THE EVOLUTION OF THE GREEK URBAN CENTERS: 1951-2011

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Abstract - *The aim of this paper is to study the evolution of urban hierarchies and the nature of urban growth processes in Greece from 1951 to 2011 using data provided by the Greek Statistical Authority. The paper delivers three series of results: firstly, when using an administrative definition of the city, the Greek cities converge towards a middle city-size population; secondly, when taking into account spatial dependence, the sizes of Greek cities still converge but this movement starts in the middle of the period, after 1981. In both cases, the preeminence of the Athens agglomeration slowly decreases; finally, the paper delivers evidence concerning the changes that affect urban demographical trends in Greece over the last decade. These changes can be related to the economic crisis and the profound socioeconomic upheaval that Greece has undergone since the beginning of the 21st century.*

Key words - URBAN GROWTH, URBAN HIERARCHIES, ECONOMIC CRISIS, GREECE

JEL Classification - J11, R10, R12, R23

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1. INTRODUCTION

Greece is among the countries that experienced limited and late industrialization (Petrakos and Economou, 2004). The growth rate and the socioeconomic evolution of its cities was associated less to the development of industry and more to historical circumstances, such as the massive arrival of refugees from Asia Minor in 1922 and the population displacements due to the Civil War (1946-1949). These events contributed drastically to the formation of the most dominant current economic and social structures in the country.

Over the past decades (Maloutas, 2000; Pavleas, 2014), the urbanization process developed rapidly in Greece, mainly because of the rural economy decline and the consequent transfers of rural population to urban areas to seek better living standards. The limited labor market of the smaller cities was becoming less attractive to the inhabitants of rural areas, compared to that of larger cities. The capital city of Athens, in particular, received the majority of the migration flows, due to the concentration of government agencies and the relatively higher share of employment opportunities. As a result, the already existing structure of the 'primate city' in the Greek urban system was enhanced, pooling in Athens the most dynamic part of human force and the largest share of the production activity in the country.

The post 2nd World War period included determining tendencies, such as a general upgrade of educational level, a reduction in manual occupations and a rise in tertiary sector's activities and high-skilled employment (Maloutas, 2000). The Greek urban system developed clear hierarchical patterns, which arise by the changes in labor market's structure, real estate and housing conditions. However, the growth of Greek cities took place without central State planning, relying basically on market forces and individual strategies. The Greek State influenced urban development through insufficient planning legislative framework and corruption phenomena, rather than applying integrated urban strategies (Giannakourou, 1999). In general, the urban areas lack of technical, environmental and social infrastructure. There are important omissions of open and green areas in the urban fringe, while uncontrolled and unauthorized residential expansion prevails. It has to be noted that urban space is mostly private, causing complex and costly obstacles to cities' administration, when policy intervention is aimed. In addition, high building and population densities are more than evident; the building stock is of low level of aesthetics, and in many cases, poor supervision of cultural and architectural heritage has degraded cities' historic centers. Finally, traffic congestion and the associated noise remain an important problem in Greek cities. (Pavleas, 2014)

Currently, the Greek urban system is affected by the adverse socioeconomic conditions, which emanate from the economic crisis, reflecting on the composition and level of employment, business initiatives and the quality of life. In spite of the fact that the crisis is an ongoing phenomenon and any attempt to estimate at this stage the urban socioeconomic footprint, gives an instantaneous picture and not conclusive medium or long-term aspects, it is quite safe to argue that the crisis and the subsequent fiscal squeeze accelerate changes in the structure of urban economy, multiplying threats and intensifying existing problems in cities.

The aim of this paper is to study the evolution of urban hierarchies and the nature of urban growth processes in Greece from 1951 to 2011 using data provided by the Greek Statistical Authority. The paper delivers three series of results: firstly, when using an administrative definition of the city, the Greek cities converge towards a middle city-size population; secondly, when taking into account spatial dependence, the sizes of Greek cities still converge but this movement starts in the middle of the period, after 1981. In both cases, the preeminence of the Athens agglomeration slowly decreases; finally, the paper delivers evidence concerning the changes that affect urban demographical trends in Greece over the last decade. These changes can be related to the economic crisis and the profound socioeconomic upheaval that Greece has undergone since the beginning of the 21st century.

The paper is built as follows: the second section of this paper deals with theoretical issues. The third section provides a descriptive analysis of the population dynamics in the Greek urban system. The fourth section delivers results on the evolution of urban hierarchies and urban growth in Greece. The fifth and concluding section discusses the findings of the previous section and focuses on the specific urban demographical trends over the last decade.

