ITU A|Z • Vol 17 No 2 • July 2020 • 83-100

The application of the regional rank-size rule in Turkey (2000-2012)

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Received: January 2019 • Final Acceptance: December 2019

Abstract

During the last two decades, an extensive literature on the city-size dynamics of urban systems in developed and developing countries has been produced through the application of Zipf 's law. In this paper, first, the regional distribution of hierarchical city-size groups is investigated in Turkey. Following this, the regional application of the rank-size rule for 2000 and 2012 is examined, and the results are compared with those of the research carried out in 1975. An analysis of the regional dynamics of hierarchical city-size distributions illustrates that the higher out-migration rates from the under-developed regions of the east to the large cities in the west of the country do not allow the full development of city systems, which is important for economic development. In addition, they have caused over urbanization in the west, which has resulted in higher costs of living, traffic congestion and pollution. Therefore, it is suggested that a more balanced distribution of investments at the country level is required to provide a more balanced distribution of economic development and urbanization.

Keywords
City size distribution, Economic development, Turkey, Urbanization, Zipf 's Law.

doi: 10.5505/itujfa.2020.10327

1. Introduction

During the last two decades, an extensive literature on the city-size dynamics of urban systems in developed and developing countries has been produced through the application of Zipf's law. According to this law, the size distribution of cities shows a striking regularity which is evaluated as a balanced structure in the urban system of a given country. The present study attempts to apply Zipf's Law in Turkey between 2000 and 2012 to illustrate the results of globalization, privatization, large construction investments and relaxing of agricultural import restrictions which increased rural migration to large cities.

Power law claims proportional changes in two quantities and emphasizes a natural order within their function, as appeared in the Zipf's Law (1949) or the Pareto distribution. Newman (2005) listed studies that had analyzed power law on city size distribution, natural phenomenon, linguistics, social and economic issues. For instance, the distribution of earthquakes according to their magnitudes follows power law where the occurrence of large scale earthquakes is lower than the occurrence of lower scale earthquakes. Okuyama et al. (1999) studied the validity of power law in income distribution of Japanese companies. They noted that power law distribution is closely associated with the "competition mechanism". Furthermore, according to Newman's (2005) conclusions, the Yule process as "a rich-get-richer" also follows power law. These two interpretations on power law are noticeable in city size distribution. Cities which have initial advantages (historical background, location, policy oriented, etc.) are able to attract more people. The diversity of incomers supports the competitiveness of the cities among the others. "Leaders" of the arena gain a continuous progress in receiving more people, more investment and more capital, thus, they get "richer".

There are critical discussions on plausibility and shortfall of using Zipf's law to explain size distribution. Zipf's law has been criticized as it does not offer a theoretical foundation, rather it is an empirical law (Okuyama et al., 1999; Nam and Reilly, 2013). There are case studies on firm size distributions to examine the validity of Zipf's law. Kaizoji et al. (2006) compared the distribution of firms in the U.S.A. and Japan and reached to a conclusion that the distribution cannot be interpreted as "universal" because of the differences in the results of both samples. Some studies claim that distribution of firms perfectly fits Zipf's law (Okuyama et al., 1999; Zhang et al., 2009), some underline either large firms should not be considered in the system for a better fit (Gupta et al. 2007) or, oppositely, only large firms follow power law (Cirillo and Hüsler, 2009; Bee et al., 2017). There are also conditional confirmations of Zipf's law such as the presence of diversity of production (Bee et al., 2017), balance between newly establishes and closed businesses (Malevergne et al., 2013) and constant rate of growth (Reed, 2003). A latent feature of the Zipf's law has been highlighted in few studies: the size and the resolution of the sample. Large samples, usually work well in fitting Zipf's law (Reed, 2003; Segarra and Teruel, 2012), however, considering the irregularities at the lower tails (either firms or cities' distributions), minimum thresholds need attention. Nam and Reilly (2013) studied size distribution of cities in a grid system covering the world and observed that when small cities are included to the system, the Zipf's law does not hold true. Likewise, Ioannides and Skouras (2013) examined the city size distribution in the U.S.A. using cells. Their remark overlays with the former conclusion: only upper tail fits Zipf's law. The lower segment of size distribution of cities -or firms- is intricate. Even slight changes in population (by absolute numbers) may create a great shift considering the share of the absolute value in the city's population. Furthermore, inclusion of all elements in size distribution may cause noise and distortion in the illustration of the data set. Cristelli et al. (2012) emphasized the "sample coherence" in size distribution models prior to discuss on how and why some distributions hold power law.

The present study investigates the

rank-size distribution of cities with populations above 10,000 at the regional level referring the changing economic and urbanization conditions in Turkey. The lower population margin has been set according to the definition of city. Settlements below the population of 10,000 are not characterized as cities and some of them –at the lowest range- might be subjected to disappear due to new adjustments or negative circumstances. Regional evaluation of rank-size distribution for a given period might be deficient for a descriptive analysis, however, a longitudinal approach which enables to compare evolution of city size distribution might give an insight on the development process of the regions. The organization of the paper is as follows. In section 2, some examples of city size distribution at country and regional level are given. In section 3, the dynamics of the city system between 1945-1975 and 2000-2012 are explained, according to different city-size groups, through changes in the city-size distribution and rank order of cities, and the socio-economic and urbanization characteristics of the regions within Turkey. In section 4, the changes in the slopes of the regional rank-size distribution of cities between 2000 and 2012 are given and compared with the results of 1975. The final section is devoted to a conclusion and suggestions for further research.

2. City size distribution

Several empirical studies have demonstrated the prevalence of, and variations in, the characteristics of urban hierarchies in different regions and different countries through the application of Zipf's law (Brakman et al., 1999; Mu and Wang, 2006). Many of these studies have tested the relationship between variations in the rank size distributions of cities and the variables on urbanization and economic development (Jones and Lewis, 1990). According to Zipf's law, the size distribution of cities within a country, or even globally, shows a striking regularity if the slope (q) obtained by the regression of the logarithm of the city size and the logarithm of the city rank, is closed to (-)1 (Mu and Wang, 2006; Zipf, 1949). The formula of the rank-size model is expressed as:

$$\log P_i = \log C - q \log r_i$$

where:
Pi = population of the city i
ri = rank of the city i
C = a constant equal to the population of the city at the rank 1
q = slope coefficient

Although previous studies have mostly applied Zipf's law at the country level, there are a few studies in which it has been applied at the regional level, including that of Dökmeci (1986) in Turkey and Griesen and Südekum (2010) in Germany. According to the latter, Zipf's law allows not only an adequate analysis on Germany's national urban hierarchy, but is also applicable at regional scale. The present study investigates the evolution of urban systems through the application of Zipf's law to illustrate the impact of the transformation from an agricultural into an industrial or post-modern economy over time within the geographical regions of Turkey.

