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DOES THE RANK-SIZE RULE MATTER IN INDONESIA? DETERMINANTS OF THE SIZE DISTRIBUTION OF CITIES[1]

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ABSTRACT

In Indonesia the cities have continously grown. However they varied in size. Some cities have the population above two million citizens, while some have below than five hundred thousands. Some economic factors are hypothesized to influence such distribution. This study aims to test the rank-size rule (Zipf's law) and to find the determinants of size distribution of cities. The panel data method is employed to satisfy the objectives of study. All district and provincial level data are used for year 1995, 2000 and 2005. The pareto exponent shows that the rank-size rule does not matter in Indonesia. Level of agglomeration economies, local government expenditure and number of administrative city increases the concentration of size of cities. The labor force participation and region's openness affects the size of cities to be more equally distributed.

Keywords: *cities, rank-size rule, Zipf's law, pareto exponent, panel data*

INTRODUCTION

The cities have continously grown in Indonesia. The number of population residing in the city has increased from 22.3 percent in 1980 into 42 percent in 2000 (BPS, 2005). In the last two decades, the city population has grown at 6.3 percent annually, which was higher than the rate of total population growth. Badan Pusat Statistik Indonesia has projected that about 68 percent of Indonesian population will live in the city at 2025.

The growth of a city can come from some economic factors. The different level of economic activities will make them different in size. Normally a nation is dominated by one or two primate cities. These cities will tend to to be the production locations of most output produced by the economy. Other more peripheral regions will tend to be focused arround successively smaller cities which dominate less populated hitherland areas. At the same time, as the size of the individual city falls, the number of such cities generally increases (McCann, 2001).

In Indonesia the size of cities highly differs. In 2005, there is only a city which has

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the population over 5 M; only a city which is over 3 M and more than ten cities are resited by more than 1 M people. The rests of cities have the population below 1 M. This unequal size distribution of cities can be identified using an indicator of the Pareto exponent. It can be viewed as a measure of inequality. The larger the value of the Pareto exponent, the more even is the populations of cities in the urban system.

This distribution of population across the urban hierarchy will challenge policy makers to devise appropriate policies for cities of different sizes. Some factors which influence the size distribution of cities should be identified. Many possible explanations for variations in the value of above Pareto exponent. Possibly the most obvious choice is a model of economic geography, as exemplified by Fujita *et al* (2001). These models can be viewed as models of unevenness in the distribution of economic activity. Some factors are hypothesized in the model, which are the degree of increasing returns to scale, transport costs, agricultural activity and barriers to trade within a country. The model predicts that economic activity will be more highly concentrated in space the larger are scale economies and the lower are transport costs, also the larger the share of non-agricultural in the economy. A greater openness to international trade is predicted to reduce the degree of agglomeration, as the strength of forward and backward linkages is reduced.

This paper basically has two basic goals. The first is to shed light on the prediction of rank-size rule in Indonesia. We pursue this goal by comparing the actual and predicted the size distribution of cities in Indonesia and approximating the Pareto exponent. The second is to identify the determinants of variations in the Pareto exponent. It will suggest some factors those influence the size distribution of cities. The second section of this paper describes the empirical literature on urban hierarchy pattern. The third section will look at some dataset and empirical method used. The last section turns to the empirical analysis of Pareto exponent and panel data analysis of determinants of the size distribution of cities in Indonesia.

Empirical Review on Urban Hierarchy Pattern

The size and spatial distribution of the urban centers exhibit a hierarchical pyramidal pattern Mccan (2001). The dominant city, which has the largest population is defined as the city with the highest-rank ordering. The next-group of similar-sized cities are defined as the second level in the rank-ordering of citi sizes, and the subsequent group as the third level of the urban hierarchy, and so on.

Empirically studies of the size distribution of cities have a long and distinguished history. The existence of very large cities, the very wide dispersion in city sizes, the remarkable stability of the hierarchy between cities over decades or even centuries, and the role of urbanization in economic development were all particularly interesting qualitative features of urban structure worldwide. The approximation of such distribution has been proposed by Auerbach using the Pareto distribution. This has fascinated many scientists. Over the years, Auerbach's basic proposition has been refined by many others, most notably Zipf. He proposed that, not only did the distribution of city sizes follow a Pareto distribution, but but that the distribution has a shape parameter (henceforth the Pareto exponent) equal to 1. This is known as "Zipf's Law" (Overman & Ioannides, 2000). However it is neither a "law" nor a "rule", but simply a proposition on the size distribution of cities. An alternative term that is frequently used is the rank-size-rule, which is a deterministic version of Zipf's Law. The rank-size-rule states that, on average, the population of any city multiplied by its rank in the urban hierarchy of the country, is equal to the population of the largest city. It is of special interest for a theory

to predict Zipf's law and other empirically important features, especially for the Indonesia case.

