\{I_1, I_2, \ldots, I_p\}$, which can be seen as a p-dimensional variable applied over the income space generated by each situation we need to study (European countries for example), across different points in time. So, we have one data matrix in each time we have considered. Let **I(t)** be such a function of $(n(t)xp)$ data matrices, with t varying in the actual time interval $[t_0 , t_1]$ and $n(t)$ as the number of cases at this time. Nevertheless, income data are characterized by its discrete presence and, thus, we have a temporary set like $T = \{t_0, t_1, \ldots, t_k\}$.

The above discussion suggests the possibility of considering a data matrices classification, where groups have been defined by the elements of the temporary set T. So, we can perform multivariate techniques on the data matrix defined over each point in time, generating a cross-section result. But all indicators in the battery are measuring poverty and, thus, their content should be determined using such a fact. This argument leads us to think of Principal Components Analysis as a useful technique to extract the common information the battery of indicators offers. Particularly useful must be the First Principal Component if the explained variance is big enough, as we can expect.

The formal construction of such a cross-section indicator follows the guidelines exposed in García, Núñez, Rivera and Zamora (2002), but now empathizing the dependence across time. So, let $(Y_1(t), Y_2(t), \ldots, Y_p(t))$ be the p-dimensional variable defined using the former variables under standardization along the corresponding cases. So, the data matrix will be **Y(t)**, whose elements are defined by:

$$Y_{ij}(t) = Y_j\,(x_i(t)) = \frac{I_j(x_i(t)) - \mu_j(t)}{s_j(t)}, \qquad i=1,2,\ldots,n(t);\ j=1,\ldots,p;\ t\in T,$$

where $x_i(t)\in D$ denotes the ith case income vector measured at the moment t in time, $\mu_j(t)$ is the mean of the indicator I_j calculated over all the cases in t and $s_j(t)$ the corresponding standard deviation. In such circumstances, let **S(t)** be the associated variance-covariance matrix from **Y(t)** and let $u_1(t), u_2(t), \ldots, u_p(t)$ be the eigenvectors extracted from **S(t)**, associated to its eigenvalues, ordered from the largest to the lowest one. Now, the first principal component can be obtained as follows:

$$Z_1(t) = Z_1(x(t)) = \sum_{j=1}^{p} u_{1j}(t).Y_j(x(t)) = \sum_{j=1}^{p} u_{1j}(t).\left(\frac{\mathrm{I}_j(\mathrm{x}_i(t)) - \mu_j(t)}{\mathrm{s}_j(t)}\right), \; x(t)\in D;\; t\in T.$$

After elementary algebraic manipulations, the proposed cross-sectional synthetic poverty indicator can be expressed in the following way:

$$Z(x(t)) = \frac{Z_1(x(t)) + K(t)}{\sum_{j=1}^{p}\left(u_{1j}(t)/s_j(t)\right)} = \sum_{j=1}^{p}\left(\frac{u_{1j}(t)/s_j(t)}{\sum_{i=1}^{p}\left(u_{1i}(t)/s_i(t)\right)}\right)\cdot I_j(x(t)) = \sum_{j=1}^{p} a_j^*(t)\cdot I_j(x(t)),$$

with $x(t)\in D$; $t\in T$, and where $K(t)$ is a value depending on $u_1(t)$, $\mu(t)$ and $s(t)$, but not on $x(t)$, except through the vectors expressed. Obviously, $\mu(t)$ and $s(t)$ are the vectors compounded by the means and standard deviations of the initial indicators, respectively. In such a manner, we have our indicator as a convex linear combination of the initial simple poverty indexes in the selected battery[8].

As it can be easily proved, this indicator is a normalized index. Further, $Z(t)$ constitutes a poverty indicator because it has been constructed using a battery of poverty indexes and this will be the primary content of the first principal component.

2.4. A synthetic poverty indicator which allows dynamic comparisons.

As far as we have reached, the proposed indicator will only generate different functions on each point in time, because the first eigenvector of **S(t)** could change whenever t varies in T. To avoid this problem, we have to remind that data come from samples of households and, thus, **S(t)** matrices are only estimations of the population ones. If we could admit that these matrices are all the same, then we will deduce

[8] Obviously, the elements of the eigenvector $u_1(t)$ must be non-negative because it was derived from the matrix **S(t).** More details about the synthetic indicator can be found in Dominguez, Núñez and Rivera (2004).

equality among all the first eigenvectors involved. In such a case, we might use a pooled estimate of the common variance-covariance matrix in order to obtain a unique eigenvector, which will be independent of time, providing an indicator that will be valid for all values in *T*.

So, as a first option, we propose the use of a test to contrast the hypothesis of a stable variance-covariance structure (correlation in our case). The test used is an adaptation of Box's M test[9]

If the same variance-covariance structure is accepted, then joint consideration of single poverty indicators is proposed, independently of their temporary period of reference, obtaining the pooled variance-covariance matrix **S**. So, we might use only the first eigenvector, u_1, valid over the whole time period, and the proposed synthetic indicator can be written as:

$$Z(x(t)) = \sum_{j=1}^{p} a_j^* \cdot I_j(x(t)) = \sum_{j=1}^{p} \left(\frac{u_{1j} / s_j}{\sum_{i=1}^{p} (u_{1i} / s_i)} \right) \cdot I_j(x(t)), \quad t \in T.$$

As it may be observed, the convex linear combination coefficients are now constant across time. So, the incidence of each country income vector operates only through its value measured by the simple poverty indexes and, thus, allows the analysis of poverty in a dynamic style, because the basic frame is the same, providing a stable weighting scheme over the initial set of poverty indexes. Also, an analysis of the differentials facts involved in the individual measuring characteristics is possible, taking into account the second principal component.

On the other hand, let us suppose now that null hypothesis of stable correlation structure has been rejected and, therefore, at least one variance-covariance matrix is different enough, compared to the rest. In such a case, to find out another solution may be still possible, using an adaptation of an algebraic method to locate the closest vector to the common space generated by principal components, proposed in Krzanowski (1979, 1982), namely the *Common Space Analysis* procedure.

[9] Further details of Box's M test can be found in Rencher, 1995, section 7.3, for example.

Let us expose the aforementioned adaptation of Krzanowski's method. So, if the first eigenvectors associated to {**S(t),** $t \in T$} were close to each other, it would be possible to find out a new vector located in a neighborhood of them, in such a manner that it minimizes the angles formed between it and each of them. Using only the first principal components, Theorem 3 included in Krzanowski (1979, pg. 705) allows to assure the vector we are looking for is the first eigenvector of the matrix:

$$H = \sum_{t \in T} u_1(t) \cdot u'_1(t)\,.$$

This solution is valid only if the first eigenvectors associated to {**S(t),** $t \in T$} are close, in such a manner that the angles between b and each of them should be small enough. At this point, it seems reasonable to expect such behaviour when we are working about poverty in the described context. Finally, the alternative synthetic poverty indicator would be the Common Space Poverty indicator:

$$Z_{CS}(x(t)) = \sum_{j=1}^{p} b_j^* \cdot I_j(x(t)) = \sum_{j=1}^{p} \left(\frac{b_j / s_j}{\sum_{i=1}^{p} (b_i / s_i)} \right) \cdot I_j(x(t)), \quad t \in T.$$

It comes now evident that if the first proposed synthetic indicator is adequate, the second must be very close to it. Nevertheless, in contexts like poverty where we should expect great correlations among the indicators included in the selected set, such as the case presented here, this second approximation must provide an interesting alternative, if the first one fails, usually when sample oscillations are important.

3. DATA DESCRIPTION.

To compute the poverty indexes presented above, data from the European Community Household Panel (ECHP) has been used. ECHP is a longitudinal survey of households and individuals, centrally designed and coordinated by the Statistical Office of the European Communities (EUROSTAT) and covering all countries of the European Union. An attractive feature of the ECHP is its comparability across countries and over time, as the questionnaire is similar and the elaboration process of the survey is carried out by EUROSTAT (Álvarez-García, Prieto-Rodríguez and Salas, 2002).

In this work, we have taken into account information from waves from 3 to 7, which correspond to years 1996 to 2000. The data of income is referred to the year before, thus giving us information about the years 1995 to 1999.

We are not going to provide a full description of the ECHP dataset in terms of sampling, response rates, weighting procedures, etc., since that can be easily found in specialized literature (EUROSTAT web page, Nicoletti and Peracchi, 2002, Ayala and Sastre, 2002, etc.), but it is necessary to point out that we had to exclude some households in the dataset for our analysis because they had missing values for total household income. Table 1 shows the initial number of cases in each country and the number of households that has been finally selected. It is interesting to see the large amount of households in Sweden for which no total income information is available.

Although Layte, Maître, Nolan and Whelan (2000) indicate that they exclude Luxembourg because it must be frequently treated as an exceptional case, we haven't found empirical evidence to discard it, or any other case.

The income measurement we have chosen for this paper, as a shake of convenience, is total net household income, which is one of the variables included in ECHP. In order to include the size of the household, *per capita* net income has been calculated. It is well known that the level of measured income poverty can vary depending on the choice of equivalence scale. The purpose of this work is not to analyse the influence of demographic factors on income poverty, but to see the way that some poverty indexes can be aggregated (for further discussion on equivalence scales, see, for example, Coulter, Cowell and Jenkins, 1992, or Buhmann, Rainwater, Schmaus, and Smeeding, 1988)

To make a comparative study of poverty in the European countries, in a cross-sectional as well as in a longitudinal sense, per capita net household income in US dollars have been calculated, using exchange rates obtained from EUROSTAT, and time series have been deflated using European Union harmonized consumer price index for each country.

