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A Tale of Hidden Cities

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Abstract. Hidden cities within a city? A large trending literature concerning urban and suburban poverty concentration patterns has been developed during the last decade. However, there are few cases where adequate data exist at a low spatial level, allowing the exploration of such socio-spatial phenomena. This paper seeks to investigate the structure and evolution of poverty within urban and suburban space, under a multidimensional framework, during a period of extended economic transformation. This paper uses the metropolitan area of Athens as its main case study, for which data at a municipal level exist, allowing the calculation of the Multidimensional Poverty Index (MPI) for the years 2006 and 2011. An extended cluster analysis, based on the calculated MPI values, results in the specification of three poverty clusters within Athens. The decomposition of the MPI index into its main dimensions highlights any existing differences between the structural and behavioural characteristics of each of them. The results indicate that there is a clear spatial concentration of poverty in the west suburban areas of Athens. The urban core of the city is characterised by middle-income municipalities, whilst the north-east and the south-east suburban areas experience low-poverty indicators. Finally, the results suggest that during the period under investigation more deprived areas were affected the most.

Key words: urban poverty; multidimensional poverty index; dynamic decomposition; Athens

1 Introduction

> *"Thus, the spatial order of human existence arises from the (social) production of space, the construction of human geographies that both reflect and configure being in the world."*
>
> E. W. Soja "Postmodern Geographies" (1989)

The investigation of socio-spatial dynamics in an urban context has long been a productive field of reflection and research by social geographers and urban poverty analysts. The existence of a socio-spatial dialectic within urban agglomerations, is one of the most commonly accepted perspectives, highlighting a bidirectional effect between cities and people who live in them. Until recently, poverty researchers have tried to investigate social phenomena by treating space as a "neutral" component of their analysis. However, it is essential to notice that "the importance of space lies in understanding it as a material product of social relations, a manifestation of social relations, and a social relation itself" (Gotham 2003, p. 724).

The fact that spatial distance follows social distance has been strongly highlighted in the literature (Duncan, Duncan 1955, Park et al. 1925). Massey, Denton (1993) indicate that poverty concentration and its variation through space are closely related to changes in the socio-economic composition of areas. This spatial segregation process has been also evaluated by Massey (2007), who points out that the conceptual - social in our case - categorization of space is a natural human tendency, based on attained and intrinsic characteristics of space. These spatial characteristics may include various parameters affecting poverty concentration, such as economic and social formation channels. As Musterd et al. (2015) state "structural theory suggests that there are at least four key factors shaping socioeconomic segregation: social inequalities, changing economic structures and levels of global connectedness, welfare regimes, and housing systems" (p. 2).

Starting from the economic driven forces related to poverty concentration, economic restructuring processes are crucial parameters responsible for reinforcing this phenomenon. Jargowsky (2002) highlights the importance of the labor market structure as an explanatory variable for poverty concentration in urban areas. The transition from a Fordist to a post-Fordist economic structure in cities has resulted in the creation of many unemployed workers, most of them characterized by low level of education or skills, that do not properly fit the new jobs, created under this post-industrial framework (Sassen 1991, Musterd 2005, Scott, Storper 2015). Given this fact, minorities with a low level of education have gradually been isolated, both in economic and social terms, giving rise to poverty concentration phenomena in cities (Cooke, Marchant 2006). Thus, the spatial isolation has reduced their integration opportunities through the labor market channel, fostering social segregation, especially in manufacturing cities or cities that experience economic restructuring processes (Musterd 2005). Under this scope, Andersson, Hedman (2016) argue that economic recession periods should also be received as economic transformation processes, due to the geographically uneven expansion of unemployment they cause.

The existence of a selective migration phenomenon, occurring towards or within the metropolitan areas, is also considered to be an important factor affecting the concentration of poverty. Flows of poor people towards the urban core of cities are driven by increased integration opportunities that exist there. Alongside with this phenomenon, counterweight selective migration movements of non-poor out of the central city area also exist (Jargowsky 2002). As middle or high-income residents decide to leave poor areas, they are being replaced by in-movers with lower socio-economic status (Andersson, Hedman 2016). It becomes evident that both cases lead to an increased concentration of poverty within the urban core.

However, in the case of the largest US metropolitan areas, a diversified behavior was observed during the 1990s. Several studies (Berube, Frey 2002, Jargowsky 2003, Kingsley, Pettit 2003, Cooke, Marchant 2006, Allard, Paisner 2016) have indicated a decline in urban core poverty during this period, accompanied with a rise in suburban poverty. Cooke, Marchant (2006) point out that increases in urban core poverty concentrations are related to the general health of the metropolitan economy, whereas respective changes in the concentration of suburban poverty relate to rapid population growth. Moreover, Cooke (2010) states that a potential rise in suburban poverty could eventually produce negative neighborhood effects in suburban areas, leading consequently to a re-concentration of poverty in the inner-ring[1] suburbs.

Under this framework, this paper tries to shed light on the developmental process of poverty concentration within the metropolitan area of Athens between 2006 and 2011. Is there any pattern of poverty concentration within this metropolitan area? Is there any evidence supporting the existence of growing suburban poverty? Given the fact that throughout this period extended economic changes have been taking place in Greece, it is crucial to investigate whether poverty concentration has changed.

Another novelty of this study, is the choice of the Multidimensional Poverty Index

[1] Cooke, Marchant (2006) define three types of regions in a metropolitan area: a) urban core; b) inner ring; and c) outer ring. Specifically, inner ring is defined as regions that are not identified as part of the urban core, with greater than 400 1950–1969 housing units per square miles, plus any continuous tract containing more than 200 1950–1969 housing units per square mile and a population density of at least 1,000 people per square mile.

(MPI) as the main methodological framework for approximating poverty instead of traditional income-based measures, as it is considered to be one of the most appropriate measures for comparing uneven development patterns between areas. The MPI index has been calculated at a municipal level, allowing to perform a cluster analysis within the metropolitan area of Athens. The cluster analysis reveals existing hidden cities within the city of Athens, that seem to follow a central-city/suburban model of poverty concentration.

The outline of this paper is the following: in Sections 2 and 3 a related literature review is presented regarding urban poverty studies for the US and EU countries, including the case of Athens. Section 4 provides a detailed analysis of the main methodological contexts that were adopted in the research. Finally, Sections 5 and 6 provide a detailed analysis of the results, along with some concluding remarks.