2. THEORETICAL ISSUES

An important amount of modern economic literature deals with urban hierarchies. Following Zipf's early work, several papers have studied the changes in a country's system of cities by using different specifications of a rank-size model (Rosen and Resnick, 1980; Parr, 1985; Soo, 2005). These studies deliver evidence that a lower-bound truncated city-size distribution is Pareto (Krugman's 1996, "urban mystery"). In this case the Pareto exponent is a very simple and elegant indicator of the urban concentration degree within a system of cities. Parr (1985) assumes that in many industrialized countries, the Pareto exponent follows an inverse-U curve: the exponent is high (low urban concentration) in the beginning of the industrialization process, then decreases with GDP/capita increase, because firms and industries tend to move to the largest urban areas in order to benefit from agglomeration economies. According to Parr, the inflexion point appears when economic growth diffuses and when the advantages of agglomeration decline because of growing congestion and higher real-estate prices. Firms and workers relocate to smaller cities which leads in demographical adjustment in urban areas (and the increase of the Pareto exponent).

Empirical studies have tested Parr's hypothesis (Eaton and Eckstein, 1997; Dobkins and Ioannides, 2001; Catin and Van Huffel, 2004; Duranton, 2006) with mitigated results. Although rank-size models remain the best option to study the evolution of urban hierarchies within a country, they only deliver a descriptive analysis that needs to be completed in order to understand the engine and the nature of urban growth.

Urban growth processes have been studied within two major analytical frameworks (Duranton, 2012; Dimou and Schaffar, 2011): the random growth and the endogenous growth theories. The first ones (Gabaix, 1999, Gabaix and Ioannides, 2004, Cordoba, 2008) admit that city-growth is a stochastic process depending upon randomly distributed exogenous shocks. In the stationary state, the urban growth processes lead to a city-size distribution that follows the Zipf law. The second ones (Eaton et Eckstein, 1997, Black et Henderson, 1999) consider that urban growth processes depend upon each city's characteristics and industrial specialization. City-growth is determined by city-size and the Zipf's law doesn't necessarily hold.

Random growth theories drive back to Simon's (1955) probabilistic model where city-growth appears as an additive process that confirms Gibrat's law. This means that the urban growth rate is independent from city-size. In the stationary state, the demographic growth of cities tend to the null and, when considering a truncated city-size distribution with a lower bound, the Pareto exponent is 1, which confirms the Zipf law for cities. Recent urban growth theories have been developed following Gabaix's (1999) original work, according to whom, under a series of restrictive hypotheses (no demographical change, constant return to scales and limited households' mobility – only for young workers), city-growth follows a random process. City-growth depends only upon exogenous shocks randomly distributed such as historical accidents, natural disasters and, more commonly, local policies improving a city's amenities or changing the local taxing system.

On the opposite, endogenous growth theories assume that a city's size depends upon the firms' localization choices. The firms compare each city's advantages (scale externalities) and disadvantages (congestion, real-estate market failures) in order to decide where to locate. These theories drive back to Lucas endogenous growth model and to Henderson's (1974, 1988) theoretical framework. Eaton and Eckstein (1997) and Black and Henderson (1999) have calibrated urban growth models where the demographical change of cities depends upon their stock of external economies and human capital spillovers. Urban growth is a determinist and smooth process (Duranton, 2012); the heterogeneity of cities is due to the differentiation of their human capital stock. Under some specific assumptions, urban growth may lead to conditional convergence in city size (Black and Henderson, 2003).

More recently, a series of papers have tried to combine the two theoretical backgrounds within some hybrid urban growth models that take into account both agglomeration economies and random shocks (Rossi-Hansberg and Wright, 2007; Duranton, 2007; Schaffar and Dimou, 2012). Urban growth studies aim to determine whether there is an optimal city-size or not and, if this is the case, under which conditions it occurs. Random growth models don't validate the optimal city-size hypothesis which implies that agglomeration economies are not an explanative factor for city growth. On the opposite, determinist growth theories produce city-size convergence which doesn't seem to correspond to empirical findings. By loosening some assumptions, hybrid growth theories deliver models that fit much better to empirical observation.

In this paper we study the evolution of urban hierarchies in Greece and we test the nature of the Greek cities' growth processes. We show that the Greek cities converge to a medium city-size while urban concentration decreases. This means that the Athens agglomeration importance declines, especially during the last thirty years. However, the recent economic crisis leads in reconsidering these long-time trends.

3. URBAN DEMOGRAPHICS IN GREECE

The density and the distribution of population is associated with the process of demographic urbanization (population masses shift from rural to urban areas), which is closely connected with the economic urbanization (shift of labor from primary to secondary and tertiary production sector) and the social urbanization (dissemination and copying of behavioral and consumption patterns). (Maloutas, 2004).