Table 1

Sample households and households selected (in brackets) in order to keep households with total income information. ECHP Countries, Waves 3 to 7

Country	Code	Wave 3 1995	Wave 4 1996	Wave 5 1997	Wave 6 1998	Wave 7 1999
Denmark	**DK**	2955 (2951)	2745 (2740)	2512 (2505)	2387 (2381)	2281 (2273)
Netherlands	**NL**	5179 (5097)	5049 (5019)	4963 (4922)	5023 (4981)	5008 (4976)
Belgium	**BE**	3210 (3191)	3039 (3013)	2876 (2863)	2712 (2691)	2571 (2555)
France	**FR**	6600 (6555)	6176 (6142)	5866 (5849)	5610 (5594)	5345 (5331)
Ireland	**IE**	3173 (3164)	2945 (2935)	2729 (2723)	2378 (2372)	1951 (1944)
Italy	**IT**	7132 (7026)	6713 (6627)	6571 (6478)	6370 (6273)	6052 (5989)
Greece	**GR**	4907 (4851)	4604 (4543)	4211 (4171)	3986 (3952)	3918 (3893)
Spain	**ES**	6267 (6133)	5794 (5714)	5485 (5439)	5418 (5301)	5132 (5048)
Portugal	**PT**	4849 (4807)	4802 (4167)	4716 (4666)	4683 (4645)	4633 (4606)
Austria	**AT**	3292 (3281)	3142 (3130)	2960 (2952)	2815 (2809)	2644 (2637)
Finland	**FI**	4139 (4138)	4106 (4103)	3920 (3917)	3822 (3818)	3104 (3101)
Sweden	**SE**	- (-)	5891 (5286)	5807 (5208)	5732 (5165)	5734 (5116)
Germany	**DE**	6259 (6252)	6163 (6156)	5962 (5955)	5847 (5845)	5693 (5687)
Luxembourg	**LU**	2472 (2471)	2654 (2651)	2523 (2521)	2552 (2551)	2373 (2373)
United Kingdom	**UK**	5011 (4991)	4965 (4958)	4996 (4975)	4951 (4935)	4890 (4866)

4. RESULTS.

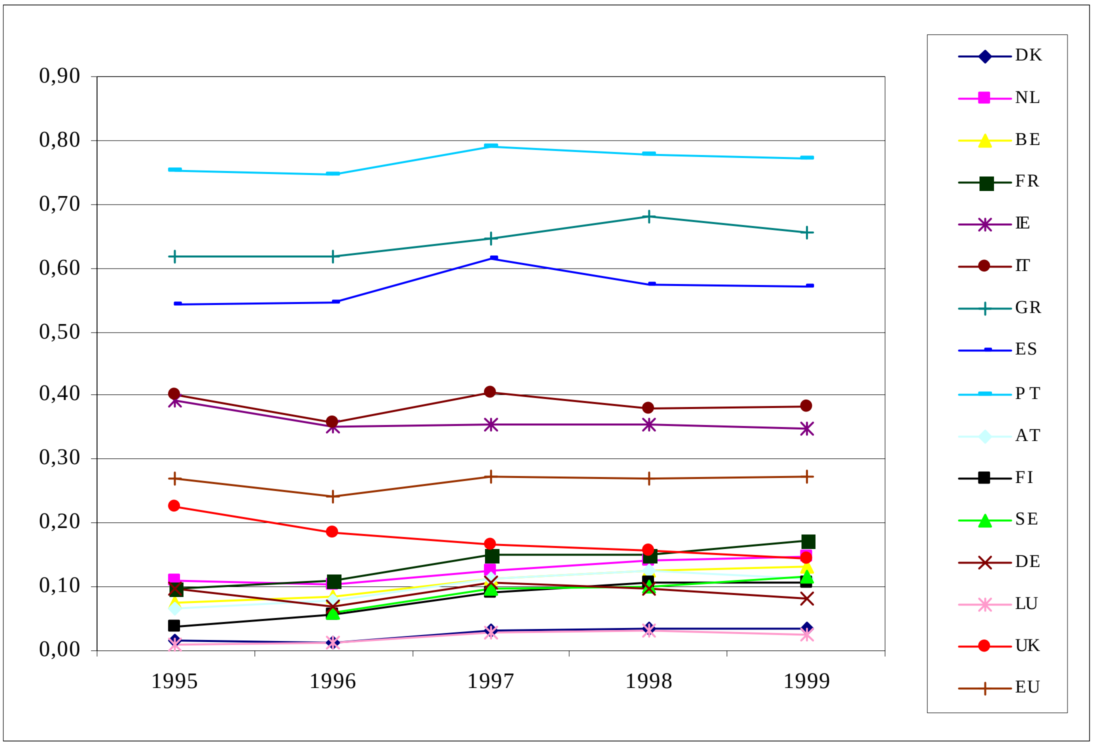
We are going to analyse poverty in European countries from three different points of view. First of all, we discuss about poverty incidence. Second, we study poverty intensity, through the longitudinal synthetic indicators proposed in section 2. Finally, we accomplish the study of the poverty gap ratio, because of its useful and meaningful interpretation, to complete the previous analysis. In all cases, the three different poverty lines, mentioned in section 2, will be used to give us a complete picture of poverty in Europe.

4.1. Poverty incidence.

4.1.1. Common EU(1995) poverty line.

In Figure 4.1.1, the headcount ratio index for each country is presented, using 50% of the mean income in European Union in 1995 as the poverty line for all cases, expressed in real US dollars. We observe that there are no uniform patterns in the evolution of the incidence of poverty in European countries.

Figure 4.1.1
Poverty incidence in EU and European Countries 1995-1999.
Common EU(1995) poverty line.



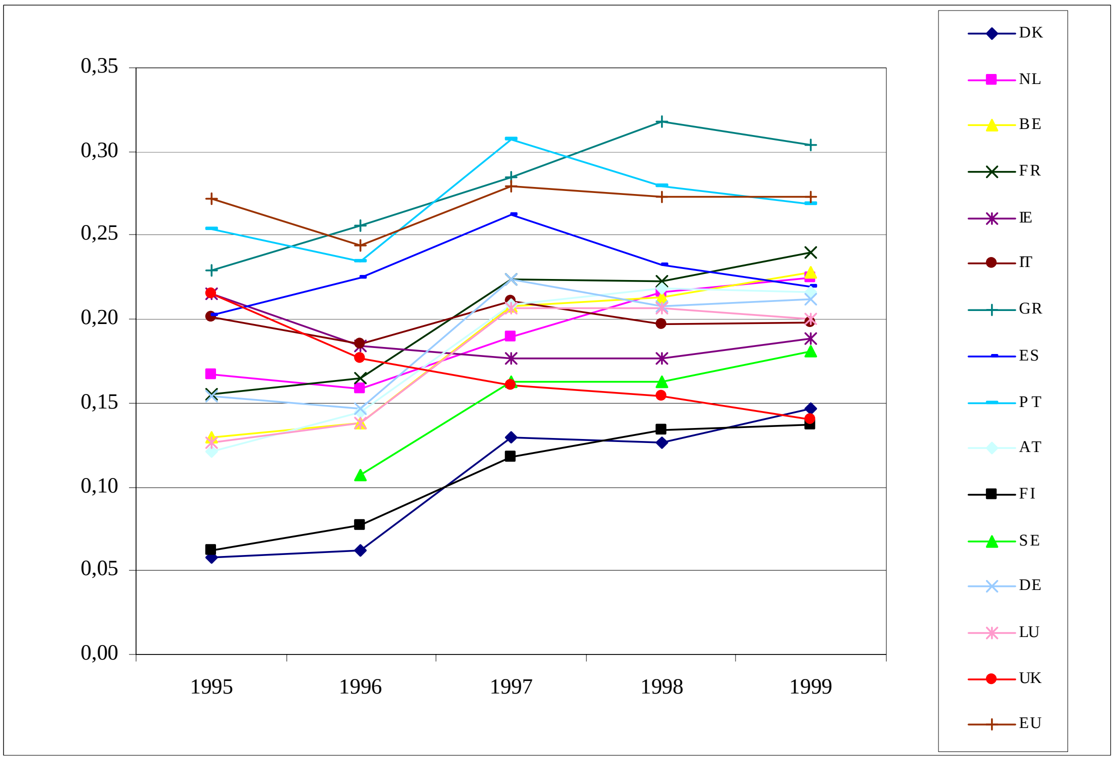
In Denmark, The Netherlands, Belgium, France, Greece, Austria, Finland, Sweden, Luxembourg and the EU as a whole, there is an increasing trend in all the period. However, in United Kingdom, poverty incidence diminishes continuously. It can be observed that countries with higher headcount ratios are, in order, Portugal, Greece and Spain and, a step lower, Italy and Ireland. It is remarkable that Denmark and Luxembourg have almost the same poverty incidence levels. Furthermore, both countries have the lowest incidence of poverty, not even reaching 5%.