2 Related Literature

During recent years, a series of studies have sought to investigate the spatial organization of poverty within metropolitan areas. Large urban agglomerations, located in highly developed countries, have most of the times been in the spotlight. Most studies explore poverty concentration in large US metros (Jargowsky 1996, 2002, 2013, Berube, Frey 2002, McMullen, Smith 2002, Kingsley, Pettit 2003, Cooke, Marchant 2006, Cooke 2010, Bischoff, Reardon 2013, Kneebone, Berube 2013, Kneebone 2014, Cooke, Denton 2015, Allard, Paisner 2016), due to higher data availability at low spatial levels, such as municipalities and neighborhoods. Most of these studies indicate a shift in the spatial location of poverty across many US metropolitan areas. The pattern of an increasing central city poverty concentration that appeared between 1970 and 1990, was replaced by a rising suburban poverty concentration in the following two decades. The number of poor persons in the suburban areas almost doubled between 1990 and 2014, illustrating a growth rate higher than the corresponding population growth (Allard, Paisner 2016), and thus leading to poverty concentration in those areas.

Nonetheless, a significant part of the literature focuses on the investigation of poverty and deprivation within EU urban areas (Pinch 1993, Pacione 2004, Hunter 2014, Musterd 2005, Hamnett 2003b,a, Lee et al. 2014, Musterd et al. 2015, Andersson, Hedman 2016). European cities, in general, indicate lower levels of socio-economic segregation, when compared to cities in the US (Musterd 2005, Musterd et al. 2015). However, income disparities between different socio-economic groups seem to have risen in many cases throughout the last decade, leading to higher concentrations of urban poverty (Musterd et al. 2015).

In terms of measurement, it is important to notice that most of the existing studies use monetary (Green 1998, Reardon, Bischoff 2011, Watson 2009), racial or gender criteria (Bischoff, Reardon 2013, Jargowsky 2013, Kneebone 2014) for evaluating socio-economic segregation within cities. However, Musterd (2005) points out that in the European case, socio-economic inequality should not be encompassed strictly in one standard, such as income, but instead, various indicators of poverty should be used, in order to capture the multidimensional aspects of this phenomenon. To the authors' knowledge, the number of existing studies using alternative measures of poverty concentration within urban areas is extremely limited, due to lack of appropriate disaggregated data. However, the need for calculating and mapping various aspects of poverty at a small-area level starts to become essential, as understanding spatial distribution of poverty in modern metropolitan areas has turned out to be crucial for defining the main challenges of urban growth in the future (Allard, Paisner 2016).

In the case of Britain there has been a great effort to map multidimensional deprivation within urban areas, starting from the work of Noble et al. (2006) and moving on to the creation of the English Indices of Deprivation (2004, 2007, 2010). Highly detailed maps of London, for the years 2004, 2007 and 2010, illustrate the distribution of the Multiple Deprivation index, highlighting the existence of possible clusters within the city. Harris, Longley (2004) also try to locate possible deprivation clusters within the city of London, by combining demographic British census data with lifestyle indicators, supplied by a

UK-based data warehouse company. Referring to London, Orford (2004) attends to reveal spatial clusters of concentrated poverty and affluence. His results suggest that clusters of affluent areas tend to be more stable through time, whereas clusters including deprived units change more easily over time. In terms of suburban poverty, a recent study by Hunter (2014) indicates that poverty is becoming a problem for suburbs, as the results for England and Wales illustrate a converging trend between the urban cores and the suburbs, in terms of poverty concentration.

Based on the previous, it becomes evident that a comprehensive analysis trying to shed light on the evolution of poverty concentration within a metropolitan area, should include insights referring not only to various structural aspects of poverty, but also to its behavioural characteristics through time.

3 The case of Athens

In general, the metropolitan area of Athens covers the largest part of the greater Region of Attica in Greece. Until recently, it has exhibited high development rates, especially in the 1990s and the early 2000s, just before the economic crisis period. According to Pantazis, Psycharis (2016), the evolution of income within the region of Attika during the 2000s can be divided in three discrete periods referring to the last decade. These include: (a) the period 2003-2008, when a general uprising trend in income was recorded; (b) the period 2008-2010, characterized by an income stagnation and at the same time, a deterioration of social conditions; and (c) the period 2011-2013, where the effects of the 2008 economic crisis started to become evident, affecting income distribution.

Regarding spatial inequality, there seems to be an East-West division of Athens, in terms of residential inequality (Maloutas 2001, Kalogirou 2011), as well as income distribution (Pantazis, Psycharis 2016). A comprehensive presentation of the evolution of socio-economic segregation in Athens has been made by Maloutas (2015), illustrating the evolution process that took place, starting before the 1970s and moving on until the 2000s. According to it, there is a discrete spatial socio-economic distribution pattern within Athens, in which high income areas are concentrated in the north-eastern and southern-eastern parts, whilst low income areas are traditionally located in its western areas. Table 1 illustrates a brief description of the main findings presented in Maloutas (2015), regarding the spatial segregation process within Athens during recent decades.

In terms of urban core and suburban development, the pre-1970s in-flow pattern towards the city center seems to be replaced, between 1970 and 1990, by a movement of middle- and high-social classes towards suburban areas. This trend is followed by a significant arrival of immigrants during the 1990s, who are mostly settled within the urban core of Athens, where they could find affordable housing. This fact has led to a class desegregation period within the city center (Maloutas 2015). During the 2000s, there were no significant changes in the existing spatial segregation patterns, despite the high level of social mobility in working-class areas. This might be due to several reasons including family solidarity networks, importance of spatial proximity with family and the fact that parental property is often located in the same area.

Based on the abovementioned analysis, we explore poverty concentration within the metropolitan area of Athens, for the years 2006 and 2011, through identifying discrete clusters with different socio-economic characteristics. Instead of using monetary poverty indicators, we choose to adopt the multidimensional poverty framework (MPI index). Finally, the choice of the years 2006 and 2011 was based on the ability to compare the results between two different time frames: one related to a period of relative economic stability and growth, whilst the other to a period experiencing economic restructuring and recession. It is essential to investigate whether poor areas were affected to a wider extent during this transition.