Brakman et al. (1999) examined the rank-size distribution of Dutch cities between 1600-1900. While the slope was lower (q=0.55) in 1600 due to the lack of connectivity among cities and the high transportation costs of the pre-industrial era, development through more integrated urban system and declining transportation costs following industrialization led to an increase (q=1.03) in the result for 1900. It decreased (q=0.72) again in 1990 due to the declining importance of industrial production and the greater importance of negative feedback, such as congestion.

There is also research that investigates the validity of Zipf's law as applied to the case of the United States at both the country and state levels, including that of Jiang and Jia (2011). Their investigation leads to the finding that Zipf's law holds up remarkably well for the entire country, but that it does not hold true for individual states. They noted that urban areas are "power law" distributed, but their Zipf value is considerably different from 1.0. Garmestani, Allen, Gallagher and

Mittelstaedt (2007) found that regional size distributions in the United States exhibited size-dependent growth rates. Utilizing time series data, they found that smaller cities grow more quickly than average whereas larger cities grow more slowly. In addition, Garmestani, Allen and Beasey (2008) illustrated the differences between two regions of the United States from 1860 to 1990. Their study showed that in the south-western region, despite a great shift in the number of cities, "the dominance of a few cities and the number of aggregations" remained constant over time. On the other hand, they noted that "the city-size distributions for the south-eastern region of the United States were discontinuous". Their findings show that city-size dynamics of each decadal period presented different hierarchical pattern among the cities in both regions of the United States. Another study by Bessey (2002) employed the rank-size model to analyze national and regional city-size data. The results revealed that there were departures from the Zipf prediction and increasing population concentrations in the largest cities of each region.

Overman and Ioannides (2001) studied the city size distribution in the United States regarding to their degrees of mobility. Their findings revealed that different regions have different degrees of intra-region distribution mobility. Additionally, second-tier cities in their study demonstrated more mobility than highest-tier cities. While the even distribution of cities in the United States has endured despite the fluctuation in the position of cities, some other nations, such as Australia, display horizontal segmentation, thus indicating that some cities are closer in size to each other than what is suggested by the rank-size rule. This is probably due to the level of intra-integration within these regions being higher than their inter-integration due to the long distances between them (Batten, 2001). Marshall (1997) applied the rank-size rule at the regional level in Canada (14 urban systems), France (9 urban systems), England and Wales (11 urban systems). According to his results, the rank-size rule still provides an accurate description of the facts in one third of urban systems. In some developed countries, such as Finland, the adjustment of city size distribution to Zipf's law was observed later than in others, depending on the speed of their industrialization and urbanization process. In Finland, Zipf's law did not hold true for the pre-war period but gradually became valid during the process of industrialization and urbanization. The estimated values of the Pareto coefficient rose consistently from a low of 0.55 to a high of 0.88 (Tervo, 2010). These results indicate that rank-size distribution allows a better characterization of sub-region size distributions for the post-war, rather than the pre-war period in Finland. These results are in line with the results of Tervo (2009), who showed that large and rapidly growing centers in Finland have produced "backwash effects on their hinterlands since the 1970s". Reed (2002) demonstrated an excellent fit to the rank-size distribution for human settlement formation using data from 4 regions (2 from Spain and 2 from the United States). According to King and Golledge (1978), intra-regional integration was stronger than inter-regional integration in the Soviet Union. In this case, the regional application of the rank-size rule fits better than its application at the country level. Kinoshita et al. (2008) showed that in post-Soviet Russia, the form of the city distribution was concave while during the Soviet era, it had been convex. Likewise, Iyer (2003) studied distribution of Russian cities between 1970 and 1999. She demonstrated differentiations of city size distribution in Western and Eastern Russia. According to this study, Western Russia is expected to continue to integrate contemporary system, whereas Eastern Russia would continue to show the style of Soviet-era urbanization. There have been studies on the application of the rank-size rule in developing countries. Primate city characteristics have been observed in developing countries, such as Peru, Argentina and Uruguay (Waugh, 2000) and Malaysia (Soo, 2007). There have been several studies that examined city dynamics in China. Ye and Xie (2011) investigated China's urban system

dynamics through an expanded version of Zipf's law at both the national and regional levels. They analyzed the rapid changes that have occurred in urban systems in China by employing Zipf's law across the country and in six macro regions. In addition, they examined the top ten city rank changes nationally and regionally, as well as their spatial impact on urban systems. Vapnarsky (1969) investigated six regions according to the rank-size rule. In Argentina, primacy is associated with integration to external systems -that is defined as low closure- and the rest of the cities follow the pattern of rank-size rule. The rank-size rule is fulfilled if the area under consideration has had a sufficiently high degree of internal inter-dependence. The only cases where the rank-size rule did not hold, were those in which the necessary conditions for internal interdependence had not yet been achieved. Dökmeci (1986) applied the rank-size rule between 1945-1975 at both country and regional levels in Turkey. The results of the study showed that the slope of the rank-size distribution of cities increased from 0.75 in 1945 to 0.90 in 1975 at the country level, largely due to growth of larger cities and investment in middle-size cities. Meanwhile, in the most developed region (Marmara), the slope decreased from 1.14 in 1945 to 1.0 in 1975. This shift was explained as due to the inner-city decentralization of the population which brought about a decrease in Istanbul's primacy. It was the period when the first bridge had been built to connect the two sides of Istanbul. Therefore, the new connection roads encouraged the expansion of the city through surrounding areas which would be called as "the second ring". However, in all the other regions, the slope slowly increased to fit the rank-size rule, although with some differences according to the degree of regional development. For the period between 1980 and 2000, Türk and Dökmeci (2001) reported a better adaption of the city system to the rank-size rule at both the country and regional level in Turkey. In a more recent study, Zeyneloğlu, Kundak and Dökmeci (2005) revealed a perfect adjustment of the urban system to the rank-size distribution of Turkish cities due to the balanced decentralization of industry in middle-size cities at the country level. Nam and Reilly (2013) revealed that the city-size distribution of a region can show variations that would be explained by the emerging socio-economic conditions in different periods. This statement also refers convergence or divergence of regional system in a country. Yet there have been disparities among regions, homogeneity in basic investments is expected to settle for a more balanced development not only at regional level, but also at country level.