4.1.2. Individual time-fixed poverty line for each country (1996).

When we are dealing with a different poverty line fixed for each country, we cannot expect to find the same groups as in the previous section. If we look at poverty incidence between 1995 and 1999 in Figure 4.1.2, we can observe that headcount ratio index has an increasing value in Finland, France and Sweden. The same occurs in Denmark, except for year 1998, where a slight reduction is produced. Nevertheless, headcount ratio index in 1999 is twice as much than in 1995 in Denmark.

Figure 4.1.2

Poverty incidence in EU and European countries, 1995-1999. Fixed poverty line for each country (1996).



United Kingdom is the only European country where the headcount ratio index is always decreasing, with respect to its own poverty line, fixed in 1996. In Greece, which appears at the top of Figure 4.1.2, an increasing tendency is observed in the first four years, followed by a slight decrease in last year.

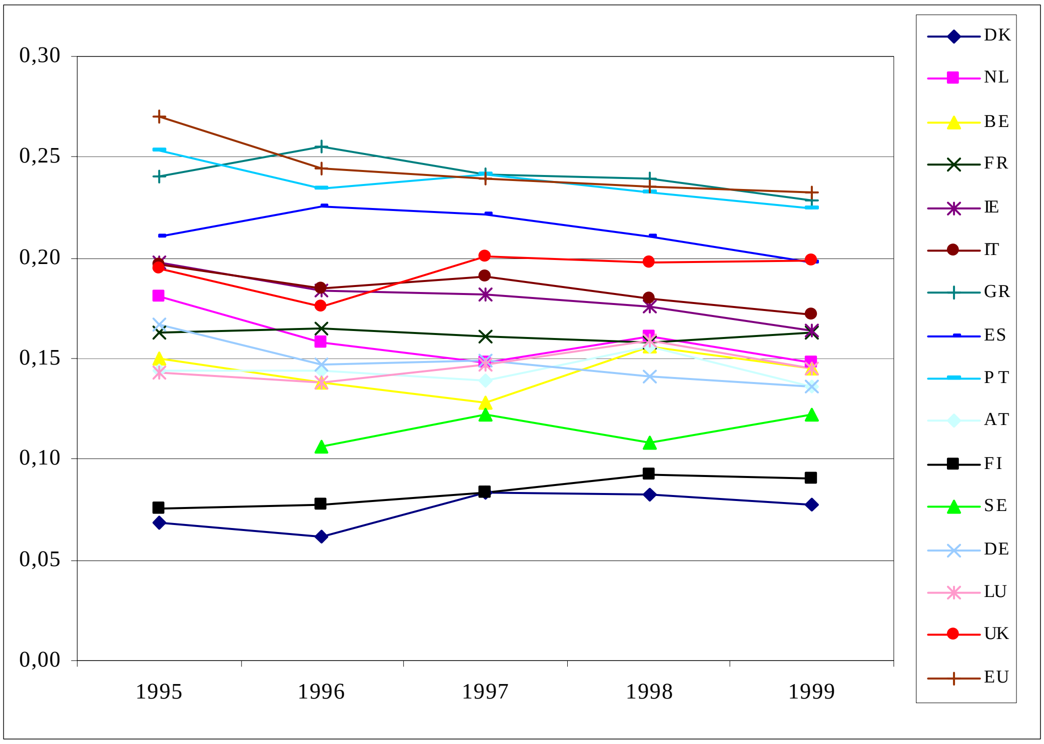
In Spain, the incidence is increasing until 1997, and then it starts to decrease. However, at the end of the whole period, headcount ratio index is bigger than at the beginning. Belgium and Luxembourg have a similar incidence of poverty in all waves.

4.1.3. Relative poverty lines.

In this section, we use a relative poverty line for each country in each year. In order to analyse the tendencies of poverty incidence, we observe Figure 4.1.3, where we find that a strong decreasing of headcount ratio indexes has been produced in Germany, The Netherlands, Ireland, Italy and Portugal. There is a moderate descent in Spain, Austria, Greece, Belgium and the EU as a whole.

Figure 4.1.3

Poverty incidence in EU and European countries, 1995-1999. Relative poverty lines (for each wave and country).



On the other hand, the stronger increases have occurred in Finland, followed by Sweden and Denmark. Luxembourg, France and United Kingdom have kept a quiet stable position. We can appreciate some kind of convergence in poverty incidence levels in European countries: In 1995, poverty levels are located between 6 and 28%, an in 1999, they are located between 8 and 23%.

4.2. Poverty intensity.

4.2.1. Poverty trends comparison among European countries. Common EU(1995) poverty line.

The corresponding weighting schemes to compute the synthetic poverty indexes based on ACP for each cross-sectional wave are presented in Table 2. We can appreciate that these weighting schemes are quite stable. That gives us the hint that it might be possible to consider that correlation structures are the same all over the period analysed.

Table 2

Weighting scheme for the computation of the cross-sectional poverty indexes based on the first Principal Component. Common EU(1995) poverty line

Poverty Index	Wave 3 1995	Wave 4 1996	Wave 5 1997	Wave 6 1998	Wave 7 1999
SEN	0.088066	0.088179	0.091304	0.089427	0.088608
THON	0.075731	0.075851	0.080043	0.078378	0.077526
FGT2	0.203784	0.203524	0.201537	0.201729	0.202190
FGT3	0.318970	0.318949	0.311040	0.317983	0.319939
EXPON	0.174633	0.174547	0.175132	0.173859	0.173687
CHACK075	0.138815	0.138949	0.140944	0.138623	0.138050

In order to prove the validity of our intuition, we shall first test the equality of the correlation matrices obtained from the indicators matrix in each wave. Applying the M-Box Test on standardized data, correlation matrices are assumed to be equal (see Table 3). This leads us to take both alternatives presented in methodology: finding of the Global First Principal Component using all the data set, with no temporal consideration, and constructing the indicator using the Common Space Analysis technique.

Table 3

Results of M-Box Test on equality of correlation matrices.

Box's M		2.842
F	Aprox.	.223
	df1	12
	df2	40193.238
	Sig.	.997

In Table 4, weights to calculate summary indexes based on Global Principal Components and Common Space Analysis are presented. It can be easily seen, that the corresponding weighting schemes are almost identical, which implies that both methods lead to the same results, when correlation matrices are assumed not to be different.

Table 4

Weighting scheme for the computation of the longitudinal poverty indexes based on the Global First Principal Component and the Common Space Analysis Technique.

Poverty Index	Global Principal Component Indicator	Common Space Indicator
SEN	0.089215	0.088610
THON	0.077597	0.077533
FGT2	0.202528	0.202210
FGT3	0.317048	0.319917
EXPON	0.174439	0.173690
CHACK075	0.139172	0.138040

Furthermore, Pearson correlation coefficients between these longitudinal indicators are presented in Table 5, to confirm that they are equivalent (the orderings obtained with the two synthetic indicators are the same).

Table 5

Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator.

		Global Principal Component Indicator	Common Space Indicator
Global Principal Component Indicator	**Coefficient**	1.000	1.000
	Significance		0.000
	N	79	79
Common Space Indicator	**Coefficient**	1.000	1.000
	Significance	0.000	
	N	79	79

To prove that these longitudinal indicators represent well the cross-sectional synthetic indexes, Pearson correlation coefficients are presented in Table 6.

Table 6

Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator and each year's Principal Component indicator.

		Global Principal Component Indicator	Common Space Indicator
1995 Principal Component Indicator	**Coefficient**	1.000	1.000
	Significance	0.000	0.000
	N	15	15
1996 Principal Component Indicator	**Coefficient**	0.999	1.000
	Significance	0.000	0.000
	N	16	16
1997 Principal Component Indicator	**Coefficient**	1.000	1.000
	Significance	0.000	0.000
	N	16	16
1998 Principal Component Indicator	**Coefficient**	0.999	0.999
	Significance	0.000	0.000
	N	16	16
1999 Principal Component Indicator	**Coefficient**	0.999	0.999
	Significance	0.000	0.000
	N	16	16

Figure 4.2.1 shows that the common space synthetic poverty indicator has the same behaviour than poverty incidence with a common EU poverty line. Luxembourg is the country with a lower level of poverty intensity, followed by Denmark and Finland. France, Ireland, United Kingdom, Germany, Sweden, Austria, Belgium and The Netherlands are located in the middle part while higher values correspond to Portugal, Greece and Spain.

Figure 4.2.1

Common Space Poverty Indicator values for each Country in the ECHP. EU (1995) poverty line.