4 Data and methodology

This section illustrates the methodological framework for calculating and decomposing MPI index, as well as performing cluster analysis based on the attained results. Data used

Table 1: Evolution of the spatial socio-economic segregation process within the metropolitan area of Athens (Maloutas 2015)

Period	Description of segregation process
Before 1970s	Rapid urbanization, especially in the urban core of Athens. Decline in living conditions in the urban core.
1970–1990	Geography of social segregation started to change (Maloutas 2000) Sub-urbanization trend. People belonging to high and middle-class start to move in the suburbs, mostly to north-east and south-east areas. Suburban growth period. Lower-classes traditionally remain settled in the western parts of the metropolitan area of Athens.
1990–2000	Large percentage of immigrants leads to lower levels of class segregation within the urban core, as immigrants can find affordable apartments only at the city center of Athens (Maloutas 2007, Maloutas et al. 2012)
During 2000s	No essential changes in the traditional social division of Athens, between east and west. High social mobility movements in working-class suburbs, not followed by high levels of residential mobility (Maloutas et al. 2006). Spatial entrapment of socially mobile groups due to family solidarity networks, importance of spatial proximity with family and parental property located in the same area (Maloutas 2004).

as input in this paper include parts of the dataset developed for the metropolitan area of Athens by Panori et al. (2017), which includes the calculated values of the MPI index at a municipal level. A further exploitation of these results through this study includes: a) the definition of an optimal number of poverty clusters within Athens, alongside with the presentation of their main socio-economic characteristics; b) the decomposition of the regional MPI index into its main dimensions for each of them; and c) the dynamic decomposition of all derived indices between 2006 and 2011. All these processes will help to identify any existing structural and behavioral differences of poverty within the city of Athens.

Starting from the empirical measurement of multidimensional poverty, the Alkire-Foster methodology has been used to conceptualise this theoretical framework (Alkire, Foster 2011a,b). Following the Apablaza, Yalonetzky (2013) notation, the multidimensional headcount ratio measuring the percentage of population being multidimensionally poor in period t is defined as follows:

$$H(t) \equiv \frac{1}{N^t} \sum_{n=1}^{N} I(c_n^t \geq k) \tag{1}$$

where N is the number of individuals, k is the multidimensional cut-off and c_n is the weighted sum of deprivations, given by:

$$c_n^t = \sum_{d=1}^{D} w_d I(x_{nd}^t \geq z_d) \tag{2}$$

where w_d is the weight of dimension $d = 1, \ldots, D$, x_{nd} is each individual's achievement for dimension d and z_d is the dimension specific cut-off. Finally, $I()$ is an indicator that takes the value of 1 if the expression in parenthesis is true, otherwise it takes the value of 0. Apart from the simple headcount ratio, this method offers the opportunity to calculate the intensity of deprivation suffered by poor people. In formal terms:

$$A(t) = \frac{1}{N^t H(t) D} \sum_{n=1}^{N^t} I(c_n^t \geq k) c_n^t \tag{3}$$

The combination of (1) and (3) gives the adjusted headcount ratio for multidimensional poverty (see (4)), which quantifies the weighted average number of deprivations. As it is shown, the adjusted headcount ratio is the product of the headcount ratio and intensity and thus is sensitive to changes in both measures.

$$M^0(t) = \frac{1}{N^t D} \sum_{n=1}^{N^t} I(c_n^t \geq k) c_n^t = H(t)A(t) \tag{4}$$

The fact that MPI is an adjusted headcount ratio gives researchers the opportunity to decompose this measure in numerous ways. First, it is possible to calculate each dimension's contribution to overall poverty (dimensional breakdown) and thus, specify the composition of multidimensional poverty. Defining the censored headcount ratio for each dimension (CHd) as the probability of being multidimensionally poor and at the same time deprived in dimension d (see (5)), it becomes clear that the adjusted headcount ratio will be a weighted sum of the censored headcount ratios. Using (6) the contribution of each dimension to the overall MPI can then be calculated as $\frac{w_d}{D}\frac{\mathrm{CH}_d}{M_0}$.

$$\mathrm{CH}_d(t) = \frac{1}{N} \sum_{n=1}^{N} I(c_n^t \geq k \cap x_{nd}^t \leq z_d) \tag{5}$$

$$M^0(t) = \sum_{d=1}^{D} \frac{w_d}{D} \mathrm{CH}_d(t), \qquad \text{where} \quad \sum_{d=1}^{D} w_d = 1 \tag{6}$$

A non-overlapping subgroup decomposition can also be implemented on the available data in order for the underlying subgroup dynamics to be revealed. Using (7) it is possible to examine each group's $i = 1, \ldots, G$ contribution to the overall regional MPI:

$$M^0(t) = \sum_{i=1}^{G} \varphi_i^t M_i^0 \tag{7}$$

where $\varphi_i^t = (N_i^t)/N^t$ is the population weight of group i in period t.

Following the EU's efforts to adjust the multidimensional measurement of poverty framework under the concept of developed countries (Atkinson, Marlier 2010), the work of Weziak-Bialowolska, Dijkstra (2014) adjusts the main dimensions of MPI at a regional level for the case of EU regions. This includes the definition of the variables that will be incorporated in each dimension, as well as the corresponding weights and cut-offs, to fit a developed country framework.

Table 2 presents the core MPI dimensions by the EU, alongside their corresponding weights and cut-offs (Weziak-Bialowolska, Dijkstra 2014, p. 22). Given the fact that our research does not focus on the development of a novel methodology regarding the MPI calculation, we have used the conceptualisation, including weights and cut-offs, proposed by Weziak-Bialowolska, Dijkstra (2014). In their case, the weighting scheme does not imply equal weights between the three key dimensions, whereas equal weights are considered for the sub-dimensional components. All variables used to calculate the MPI values are included in the European Survey on Income and Living Conditions (EU-SILC) database, and cut-offs for the three deprivation indices in the case of the living standards dimension are defined by the EU-SILC methodology. Detailed definitions for all the variables used in this study are given in Appendix A.

As a next step, a cluster analysis was conducted, in order to classify municipalities into groups based on their multidimensional poverty level. First, Ward's hierarchical grouping method was applied, using the minimum variance criterion as the base for the objective function optimization (Ward 1963). According to this criterion the objective function value that needs to be minimized is the sum of the squared deviations from the group mean (ESS) and it is given by:

$$\mathrm{ESS} = \sum_{i=1}^{n} x_i^2 - \frac{1}{n} \left(\sum_{i=1}^{n} x_i \right)^2 \tag{8}$$

Table 2: MPI dimensions and indicators, including their weights and cut-offs (Weziak-Bialowolska, Dijkstra 2014)

MPI Dimensions (cut-off: **2 out of 3**)
• **Health**, weight: **2/6**, cut-off: **2 out of 3**
– General Health, weight: 1/3
– Unmet medical need due to lack of affordability and accessibility, weight: 1/3
– Unmet dental need due to lack of affordability and accessibility, weight: 1/3
• **Education**, weight: **1/6**, cut-off: **1 out of 1**
– No educational attainment
• **Living Standards**, weight: **3/6**, cut-off: **1 out of 3**
– **Material Deprivation**, weight: **1/3**, cut-off: **3 out of 9**
* Material Deprivation Index — MDI
– **Housing Deprivation**, weight: **1/3**, cut-off: **2 out of 4**
* Multidimensional Poverty in Housing Index – MPHoI
– **Environment Deprivation**, weight: **1/3**, cut-off: **2 out of 3**
* Multidimensional Poverty in Environment Index – MPEnI

Notes: For an extended description of the weights and cut-offs please see Weziak-Bialowolska, Dijkstra (2014)

where x_i is the score of i-th individual, which in our case takes the municipal MPI values corresponding to the year 2006. To perform a valid comparison between the obtained cluster groups for the years 2006 and 2011, we do not perform an additional cluster analysis for the year 2011. Results coming from this hierarchical procedure are presented in the form of a dendrogram (Figure 1). As is shown, several discrete clusters can be derived within the metropolitan area of Athens, based on their MPI values for 2006. Specifically, the case of $k = 3$ has been highlighted on the dendrogram, pointing out the three discrete groups of municipalities that can be derived in this case.