The key empirical study of the size distribution of cities came from Rosen and Resnick (1980). They investigated the value of the Pareto exponent for a sample of 44 countries. Their estimates ranged from 0.81 (Morocco) to 1.96 (Australia), with a sample mean of 1.14. The exponent in 32 out of 44 countries exceeded unity. This indicated that populations in most countries were more evenly distributed than would be predicted by the rank-size-rule. Rosen and Resnick also found that the value of the Pareto exponent was lower for urban agglomerations as compared to cities. Soo (2002) updated Rosen and Resnick's study. The observation was increased to 73 countries. The author found that Kuwait has the largest Pareto exponent of 1.72. This number associated with many number of small cities and there is no primate city in Kuwait. The countries in Europe and North America have the Pareto Exponent more than 1.2. However countries in Asia, South America and Africa have the lower Pareto Exponent.

While obtaining the value for the Pareto exponent for different countries is interesting in itself, there is also great interest in investigating the factors that may influence the value of the exponent. Rosen and Resnick (1980), for example, found that the Pareto exponent was positively related to per capita GNP, total population and railroad density, but negatively related to land area. Soo (2002) identified some political factor such as civil freedom, government expenditure, involvement in the world war and the length of independence explains the variation in Pareto exponent. Moreover some other studies such as Duranton (2002) concluded that innovation is an engine of city growth. Crampton (2005) using the 14 countries data in Europe found that countries which has a stronger government and regional city-state history showed more equal size distribution of cities.

Empirical observation on urban hierarchy pattern in Indonesia is still limited. Some studies have been conducted to look at the urbanization process and growth of cities. Prabatmodjo (2000) identified the urbanization process in Indonesia using the data from 1971 up to 1980. The author concluded that the big cities have contributed on the increasing number of people residing in cities. Generally Indonesia was categorized in the advanced primate city stage, where some cities have been faced by the congestion problems. Mulatip & Brodjonoegoro (2002) studied the determinants of city growth in Indonesia using the cross section analysis. They found that the population density, economic specialization negatively related to economic growth. However economies of urbanization and localization and level of education positively related to the growth of city.

Data and Estimation Method

Following McCann (2001), if the number of urban areas is given as T and $F(x)$ is frequency distribution of cities; the size distribution of cities function R(x) is defined

$$R(x) = T\,[1-F(x)] \qquad (1)$$

Within urban and regional economics, the usual functional form of the size distribution of cities is a modified version of the Pareto-income distribution function given as

$$R(x) = Mx^{-a} \qquad (2)$$

where M is the population of the dominant city in a country. This equation can be estimated econometrically by taking its log transformation

$$\log R(x) = \log M - a \log x \qquad (3)$$

The situation in which the value of Pareto exponent in eq. 3 is assumed to be close to 1 is known as the rank size rule or Zipf's Law.

This number will show whether such rule matters or not in Indonesia.

Moreover this study aims to find the determinants of size distibution of cities. This will be answered by looking at the factors which influence the variation of Pareto exponent. The Pareto exponent from the estimation of eq. 3 is then used as the dependent variable in a second stage regression. The objective is to explain variations in this measure by employing some variables obtained from models of political economy and economic geography. The empirical model used to answer this problem follows

$$a_{it} = \alpha_i + X'\beta + \varepsilon_{it} \quad (4)$$

where

a_{it} = Pareto exponent of province i at time t

X is a vector of length of paved road (Road); economies of urbanization (Urban); economies of localization (Loc) and economies of specialization (Spec); labor force (Labor); per capita provincial gross domestic product (GDP); ratio of government expenditure for infrastructure on total revenue (G); number of adminsitrative city (Adm) and degree of region's openness (Open). The economies of urbanization is measured from the ratio of size of the biggest city divided by size of city i in a province. The economies of localization is measured from the share of agriculture on provincial GDP. The economies of specialization is measured following Kuntjoro (2002). It uses the Herfindahl index of sectoral share on provincial GDP. The degree of region's openness is measured from the ratio of export plus import on provincial GDP. Export and import comes from the data of inter islands transaction within Indonesia plus the direct export and import to and from foreign countries.

The eq. 3 is estimated using the standard OLS. The eq. 4 is estimated using both Fixed-effects model (LSDV) and Random-effects model. To find the robust one, we employ the Hausman test (Hsiao, 2004; Verbeek, 2004). In this study we use the data from Badan Pusat Statistik Indonesia (Central Statistics Agency). The three set time-series data of year 1995, 2000 and 2005 are explored. The data cover 25 provinces and 336 cities (DKI Jakarta is included in West Java because the province of Jakarta is viewed as a city). The definition of a city in this study refers to Badan Pusat Statistik, which is an urban area that has more than 20 thousands residing people.

Results and Discussion

Table 1 shows the comparison of Pareto exponents among the main islands in Indonesia. The observation covers three years of 1995, 2000 and 2005. Overall the Pareto exponents decreases from 0.84 in 1995 to 0.80 in 2000 and 0.79 in 2005. The decrease in Pareto exponents means that the less even in size are the cities in Indonesia. However in Sumatera, the Pareto exponents in 2005 is larger than in 1995, means that the size distribution of cities become more equal in that period.