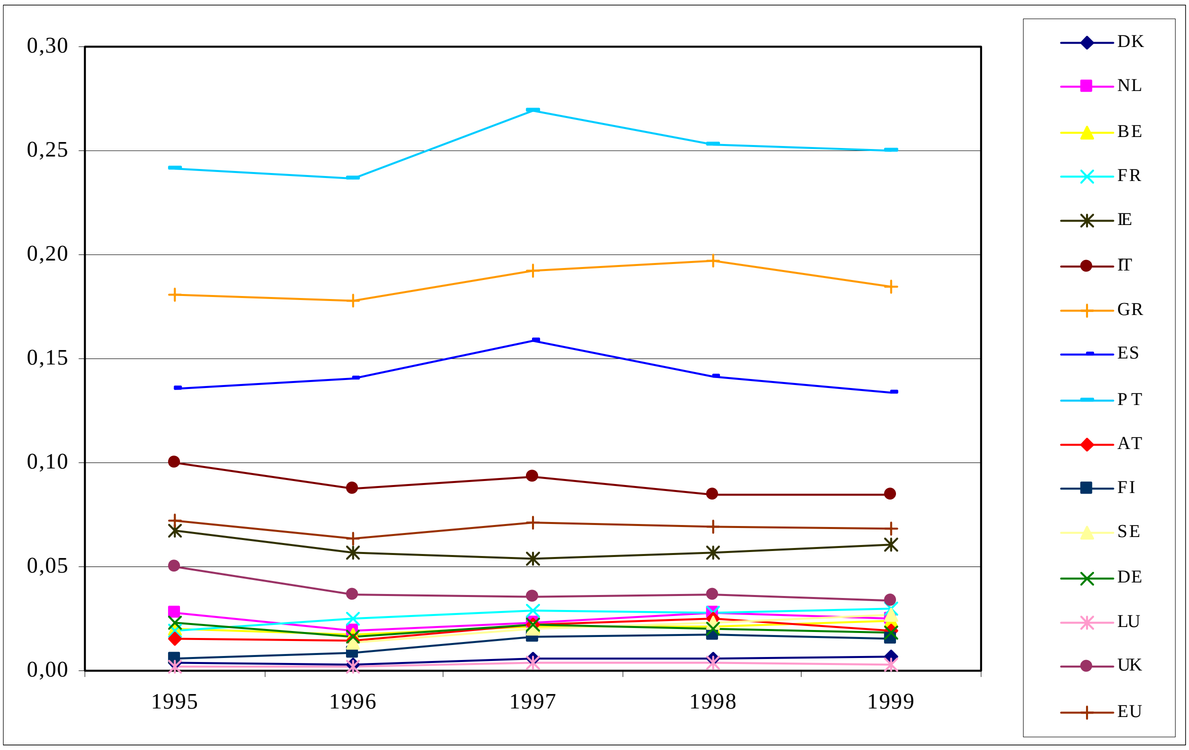


Figure 4.2.2 shows the resulting dendrogram from a cluster analysis, using centroid agglomeration method and euclidean distance between cases. It allows clearly to distinguish four groups: first of all, Portugal is the country with a higher poverty intensity, when compared with the EU as a whole. Second, Greece and Spain are located under Portugal, but over the European Union. After, Italy and Ireland are close to the global European Union levels of poverty intensity. Below them, the fourth group is formed by the other EU countries.

Figure 4.2.3 shows the geographical situation of these groups.

Figure 4.2.2

Dendrogram of the countries' common space based poverty index. 1995-1999.

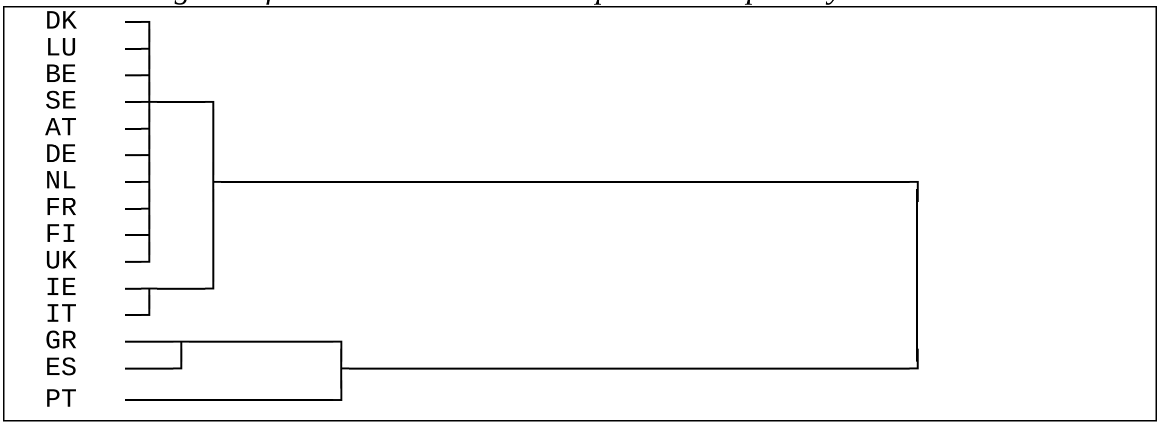
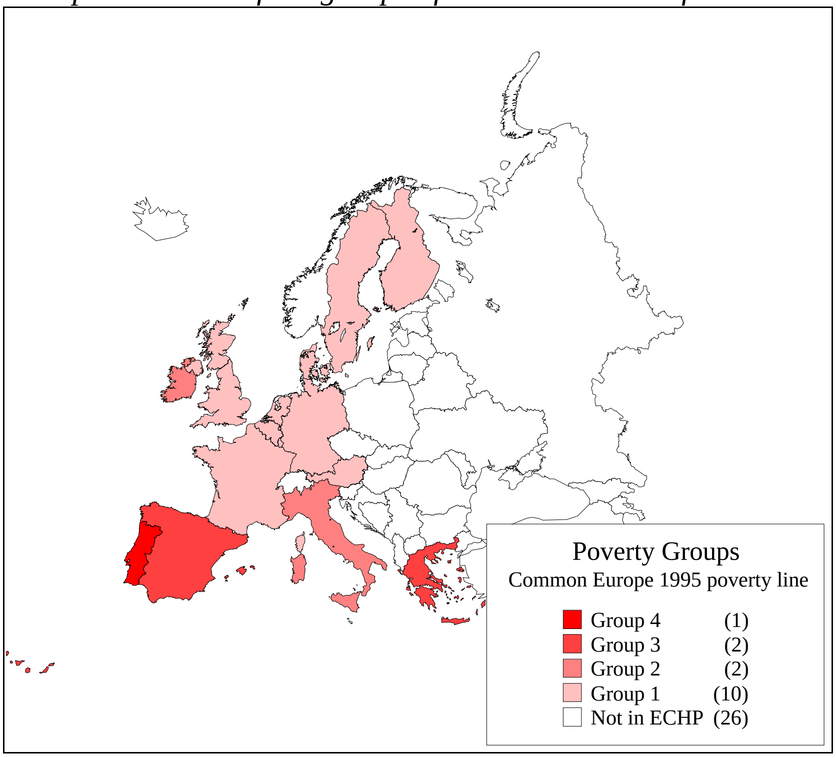


Figure 4.2.3

Geographical representation of the groups of countries derived from the classification.



4.2.2. Poverty trends comparison among European countries. Fixed poverty line for each country (1996).

In Table 7, the corresponding weighting schemes to compute the synthetic poverty indexes based on ACP for each cross-sectional wave, are presented. As in the previous section, we can appreciate how these weighting schemes are quite stable. Again, it might be possible to consider that correlation structures are the same all over the period analysed, when considering different poverty lines in each country.

Table 7

Weighting scheme for the computation of the cross-sectional poverty indexes based on the first Principal Component.

Poverty Index	Wave 3 1995	Wave 4 1996	Wave 5 1997	Wave 6 1998	Wave 7 1999
SEN	0,087026	0,087348	0,088534	0,085966	0,086695
THON	0,065490	0,065714	0,067734	0,065498	0,065614
FGT2	0,212179	0,211089	0,208157	0,208717	0,209290
FGT3	0,310278	0,310539	0,310965	0,322314	0,318722
EXPON	0,181338	0,181107	0,180194	0,177834	0,179134
CHACK075	0,143690	0,144204	0,144416	0,139671	0,140545

In Table 8, we can see that null hypothesis on correlation matrices equality cannot be rejected.

Table 8

Results of M-Box Test on equality of correlation matrices.

Box's M		26,868
F	Aprox.	1,019
	df1	24
	df2	15033,849
	Sig.	,436

Thus, it may be possible to consider all data together (global principal component) or to compute the common space-based synthetic indicator. As we see in Table 9, the weighting schemes are very similar in both cases:

Table 9

Weighting scheme for the computation of the longitudinal poverty indexes based on the Global First Principal Component and the Common Space Analysis Technique.

Poverty Index	Global Principal Component Indicator	Common Space Indicator
SEN	0,086227	0,086184
THON	0,065516	0,065470
FGT2	0,210949	0,210732
FGT3	0,315338	0,316124
EXPON	0,180098	0,179776
CHACK075	0,141872	0,141715

To verify the equivalence of these two synthetic indicators, Pearson correlation coefficients have been computed, which are shown in Table 10. We observe that these correlation coefficients show equivalent behaviours when both synthetic indicators are compared.

Table 10

Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator.

		Global Principal Component Indicator	Common Space Indicator
Global Principal Component Indicator	**Coefficient** **Significance** **N**	1.000 79	1.000 0.000 79
Common Space Indicator	**Coefficient** **Significance** **N**	1.000 0.000 79	1.000 79

To analyse the adequacy of this synthetic indicators to summarize the information contained in ECHP waves, we have used the same procedure. Thus, we have computed Pearson correlation coefficients between the longitudinal and the cross-sectional synthetic indicators. The results (see Table 11) prove that the values obtained are equivalent.