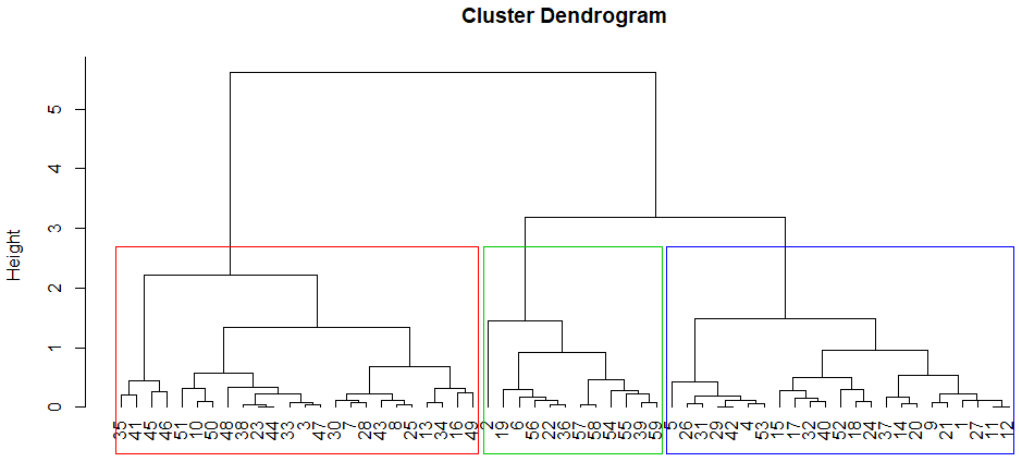
For further strengthening the robustness of the clustering process, k-means clustering was also applied. Being a non-hierarchical technique, k-means is based on partitioning a set of n observations $(x = x_1, x_2, \ldots, x_n)$ into k sets $(S = S_1, S_2, \ldots, S_k)$, and then minimize the within-cluster sum of squares (WCSS), or in other words the within cluster variance, as given below:

$$\text{WCSS} = \sum_{i=1}^{k} \sum_{x \in S_i} \|x - \mu_i\|^2 = \sum_{i=1}^{k} |S_i| \text{Var} S_i \tag{9}$$

Results coming from the k-means process are presented in the form of scatter plots (Figures 2 – 4). Three discrete diagrams are illustrated, covering the cases where $k = 3, 4$ or 5, respectively. These cases have been chosen based on the previous dendrogram results, that included all possible cluster combinations.

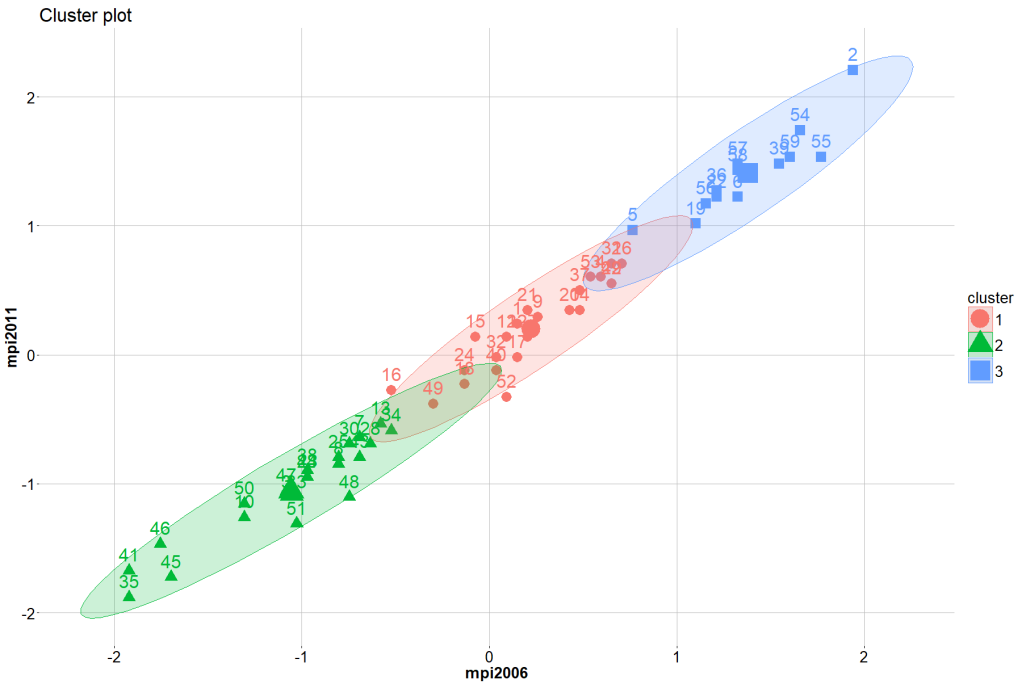
Moving on, the elbow method was used as the main criterion (Sugar 1998, Sugar, James 2003) to define the optimal number of clusters. According to it, the optimal number is specified with regards to the percentage of variance explained by the clusters, against the number of clusters. This means that the optimal number is reached, when the marginal gain of information of an additional cluster starts to decrease. Figures 5 and 6 illustrate the corresponding plots referring to the elbow criterion, for the cases of hierarchical and k-means clustering. In both cases, there is an evident "elbow" for $k = 3$, indicating this as the optimal choice for the number of clusters.