Table 1: Evolution of urban population in Greece, 1951-2011

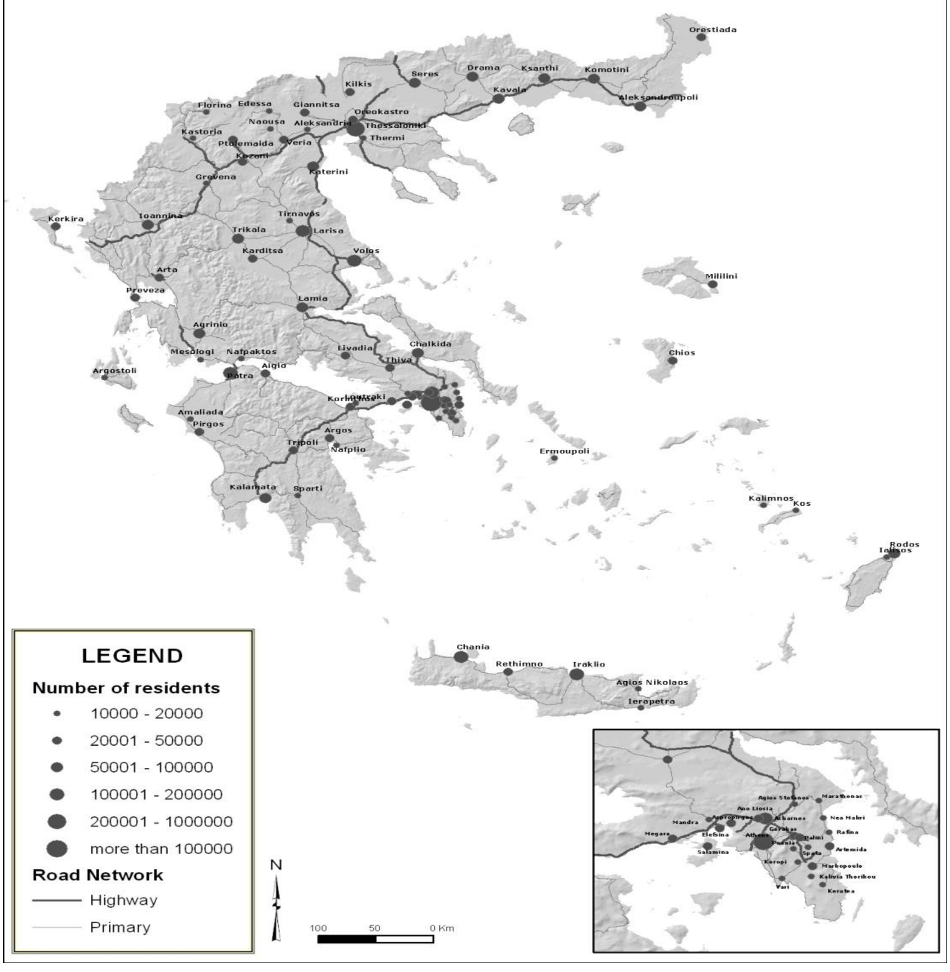
Years	Total population	Urban Population	Share of urban population (%)
1951	7,632,801	2,948,903	38.6
1961	8,388,553	3,661,456	43.6
1971	8,768,372	4,680,770	53.4
1981	9,738,243	5,680,396	58.3
1991	10,258,364	6,057,823	59.1
2001	10,964,020	6,650,284	60.7
2011	10,815,197	6,931,633	64.1

Source: Hellenic Statistical Agency - Own elaboration.

The share of urban population in Greece showed a constant upward trend over time (Table 1), accompanied with a rather strongly uneven distribution. To be more specific, urban population added up to 38.6 % of the total population of the country in 1951 and it increased up to the level of 58.3% in 1981, while in 2011 it reached a peak of 64.1%. The geographical distribution of the urban population, at the beginning of the post 2^{nd} World War period, showed a significant concentration in areas near the main highway axis of the country (Patra-Athens-Thessaloniki) and in several islands. Since the 1980s and mainly the 1990s, urban concentration diffused to other areas of the country, creating a second minor axis in western Greece (Patra - Ioannina), an area now crossed by the Ionian highway, which is under construction. Urban population growth showed, in the last three decades, a general trend of establishing in urban areas of local, regional or national importance. The dominant trend however regards the disproportionate growth of the two largest urban centers, Thessaloniki and especially Athens, compared with the rest of the urban areas (Map 1). At the same time, smaller urban centers (such as Patra, Larissa, Volos, Heraklio, Ioannina and Kavala) grew considerably gaining significant role at regional scale.

An analysis of the population census data for the period of 1951 to 2011 shows that the number of urban centers increased significantly over time. In 1951 the relative number was 55, in 1991 the number increased up to 71, while in 2001 and 2011, the number of urban centers seems to have relatively stabilized at 83 and 84 respectively (Table 1). It should be clarified that 'urban centers' are considered the settlements with a population over 10,000 inhabitants, according to the definition of the Hellenic Statistical Agency.

Map 1: Greek urban centres over 10.000 residents, 2011



The growth of Greek cities has been quite diverse, since they grew at different rates. Map 2 verifies this argument and depicts population change for the cities, which are over 10.000 residents in 2011 and for the period 1951-2011. The range of changes begins from the minimum value of -53.9% (for the city of

Ermoupoli) to the maximum value of 2624.7% for the city of Oreokastro. It seems that the only two cases with negative change refer to the island cities of Ermoupoli and Chios, while, in general, the relatively smaller changes attribute to agglomerations in islands and to smaller cities of mainland. Moreover, Map 2 shows that there is a considerable number of cities that magnified over 5 and 10 times their size during this period and they are located dominantly in the area of Athens' metropolitan functional influence.