Table 11

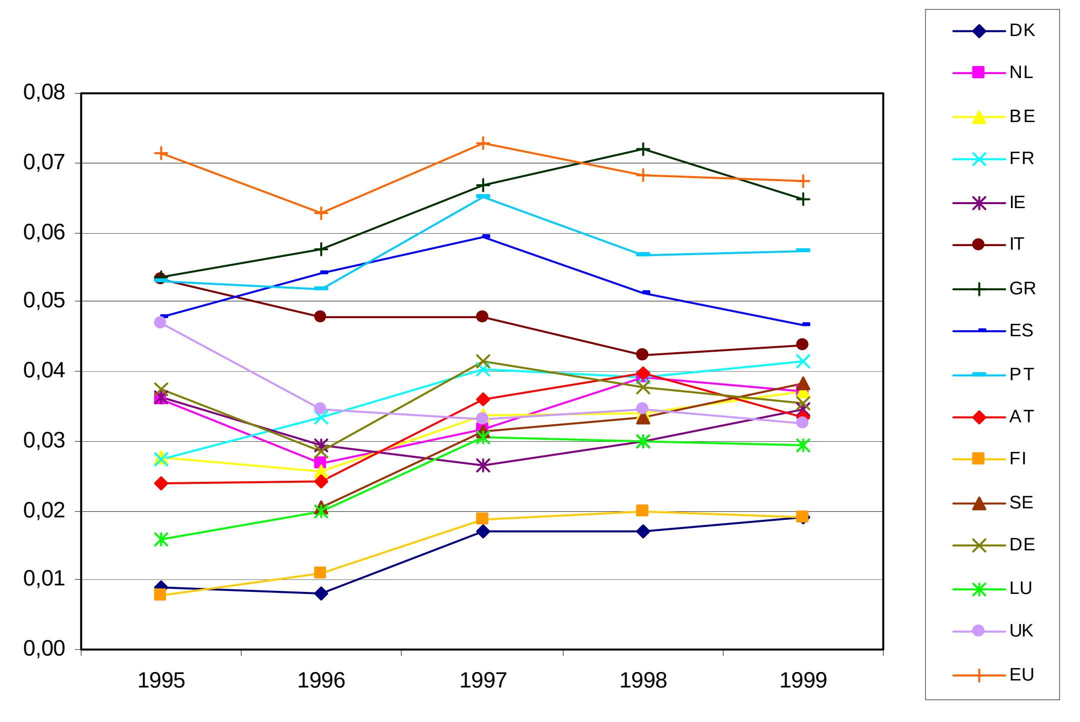
Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator and each year's Principal Component indicator.

		Global Principal Component Indicator	Common Space Indicator
1995 Principal Component Indicator	**Coefficient** **Significance** **N**	1.000 0.000 15	1.000 0.000 15
1996 Principal Component Indicator	**Coefficient** **Significance** **N**	0.999 0.000 16	1.000 0.000 16
1997 Principal Component Indicator	**Coefficient** **Significance** **N**	1.000 0.000 16	1.000 0.000 16
1998 Principal Component Indicator	**Coefficient** **Significance** **N**	0.999 0.000 16	0.999 0.000 16
1999 Principal Component Indicator	**Coefficient** **Significance** **N**	0.999 0.000 16	0.999 0.000 16

Figure 4.2.4 shows that Greece is the European country with a bigger poverty intensity, followed by Portugal and Spain. However, Italy, which is at the same level that Portugal and Spain in 1995, has a decreasing behaviour. United Kingdom has also the same descending trend. In general, we can appreciate how quantified values have clearly a smaller range when each country poverty line is considered.

Figure 4.2.4

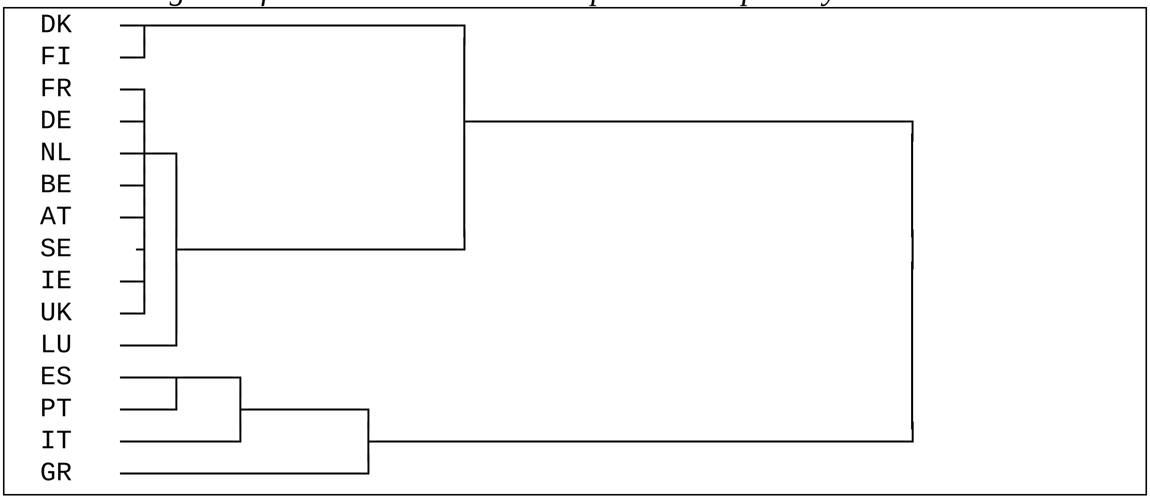
Common Space Poverty Indicator values for each Country in the ECHP. Fixed poverty line for each country (1996)



Next, we present the corresponding dendrogram in Figure 4.2.5, constructed using the same method as before. Once again, we can classify the countries in four groups, attending to their poverty intensity levels. The first one, is formed by Finland and Denmark. The second, is compounded of France, Germany, The Netherlands, Belgium, Austria, Sweden, Ireland, United Kingdom and Luxembourg. The third one includes Spain, Portugal and Italy. Finally, the last group is formed by Greece, which remains isolated.

Figure 4.2.5

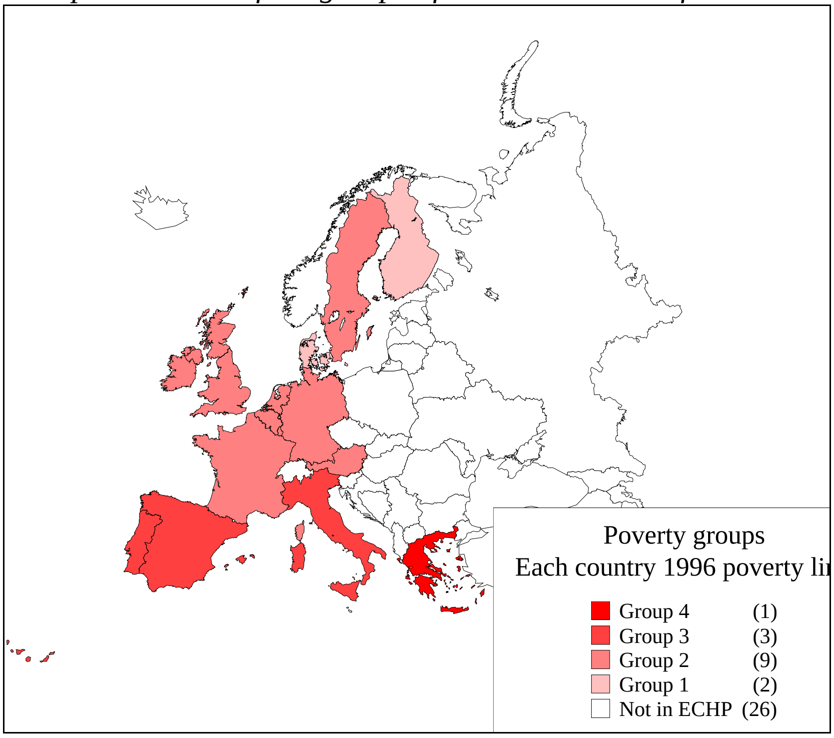
Dendrogram of the countries' common space based poverty index. 1995-1999.



In Figure 4.2.6, the geographical situation of these groups is represented.

Figure 4.2.6

Geographical representation of the groups of countries derived from the classification.



4.2.3. Poverty trends comparison among European countries. Relative poverty lines.

We shall follow the same scheme as in previous sections. So, in Table 12, weighting schemes are presented to calculate the cross-sectional synthetic indicators based on PCA. We can observe that these structures are very similar again.

Table 12

Weighting scheme for the computation of the cross-sectional poverty indexes based on the first Principal Component.

Poverty Index	Wave 3 1995	Wave 4 1996	Wave 5 1997	Wave 6 1998	Wave 7 1999
SEN	0.088938	0.087333	0.086551	0.084264	0.084346
THON	0.066909	0.065711	0.064720	0.062996	0.063006
FGT2	0.210773	0.211110	0.210887	0.211234	0.211415
FGT3	0.304899	0.310546	0.316643	0.325033	0.324272
EXPON	0.182317	0.181103	0.179421	0.177795	0.177856
CHACK075	0.146164	0.144197	0.141777	0.138679	0.139105

The hypothesis of equality of correlation matrices has been accepted, based on sampling correlation matrices obtained in each wave, as it can be seen on Table 13:

Table 13

Results of M-Box Test.

Box's M		14.050
F	Aprox.	.533
	df1	24
	df2	15033.849
	Sig.	.969

Thus, computation of longitudinal synthetic indicators based on Principal Component Analysis and Common Space has been possible, and corresponding weights appear in Table 14.

