

A Regional Analysis of Rank-Size Rule in Haryana

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Abstract

Rank-Size rule is used to measure some primacy parameters at national and regional scale. The rank size rule depicts a harmonic progression of rules within the urban hierarchy such that if the population of the largest city is known, the population of all other cities can be derived from the cities of their rank. When the ranks of cities arranged in descending order with rank 1 given to the largest city are plotted against their population in a double logarithmic graph, a rank-size distribution of cities results. A rank-size distribution is expected to indicate political unity, economic development and an integrated urban system (Gregory and Urry, 1985).

Keywords: Rank-Size distribution, Size-Class, Pareto's Law.

Introduction

The spatial analysis is basically related with articulated and integrated system of settlements which promote potential access for people to the markets of different size as well as to wide variety of urban amenities (Tiwari). The towns situated within a spatial network of region work as growth foci / service centers and help in development by propelling the development impulses. Large towns and cities command large areas of hinter-land and small towns cover small areas as their trickle-down effect is minimum.

Towns are essentially settlements which provide services for their own population as well as for population of their hinter-land. They provide important economic, social and physical functions to the surrounding area such as administration, education, professional services. Banking, market facilities, employment opportunities and so on.

The existing Rank-Size rule describes the empirical relationship between a town's population and its ranking relative to other towns within an interacting geographical area. This regularity was first noted by Auerbach (1933) and later popularized by Zipf (1949).

Study Area

The study area covers state of Haryana located on North-Western side of Indian Union adjoining the capital of India, New Delhi. It is bounded by Himachal Pradesh in North-East, Uttar Pradesh and Delhi in the East, Rajasthan in the South and South-West, Punjab and Chandigarh in the North-West. The state has an area of 44212 sq. km. and urban population of 61.16 lac residing in 97 towns.

Objectives

To find out the applicability of Rank – Size rule in relation with population of towns of Haryana. In this research framework population size is tested to its rank.

Data Source And Methodology

The study is based on secondary data .Further to study rank-size distribution of towns in Haryana data about cities and their population in 2001 census year was required. For this purpose population of urban settlements for the census year 2001 was obtained. To examine the patterns of rank-size distribution in Haryana population data of cities of this census year was applied on the Law of Rank-Size rule.

This paper makes an attempt to find whether city-size distribution of Haryana fits in this pattern or not. It also tries to analyze the spatial distribution of towns in terms of rank-size. The analysis has been done in regional terms.

Application of Rank-Size Rule

The Rank-size rule is an empirical regularity found in the urban system of the many countries of the World. This regularity is more evident in many advanced countries which have an old urban tradition. According to this rule the population of a town is related with its rank in the form of Pareto’s Distribution (Aslam Mehmood). Two conflicting schools of thought have dominated the studies of city – size distribution. One of these “the law of primate city” which is associated with Mark Jefferson suggests a primate pattern of city – size distribution, where the entire settlement system is overshadowed by one settlement, which dominates the entire spectrum of region’s activities. Not only does this settlement stand out from the other settlements of the region but also blocks the emergence of other settlements of its size. In contrast to this sort of spatial structuring is the ‘Rank - Size’ suggested by G.K. Zipf (1949). The occurrence of Rank – Size or Primate City pattern has variously been related with differing levels of economic development. The Rank – Size rule is often related with large territories, a long tradition of urbanizations and a complex political and economic system. On the other hand small territories with a short tradition of urbanization and a simple political system are said to have a primate city pattern. In spite of their general appeal, this relationship cannot be regarded as universally applicable.

According to this rule the population of a town is related with its rank in the following form of PARETO’s distribution (Aslam Mahmood 1977).

$$P_r = KR^{-b} \text{-----(i)}$$

Where P_r is the population of town whose rank is ‘ R ’. K and b are the constants.

The above relationship gets transformed into the following linear form after taking the logarithm of both the sides.

$$Y = a - bX \text{----- (ii)}$$

Where, $Y = \log P_r$

$$X = \log R$$

And $a = \log K$

Appendix gives the population of Haryana's towns in 2001 with their ranks. These populations and their ranks have been converted into their logarithms and a regression line is fitted in the usual manner.

or $a = Y - bX$

$$\text{and } b = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum X^2 - \frac{(\sum X)^2}{n}}$$

$K = \text{Antilog of } a$

If in the above equation we put $R = 1, 2, 3, 4$ and 5 etc. we get estimated populations of cities ranking 1st, 2nd, 3rd etc. according to the Rank – Size rule. The actual population of a city is rarely exactly equal to the estimated population but maybe close to it, as no city system fits completely into a Rank – Size rule. The population of 2001 Census year of Haryana state is estimated according to the fitted Rank – Size relationship given in above equation.

Keeping in view the Rank – Size scale, we have calculated the population for towns of Haryana and seen that actual population of the town is different from expected calculated figures. The discrepancy between the calculated and actual population represents the degree of deviation from the Rank – Size rule.