Finally, a cluster evaluation is needed to support the robustness of the previous results. In this case the stability of the cluster is assessed using the bootstrap method, for $B = 100$ resampling runs and $k = 3$ clusters. The results for each cluster are illustrated in Table



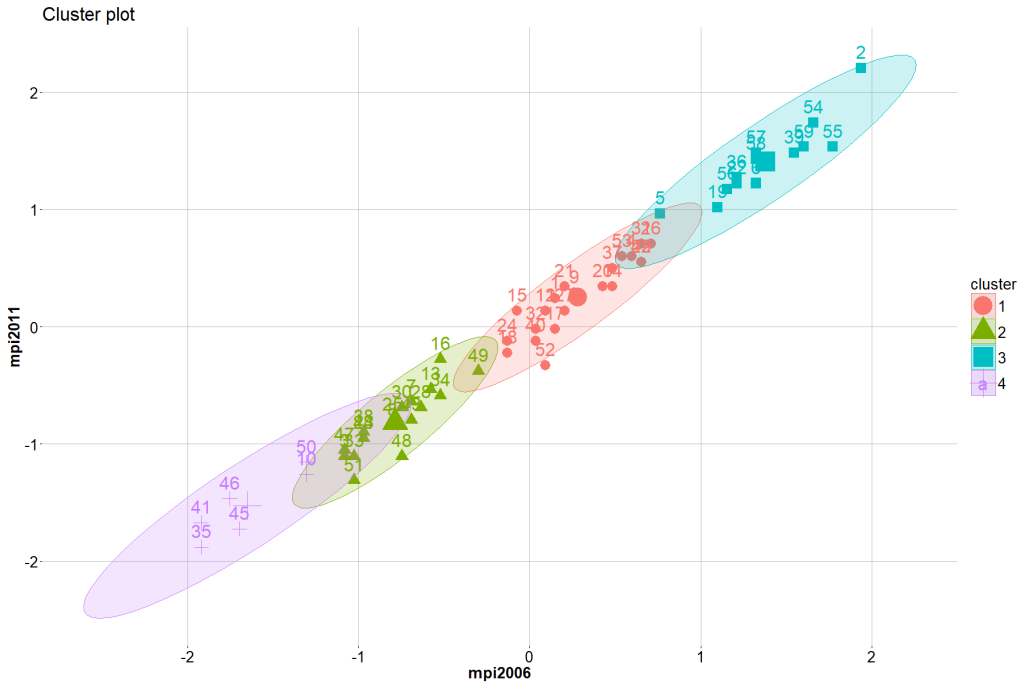
Source: Author's calculation
Notes: The numbers correspond to specific municipality IDs, which are given in Appendix B

Figure 1: Dendrogram for Ward's hierarchical clustering method based on the 2006 MPI values for municipalities in Athens



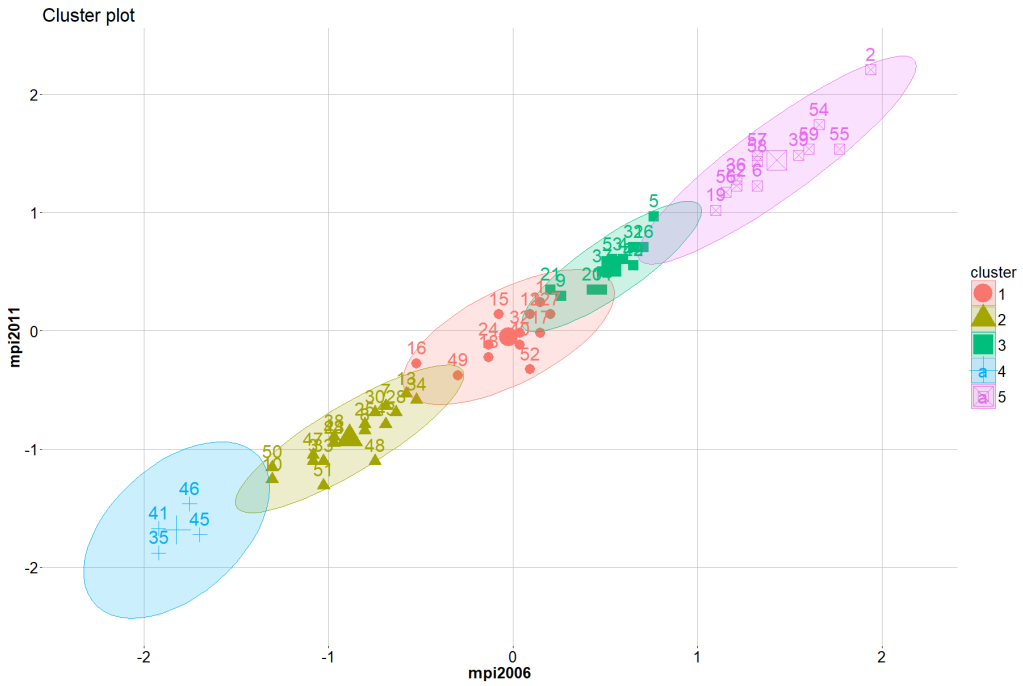
Source: Author's calculation
Notes: The numbers correspond to specific municipality IDs, which are given in Appendix B

Figure 2: Scatter plots for k-means clusters' solutions – k = 3



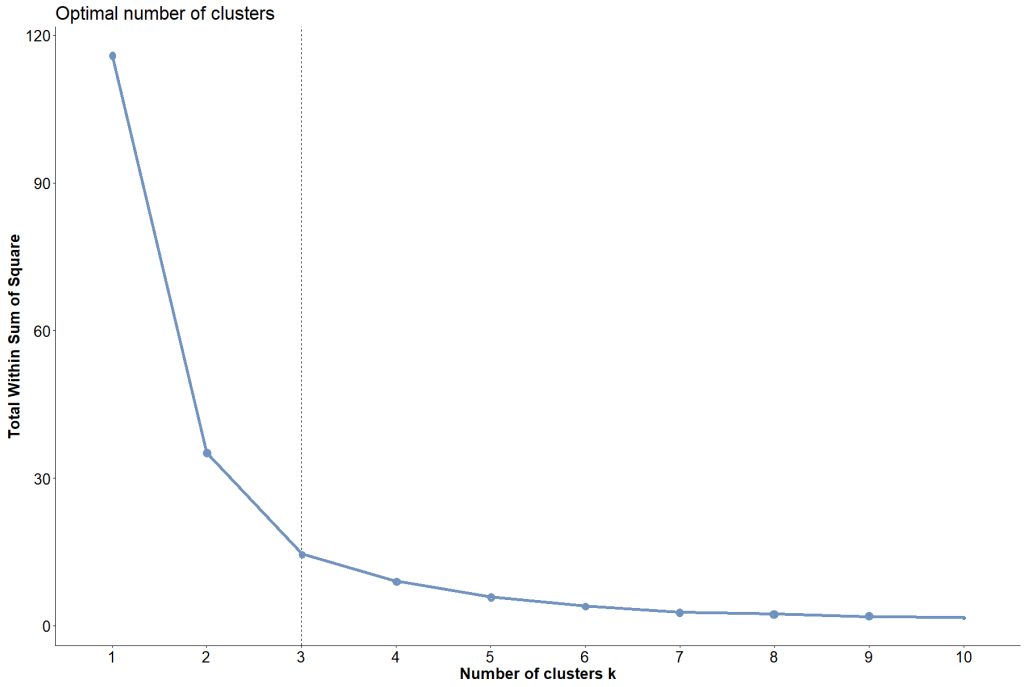
Source: Author's calculation
Notes: The numbers correspond to specific municipality IDs, which are given in Appendix B