3. The dynamics of urban systems in Turkey and regional socio-economic characteristics

Since the 1950s, Turkey has experienced intense migration from rural to urban areas. This has led to an urbanization process due to the transformation of the economy from agricultural to industrial, which has had a strong impact on the urban systems. The application of the rank-size rule to the period between 1945 and 1975 reveals that the slope increased from 0.75 to 0.90 while the primacy of Istanbul decreased due to increasing urbanization at the country level (Dökmeci, 1986). This rapid urbanization continued after the 1980s due to the impact of the post-modern economy and an increase in the number of service jobs such as banking, trade, real estate, architecture and engineering, education, accounting, law, advertising and tourism (Dökmeci and Berköz, 1994). The closure or privatization of factories in rural areas, together with the application of a free trade policy to import agricultural products, has continuously stimulated the migration of agricultural workers to the cities. In addition, metropolitan areas (which are more open to international trade) tend to grow faster than others (Duran and Özkan, 2015). Further, in 2000, the slope reached 1.0 as a result of the increase of middle-size cities (Zeyneloğlu et al., 2005) and the decentralization of industry (Özcan, 2000). After 2000, the primacy of Istanbul started to increase once more (Figure 1). This had been previously

suggested by Lyman (1992), and was due to the impact of a free trade policy and globalization. The trans-nationalization of production, the manufacture of global products stimulated the growth of primate cities, as has occurred in other developing countries (Clark, 1998; Dicken, 1992). Although urbanization depends on the growth of the industrial and service sectors, the level of agricultural employment (33.9%) was still higher than that of industrial employment (17.3%) and service employment (22.7%) at the national level in Turkey (TurkStat, "Population Census", 2003).

With respect to the socio-economic characteristics of the regions, the Marmara region was more industrialized (31%) and had more services (28.2%) than the other regions in 2003 (Table 1), and its urbanization rate was also the highest (79%) in 2000 (Table 2). The Aegean region was the second most industrialized region (17.2%) and was fourth with respect to services (21.0%) in 2003, while its urbanization rate was fourth (61.4%) in 2000. In 2003, in the Central Anatolia region, industrial employment was the fourth largest (15.3%), its service employment level was the third largest (25.1%) and its urbanization rate was the second largest (69.2%) in 2000. The Mediterranean region was the fifth highest (12.1%) with respect to industrial employment, it had the second largest service employment rate (27.6%) and its urbanization rate was the fifth largest (59.7%) in 2000. A large amount of investment in tourism played an important role for the development of the service sector in this region. The South-East Anatolia region was the third largest with respect to industrial employment (16.9%) and urbanization (62%), it had the fifth largest service employment level (17.6%). The East Anatolia and Black Sea regions were much less developed and had lower urbanization rates (53% and 49%, respectively) than the other regions, due to the lack of necessary industrial investment and their large amount of out-migration (Yazgi et al., 2014).

Economic transformation and human mobility have been shown to affect the level of urbanization and the distribution of city size groups (Table 3 and Table 4). While there was a rapid increase in the number of cities from 325 in 1975 to 458 in 2000, their number decreased to 417 in 2012. This was largely due to a reduction in the number of small cities and the increased populations of the large cities. The number of small cities with populations between 10,000-50,000 decreased from 335 to 262, in 2000 and 2012 respectively. While 12.5% of this decrease was due to the dropping of their population below 10,000, the rest was the result of their inclusion in the larger city size group due to their population increases. Meanwhile, the number of cities between 50,000-100,000 increased from 68 to 77. Increases in production and trade played an important role in this growth. In addition, the cities between 100,000 and 500,000 also had a dynamic nature and their number increased from 43 to 62, which is a result of the partial decentralization of industry from the large cities and the improvement of educational and health facilities in addition to greater economic development. Meanwhile, the number of cities between 500,000 and 1,000,000 remained stable although their populations increased. Moreover, the increase in the number of cities above 1,000,000 from 5 to 9 was the highest. The implementation of a free trade policy and

Table 1. *The Ratio of Industrial, Service and Agricultural Employment Distribution According to Regions in Turkey (1990-2003) (TurkStat, 1990; TurkStat, 2003).*

	Agriculture (%)		Industry (%)		Services (%)		Others (%)	
Regions	1990	2003	1990	2003	1990	2003	1990	2003
Marmara	18.9	14.2	33.6	31.0	17.4	28.2	20.1	26.6
Aegean	54.1	37.9	12.5	17.2	10.2	21.0	23.2	23.9
Central A.	50.5	21.3	10.2	15.3	10.6	25.1	28.7	38.3
Mediterranean	57.3	33.8	9.6	12.1	10.0	27.6	23.2	26.5
South-East A.	67.3	43.7	5.9	16.9	6.4	17.6	20.4	21.8
East A.	71.9	53.2	3.5	3.8	4.3	16.9	20.3	26.1
Black Sea	71.1	61.1	6.2	7.3	5.5	13.8	17.2	17.8
Turkey (total)	53.7	33.9	11.9	17.3	10.2	22.7	24.2	26.1

Table 2. *Regional Urbanization Ratios in 1990 and 2000 (%) (TurkStat, 1990; TurkStat, 2000).*

Regions	1990	2000
Marmara	77.8	79.0
Aegean	57.8	61.4
Central Anatolia	64.6	69.2
Mediterranean	57.6	59.7
South-East Anatolia	55.3	62.0
East Anatolia	42.7	53.0
Black Sea	41.2	49.0

Table 3. *The Number of Different Size Cities in the Regions of Turkey in 2000 (TurkStat, 2000).*

	Marmara	Aegean	Central A.	Mediterranean	South-East A.	East A.	Black Sea	TOTAL
1,000,000+	2	1	1	1	-	-	-	5
500,000-1,000,000	1	-	2	2	2	-	-	7
100,000-500,000	6	6	6	7	5	6	7	43
50,000-100,000	5	8	10	10	11	12	12	68
10,000-50,000	49	48	66	33	20	51	68	335
TOTAL	63	63	85	53	38	69	87	458