DISCUSSION AND RESULTS

According to 2001 Census of India the urban structure of Haryana comprised of 97 towns and a population of 61,15,304 persons accounting to 29 per cent of urban population. The growth rate of Class – I towns was 58.33 per cent which was highest followed by Class – III (41.17 per cent) and Class – IV (6.66 per cent) whereas Class – II, V and VI towns registered a negative growth rate which was highest (- 50 per cent) in Class – VI category. It is necessary to mention here that Class – VI towns of Haryana are merely expanded villages which due to its natural population growth, is upgraded to higher class.

On the basis of task force study; Class – I towns have been classified as cities. Class – II & III towns as medium towns and Class – IV, V, VI towns as small towns because there is only one town in Class – VI category.

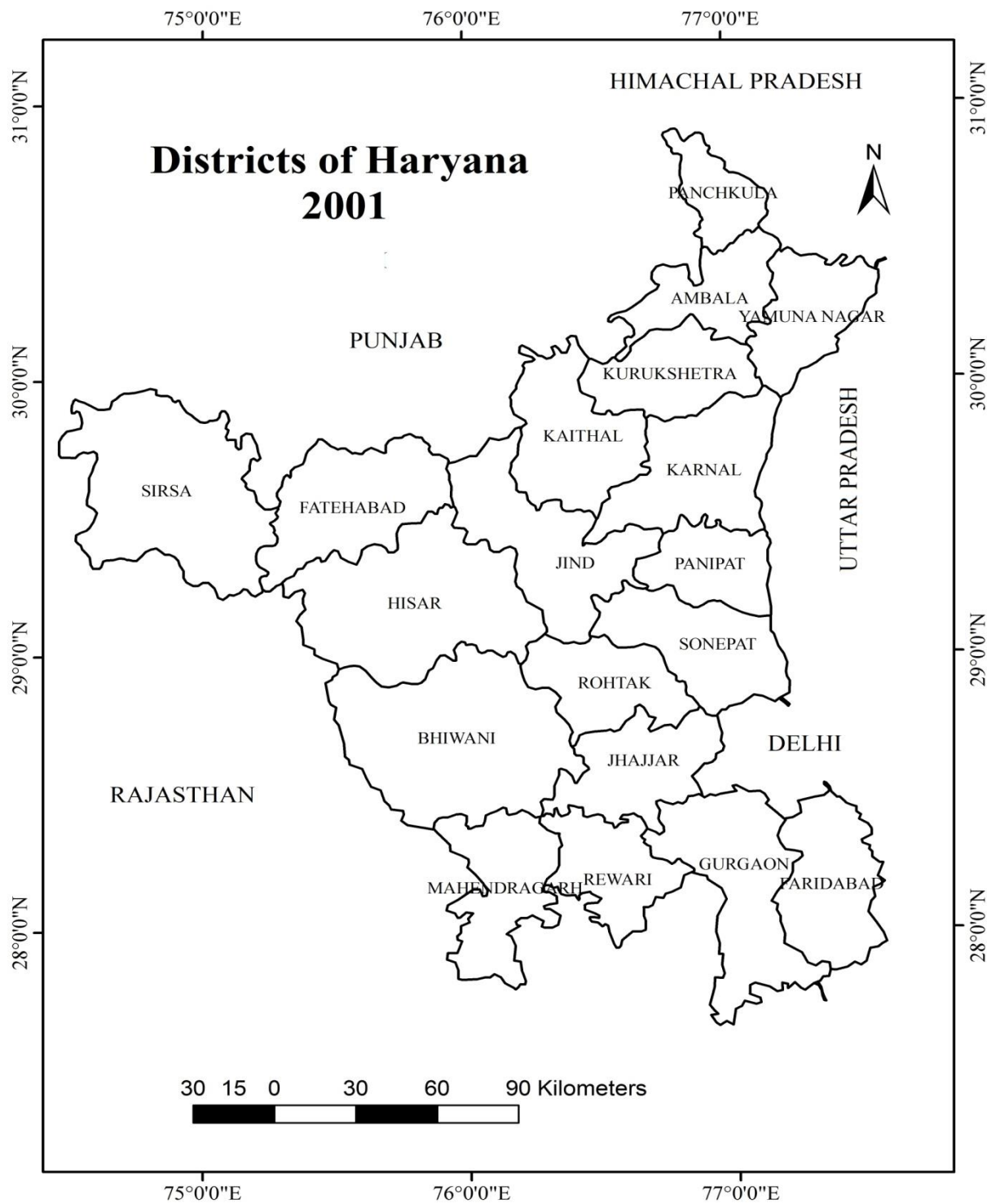
Table 1

Classification of Towns by Size - Class

Size – Class	Population	Category
I	1 Lakh and above	Cities
II	50,000 to 99,999	Medium Towns
III	20,000 to 49,999	
IV	10,000 to 19,999	Small Towns
V	5,000 to 9,999	
VI	Below 5,000	

The degree of urbanization in any country or region is one of the important measures of socio-economic progress. New innovations, technology, modern traits of life and new ideas grow in towns and from there they spread to country side. The degree and rate of diffusion of these traits determine the speed of transformation of region. The spatial pattern of urbanization is an expression of level of development in various areas with particular reference to industrialization and commercialization of agriculture. There are striking spatial variations in degree of urbanization over various parts of the state.