Figure 3: Scatter plots for k-means clusters' solutions – k = 4



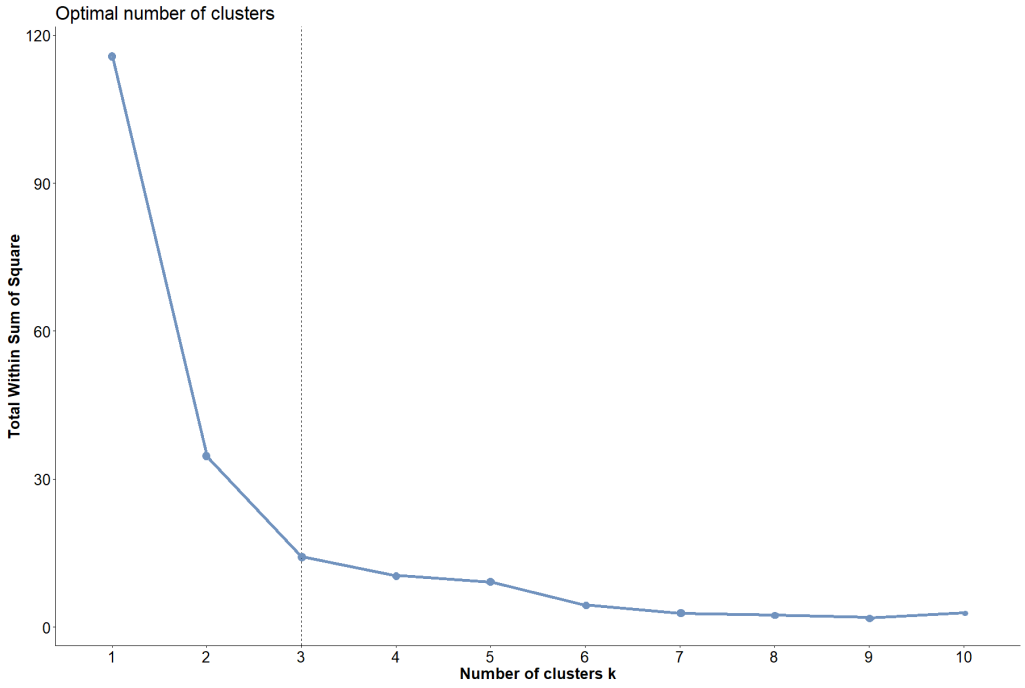
Source: Author's calculation
Notes: The numbers correspond to specific municipality IDs, which are given in Appendix B

Figure 4: Scatter plots for k-means clusters' solutions – k = 5



Source: Author's calculation

Figure 5: Identification of the optimal number of clusters using the elbow criterion for hierarchical clustering



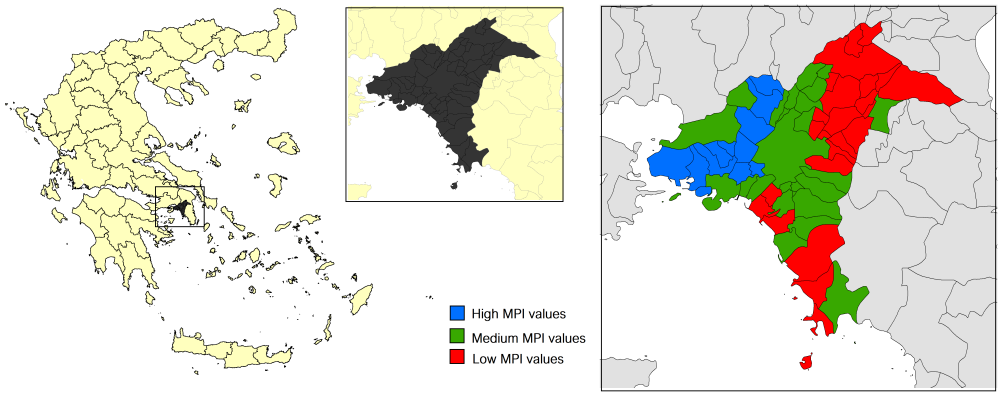
Source: Author's calculation

Figure 6: Identification of the optimal number of clusters using the elbow criterion for k-means clustering

Table 3: Results for bootstrap method of resampling

Cluster number	Jaccard bootstrap mean	Times a cluster has been dissolved	Times a cluster has been successfully recovered
1	0.906	0	91
2	0.923	1	88
3	0.947	0	99

Source: Author's calculation



Source: Panori et al. (2017) and author's calculations

Figure 7: Map illustrating three main clusters arising within the metropolitan area of Athens based on MPI values (2006)

3, including the Jaccard bootstrap mean value, the number of times a cluster has been dissolved and successfully recovered. In general, a valid, stable cluster should yield a mean Jaccard similarity value of 0.75 or more, whilst "highly stable" clusters should yield values of 0.85 and above (Hennig 2007, 2008). The values in our case indicate a high stability of the cluster results, obtained through the previous analysis.

This section presented a detailed description of the methodological framework used in this paper, regarding the calculation of the MPI index, under an EU country framework, as well as the process for building the clusters within the metropolitan area of Athens. It has also illustrated an assessment framework for the obtained clusters, in order to evaluate their stability.

5 Results

The aim of this paper is to reveal and compare the high, medium and low MPI clusters within the metropolitan area of Athens, in order to investigate for any existing structural differences of poverty between them. Figure 7 illustrates a spatial representation of the three derived clusters within Athens, based on the results of the previous analysis. A first observation is that the clusters illustrate high level of spatial concentration, indicating a social segregation pattern within Athens.

Some general characteristics for each cluster are shown in Table 4, focusing on further exploring this segregation pattern. By looking at the map, it becomes evident that high MPI municipalities span across the western part of Athens, encompassing highly deprived areas characterized by low mean income values. At the same time, the cluster that includes medium MPI municipalities is the largest one, in terms of population share, covering the central part of Athens, where the urban core lies. It is evident that municipalities belonging to this cluster are mostly medium-income areas. Finally, low MPI areas are located mainly in the north-east and south-east parts of Athens, encompassing

Table 4: Main characteristics of three clusters

Group	No. of obs	Pop. share 2006	Pop. share 2011	Mean income 06	Mean income 11	MPI 2006	MPI 2011
1/ High MPI	13	21.1	21.2	13177	11796	0.097	0.102
2/ Medium MPI	24	56.6	55.8	14297	12819	0.078	0.082
3/ Low MPI	22	22.3	23.0	15744	14175	0.059	0.060

Source: Author's calculations
Notes: Mean income is measured in €/capita.