Table 14

Weighting scheme for the computation of the longitudinal poverty indexes based on the Global First Principal Component and the Common Space Analysis Technique.

Poverty Index	Global Principal Component Indicator	Common Space Indicator
SEN	0.086883	0.086860
THON	0.065175	0.065169
FGT2	0.211148	0.211084
FGT3	0.313469	0.313615
EXPON	0.180375	0.180343
CHACK075	0.142950	0.142929

To prove the equivalence of both approaches, Table 15 presents Pearson correlation coefficients between them.

Table 15

Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator.

		Global Principal Component Indicator	Common Space Indicator
Global Principal Component Indicator	**Coefficient**	1.000	1.000
	Significance		0.000
	N	79	79
Common Space Indicator	**Coefficient**	1.000	1.000
	Significance	0.000	
	N	79	79

In order to prove that both longitudinal synthetic indicators summarize well the information contained in each wave, correlation coefficients between each cross-sectional indicator and each longitudinal indicator have been computed. In Table 16, we observe that these correlation coefficients are almost unity in all cases.

Table 16

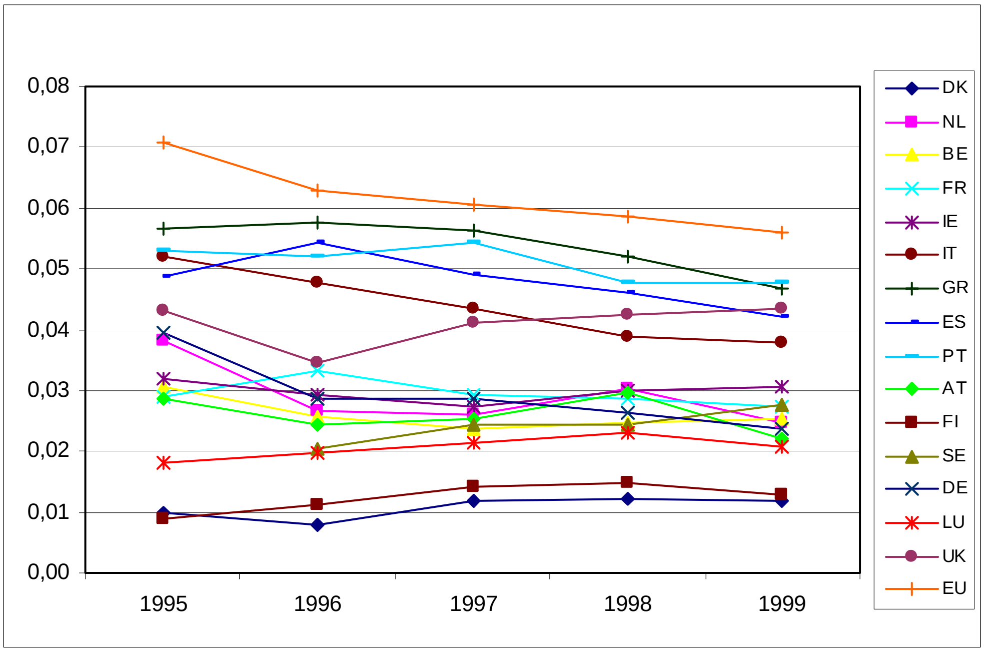
Pearson correlation coefficients between Global Principal Component indicator and Common Space Indicator and each year's Principal Component indicator.

		Global Principal Component Indicator	Common Space Indicator
1995 Principal Component Indicator	Coefficient Significance N	1.000 0.000 15	1.000 0.000 15
1996 Principal Component Indicator	Coefficient Significance N	0.999 0.000 16	1.000 0.000 16
1997 Principal Component Indicator	Coefficient Significance N	1.000 0.000 16	1.000 0.000 16
1998 Principal Component Indicator	Coefficient Significance N	0.999 0.000 16	0.999 0.000 16
1999 Principal Component Indicator	Coefficient Significance N	0.999 0.000 16	0.999 0.000 16

In Figure 4.2.7, evolution of poverty intensity between 1995 and 1999 can be observed. We have a strong decrease in Germany, The Netherlands, Italy, Spain, Greece and the European Union as a whole. A relatively moderated decreasing has occurred in Portugal, France, Belgium and Ireland. Finland, Sweden, Denmark and Luxembourg have had a moderate increase. United Kingdom and Austria remain stable.

Figure 4.2.7

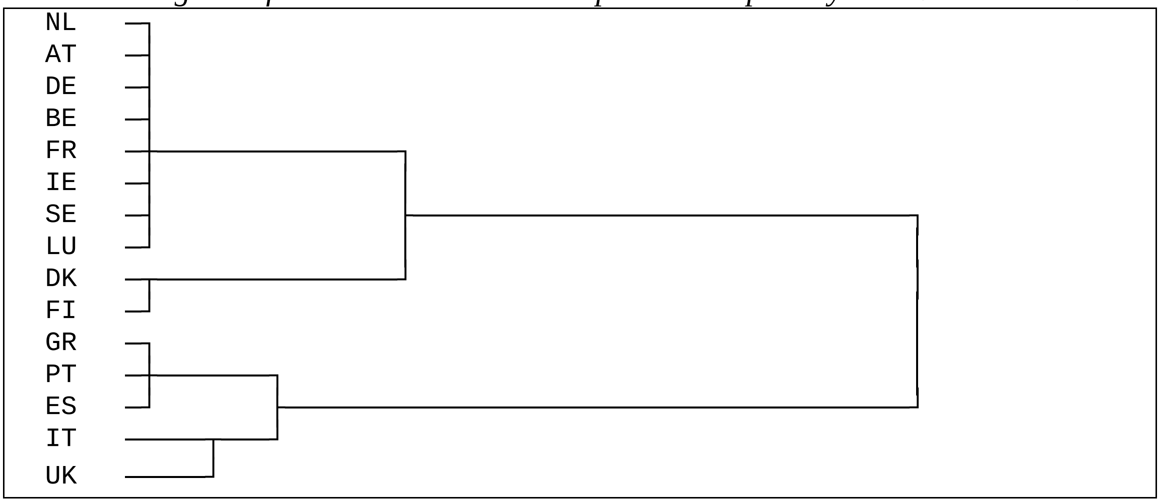
Common Space Poverty Indicator values for each Country in the ECHP. Relative poverty line in each country and each year.



Another similar dendrogram is presented in Figure 4.2.8. Again, we observe four groups, which now are the following: The first one comprises Denmark and Finland. The second one includes The Netherlands, Austria, Germany, Belgium, France, Ireland, Sweden and Luxembourg. The third one is formed by Italy and United Kingdom. In the last one, we can find Greece, Portugal and Spain.

Figure 4.2.8

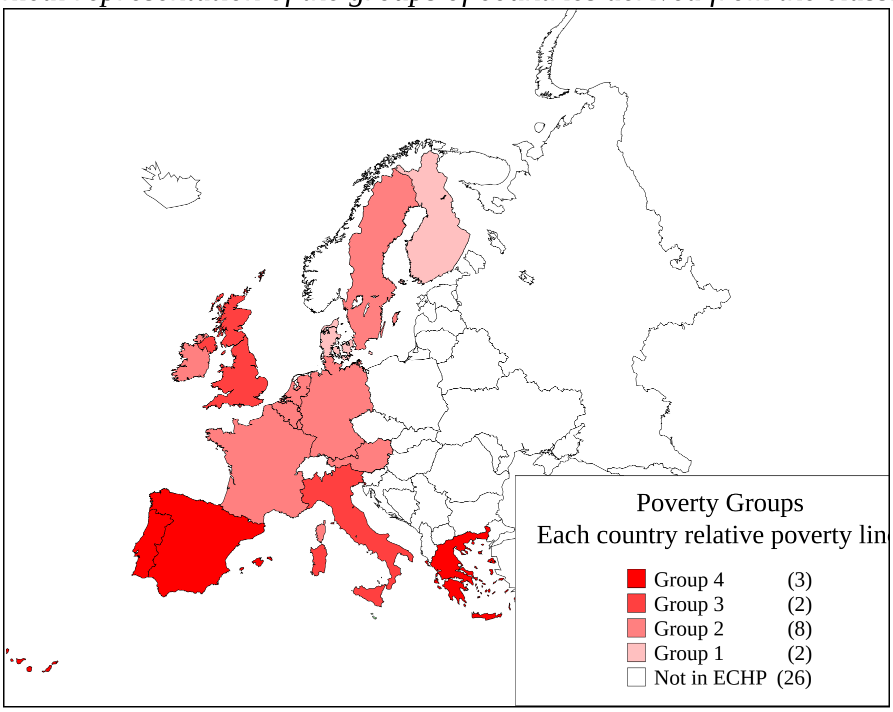
Dendrogram of the countries' common space based poverty index. 1995-1999.



In Figure 4.2.9, the geographical situation of these groups is represented.

Figure 4.2.9

Geographical representation of the groups of countries derived from the classification.