Map 2: Population change of Greek urban centres, 1951-2011

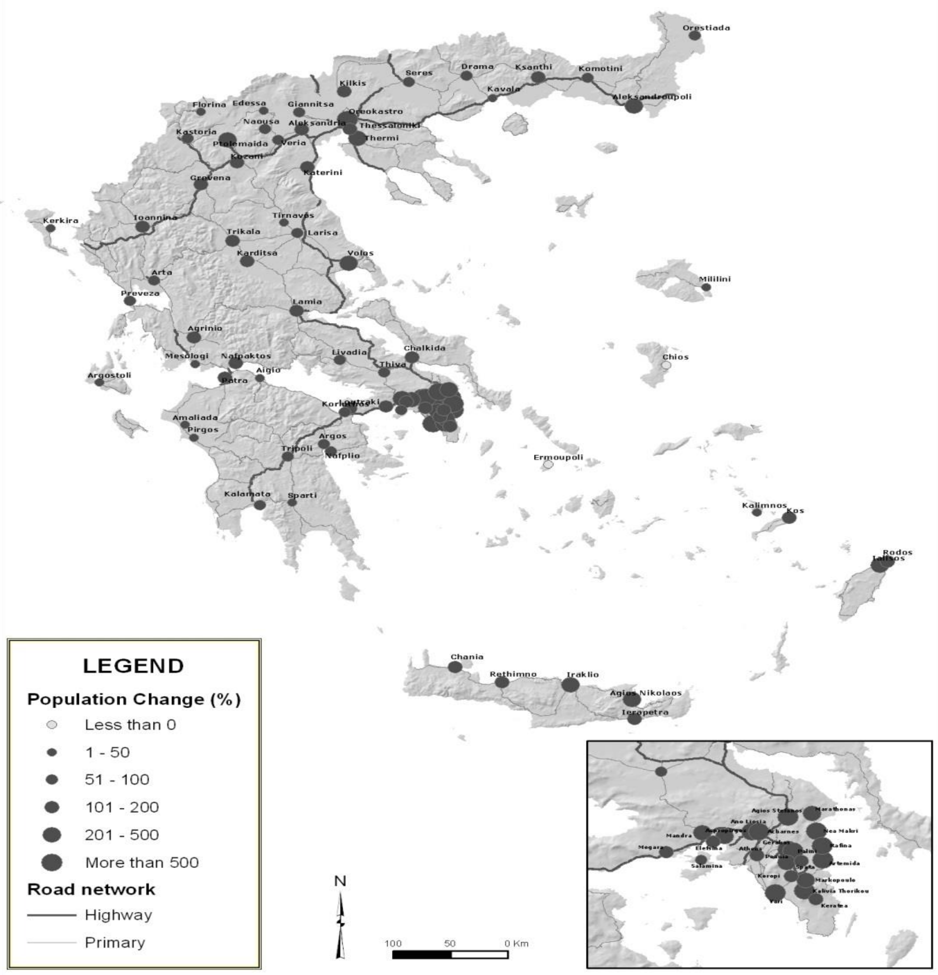


Table 2 shows the number of urban centers by population category, from 1951 to 2011. From a general point of view, the intense asymmetries of Greek urban space are corroborated. The urban complex of Athens is the only case, which exceeds 1,000,000 inhabitants, accounting for 46.75% (in 1951) and 44.57% (in 2011) of the total urban population (Table 3).

Likewise, the urban complex of Thessaloniki is the only settlement in the category of 500,000 to 1,000,000 inhabitants, participating in urban population with 11.90% (in 1971) and 11.38 % (in 2011). During the last decade, the population of the two largest urban centers showed for the first time signs of decline. It should be emphasized that the Greek urban system lacks urban agglomerations of size between 200,000 and 500,000 residents, which is the relative determinant framework for medium-sized cities in the European urban context (Pavleas and al, 2005). Interestingly, in the last thirty years (1981-2011) the number of cities from 100,000 to 200,000 residents increased from 4 in 1981 to 6 in 2011, while the cities between 50,000 and 100,000 increased abruptly from 2 to 14. The last trend was due to the penetration of additional cities, which belonged to the category of 20,000 to 50,000 and grew significantly at the same period.

Table 2: Number of cities by population size, 1951-2011

	Number of urban centers						
Population	1951	1961	1971	1981	1991	2001	2011
Over 1.000.000	1	1	1	1	1	1	1
500.000-1.000.000	0	0	1	1	1	1	1
200.000-500.000	1	1	0	0	0	0	0
100.000-200.000	0	1	1	4	4	4	6
50.000-100.000	3	3	4	2	7	5	14
20.000-50.000	22	25	27	32	29	35	30
10.000-20.000	28	25	23	23	29	37	32
Total	55	56	57	63	71	83	84

Source: Hellenic Statistical Agency – Own elaboration.