Table 5: Calculated dimensional specific MPI values for each group

Group	2006			2011		
	Health	Education	Standard of Living	Health	Education	Standard of Living
1/ High MPI	0.041	0.491	0.109	0.059	0.462	0.126
2/ Medium MPI	0.038	0.359	0.108	0.056	0.347	0.120
3/ Low MPI	0.033	0.235	0.107	0.051	0.239	0.110

Source: Author's calculations

all high-income areas. Moreover, it is essential to notice that during the period under investigation there is no significant change in the population share of each group, a fact which helps to minimize the effects of population changes on the MPI evolution.

By decomposing the regional MPI index in its three main dimensions, additional differences arise between the clusters (Table 5). As expected, dimension-specific values remain larger for the high MPI cluster, in all cases. Moreover, it is interesting to notice the significant variation between high and low MPI clusters in the case of education, as well as the diversified reaction of this dimension during the period 2006-2011. More specifically, education illustrates a positive performance throughout this period, despite the deterioration in health and living conditions. This is a finding that could be used as preliminary evidence, in favour of claiming that during periods of economic recession, education may be treated as an investment opportunity, especially by the low-income classes.

Moving on, Table 6 presents the cluster headcount ratios for the three key dimensions. First, low headcount ratios for health (4-6% for 2006 and 7-8% for 2011) indicate a relatively small percentage of people being deprived in terms of this dimension. On the other hand, educational headcount ratios indicate a significant gap between the high and low MPI clusters. The share of educationally deprived people, located in a municipality that belongs to cluster 1, is more than two times higher when compared to the share of educationally deprived residents of cluster 3. Another finding is the increase in the living conditions' headcount ratios, which despite its very low level, is not similar in all groups. More specifically, the less advantaged group (cluster 1) was affected the most.

Table 7 presents the contribution of each dimension to the overall regional MPI value,

Table 6: Headcount ratio (%) for dimensional specific MPI values for each group

Group	2006			2011		
	Health	Education	Standard of Living	Health	Education	Standard of Living
1/ High MPI	5.7	49.1	24.8	8.2	46.2	27.9
2/ Medium MPI	5.2	35.9	24.8	7.7	34.7	26.7
3/ Low MPI	4.6	23.5	24.6	7.0	23.9	24.6

Source: Author's calculations

Table 7: Contribution (%) of each dimension to the overall MPI within each group

Group	2006			2011		
	Health	Education	Standard of Living	Health	Education	Standard of Living
1/ High MPI	23.21	35.35	41.44	24.65	34.36	40.99
2/ Medium MPI	24.96	33.49	41.55	27.34	32.18	40.48
3/ Low MPI	27.55	30.07	42.38	29.91	29.92	40.17

Source: Author's calculations

Table 8: Contribution (%) of each group to the overall regional MPI

Group	2006			2011		
	Contribution (a)	Population share (b)	Ratio (a)/(b)	Contribution (a)	Population share (b)	Ratio (a)/(b)
1/ High MPI	26.3	21.1	1.25	26.6	21.2	1.26
2/ Medium MPI	56.8	56.6	1.01	56.4	55.8	1.01
3/ Low MPI	16.9	22.3	0.76	17.0	23.0	0.74

Source: Author's calculations

in order to provide some additional information regarding the structural characteristics of multidimensional poverty within each cluster. It should be noted that there are no great differences between the three clusters, which illustrate a similar structure of multidimensional poverty through space. In general, there is an increased participation of the living conditions component in all cases, whilst the educational dimension is the second most important component of multidimensional poverty, especially in the case of low-income areas (cluster 1).

Besides investigating the structure of multidimensional poverty in each cluster separately, it is also very interesting to examine the results that arise when combining all data in order to represent the contribution of each cluster to the overall regional MPI of the metropolitan area of Athens. Table 8 illustrates the results based on (7). As expected, the main contribution to the overall MPI comes from the medium MPI cluster, which is the most populated, including the urban core of the city. Nonetheless, it is important to point out that there is a noticeable difference in the case of the other two (high and low MPI) clusters, when comparing their population shares with the share of their relative contribution to the overall regional MPI.

Although the high MPI cluster has a population share of 21.20% in 2011, its contribution to the overall regional MPI reaches 26.64%. This is expected, as it includes highly deprived areas, which contribute to a larger extent to the overall poverty levels within Athens. On the other hand, the population share of the low MPI cluster is 23%, whereas its contribution on multidimensional poverty is 17.00%. This difference becomes clear when looking directly at the ratio columns. Values higher than 1 indicate a contribution to the regional MPI which is higher than the corresponding population share, and vice versa. For the case of the medium MPI cluster, the ratio is almost equal to unity, indicating a balanced behaviour due to its large population share.

In order to explore any existing differences regarding the dynamic behaviour of the three clusters, it is essential to show the absolute and relative changes of the MPI values within each group (Table 9). Starting from the overall regional MPI index, both absolute and relative changes increase as we move to higher MPI clusters. A similar trend is also observed in the case of the standard of living component. In this case, the high MPI cluster experiences a sharp relative increase between 2006 and 2011, which is almost 4.5 times higher (15.95%/3.60%=4.43) when compared to the corresponding change in the low MPI cluster. Nonetheless, these variations seem to have different behaviour when it comes to health and education components. In the first case, an opposite movement is observed, when moving from cluster 1 to cluster 3, which does not seem to be in line with the corresponding absolute changes, due to differences between the initial values.

Table 9: Absolute and relative changes 2006/11 of the MPI values within sub-groups and for each dimension separately

		Total	High MPI	Medium MPI	Low MPI
Regional MPI	Absolute	0,003	0,004	0,003	0,001
	Relative (%)	3,55	4,38	3,93	1,82
Health	Absolute	0,018	0,018	0,018	0,017
	Relative (%)	47,21	43,00	47,62	51,36
Education	Absolute	-0,013	-0,029	-0,012	0,003
	Relative (%)	-3,54	-5,83	-3,39	1,39
Standard of Living	Absolute	0,012	0,017	0,012	0,004
	Relative (%)	10,68	15,95	11,54	3,60

Source: Author's calculations

However, in the case of education, a decrease on MPI values for high and medium MPI clusters is observed, whilst the low MPI cluster seems to experience a relative increase of 1.39% on its educational MPI component.