4.3. The poverty gap ratio (HI index).

This measure represents the per capita income gap, i.e. the proportion of necessary income to situate all the poor households at the level of the poverty line compared with its maximum. It is defined as:

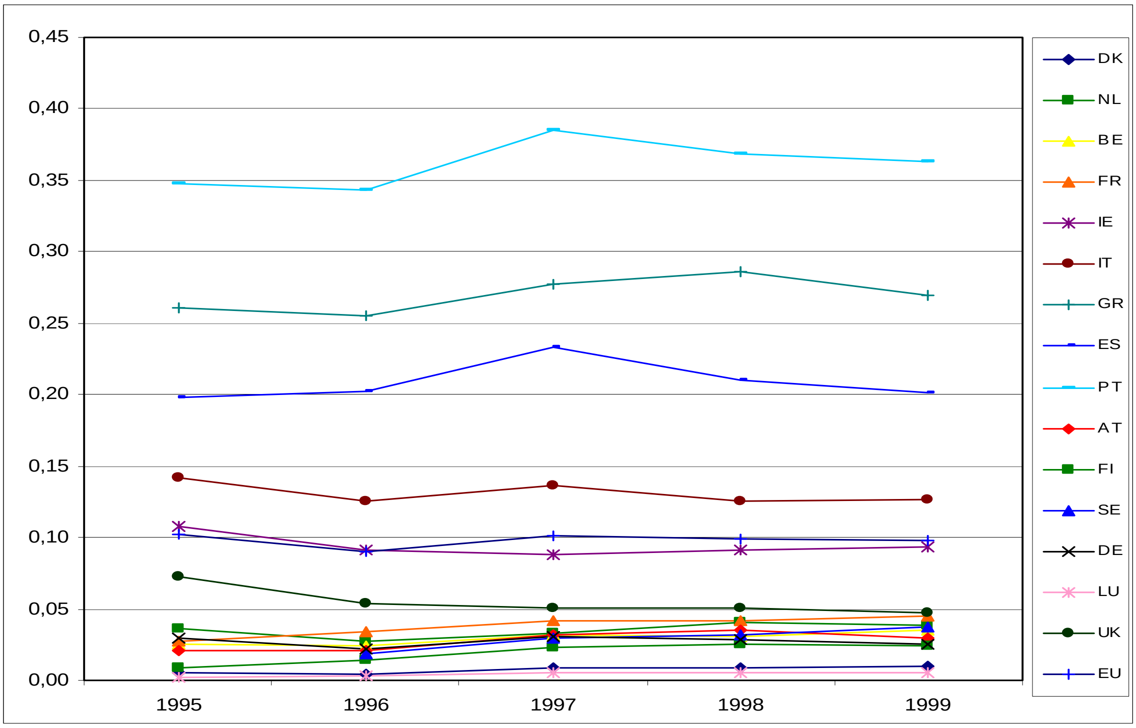
$$HI = \frac{q}{n}\frac{1}{qz}\sum_{i=1}^{q}(z - x_i) = \frac{1}{nz}\sum_{i=1}^{q}(z - x_i).$$

4.3.1. Measure HI. Common E.U. (1995) poverty line.

In Figure 4.3.1, it can be observed that Portugal is the country with the highest level of poverty, followed by Greece and Spain. A little bit further, we have Italy and Ireland. United Kingdom has a decreasing tendency all over the period. At the bottom, we find Luxembourg and Denmark. In both countries, poverty evolution is practically identical.

Figure 4.3.1

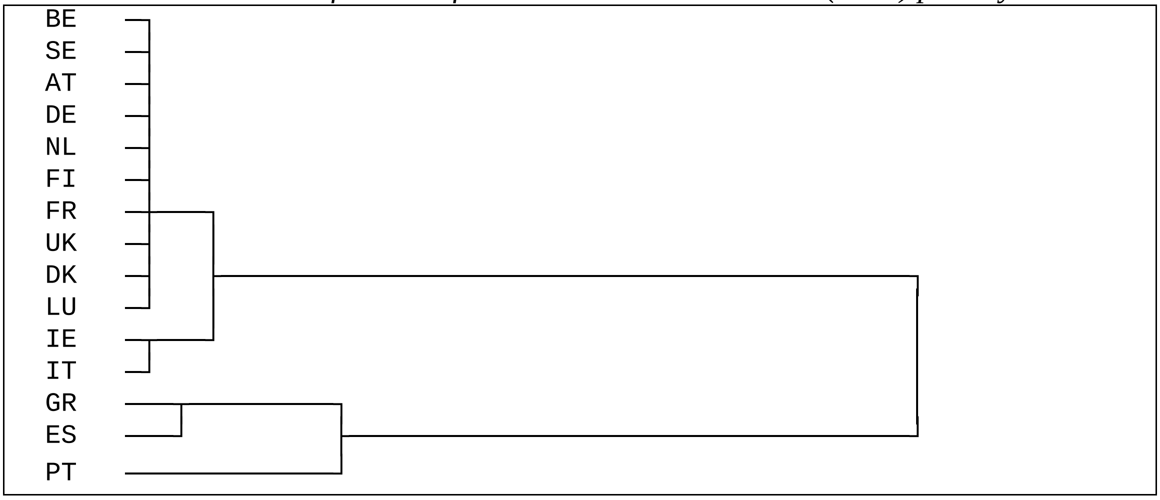
HI indicator. Common EU (1995) poverty line.



These details can be easily seen in Figure 4.3.2, where we observe that groupings previously obtained still remain present in data.

Figure 4.3.2

Measure HI. Classification of the countries. Common EU (1995) poverty line.

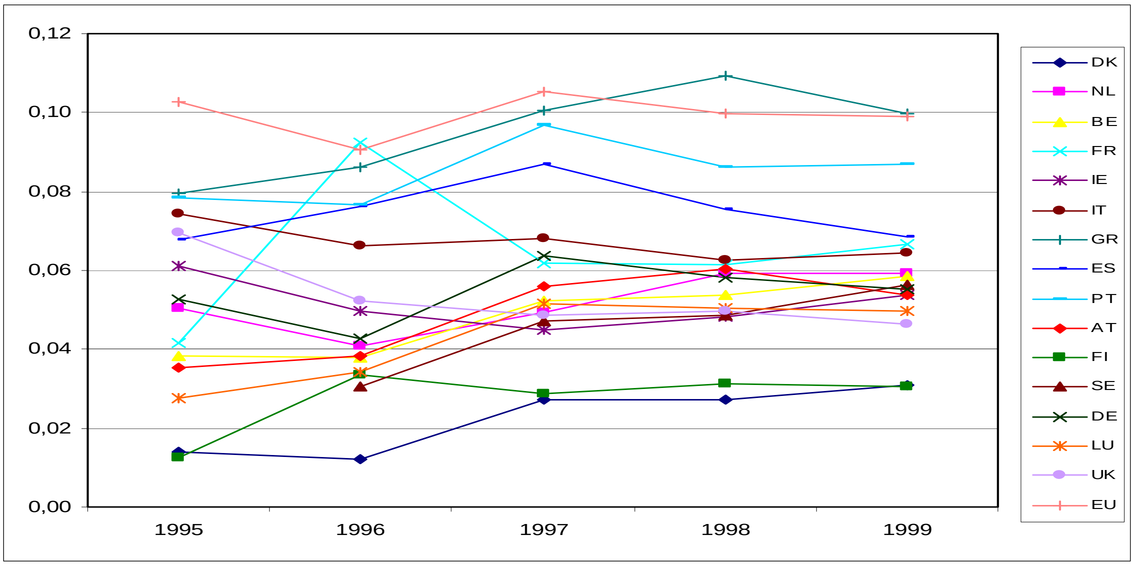


4.3.2. Measure HI. Fixed poverty line for each country (1996).

If we fix the poverty line in 1996 for each country, the corresponding trends of HI are presented in Figure 4.3.3. So, Greece shows the higher levels in European Union, followed by Portugal and Spain. United Kingdom has a decreasing tendency along the period. Finland and Denmark are located in the lower strip of poverty. Nevertheless, when a different poverty line for each country is considered, the results are contained in a smaller range than in Figure 4.3.1. Thus, grouping of countries is not as clear as before, but general patterns are roughly similar.

Figure 4.3.3

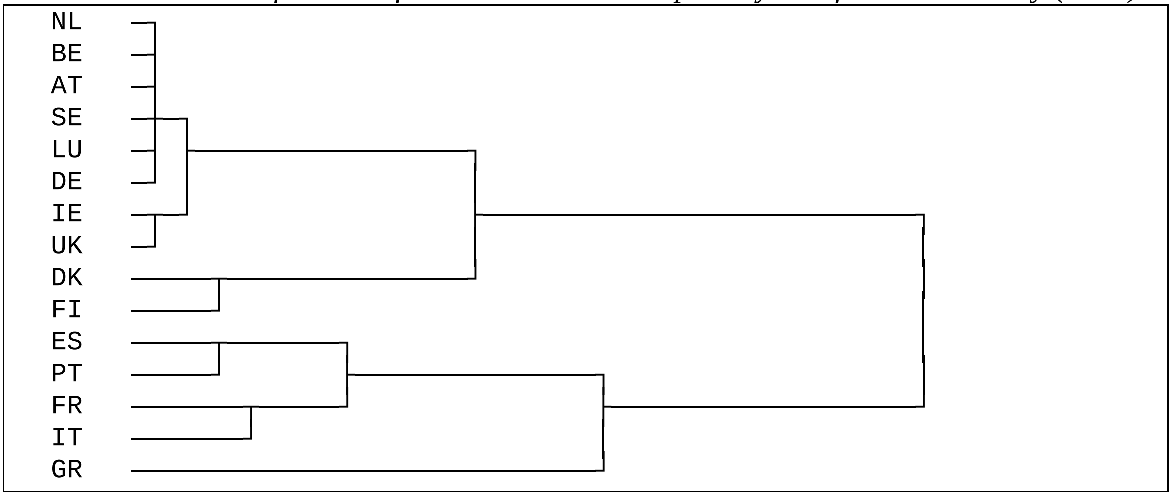
HI indicator. Fixed poverty line for each country (1996).