In Haryana; the districts along G.T. Road; like Karnal, Faridabad and Ambala are the most urbanized districts of the state. By comparison, the north part of Haryana, which are mainly market towns as centers of agro industry is only moderately urbanized. The central part of the state comprising the districts of *Bhiwani*, *Jind*, *Mahendergarh* and *Sonapat* is an area of low degree of urbanization consistent with its general economic backwardness.



The maximum proportion of population concentrated in cities, the proportionate share of population living in Class – IV, V, VI towns has been decreasing.

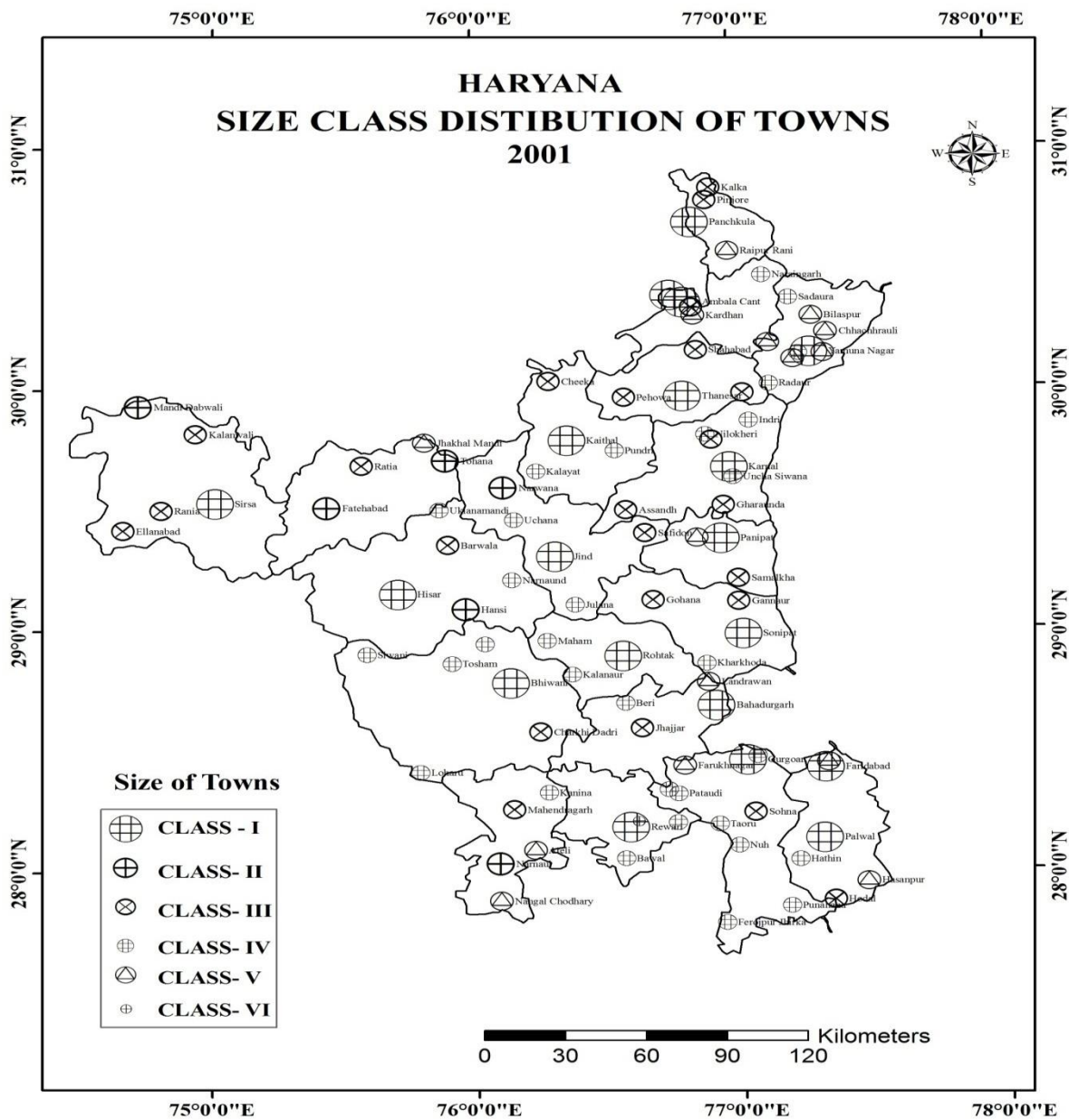


Fig. 1 Size – Class distribution of towns in Haryana (2001)

Census data reveals that there has been a remarkable growth in number and population of towns in India. The number of towns has increased from 1916 in 1901 to 5161 in 2001 and urban population from 2.59 million to 28.61 million in India. In Haryana also the number of towns and urban population has increased from 54 in 1901 to 97 in 2001 and urban population from 574074 persons to 6114139 persons. Only 12.42 per cent of population of Haryana was recorded as urban at 1901 Census which has risen to 29 per cent as per 2001 Census. In other words almost 3 out of every 10 persons in Haryana are staying in urban areas. This indicates that while the number of towns has almost doubled; population of such places has also increased by almost 16 per cent in last 100 years.