Table 4. *The Number of Different Size Cities in the Regions of Turkey in 2012 (TurkStat, 2012).*

	Marmara	Aegean	Central A.	Mediterranean	South-East A.	East A.	Black Sea	TOTAL
1,000,000+	3	1	2	2	1	-	-	9
500,000-1,000,000	-	-	2	2	2	-	1	7
100,000-500,000	13	9	9	8	7	6	10	62
50,000-100,000	14	13	6	12	10	12	10	77
10,000-50,000	42	36	43	29	23	35	54	262
TOTAL	72	59	62	53	43	53	75	417

Table 5. *q and R^2 values for 2000 and 2012 according to Regions.*

Regions	2000		2012	
	q	R^2	q	R^2
Marmara	1.63	0.96	1.66	0.96
Aegean	1.27	0.97	1.32	0.97
Central Anatolia	1.27	0.97	1.32	0.97
Mediterranean	1.18	0.98	1.27	0.98
South-East Anatolia	1.14	0.95	1.30	0.97
East Anatolia	0.88	0.97	0.92	0.93
Black Sea	0.80	0.96	0.89	0.96

Table 6. *Energy consumption (MWh) (million) in 2000 according to regions (TurkStat, 2000).*

Regions	Total	Industry	Trade/Services	Housing	Others
Marmara	38.09	22.02	3.88	8.61	1.72
Aegean	15.85	8.41	1.54	3.27	1.26
Central Anatolia	13.14	5.61	1.35	3.59	1.40
Mediterranean	12.67	6.39	1.59	2.78	1.01
South-East Anatolia	6.08	2.60	0.26	1.18	1.42
East Anatolia	3.00	0.98	0.16	0.85	0.44
Black Sea	8.33	4.19	0.53	2.36	0.57

Table 7. *Energy consumption (MWh) (million) in 2012 according to regions (TurkStat. 2012).*

Regions	Total	Industry	Trade/Services	Housing	Others
Marmara	74.22	38.93	13.56	16.03	1.25
Aegean	31.44	15.56	4.79	7.27	1.44
Central Anatolia	26.97	9.96	4.66	6.77	2.27
Mediterranean	28.33	13.95	4.63	6.39	1.13
South-East Anatolia	12.99	5.51	1.41	2.85	1.23
East Anatolia	5.70	1.30	0.72	1.83	0.38
Black Sea	15.27	7.08	2.05	4.24	0.73

globalization affected the continuous attraction of the large cities, which contributed to their socio-economic development and urban restructuring, but which also increased in their levels of pollution and traffic congestion (Arnott and Small, 1994).

One striking feature of the Turkish urban system is that Istanbul was not as dominant between 1975 and 2000 as the largest cities of other developing countries (Zeyneloğlu and Dökmeci, 2010). For instance, Jakarta was over 3 times as large as Surabaya, and Bangkok was over 21 times larger than its nearest rival. After the 2000s, the primacy of Istanbul started to increase again because of the relaxation of construction regulations to build high rise offices and residences in answer to the pressures of population growth brought about by the post-modern economy and high level of in-migration. This haphazard development of the city caused tremendous traffic congestion despite large investments in transportation infrastructure. The management of large cities is very expensive and requires high levels of technology, much of which is beyond the financial and technological capacity of developing countries. For them, it is crucial to spend their limited budgets on education to create new jobs rather than on the infrastructure and operation of large cities.

The distribution of city sizes according to their regions shows new hierarchical pattern due to trade, lower transportation costs or physical changes of cities (Rosser, 1994). In addition, their growth pattern depends on the economic characteristics of these regions and their locations, which is explained in the following section.

4. Regional rank-size distribution of cities in Turkey

Empirical studies have indicated the ubiquity of changes in the characteristics of urban hierarchies in different regions (Jones, 1990). In the Marmara region, while the number of cities with populations above 10,000 increased from 63 to 72 between the years 2000 and 2012, at all levels, except the number of small cities, which decreased from 49 to 42, in common with the

trend during this particular development level (Table 3 and Table 4). The rank-size distributions of the cities within the Marmara region are given for the years 2000 and 2012, in Figure 1. While the slope was 1.14 and r^2=0.82 in 1975 (Dökmeci, 1986), it became 1.63 and r^2=0.96 in 2000 and 1.66 and r^2=0.96 in 2012 (Table 5). Thus, the primacy of Istanbul increased during this period since it was the hub for the increasing number of international interactions. If the entries of Istanbul, Bursa and Kocaeli are removed, the slope of the rank-size distribution of cities in 2000 would fit well to Zipf's law. However, it became convex in 2012 due to the over development of the major cities as a result of a free trade policy (Duran and Özkan, 2015), increasing globalization and immigrants from their periphery as well from the rest of the country (Koramaz and Dökmeci, 2016). Sharma (2003) suggests that cities display a long-term growth rate which are due to great shifts in the growth trends in the short term. Congestion, overcrowding, and declining opportunities can begin to have an effect on city growth, which then begins to slow down. Likewise, the continuous population increase of Istanbul, as well as the cities in Marmara region, might be taken as a warning sign for the near future. On the other hand, even though the dominance of Marmara region still exists on population, employment rate and energy consumption etc., the rest of the country shows slight changes at country level, but great shifts at the regional level (Table 6-7-8-9).

The Aegean region had 63 cities with populations above 10,000 in 2000. This had dropped to 59 cities by 2012 (Table 3 and Table 4). The reason for this decline is the reduction of the number of small cities from 48 to 36, despite the population growth of middle size cities. Meanwhile, the ranking of the major cities stayed stable. While the slope of the rank-size distribution of cities was 0.92 and R^2=0.96 in 1975 (Dökmeci, 1986), it increased to 1.27 and R^2=0.97 in 2000 and 1.32 and R^2=0.97 in 2012 (Table 5 and Figure 2). Izmir is a primary city in the west of the country as it is a port for Anatolian exports, a major transportation hub and tourism center (Önder et al., 2012) with associated industrial clusters (Eraydın and Armatlı-Köroğlu, 2007), trade and in-migration (Koramaz and Dökmeci, 2016). If the result for Izmir is removed, the rest of the distribution of the city sizes fits well to Zipf's law in 2000. The form of the city distribution became convex in 2012 due to the impact of globalization which supported vertical linkages between higher and lower centers at the expense of horizontal linkages between lower order places, and thus led to population growth within large cities. Furthermore, in the twelve year period, Aegean region kept the second largest exporter position with a percentage of 11, whereas Marmara region has led with 73% in 2002 and 68% in 2012 (Table 9).