The previous analysis has shown that only small variations exist between the derived clusters. Any distributional and/or behavioural differences reflects the underlying urban dynamics within the metropolitan area of Athens. These encompass complex processes, such as economic restructuring, migration and the welfare state, leading to different socio-spatial outcomes. Economic disturbances, including the 2008 economic crisis, constitute additional forces, that push poverty structures, alongside with their dimensional components, into similar or opposite directions. The evolution of education and living standards are two indicative examples, regarding the diversified impact of urban dynamics on these two dimensions of poverty.

6 Concluding remarks

This paper focuses on exploring poverty concentration and structure within the metropolitan area of Athens. The study tried to investigate poverty under a multidimensional framework, revealing the necessity of expanding the notion of that kind of urban phenomena to other non-income-based dimensions. Using the MPI approach to identify and map poverty concentration patterns within the city of Athens, has yielded very interesting findings.

First, a cluster analysis has been performed to define the optimal number of clusters. The results, coming from both hierarchical and partitioning techniques, have shown that the division of the metropolitan area of Athens into three discrete groups of municipalities, based on their MPI values for the year 2006, is the best way to approach multidimensional poverty segregation. The analysis revealed the existence of a spatial concentration of multidimensionally poor areas on the west suburban area of Athens, being traditionally inhabited by low-income workers. At the same time, less deprived municipalities of the city are primarily located on the south-east and north-east suburbs of Athens, whilst the urban core of the city seems to be characterised by medium-level MPI values. The existing differences between these clusters, in both income and MPI values, indicated the necessity of expanding the analysis, in order to explore any structural variances.

When looking at the structural and dynamic features within separate clusters, there are no considerable differences in terms of health and living conditions. An increase in health values similar for all groups has been noticed, whereas living conditions seem to have deteriorated slightly more in already deprived areas. More specifically, areas being part of the high MPI cluster seem to have been mostly affected in terms of material deprivation, housing problems and environment. Given the fact that during the period under investigation extended recessionary economic transitions have been taking place within Greece, this finding is in line with Andersson, Hedman (2016), which point out that economic crisis exhibits geographically uneven outcomes affecting poor areas the most.

Furthermore, it is essential to point out an existing significant gap in the educational component. As expected, highly deprived suburban areas show much lower educational attainment. However, there seems to be a convergence of the two tails of the educational distribution during the period 2006-2011, as the gap between high and low MPI areas becomes smaller. Given the high complexity of the social processes taking place at the urban level, more research should be made towards identifying the reasons for these movements. Possible reasons for this behaviour might include first, a high level of positive social mobility in those areas, not being followed by an additional residential mobility, and second, the brain drain phenomenon that has broadly affected high-income areas.

Existing variations in between-group behaviour highlight the necessity for expanding urban poverty research, especially in cases of large metropolitan areas. Through this paper, a step has been made towards a better understanding of the socio-spatial dialectic within the city of Athens, aiming to reveal the underlying interactions that form and maintain various aspects of poverty. Although it is difficult to generalise the conclusions of this specific case study, the implementation of similar analyses to other urban areas could offer a more holistic view regarding the structure of poverty within different socio-economic contexts.

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A Appendix A

This appendix presents in detail all indicators used to calculate the MPI components, based on Weziak-Bialowolska, Dijkstra (2014) conceptualization of regional MPI for the EU countries. All variables are included in the EU-SILC database.

Dimension 1: Health (cut-off: 2 out of 3)

Component 1.1: General health:

PH010 — Reporting bad or very bad conditions.

Component 1.2: Unmet medical need due to lack of affordability and accessibility

PH040, PH050 — Unmet need for medical examination or treatment because it was not affordable, there was a waiting list or it was too far to travel/no means of transportation.

Component 1.3: Unmet dental need due to lack of affordability and accessibility

PH060, PH070 — Unmet need for dental examination or treatment because it was not affordable, there was a waiting list or it was too far to travel/no means of transportation.

Dimension 2: Education (cut-off: 1 out of 1)

Component 2.1: Educational attainment

PB010, PB140, PE010, PE040 — A person of more than 24 years not having at least upper secondary education or in the age range 16-24 years who has finished no more than lower secondary education and is not involved in further education (based on early school leaver definition).

Dimension 3: Living Standards (cut-off: 1 out of 3)

Component 3.1: Material Deprivation (3 out of 9)

HS070, HS090, HS100, HS110 — Household cannot afford: a telephone (including a mobile phone), a computer, a washing machine, a car.

HS010, HS011, HS020, HS021 — Households with arrears on mortgage or rent payments or utility bills.

HS040 — Lack of capacity in a household to afford paying for one-week annual holiday away from home.

HS050 — Lack of capacity in a household to afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day.

HS060 — Lack of capacity to face unexpected financial expenses.

HH050 — Household without ability to keep home adequately warm.

Component 3.2: Housing problems (cut-off: 2 out of 4)

HH030 — Crowding index (average number of people per room available to the household) larger than 2

HH040, HH080/HH081, HS160 — Problems with dwelling: - leaking roof, damp walls/-floors/foundation, or rotten window frames or floor – too dark, not enough light – without bath or shower for sole use in dwelling.

Component 3.3: Environment (cut-off: 2 out of 3)

HS170, HS180, HS190 — Household experiences: - noise from neighbours or from the street – pollution, grime or other environmental problems – crime, violence or vandalism in the area.

B Appendix B

This appendix illustrates the list of municipalities within the metropolitan area of Athens, alongside with their ID numbers.

ID	Municipality	ID	Municipality
1	Athens	31	Nea Filadelfeia
2	Agia Varvara	32	Nea Chalkidona
3	Agia Paraskevi	33	Neo Psychiko
4	Agios Dimitrios	34	Palaio Faliro
5	Agioi Anargyroi	35	Papagou
6	Aigaleo	36	Peristeri
7	Alimos	37	Petroupoli
8	Amarousio	38	Pefki
9	Argyroupoli	39	Tavros
10	Vrilissia	40	Ymittos
11	Vyronas	41	Filothei
12	Galatsi	42	Chaidari
13	Glyfada	43	Chalandri
14	Dafni	44	Cholargos
15	Elliniko	45	Psychiko
16	Zografou	46	Ekali
17	Ilioupoli	47	Nea Penteli
18	Irakleio	48	Penteli
19	Ilio	49	Vari
20	Kaisariani	50	Voula
21	Kallithea	51	Vouliagmeni
22	Kamatero	52	Gerakas
23	Kifisia	53	Piraeus
24	Lykovrysi	54	Agios Ioannis Rentis
25	Melissia	55	Drapetsona
26	Metamorfosi	56	Keratsini
27	Moschato	57	Korydallos
28	Nea Erythraia	58	Nikaia
29	Nea Ionia	59	Perama
30	Nea Smyrni		