Table 3: Distribution of urban population by city-size, 1951-2011

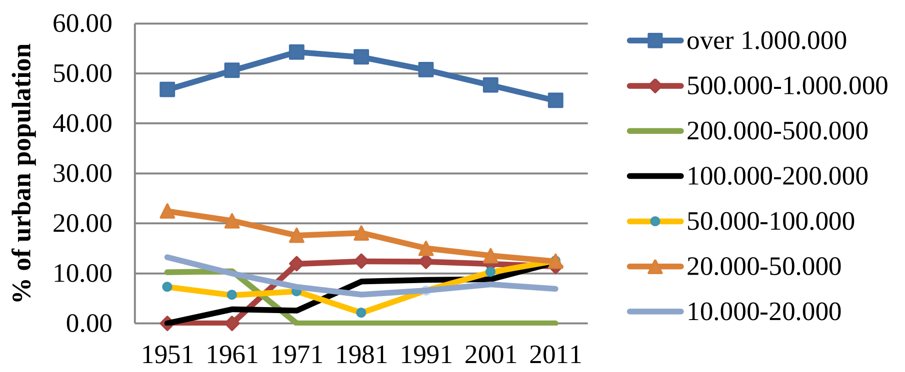
Population	Share (%) of urban population						
	1951	1961	1971	1981	1991	2001	2011
1.000.000 <	46.75	50.6	54.7	53.29	50.73	47.66	44.57
500.000-1.000.000	0	0	11.9	12.43	12.37	11.93	11.38
200.000-500.000	10.25	10.4	0	0	0	0	0
100.000-200.000	0	2.84	2.58	8.37	8.69	8.82	12.19
50.000-100.000	7.28	5.65	6.39	2.09	6.56	10.24	12.53
20.000-50.000	22.47	20.5	17.59	18.09	15.03	13.56	12.43
10.000-20.000	13.25	10	7.27	5.73	6.62	7.79	6.90
Total	100	100	100	100	100	100	100

Source: Hellenic Statistical Agency - Own elaboration.

The tendencies presented above are also reflected in Table 3 and Graph 1, which show the evolution of urban population's distribution by population category for the same time period. The sum of shares of Athens and Thessaloniki in urban population reaches 63% in 1991, 59.59% in 2001 and 56 % in 2011, which may indicates that the relative importance of the two largest urban centers decreases in recent decades. At the same time, the participation of the cities from 50,000 to 200,000 residents seems to have been enhanced. Moreover, the share of smaller urban centers (20,000 to 50,000) presents diminishing trends in the last 30 years, while cities from 10,000 to 20,000 inhabitants show mixed trends over time, remaining however at relatively low levels of 6% to10%.

In total, the urbanization process in Greece, during the period 1951-2011, seems to have set off from a spatially polarized urban pattern (Athens - Thessaloniki), continued with growth of the relatively smaller urban centers, and resulted in a stabilization of a concentrated urban status, due to reduced demographic growth and migratory movements. In the last decades, the importance of cities from 50,000 to 200,000 has been enhanced, while the urban share of Athens and Thessaloniki seems to have tapered. The question (Pavleas and al, 2005) whether the trends analyzed above, can be really interpreted as evidence of deconcentration in the Greek urban system remains a crucial topic and only merely investigated in Greek literature.

Graph 1: Evolution of urban population's distribution, 1951-2011



Source: Hellenic Statistical Agency - Own elaboration.

4. URBAN HIERARCHIES AND CITY-GROWTH

In order to study the evolution of urban hierarchies and the nature of urban growth in Greece between 1951 and 2011, we use two different samples: an administrative definition of the cities' sample and a geographical and economic definition of the cities' sample which takes into account agglomeration effects and spatial dependence, especially for the two major cities, Athens and Thessaloniki. Data is provided by the Hellenic Statistical Agency.

We use the Gabaix and Ibragimov (2011) correction for the rank size model (Schaffar, 2009:2).

$$\ln\left(R-\frac{1}{2}\right)=a+\beta\ln(S)$$

Then we study the convexity of the distribution, by using the Rosen and Resnick (1980) quadratic model.

$$\ln(R)=a+\beta\ln(S)+\theta\ln(S)^2$$

with R the rank of a city and S its demographical size. Table 4 delivers both the results for the rank-size model and the quadratic model, when we use the administrative cities sample.

The evolution of the Pareto exponent clearly shows that urban concentration decreases and that the medium-size cities become more important within the Greek urban landscape. After 2001, the Pareto exponent is stable and almost equal to 1. This means that when defined by an administrative point of view, medium-size Greek cities tend to grow and the distribution of urban population becomes less hierarchical over time. The quadratic model confirms that the number of medium size cities become more important within the distribution since the δ systematically increases during the whole period.