The Central Anatolia region had 85 cities with populations above 10,000 in 2000. This had dropped to 62 by 2012 (Table 3 and Table 4), mainly as the result of decrease in the number of small cities from 66 to 43, whereas the number of large and middle-size cities increased. Location within the city systems and the development of transportation played an important role for the mobility of small cities either toward the upper levels of the urban hierarchy or to the category of those with populations below 10,000 due to out-migration (Zeyneloğlu and Dökmeci, 2010). While the slope of the rank-size distri-

Table 8. *Percentage of change in energy consumption between 2000 and 2012.*

Regions	Total	Industry	Trade/Services	Housing	Others
Marmara	94.85	76.77	249.27	86.13	-27.07
Aegean	98.42	85.02	212.09	122.60	13.81
Central Anatolia	105.21	77.58	245.87	88.56	62.53
Mediterranean	123.61	118.16	190.88	130.37	11.93
South-East Anatolia	113.79	112.20	441.78	142.10	-13.04
East Anatolia	89.90	32.46	340.03	115.00	-12.95
Black Sea	83.25	69.09	288.20	79.74	28.75

Table 9. *Export (1,000 USD) for the years 2002 and 2010 according to regions (TurkStat 2002 and TurkStat 2012).*

Regions	2002	2010	Change (%)
Marmara	26.642.212	103.734.901	289,36
Aegean	4.111.475	17.065.440	315,07
Central Anatolia	2.252.989	11.734.335	420,83
Mediterranean	1.483.189	7.432.222	401,10
South-East Anatolia	737.394	7.314.340	891,92
East Anatolia	85.227	1.662.773	1850,99
Black Sea	735.693	3.513.990	377,64

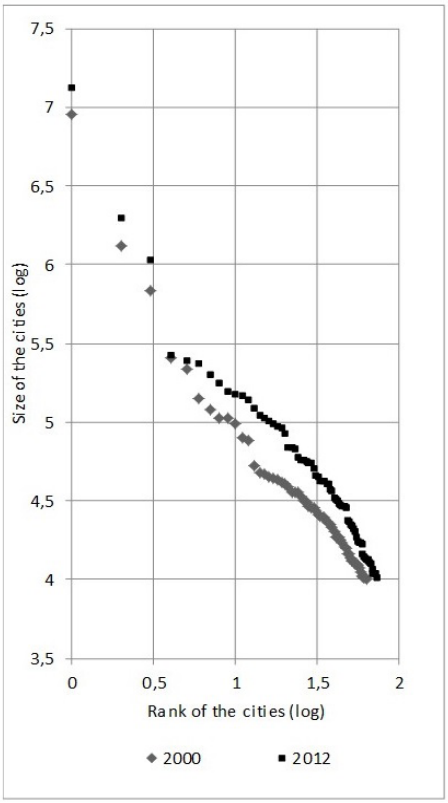

Figure 1. *City size distribution in the Marmara Region in 2000 and 2012.*

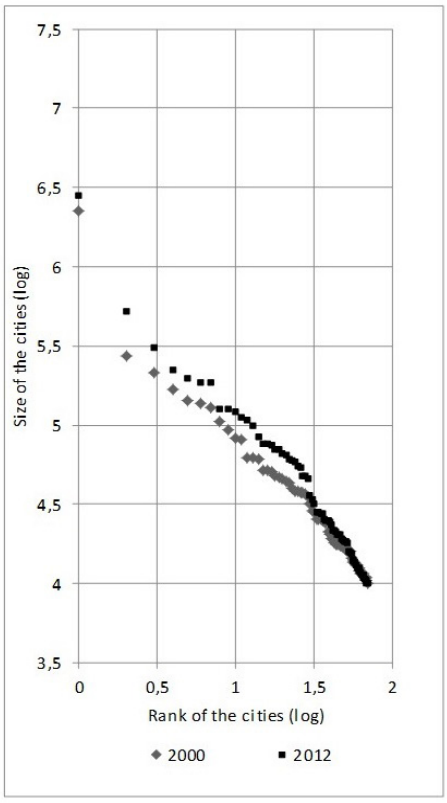

Figure 2. *City size distribution in the Aegean Region in 2000 and 2012.*

bution of cities was 1.09 and R^2= 0.98 in 1975 (Dökmeci, 1986), it increased to 1.27 and R^2=0.97 in 2000 and to 1.32 and R^2=0.97 in 2012 (Table 5 and Figure 3). Ankara is the primary city of the region; it supplies a large amount of service jobs due to its being the capital of the country and it is having high quality educational facilities that attract migrants from all over the country. At the same time, the growth of the other major cities in the region (Konya, Kayseri (Özcan, 2000) and Eskişehir) is beyond the capacity of their sub-regions because of the impact of globalization on their increasing levels of exports which quadrupled between 2002 and 2012 (Table 9). Thus, they form a small convex step in the rank-size distribution of cities over both periods due to their 'backwash urbanization' at the expense of their surrounding provinces such as Çankırı, Kırşehir, Yozgat, Nevşehir and Niğde (Koramaz and Dökmeci, 2016), all which is parallel to the claims of Auty (1995).

The Mediterranean region had 53 cities with populations above 10,000 in both 2000 and 2012 (Table 3 and Table 4). Meanwhile, the reduction of the number of small cities from 33 to 29 was balanced by the increase of the number of larger ones. During this period, the ranking of the large cities was largely stable. While the slope of the rank-size distribution of cities was 1.18 and R^2=0.98 in 2000, it increased to 1.27 and R^2=0.98 (Table 5 and Figure 4). Despite large investments in tourism and growing tourism activities in Antalya (Erkuş-Öztürk, 2010), industrial investments in Adana and international port activities and tourism in Mersin and thus the attraction of a large number of young and old in-migrants from all over the country (Koramaz and Dökmeci, 2016), there is no primary city in this region although it was illustrated by previous studies that low-closure urban systems located on the shore line have primacy in Argentina (Vapnarsky, 1969). Nevertheless, the change of energy consumption (Table 6-7-8) and the increasing export rates (Table 9) in Mediterranean region enlighten the improvement of the region. There are also small convex steps on the rank-size distribution

of cities, thereby indicating that some cities are closer in size to each other than is suggested by the rank-size rule. This is due to the existence of more intra-integration of these sub-regions than their inter-integration due to the long distances between them along the Mediterranean shoreline.