The log graph between actual and estimated population clearly indicates that rank size – rule does not apply. The following analysis also reveals that majority of towns have negative percentage difference which means all the towns are larger than their size. Another fact that has caught the attention is that the largest towns are showcasing lower actual size than the expected size.

Regional Divisions

The plain of Haryana has been divided into three physiographic areas depending on local topography. The regional analysis follows the three divisions of plain into Eastern, Western and Southern for the present analysis.

In Haryana in 2001 there were total 97 towns in which majority of towns showed negative population growth than estimated while 42 towns show positive population growth than estimated.

Rank – Size Relationship In Eastern Plain

In Haryana in 2001 out of total 97 towns 52 are located in Eastern Plain. Out of these 52 towns 27 towns show positive percentage difference while 25 towns show negative population difference percentage. Highest number of positive percentage population towns i.e. 9 occur in Class – V category surprisingly this category has no town with negative growth difference.

Table2: Rank - Size Relationship of Towns of Eastern Plain of Haryana (2001)

Name of Towns	Rank	Estimated Population	Actual Population	Difference	Difference%
Panipat	1.	1135795	354148	781647	68.82
Yamunanagar	2.	493117	306740	186377	37.80
Rohtak	3.	302684	294577	8107	2.68
Sonipat	4.	214092	225074	10982	-5.13
Karnal	5.	163663	221236	-57573	-35.18
Ambala	6.	131413	168316	-36903	-28.08
Panchkula	7.	109158	140925	-31767	-29.10
Ambala City	8.	92950	139279	-46329	-49.84
Jind	9.	80664	135855	-55191	-68.42
Bahadurgarh	10.	71056	131925	-60869	-85.66
Thanesar	11.	63354	122319	-58965	-93.07
Kaithal	12.	57054	117285	-60231	-105.57
Narwana	13.	51814	50435	1379	2.66
Gohana	14.	47392	48532	-1140	-2.41
Jhajjar	15.	43615	39002	4613	10.58
Shahbad	16.	40355	37289	3066	7.60
Pehowa	17.	37515	33564	3951	10.53
Cheeka	18.	35021	32128	2893	8.26
Kalka	19.	32814	30830	1984	6.05
Gharaunda	20.	30850	30172	678	2.20

Samalkha	21.	29090	29866	-776	-2.67
Pinjore	22.	27506	29609	-2103	-7.65
Gannaur	23.	26073	29006	-2933	-11.25
Safidon	24.	24771	27541	-2770	-11.18
Assandh	25.	23583	22707	876	3.71
Ladwa	26.	22496	22339	157	0.70
Taroari	27.	21496	22201	-705	-3.28
Babyal	28.	20576	21644	-1068	-5.19
Kharkhoda	29.	19725	18763	962	4.88
Naraingarh	30.	18936	18210	726	3.83
Meham	31.	18203	18174	29	0.16
Kalayat	32.	17521	17051	470	2.68
Pundri	33.	16884	17018	-134	-0.80
Kalanaur	34.	16288	16853	-565	-3.47
Nilokheri	35.	15729	16405	-676	-4.30
Beri	36.	15205	16162	-957	-6.30
Kanspur	37.	14711	14952	-241	-1.64
Indri	38.	14247	14511	-264	-1.86
Uchana	39.	13808	14111	-303	-2.19
Julana	40.	13394	13635	-241	-1.80
Sadhaura	41.	13001	13176	-175	-1.34
Radaur	42.	12630	11737	893	7.07
Uncha Siwana66713	43.	12277	10610	1667	13.58
Buria	44.	11942	9830	2112	17.69
Chauchrauli	45.	11623	9710	1913	16.46
Bilaspur	46.	11320	9621	1699	15.01
Kardhan	47.	11031	9579	1452	13.16
Faraukh Nagar1418	48.	10754	8740	2014	18.73
Mustafabad	49.	10491	8516	1975	18.82
Assan Khurd	50.	10239	8066	2173	21.22
Ladrawan	51.	9998	8008	1990	19.90
Raipur Rani	52.	9767	7031	2736	28.01

This trend gives the impression that the towns which show negative percentage difference (i.e. actual population greater than estimated population) are developing fast. The reason can be varied ranging from

Govt. policy to nearness to big town or city, or location on important transport route etc. Except some towns all other towns have shown very low difference which shows that Rank – Size application does not exist.