In Figure 4.3.4, we observe that it is possible to distinguish four groups. The first one, is formed by Greece, which is isolated. The second group is composed by Spain, Portugal, France and Italy. The third group comprises The Netherlands, Belgium, Austria, Sweden, Luxembourg, Denmark, Ireland and United Kingdom. The last group is formed by Denmark and Finland.

Figure 4.3.4

Measure HI. Classification of the countries. Fixed poverty line for each country (1996).

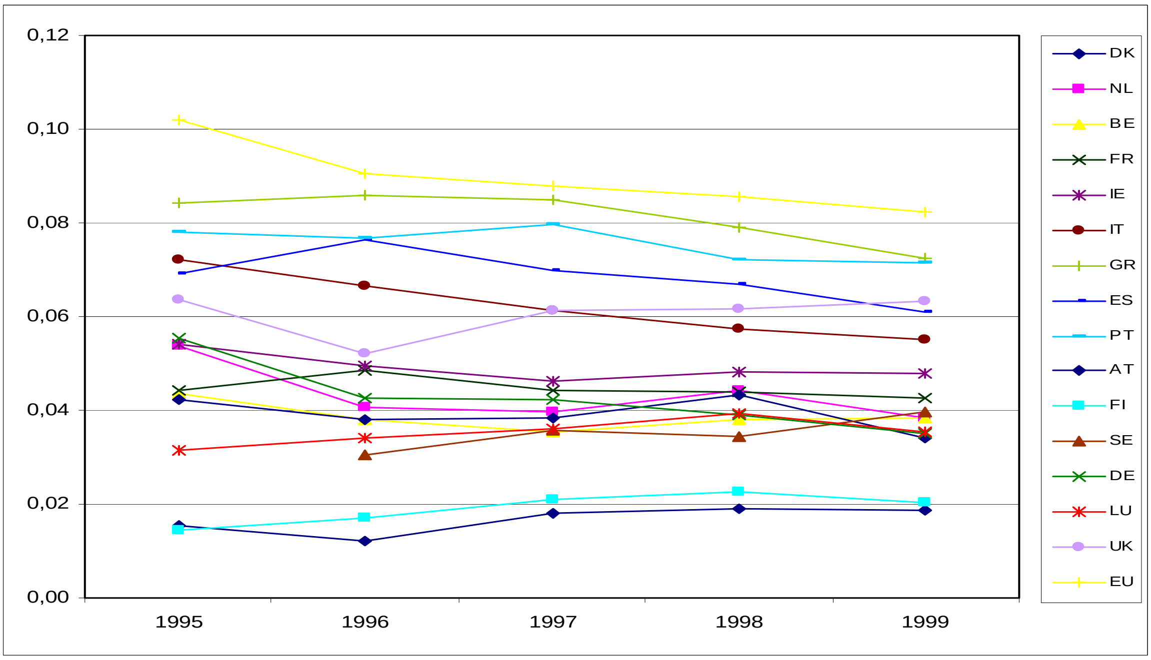


4.3.3. Measure HI. Relative poverty lines.

Figure 4.3.5 shows the measure HI when relative poverty lines are considered for all cases in all periods.

Figure 4.3.5

HI indicator. Relative poverty lines.

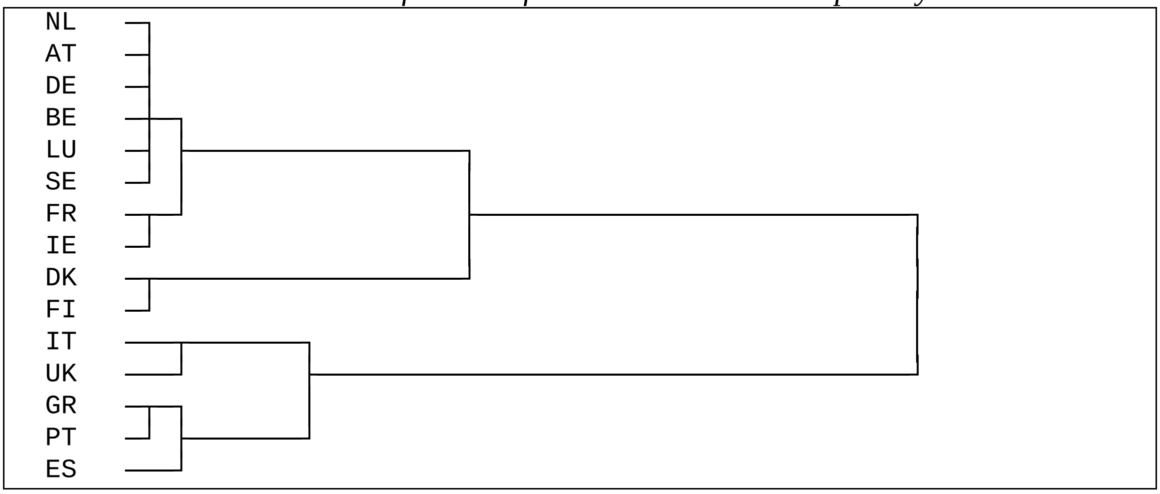


On the one hand, European Union and Italy have decreasing trends along the period when indicator HI is used. Spain follows this evolution since 1996. The same descending pattern is found in Greece and Portugal since 1997. On the other hand, United Kingdom, Sweden, Luxembourg, Finland and Denmark have increasing trends in HI after 1996.

The grouping of countries is clear enough, again, as Figure 4.3.6 is showing. Four groups are easily found. The first group, composed by Denmark and Finland, shows lower levels in measure HI. The second group is formed by The Netherlands, Austria, Germany, Belgium, Luxembourg and Sweden. The third group is composed by Italy and United Kingdom. The last group, with higher levels of poverty, comprises Greece, Portugal and Spain.

Figure 4.3.6

Measure HI. Classification of the countries. Relative poverty lines.



5. CONCLUSIONS.

In this paper, we have proposed a synthetic poverty measure, based on a battery of six one-dimensional poverty indicators, which verify good properties. The advantage of the exposed methodology is that we can evaluate poverty intensity among countries, not only in the same period of time, but also in a longitudinal sense, with the same synthetic indicator. This approach allows us to overcome the problem consisting of the selection of a better poverty measure among the great number of proposed ones. This methodology has proved to be useful to compare among several cases, such as EU countries in this study. Moreover, it is fully compatible with measure HI, as shown by empirical results.

We have checked that when several correlation matrices can be assumed to be statistically identical, then our Krzanowski's Common Space Analysis adaptation produces exactly the same results than First Principal Component based indicator applied on the pooled correlation matrix. Furthermore, their respective weighting coefficients have been proved to be close enough to each other.

Using household income data provided by the ECHP, from 1996 to 2000 waves, we have computed all one-dimensional poverty indicators selected in order to elaborate the synthetic indicators proposed in methodology. In this case, correlation matrices computed over the indicators in each wave have turned out to be identical, thus allowing us to construct the synthetic poverty intensity indicator, whose weighting scheme is the same all over the period of time considered.

We have analysed poverty trends among European countries from three different points of view. First of all, we have studied poverty incidence through headcount ratio index. Nordic countries (Finland, Denmark and Sweden) present a lower incidence of poverty. Nevertheless, their poverty incidence levels are increasing all over the period. On the other hand, Greece, Portugal and Spain present the higher poverty incidence levels along the period, while the rest of the countries remain in a middle class. Among this group, United Kingdom has a remarkable behaviour, because it is the only country in which the headcount ratio index is always decreasing. According to the use of different poverty lines in this paper, we find that the same structure is obtained, roughly speaking. However, strong differences appear when scale is considered. In case where relative poverty lines have been used, a slight convergence in poverty incidence levels has been observed.

Secondly, poverty intensity has been analysed through the synthetic indicators proposed in methodology, as a summary of a set of one-dimensional poverty intensity indicators. Results are different, depending on the poverty line considered. When the common EU (1995) poverty line is considered, Portugal, Greece and Spain are the countries with a higher degree of poverty intensity, far away from the rest. When a time-fixed poverty line is considered independently in each country, then synthetic indicator values fall under 0.08 for all of them, thus making comparisons more difficult. However, Greece, Spain and Portugal stay at the top, indicating a bigger intensity of poverty in this countries. When relative poverty lines for each country and year are considered, the values of the synthetic indicator show a slight convergence between years 1995 and 1999. In this case, Portugal, Greece and Spain rest at the top. As a consequence, the picture of poverty intensity in Europe is as follows: Portugal, Greece and Spain are the countries where poverty intensity is bigger, and Finland and Denmark have the lowest values for the synthetic indicator, no matter what poverty line is used.

Finally, when common EU(1995) poverty line is used, results must be carefully understood, because absolute income levels play an important role, and they do not take into account purchasing power parities. This fact seems clear if we compare EU relative position with all countries. Nevertheless, changes in results depending on the poverty lines considered may be useful to illustrate how poverty comparisons would change when different references are chosen about what a poor household is.

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