The South-East Anatolia region had 38 cities with populations above 10,000 in 2000 and their number had increased to 43 by 2012 (Table 3 and Table 4), largely due to rapid population and urbanization growth and economic development in this region during this period. Many industrial (Özcan, 2000), residential (Alkay et al., 2015) and educational investments, and the construction of dams have resulted in this development. In fact, the industrial sector (Table 1) and urbanization ratios (Table 2) of this region were third in the country. Despite this fact, there is still a high level of out-migration from young people to the more developed western regions (Koramaz and Dökmeci, 2016; Var et al., 2014). On the other hand, data on energy consumption and export rates give some insights for the future. For instance, a dramatic increase in the energy consumption in trade and services might be considered as a rapid development of the tertiary sector in South-East Anatolia (Table 6-7-8). Furthermore, export rates of the region grew approximately 9 times from the year 2002 to 2012, while the country average was an increase of three times for the same period (Table 9). The slope of the rank-size distribution of cities was 1.14 and R^2=0.95 in 2000 and this increased to 1.30 and R^2=0.97 in 2012 (Table 5 and Figure 5). There were small, convex steps on the distribution of the cities due to a lack of necessary interaction among the provinces that stem from the cultural differences in this region. Although there were no cities with populations above 1,000,000 in 2000, there was one in 2012. At the same time, the number of cities in the other groups increased as well. Thus, the distribution of the number of cities among the different size groups became quite balanced. Meanwhile, the rank of the large cities stayed stable.

The East Anatolia Region had 69 cities with populations above 10,000 in

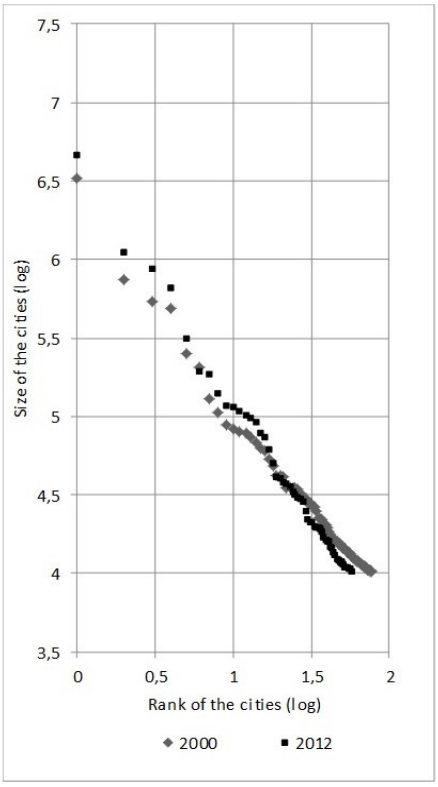

Figure 3. *City size distribution in the Central Anatolia Region in 2000 and 2012.*

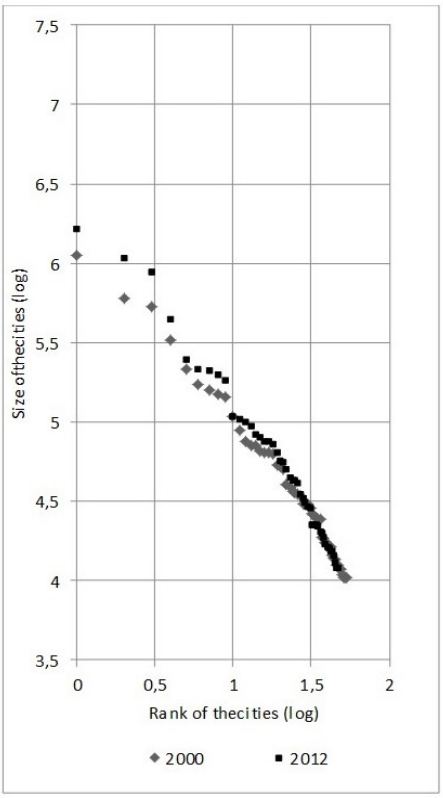

Figure 4. *City size distribution in the Mediterranean Region in 2000 and 2012.*

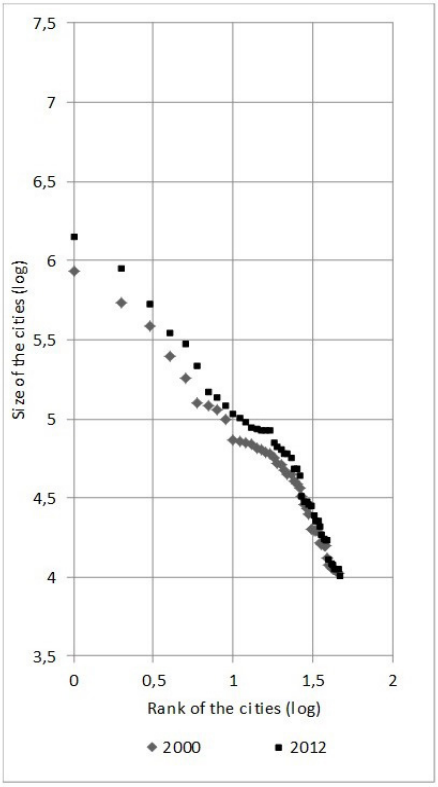

Figure 5. *City size distribution in the South-East Anatolia Region in 2000 and 2012.*