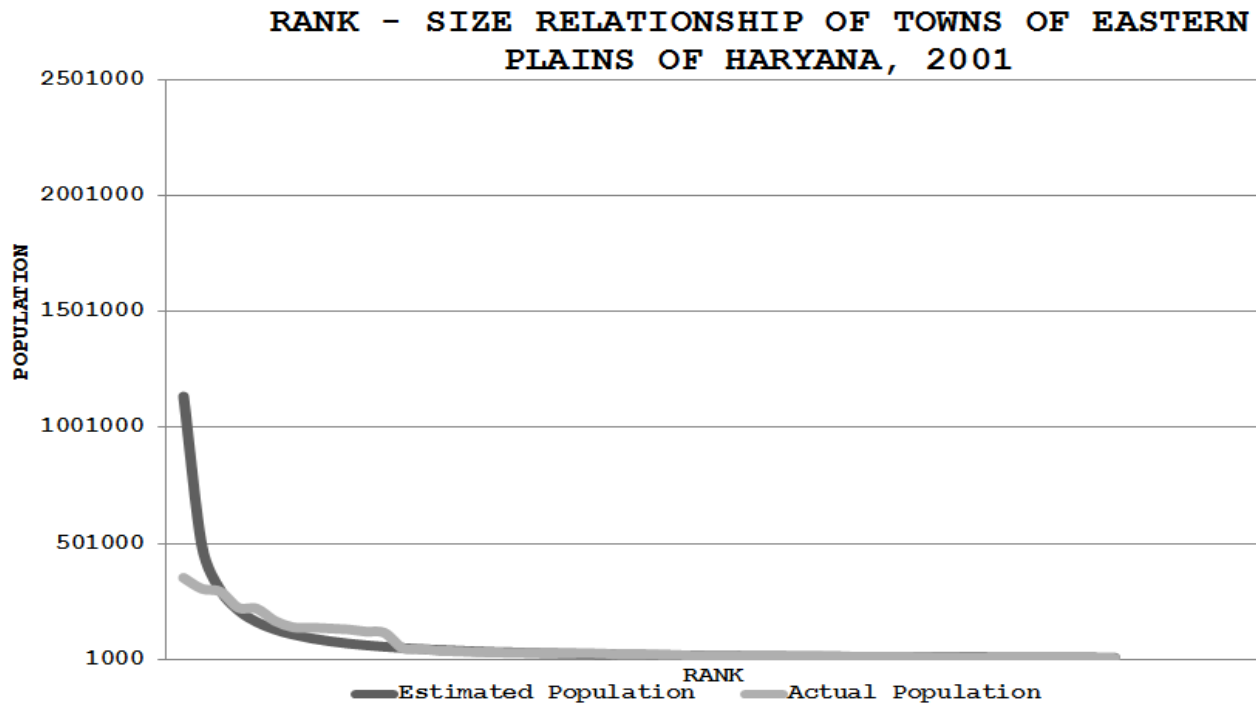


Figure.2 : Rank - Size Relationship of Towns of Eastern Plain of Haryana (2001)

Thus if on a log graph paper the population (P_r) of towns are plotted on Y – axis and their ranks (R) plotted on X – axis we will get a scatter diagram which closely form a straight line having a negative slope. If the actual and estimated population are plotted on the log paper some towns have both the points so close to each other that they seem to merge into one though as mentioned earlier, complete equality between the two points is a rarity.

Highly positive percentage growth difference i.e 68.82 per cent is in Panipat town and lowest i.e. 0.16 per cent is of Meham town.

Lowest negative percentage difference between estimated and actual population (-0.80) is in town Pundri. Highest negative percentage difference between estimated and actual population (-105.57) exists in Kaithal town.

In 2001 in Class – I category out of total 12 towns first 3 towns, namely Panipat, Yamunanagar, Rohtak, have shown higher estimated population than actual population. Rest of the 9 towns have lower population growth than the estimated population growth.

Medium Town Category

In Medium Town category i.e. Class – II and Class – III towns the only Class – II town, namely Narwana, has lower actual population than estimated population. Whereas in Class – III category out of 15 towns only 8 towns have lower population i.e. positive growth difference between estimated and actual population and these towns are Jhajjar, Pehowa, Cheeka, Kalka, Gharaunda, Assandh, Ladwa.

In Class – III category of towns Gohana, Samalkha, Pinjore, Gannaur, Safidon, Babiya, Taraori have negative growth difference i.e. more actual population than estimated population.

Small Town Category

In Class – IV category Kharkhoda, Naraingarh, Meham, Kalayat, Radaura and Uncha Siwana have more population than estimated which shows a positive percentage difference. Rest of the 9 towns have more actual population than estimated population resulting in negative population growth difference.

In Class – V category all towns have lower actual population than estimated population. Highest positive population percentage difference is in Raipur Rani i.e. 28.01 per cent while lowest positive percentage difference is 13.16 per cent which is of Kardhan town.

Rank – Size Relationship in Western Plain

Western Haryana Plain in 2001 comprised of 21 towns. It has 8 towns which have lower actual population than estimated population resulting in positive percentage difference in population while 12 towns have more actual population than estimated population thus showing negative percentage difference of population. One town, namely Fatehabad, has almost no difference (difference of only 1 person) between estimated population and actual population leading to 0 per cent difference between estimated and actual population.