Table 4: Pareto exponent and quadratic model parameters for the Greek cities-size distribution (administrative definition)

Rank-size	*1951*	*1961*	*1971*	*1981*	*1991*	*2001*	*2011*
ln(Pop)	-0.72***	-0.79***	-0.83***	-0.87***	-0.95***	-1.01***	-1.01***
R^2 adjusted	0.81	0.86	0.89	0.92	0.96	0.97	0.96
Quadratic	1951	1961	1971	1981	1991	2001	2011
ln(Pop)	-0.26***	-0.22***	-0.29***	-0.76***	-0.93***	-1.15***	-1.18***
$\ln(Pop)^2$	-0.07***	-0.048***	-0.023**	-0.002	0.038***	0.059***	0.043***
R^2 adjusted	0.872	0.880	0.890	0.917	0.954	0.968	0.961
Number of obs.	87	87	87	87	87	87	87

**** sig at 1% ** sig at 5% * sig at 10%.*

Table 5 gives the same results for the Greek agglomerations. This sample only contains 67 cities, since 20 cities from the previous sample belong to the Athens or to the Thessaloniki agglomerations.

Table 5: Pareto exponent and quadratic model parameters for the Greek cities-size distribution (agglomerations)

Rank-size	*1951*	*1961*	*1971*	*1981*	*1991*	*2001*	*2011*
ln(Pop)	-1.00***	-0.81***	-0.83***	-0.87***	-0.96***	-1.01***	-1.01***
R^2 adjusted	0.91	0.85	0.87	0.91	0.94	0.95	0.94
Quadratic	1951	1961	1971	1981	1991	2001	2011
n(Pop)	-1.26***	-0.26	-0.68**	-1.12***	-2.13***	-2.55***	-2.17***
$\ln(Pop)^2$	0.016**	-0.024**	-0.004	0.015**	0.057***	0.073**	0.056**
R^2 adjusted	0.893	0.856	0.867	0.896	0.945	0.958	0.896
Number of obs.	67	67	67	67	67	67	67

**** sig at 1% ** sig at 5% * sig at 10%.*

Compared to the previous results, Table 5 shows a U curve trend for the Pareto exponent. Until the mid-70s there is a clear urban concentration dynamic, then the trend changes; this is also confirmed by the Rosen and Resnick's δ change over time. Although the definition of cities is different[1], both results show that after 1981 there is a tendency for urban diffusion and the importance of the largest cities slightly diminishes compared to the medium-size cities. This means that the prominence of the Athens' agglomeration has reached to a limit when compared to the other urban centers in Greece and slowly decreases after 1981 (which doesn't' mean that the Athens population diminishes! It just grows slower than other medium-size agglomerations).

We next study urban growth in Greece following a methodology developed by Schaffar (2009:1) and Schaffar and Dimou (2012). Firstly, we apply unit-root models on panel data to test whether city-sizes are stationary; secondly, we use a Markov chain procedure to study the relative growth of cities.

First generation panel data unit-root tests have been developed by Levin, Lin and Chu (2002), Maddala and Wu (1999), Im, Pesaran and Shin (2002) and Choi (2002). When using these tests, we assume that each city's growth process is independent from other cities' growth processes. Heterogeneity depends only upon each city's characteristics. The second generation panel data unit-root tests loosen this assumption and consider interaction between urban growth processes (Choi, 2002; Pesaran, 2003).

We test two different growth models both with fixed effects, with or without a drift.

Model with fixed effects without a drift:

$$\Delta \ln S_{it} = c_i + \gamma_i \ln S_{it-1} + \sum_{j=1}^{p_i} \beta_j \Delta \ln S_{t-j} + \mu_{it}$$

Model with fixed effects and a drift:

$$\Delta \ln S_{it} = c_i + \delta_i t + \gamma_i \ln S_{it-1} + \sum_{j=1}^{p_i} \beta_j \Delta \ln S_{t-j} + \mu_{it}$$

where c_i controls city heterogeneity, $\delta_i t$ the upward trending and p_i is the number of the lagged difference term for city *i*. $H_0 : \gamma_i = 0, \forall i$ is the instability hypothesis, where cities' sizes are not stationary, versus the alternative $H_1 : \gamma_i < 0, \forall i$ where the logarithms of cities' sizes converge to a constant value in the steady-state. The null hypothesis doesn't reject the Gibrat law for cities. Table 6 provides results for first generation tests.

[1] Chesire (1999) discuss the advantages for each definition, when studying urban hierarchies. Henderson (1988) considers only the agglomerations, since they are economically defined. However, other studies insist on the interest of using administrative cities since they allow taking into account urban policies differentiation.

The LL and the IPS tests reject the hypothesis H_0 for both samples. This means that whatever sample we use, the Gibrat law for cities doesn't' hold and cities' sizes converge.