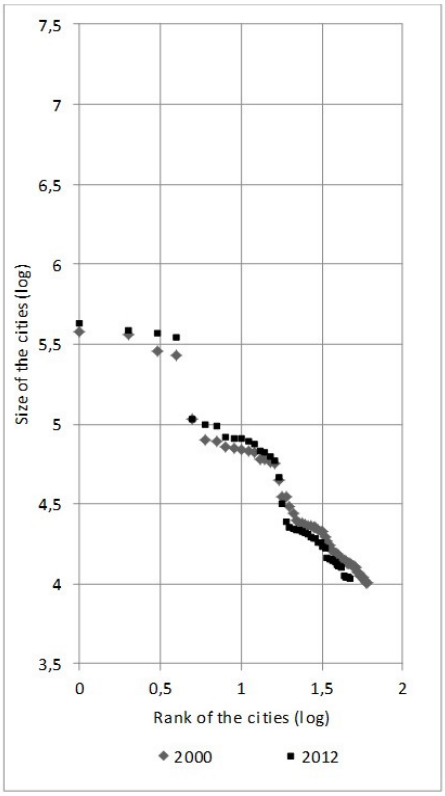

Figure 6. *City size distribution in the East Anatolia Region in 2000 and 2012.*

2000 and this had fallen to 53 by 2012 (Table 3 and Table 4), especially due to a decrease in the number of small cities from 51 to 35. This was a result of high levels of migration to the industrially more developed areas in the west of the country and the high unemployment rate of the East Anatolia region. The industrialization rate (3.8%) was the lowest, the service sector rate (16.9%) (Table 1) and the urbanization rate (53%) (Table 2) were the second lowest in the country. There were no large cities and the number of middle size cities stayed stable over this period. The slope of the rank-size distribution of cities was 0.88 and R^2=0.97 in 2000 and it increased to 0.92 and R^2= 0.93 in 2012 (Table 5 and Figure 6). The pattern of the slope consists of three clusters of cities which are separated from one another by mountains and which are semi-independent. According to Harris (1970), if a region consists of isolated sub-regions, their size distribution would lead to a step-wise curve as observed in the data on East Anatolia. As shown in the Figure 6, there are noticeable patterns in each step. While the slope approaches to zero at the upper group, the rank-size distribution at the lower group tends to reach to a better fit. The interruption of economic integration due to a challenging topography, the lack of investment and limited arable land have caused the economic decline of the region and have led to continuous out-migration (Yazgı et al., 2014). An explanation of the growth pattern of city system under such limiting conditions is given in an empiric model by Bura et al. (1996). Despite geographical disadvantages, East Anatolia region showed great shifts in energy consumption in trade and services between 2000 and 2012 (Table 6-7-8) and export rates between 2002 and 2012 (Table 9). Even though the economic competence of the region is still low, the development momentum is higher than the country's average.

The Black Sea region had 87 cities with populations above 10,000 in 2000. This had decreased to 75 by 2012, mainly due to a reduction in the number of small cities from 68 to 54 during this period. This region had the second lowest industrialization rate (7.3%), the

lowest service sector rate (13.8%) (Table 1) and the lowest urbanization rate (49%) across the entire country (Table 2). Although there were no cities with populations of more than 500,000 in this region in 2000, the population of Samsun reached 510,678 in 2012. Since there are mountains that run parallel to the sea shore, they do not allow large hinterlands to support the growth of the cities in this region except in the case of Samsun. The slope of the rank-size distribution of cities was 0.80 and R^2=0.96 in 2000 and it increased to 0.89 and R^2= 0.96 in 2012 (Table 5 and Figure 7). During both years, the city size distribution had small convex steps due to the difficulty of the spatial integration of the settlements which extend along the shoreline of the Black Sea. If there are barriers against spatial integration, according to Fujita et al. (1999), there will be a more uneven distribution of city sizes (smaller Pareto exponent); the smaller the share of manufacturing in the economy – the lower the share of international trade in the economy. This has occurred in the Black Sea region of Turkey. Despite the positive figures represented in energy consumption (Table 6-7-8) and export rates (Table 9), likewise East Anatolian Region, the progress of the region remains limited once comparing to the national averages. These results are within the scope of the concept set out by Pickett et al. (1997). In this, variables such as wealth, education, status, property and power, distributed inequitably and expressed at different spatial and temporal scales alter the hierarchical structuring of urban systems.

Thus, although Griesen and Südekum (2010) have shown that city distributions within economically meaningful regions exhibit a strikingly linear rank-size relationship in Germany, in Turkey, either the slope is above what is suggested by the rank-size rule, as in the more developed regions in the west of the country, or is under the regular slope as in the economically backward eastern regions (Figure 8). It is therefore possible to state that the unbalanced distribution of econom-