Table3: Rank - Size Relationship of Towns of Western Plain of Haryana (2001)

Name of Towns	Rank	Estimated Population	Actual Population	Difference	Difference%
Hisar	1.	453941	263186	190755	42.02
Bhiwani	2.	189777	169531	20246	10.67
Sirsa	3.	113942	160735	-46793	-41.07
Hansi	4.	79339	75747	3592	4.53
Fatehabad	5.	59918	59917	1	0.00
Mandi Dabwali	6.	47635	53811	-6176	-12.96
Tohana	7.	39237	51519	-12282	-31.30
Charkhi Dadri	8.	33169	44895	-11726	-35.35
Barwala	9.	28600	33132	-4532	-15.84
Ellanabad	0.	25050	32795	-7745	-30.92
Kalanwali	1.	22219	25163	-2944	-13.25
Ratia	2.	23826	23826	-3911	-19.64
Rania	3.	18007	20961	-2954	-16.41
Bawani Khera	4.	16404	17424	-1020	-6.22
Siwani	5.	15040	15850	-810	-5.39
Narnaund	6.	13867	15116	-1249	-9.01
Loharu	7.	12848	11421	1427	11.11
Tosham	8.	11957	11272	685	5.73
Uklana Mandi	9.	11170	10937	233	2.09
Jakhal Mandi	0.	10472	6895	3577	34.16
Rewari(R)	1.	9849	4453	5396	54.79

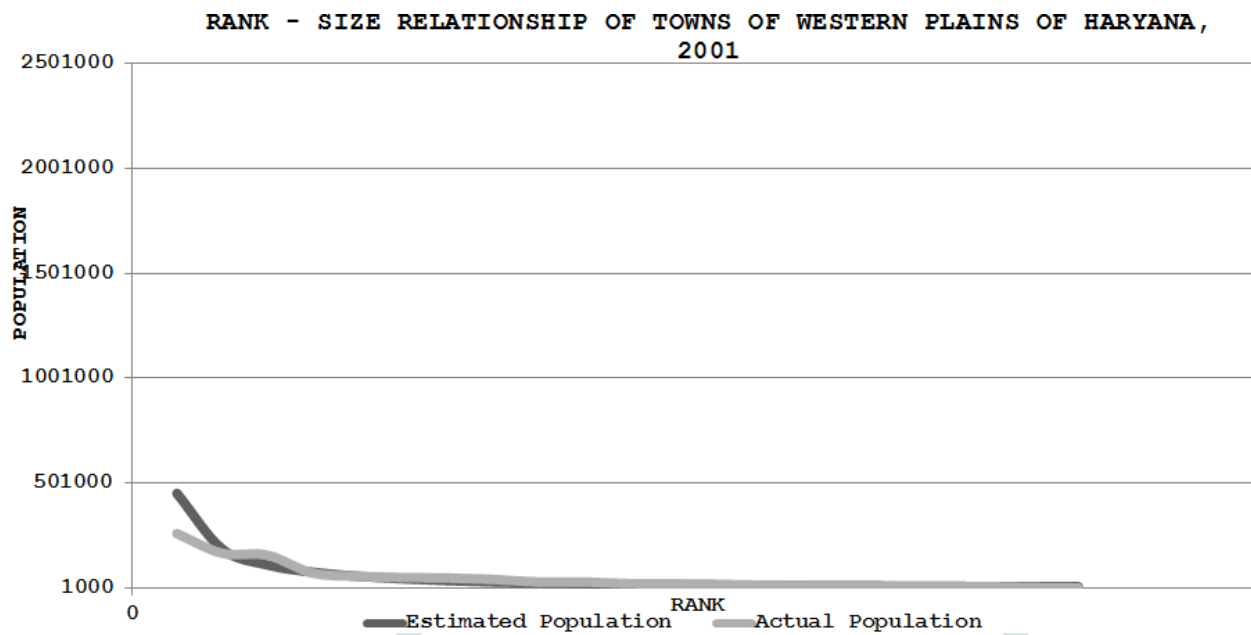


Figure.3: Rank - Size Relationship of Towns of Western Plain of Haryana (2001)

Rank – Size Relationship in Class – I towns

Out of total 3 Class – I category towns only one town namely Sirsa has negative population (- 41.07) percentage difference between estimated and actual population while rest of the 2 cities, namely Hisar and Bhiwani, have positive percentage difference.

Rank – Size Relationship in Medium towns

In Western Plain of Haryana in 2001 there are total 10 towns in Class – II and Class – III category. In Class – II category out of total 4 towns; 2 of them, namely *Tohana* and *Mandi Dabwali*, have negative percentage population growth i.e. actual population is higher than estimated population. While *Hansi* town has lower actual population than estimated population thus having positive percentage difference.