Table 6: Results for the first generation panel unit-root tests

	Test	Stats	Model with drift	Model without drift
87 cities sample	Levin Lin and Chu (2002)	LL	18.541 (1.00)	11.928 (1.00)
	Im Pesaran and Shin (2003)	$\overline{Z}_t$	-12.225 (0.00)	-12.355 (0.00)
		$\overline{W}_t$	-12.452 (0.00)	-12.376 (0.00)
67 cities sample	Levin Lin and Chu (2002)	LL	18.662 (1.00)	12.296 (1.00)
	Im Pesaran and Shin (2003)	$\overline{Z}_t$	-13.662 (0,00)	-12,718 (0.00)
		$\overline{W}_t$	-13.058 (0.00)	-12.933 (0.00)

p-values in braquets.

Table 7: Results for the second generation panel unit-root tests

	Test	Stats	Model with drift	Model without a drift
87 cities sample	Choi (2002)	P_m	21.723 (0,00)	21.723 (0,00)
		Z	-9.840 (0,00)	-9.630 (0,00)
		L^*	-13.435 (0,00)	-13,105 (0,00)
	Pesaran (2003)	$CIPS$	-9.664 (0,01)	-9,411 (0,01)
		$CIPS*$	-6,501 (0,01)	-6,278 (0,01)
67 cities sample	Choi (2002)	P_m	21.567 (0.00)	21,011 (0,00)
		Z	-9.651 (0.00)	-9,110 (0,00)
		L^*	-12.121 (0.00)	-12.098 (0.00)
	Pesaran (2003)	$CIPS$	-7.214 (0.01)	-7.260 (0.01)
		$CIPS*$	-6.502 (0.01)	-6,.311 (0,01)

p-values in braquets.

The results from the most robust second generation panel unit-root tests (Table 7) confirm those from the first generation tests: the Greek cities' sizes converge. This is relevant with the results from the static analysis delivered by the rank-size model and the quadratic model. Cities' size convergence goes against the usual belief in Greece supporting the idea of a strong urban concentration movement in the Athens region. It is worthy reminding that these results are confirmed for both samples, although when using the agglomerations distribution, convergence and urban diffusion only appear after 1981.

Finally intra-distributional dynamics for the Greek cities are studied. Following Black and Henderson (2003) and Dimou and alii (2008), we use Markov chains techniques. This requires the discretization of the distribution by assigning each city to one predetermined number of groups, based on its relative size. In this paper, the discretization process is made with cut-off points exogenously defined at relative city sizes of 0.1m, 0.3m, 0.5m and 0.8m, where m is the average city size for a given year t. It is assumed that the distribution follows a homogenous stationary first-order Markov process and F_t denotes the vector of distributional shares for each group of the discretized distribution

$$F_{t+1} = M \times F_t$$

Each element P_{ij}^t of the transition matrix M_t represents the probability that a city moves from the group i to the group j in t. The transition probabilities are estimated with the maximum likelihood method. Tables 8 and 9 deliver the results for the transition matrices for both samples (87 and 67 cities).

Table 8: Transition matrix for the 87-cities sample

$\hat{p}_{ij}$	C_1	C_2	C_3	C_4	C_5
C_1	0.7142	0.2857	0	0	0
C_2	0.0147	0.9411	0.0441	0	0
C_3	0	0.1818	0.7727	0.0454	0
C_4	0	0	0.1	0.8555	0.0444
C_5	0	0	0.0161	0.1451	0.8387

Table 9: Transition matrix for the 67-cities sample

$\hat{p}_{ij}$	C_1	C_2	C_3	C_4	C_5
C_1	0.9658	0.0341	0	0	0
C_2	0.15	0.79	0.06	0	0
C_3	0	0.2461	0.6307	0.1230	0
C_4	0	0	0.1282	0.8461	0.0256
C_5	0	0	0	0.0952	0.9047

Tables 10 and 11 show the mean first passage time for a city from one group to another for each sample while Table 12 compare the initial and the ergodic distributions for the two samples.

The Markov chains procedure globally confirm our previous findings. The ergodic distributions for both samples show that there is a strong convergence to the lower city-sizes groups (the first for the 87-cities sample and the second for the 67-cities sample). Instability is extremely high in both distributions, which is rather rare for an industrialized country. One should note that even for the last group of cities (c_5) instability is rather high (the diagonal elements are equal to 0.83 and 0.90 for each group). Obviously, the discretization process plays an important role for these statistics, thus we have tested other discretization processes with various cut-off points for both distributions and they all confirm the high instability of the Greek cities' ranks.

The results in Tables 10 and 11 show the high rate of convergence process of the Greek cities' sizes. When using the administrative definition of cities' sample, it only needs 3.5 years for a city from group c_1 to reach the group c_2. In a similar way, when considering agglomerations, it takes 10.5 years for a city from the second group c_2 to pass to $c_{1.}$ In general, downward mobility is higher when using the agglomeration sample and upward mobility is higher when using the administrative cities sample.