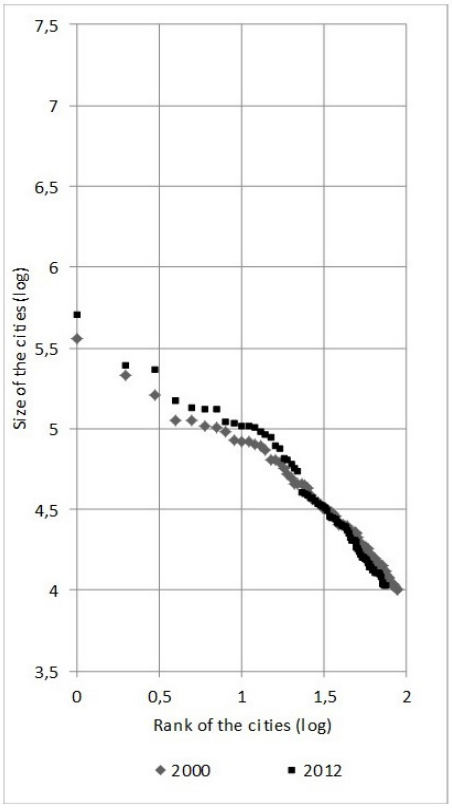

Figure 7. *City size distribution in the Black Sea Region in 2000 and 2012.*

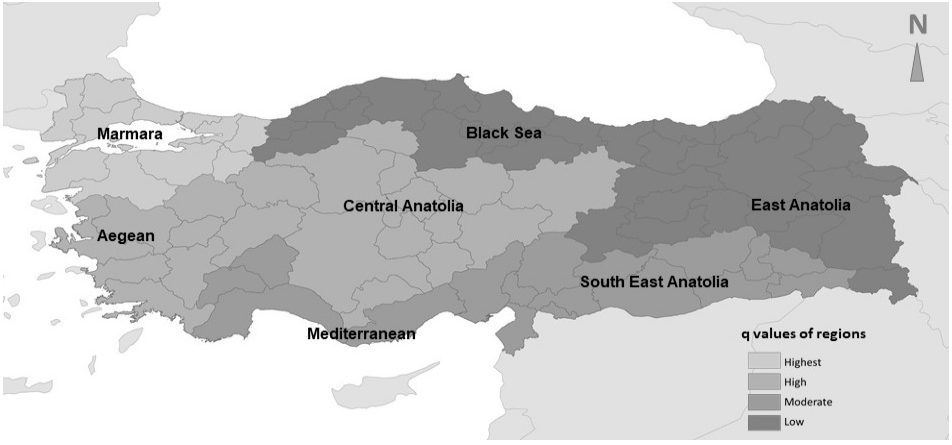

Figure 8. *q values of regions.*

ic development at the country level in Turkey is the primary reason for this difference. Meanwhile, the results of the study were parallel to the results of Bessey (2002) in that there were departures from Zipf's prediction and increasing population concentrations in the largest cities in most of the regions. Moreover, mountainous areas, and those regions that are spread along the sea shores, consisted of interrupted sub-regions which have lower than rank-size rule slopes and step-wise convex city distributions. In other words, the presence of 'steps' in the rank-size curve indicates strong barriers between sub-regions, which puts limits on the further growth of regional centers in the East Anatolia and the Black Sea regions, or cultural differences that act as similar barriers to growth in the South-East Anatolia region. This trend has long been observed in other locations (Johnson, 1980). On the other hand, other regions that are well-integrated and which have good national and international connections have higher slopes than the rank-size rule requirement. The new economic order of post-modernism and telecommunication systems are principally responsible for the recent rapid urbanization of the periphery (Timberlake, 1987). Finally, it is important to notice that in all the regions, urbanization and the slopes of city distributions are increasing at the expense of quality-of-life in the larger cities due to the pressures caused by over-population.

5. Conclusion

Turkey has urbanized since 1950; this has occurred as a consequence of a new economic order resulting from the organization of production, labor, finance, service provision and rural migration. Much production has shifted from the developed to the developing world, both as a means of penetrating local markets and to allow the use of cheap labor in the manufacture of goods for the global market. Thus, new local and international production investments have altered urban systems by providing the potential for new jobs and stimulating inter-regional migration.

The objective of this paper is twofold: first, to investigate changes in the city-size groups according to the geographical regions in Turkey between 2000 and 2012; and, secondly, to illustrate the regional rank-size distribution of cities for the same years and to compare the results with those of 1975. Urbanization increased from 40% in 1950 to 76% in 2012 at the country level; this is comparable to the results from other developing countries such as Venezuela, Uruguay, Chile and Argentina, in which more than 80% of the population live in towns and cities (Clark, 1998). However, in Turkey the level of urbanization occurs over a wide spectrum that ranges from 79% in the Marmara region to 49 % in the Black Sea region. This difference is the result of the poor distribution of industry, which varies from 31.0 % in the Marmara region to 3.8% in the East Anatolia region, and also of the service sector which varies from 28.2 % in the Marmara region to 13.8% in the Black Sea region. This wide gap between the east and the west of the country with respect to urbanization and development is also reflected in the distribution of different size cities within the regional city systems.

Between the years 2000 and 2012, while the number of large and middle-size cities increased in the regions located in the west, the number of small cities decreased at the country level due to the transformation of an agricultural economy into an industrial and a service economy and the associated continuous migration from the economically backward regions from the east to the developed areas in the west. In the Marmara region, the slope of the rank-size distribution of cities has continued to increase above what is suggested by the rank-size rule. Istanbul was dominant not only in the Marmara region but also in the country with respect to industry, services and international relationships. The apparent growth of Kocaeli and Bursa can also be observed on the slope line from the rest of the cities in the region due to the decentralization of industry from Istanbul and foreign investments in these cities.

During the same period, in the Aegean region, the slope of the city-size

distribution was also higher than rank-size rule suggested. However, if the primacy of Izmir was removed from the results, the slope of the rest of the cities perfectly fitted to the rank-size rule law. Similarly, in the Central Anatolia region, the slope of the city size distribution increased due to high population growth of Ankara (the capital) and the industrial and population growth of the major cities as a result of globalization. In addition, in the Mediterranean region, the slope of the distribution of city-sizes increased between 2000 and 2012. Despite large tourism investments in Antalya, industrial investments in Adana and the expansion of port facilities in Mersin, there is no primary city in this region, but the results of this study reveal small convex steps due to the lower spatial integration of cities which are taking place along the Mediterranean shoreline.

In the South-East Anatolia region, a rapid population and urbanization growth was observed at all levels of the city hierarchy due to large agricultural, industrial and infrastructure investments. During this period, the slope of the city-size distribution line increased above what is suggested by the rank-size rule. In the East Anatolia region, despite the high migration rate, the slope of the distribution of city sizes increased, but it was still lower than rank-size rule requirement. Meanwhile, the pattern of the slope line consisted of three clusters of cities which are separated by mountains and are therefore made semi-independent with respect to their inter-city relationships. In the Black Sea region, there are mountains which run parallel to the sea shore line and which do not allow the development of large hinterlands to support the growth of cities except in the case of Samsun. Although the slope of the rank-size distribution of cities increased, it was still below the rank-size rule requirement.

Thus, between 2000 and 2012, the number of cities decreased everywhere except the Marmara region (only the number of small cities decreased), the Mediterranean region and the South-East Anatolia region. In all the regions, the slopes of the city size distribution increased above the rank-size rule requirement except in the cases of the East Anatolia region and the Black Sea region. This was due to the lack of sufficient investment, high out-migration rates and the topographic limitations in these regions. It is also apparent that despite differing developmental histories, the regional urban systems in the Marmara, Aegean, Central Anatolia and South-East Anatolia regions concentrate their populations in the largest cities. This can be stated to be a result of the connectivity of cities through the global economic system and the slope of the rank-size distribution of cities continues to increase above the rank-size rule. Heavy population concentrations in cities often produces higher living costs, traffic congestion, social and pollution problems which are difficult to solve financially and technologically, especially for developing countries. Therefore, it would be more efficient to provide balanced investments at the country level in order obtain more even rates of nationwide economic development and urbanization.

It would be interesting for future work to examine regional city-size distributions and urban growth processes in the other developing countries. Furthermore, investigation of the relationships between the hierarchy of cities and trade, the development of transportation network, migration between cities and the economic development of the provinces is also suggested for future work. According to indirect figures on economic development presented in the last section of this paper, in some cases, there is a gap between the city size distribution according to regions and the improvements at regional level. This contradiction is worthy to examine to see if the investments are enough to attract people back to the less developed regions of past times. The results of this study may prove to be useful for urban and regional planners, administrators, economists, geographers, demographers, investors and policy makers.

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