In Class – III category all the 6 towns, namely *Charkhi Dadri*, *Barwala*, *Ellnabad*, *Kalanwali*, *Ratia*, *Rania*, have negative percentage difference i.e. these towns have more actual population than the estimated population.

Rank – Size Relationship in Small towns

In Western Plain of Haryana total 8 towns come in this small town category. Out of them 3 towns *Bawani Khera*, *Siwani*, *Narnaund* have more actual population than the estimated population thereby showing a negative percentage difference of population. While rest of the 5 towns have lower actual population than the estimated population. These towns are *Loharu*, *Tosham*, *Uklana Mandi*, *Jhakkhal Mandi*, *Rewari (R)*. Highest positive percentage difference (i.e 54.79 per cent) is occurring in *Rewari (R)* which is a Class – VI category town.

Rank – Size Relationship in Southern Plain

In Southern Plain, just like Western Plain, ratio of towns having negative percentage difference is more. Out of total 24 towns 13 towns have higher actual population than estimated population thus showing negative percentage difference. Out of these *Faridabad* (- 59.46 per cent), *Hasanpur* (- 24.48 per cent), *Faraukh Nagar* (- 21.30 per cent) and *Kanina* (- 20.39 per cent) have higher negative percentage difference.

In 11 towns of positive percentage difference i.e. actual population lower than estimated population *Dharuhera*, *Sohna*, *Palwal* are important with positive percentage between 20 – 30 per cent.

Table 3: Rank - Size Relationship of Towns of Southern Plain of Haryana (2001)

Name of Towns	Rank	Estimated Population	Actual Population	Difference%	Difference
Faridabad	1.	62216	1055938	-393722	-59.46
Gurgaon	2.	237315	228820	8495	3.58
Palwal	3.	130203	100722	29481	22.64
Rewari	4.	85045	100684	-15639	-18.39
Narnaul	5.	61119	62077	-958	-1.57
Hodal	6.	46660	38309	8351	17.90
Sohna	7.	37139	27570	9569	25.77
Mahendargarh	8.	30477	24323	6154	20.19
Dharuhera	9.	25600	18892	6708	26.20
Ferozpur Zhirka	10.	21903	17755	4148	18.94
Tavauru	11.	19020	17328	1692	8.90
Hailey Mandi	12.	16721	17081	-360	-2.15
Pataudi	13.	14853	16085	-1232	-8.30
Punhana	14.	13309	13179	1300	0.98
Bawal	15.	12017	12144	-127	-1.06
Nuh	16.	10922	11039	-117	-1.07
Hathin	17.	9984	10916	-932	-9.33
Dundahera	18.	9174	10626	-1452	-15.82
Kanina	19.	8468	10195	-1727	-20.39
Faraukh Nagar	20.	7849	9521	-1672	-21.30
Hasanpur	21.	7302	9090	-1788	-24.48
Nangal Chaudhary	22.	6816	7368	-552	-8.10
Tilpat	23.	6382	6369	913	0.20
Ateli	24.	5992	5673	319	5.33

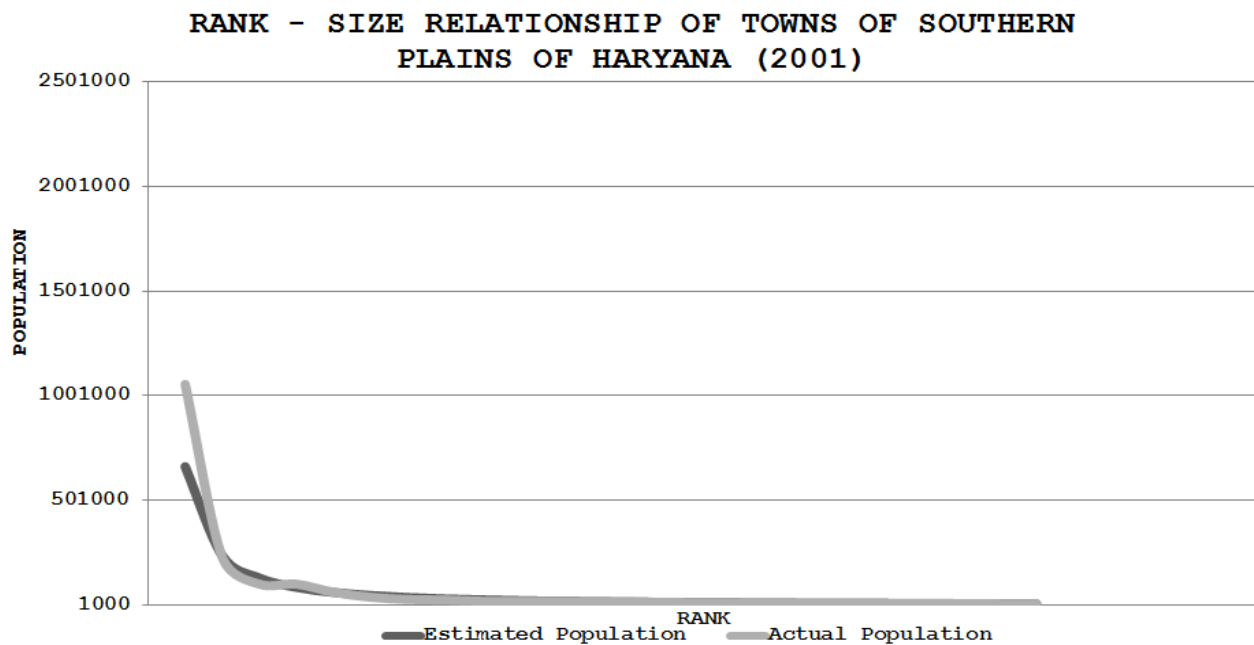


Figure.4 :Rank - Size Relationship of Towns of Southern Plain of Haryana (2001)