Table 10: Mean first-time passage for the 87-cities sample

M	C_1	C_2	C_3	C_4	C_5
C_1	0	3,5	27,3	144,6	431,1
C_2	93,6	0	23,8	141,1	427,6
C_3	102,2	8,5	0	117,3	403,8
C_4	114,4	20,7	12,2	0	286,5
C_5	119,4	25,7	17,1	17,9	0

Table 11: Mean first-passage time for the 67-cities sample

M	C_1	C_2	C_3	C_4	C_5
C_1	0	29,2	119,1	306,7	1284,3
C_2	10,3	0	89,8	277,5	1255,1
C_3	19,2	9,0	0	187,7	1165,2
C_4	29,1	18,9	9,9	0	977,5
C_5	39,7	29,4	20,4	10,5	0

Table 12: Initial and ergodic distributions

	C_1	C_2	C_3	C_4	C_5
87 cities sample					
Initial distribution	0.16	0.22	0.27	0.15	0.20
Ergodic distribution	0.04	0.70	0.17	0.07	0.02
67 cities sample					
Initial distribution	0.18	0.24	0.21	0.22	0.15
Ergodic distribution	0.74	0.17	0.04	0.04	0.01

5. THE CHANGING PATTERNS OF URBAN HIERARCHIES

Our findings in previous sections lead to three series of conclusions.

Firstly, urban concentration in Greece decreases after 1981 whatever definition of a city is used. This is confirmed from descriptive statistics but also from our findings when using the rank-size model and the quadratic model as well as from the tests concerning the nature of urban growth processes.

Secondly, cities' sizes converge towards a middle city-size. This confirms Parr's (1985) hypothesis that urban hierarchies follow a U-trend movement, according to the industrialization process. The Greek urban system has been characterized by demographic concentration during the early industrialization stages. After 1981, when the country's growth rate met a slight but steady decrease, urban concentration stopped and medium sizes cities emerged in a more dynamic way. Athens remains of course a huge agglomeration compared to the other Greek cities but grows slower than the rest of the country. It is important to note that in any case the Gibrat law for cities doesn't hold.

Thirdly, the cities' sizes convergence rate is extremely high, when considering distributional dynamics within the whole period, that is, from 1951 to 2011. Downward mobility for cities is almost as high as upward mobility.

Following these long-term results, one of the questions that occur is whether the recent economic crisis has changed the trends of the Greek urban system over the last decade. The results from the rank-size and the quadratic models show that in 2011 both the Pareto exponent and the Rosen and Resnick □□have slightly decreased (compared to 2001) which contrasts with the Greek urban demographics dynamics since 1981. This leads to the assumption that the convergence process has weakened and confirms previous findings for the Balkans cities delivered from Dimou and Schaffar (2009) according to whom, a country's city-size distribution is characterized by less mobility during a period of crisis.

We have applied the Markov chains method in the Greek cities' size distribution but this time we run the model only considering the intra-distributional movements that have taken place during the last decade. The results in Table 13 deliver some interesting complements on the previous information concerning urban hierarchies and urban growth in Greece during the crisis period.

Table 13: Transition matrix for the 67-cities sample (2001-2011 trend)

$\hat{p}_{ij}$	C_1	C_2	C_3	C_4	C_5
C_1	0.7857	0.2142	0	0	0
C_2	0.0714	0.7857	0.1428	0	0
C_3	0	0.0625	0.8125	0.125	0
C_4	0	0	0	0.9485	0.0514
C_5	0	0	0	0	1

The intra-distributional mobility is quite lower than the one observed in the previous matrices. For the two last groups of cities, this mobility almost falls down to 0. Moreover downward mobility is extremely law in all cases, on the opposite of what we have observed in the previous matrices. In the stationary state (ergodic distribution), there is convergence to the higher city-size so all cities reach the last group. However, the upward movements are extremely long and it needs more than 2 000 years for a city from the first group to reach the second one and an infinite time (40 000 years) to reach the last group c_5.

Obviously, these results must be considered with a lot of criticism and one should take into account the fact that they draw upon the intra-distributional movements of Greek cities within a single period (2001-2011). However, they clearly show the strong immobility in the Greek city-size distribution during the crisis decade. This also means that temporary shocks such as the economic and financial crisis that Greece is undergoing since 2009 don't produce instability in urban demographics but tend to "freeze" the existing urban hierarchies.

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CROISSANCE ET HIÉRARCHIE URBAINES EN GRÈCE (1951-2011)

Résumé **-** *Cet article propose d'étudier l'évolution des hiérarchies urbaines et la nature de la croissance urbaine en Grèce entre 1951 et 2011, en s'appuyant sur une base de données de la Greek Statistical Autority. Trois séries de conclusions apparaissent : (i) lorsqu'on utilise une définition administrative des villes, les villes grecques convergent vers une taille moyenne ; (ii) lorsqu'on tient compte des effets d'agglomération, on constate également une convergence, mais le processus démarre plus tardivement, après les années 1980. Dans les deux cas de figure, l'importance d'Athènes décroît ; (iii) la crise économique depuis 2008 a fortement modifié les trajectoires urbaines précédentes.*

Mots-clés **-** CROISSANCE URBAINE, HIÉRARCHIES URBAINES, CRISE ÉCONOMIQUE, GRÈCE.