Class – I Towns in Southern Plain

Out of total 4 towns in this category *Faridabad* is having highest negative percentage difference i.e. – 59.46 per cent i.e. actual population is more than estimated population whereas *Rewari* has – 18.39 per cent difference while *Gurgaon* has 3.58 per cent difference i.e. actual population is lower than estimated population and *Palwal* has 22.64 per cent positive population growth difference.

Medium Towns in Southern Plain

Four towns, namely *Narnaul*, *Hodal*, *Sohna*, *Mahendergarh*, come in medium town category. *Narnaul* the only Class – II town has lower actual population than estimated population with – 1.7 per cent population difference. All Class – III towns have higher estimated population than actual population thereby having positive difference of population with *Sohna* having positive difference of 25.77 per cent.

Small Towns in Southern Plain

In Southern Plain of Haryana a total of 16 towns come in small town category i.e. Class – IV and V. There is no Class – VI category town in this plain. Out of 11 towns of Class – IV category *Dharuhera*, *Ferozpur*, *Zhirka*, *Tavarou*, *Punhana* have more estimated population than actual population thereby showing positive percentage difference of population. While rest of 7 towns, namely *Hailey Mandi*, *Pataudi*, *Bawal*, *Nuh*, *Hathin*, *Dundaheera*, *Kanina*, have negative percentage difference of population.

In Class – V category *Hasanpur* is having highest neative growth i.e. – 24.48 per cent while *Faraukh Nagar*, *Nangal Chaudhary* too have negative percentage population difference. Two towns *Tilpat*, *Ateli* have positive population difference.

In the above mentioned analysis of Haryana Plains the observations made in expected and actual population in whole of Haryana 55 towns out of 97 towns have negative percentage difference while 42 towns show

positive percentage difference. In Class – I towns out of 19 towns 12 towns have negative percentage difference. In Medium towns (Class – II and III) out of 30 towns; 27 towns have negative percentage difference and in Small Town category (Class – IV, V, VI) out of 48 towns 16 towns have shown negative percentage population difference while 32 towns have positive percentage population difference.

This shows that most of the towns have more actual population than the expected population and hence rank – size rule does not exist.

CONCLUSION

It is a common observation that cities differ in size. The distribution of cities by size has been explained by the law namely Rank-size rule .Haryana is a state of medium level of urbanization. Which does not conforms to the Rank-size rule. As a whole some large cities' actual and estimated population is so close that the applicability of rank-size rule seems to be absent.

The log graph of actual and estimated population also clearly indicates that Rank-Size rule does not apply on the population and towns of Haryana. The analysis also reveals that majority of towns have negative percentage difference which means all the towns are larger than their size. Another fact that has caught the attention is that the largest towns are showcasing lower actual size than the expected size. Findings also reveal that all places in the urban system are growing with small towns which are growing at a faster rate. The largest cities and the smallest towns display higher persistence than medium sized cities.

There are very less studies of this type in our country. New studies can throw more light and give new fruitful result in this direction. Geographers accept the significance of these rules for studying the distribution of towns and seek for the economic characteristics in this context.

The long run analysis of the size distribution of cities in a region offers information about what has occurred and it allows us to glimpse what might be the future behavior.

RELATED STUDIES

The existing Rank-Size rule describes the empirical relationship between a town's population and its ranking relative to other towns.

Auerbach (1913; Singer, 1936) studies were among the first to demonstrate a Pareto Distribution of city size i.e. Pareto's Law describes the negative linear relationship between the logarithm of population size and logarithm of city-rank. Since the early 20th century, numerous studies have been conducted on City-Rank Size distribution using Pareto's Law (Allen 1954, Malecki 1975; 1980, Rosen and Resnick 1980, Gabaix; 1999, Delgado and Godinho, 2004, Subbarayan, 2009, Subbarayan Et. Al.; 2011.

Echout (2004; 2009) has found Pareto's distribution resemble at best. Soo (2007) analyzed the Rank-size distribution of Malaysian cities and examined the change in Pareto's co-efficient by successively reducing the number of cities in sampling.

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Task Force Classification of Towns by Population Range.

Population Size	Category
1,00,000 to 3,00,000	Small Cities
20,000 to 1,00,000	Medium Towns
5,000 to 20,000	Small Towns

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