The findings of less than one Pareto exponents in off-Java islands shows more unequal size distribution of cities compared to the distribution in Java island. In Java island, the Pareto exponents are almost equal to one from 1995 up to 2005. This is not surprising, where in out of Java island, the domination of primate city is higher than in Java. Historically, the cities in Java island have developed for a longer period. They have grown since the Dutch Colonialism, while many cities in off-Java islands have developed after the first period of Five Years Development Plan (late 1960s). The regioal autonomy since 2000 also places a greater authority for centre of districts in off-Java islands to more develop.

The observations on the number of population among the cities in Indonesia show that the actual rank is different with the rank-size rule prediction (Table 2). The actual rank

in Table 2 shows that the number of cities which resided by over 1.3 million people increased from 4 in 1995 into 11 in 2005. It also happens for the cities resided by over six hundred thousands people. The number of cities are equally distributed in the ranks of below three hundred thousands people. From Table 1 and 2 can, it can be concluded that the rank-size rule does not matter in Indonesia.

The variation in Pareto exponents among the provinces will be explained using the panel data model. The Hausman test has been conducted. It rejects the null hypothesis that the random effects model is appropriate. The choice of fixed effects model is reasonable because the cross-sectional used in the estimation represents a broadly exhaustive sample of population. This study covers the full sample of provinces and districts in Indonesia. The fixed-effects model is fit indicated by the high adjusted-R^2 of 91.02 percent. The tests also indicate that the model is free of autocorrelation problem.

The coefficients and standard errors from the fixed effects estimation are reported in Table 3. Both economies of urbanization and economies of localization, local government expenditure and number of administrative city are negatively and statistically significant to influence the Pareto exponents. They are indicated by the value of t-statistics which are more than two. The negative impacts of those fators are not surprising. The agglomeration process have forced a city to more develop than others. It will attracts more people to come than the city become larger and larger. Moreover in Indonesia, the Law No. 25/1999 on fiscal equalization between center and regions, has forced the districts to more develop. The districts which are rich of natural resources will develop faster than the poor ones. They tends to become the primate cities

Table 1. The Pareto Exponent in Main Islands of Indonesia

Year	Indonesia	Sumatera	Java	Kalimantan	Sulawesi	Others
1995	0.84	0.65	1.05	0.67	0.75	0.86
2000	0.80	0.66	1.03	0.75	0.68	0.65
2005	0.79	0.69	1.02	0.69	0.65	0.60

Source: Author's (2008)

Table 2. The Actual and Predicted of Rank-Size Rule in Indonesia

Population	Actual Rank			Rank-Size Rule Prediction		
	1995	2000	2005	1995	2000	2005
> 5.120.000	1	1	1	1	1	1
2.560.000 - 5.120.000	2	2	1	2	2	2
1.280.000 - 2.560.000	4	9	11	4	3	3
640.000 - 1.280.000	10	15	18	7	7	7
320.000 - 640.000	32	39	38	14	13	14
160.000 - 320.000	46	60	60	28	26	28
80.000 - 160.000	69	65	66	56	52	55
40.000 - 80.000	56	54	73	113	105	110
20.000 - 40.000	40	56	68	225	209	211

Source: Author's (2008)

and will result a lower Pareto exponents or more unequal size distribution of cities.

Labor force participation and region's openness are positively statistically significant to affect the size distribution of cities in Indonesia. The increase in labor force in a region will push the people to move to other egions. It will increase the number of population in other regions. The openness of a region will attracts other regions to more develop. The inter-region trade will push the economic activites in all regions involved. However the goods movement among the islands in Eastern Indonesia are constrained by a low quality infrastructure and a high transaction costs. This results a decrease in the Pareto exponents in Kalimantan, Sulawesi and other islands (Table 2). Both labor participation and region's openness will increase the Pareto exponents closer to one, or they will push the size of cities become more equally distributed.

Table 3. Determinants of the Size Distribution of Cities

Variable	Coefficient	Std. Error	t-statistic
Road	-0.1212	0.0921	-1.3164
Urban	-0.7293	0.0745	-9.7925*
Loc	-0.1907	0.0800	-2.3820*
Spec	-0.2188	0.1473	-1.4856
Labor	0.0063	0.0017	3.8085*
GDP	0.0074	0.0042	1.7701
G	-0.1402	0.0163	-8.6236*
Adm	-0.0123	0.0040	-3.0499*
Open	0.0414	0.0095	4.3522*
R-squared		0.9511	
Adj R-squared		0.9102	
F-statistic		23.33 (Prob = 0.0000)	
Durbin-Watson Stat		2.4015	

Note: * *Statistically significant at level 5%*
Source: Author's (2008)

CONCLUSION

This study has shown that the the rank-size rule does not matter in Indonesia, indicated by the value of Pareto exponents are not equal to 1. The Level of agglomeration economies, local government expenditure and number of administrative city increases the concentration of size of cities. The labor force participation and region's openness affects the size of cities to be more equally distributed.

REFERENCES

Badan Pusat Statistik., 2005. *Indonesia Population Projection 2000-2005*. Jakarta.

Crampton, G., 2005. The Rank Size Rule in Europe: Testing Zip's Law using European Data. ERSA 2005, *Paper 185*, Theme K, Amsterdam.

Duranton, G., 2005. *City Size Distribution as a Consequence of Growth Process*. Center for Economic Performance. London School of Economics and Political Sciences. Draft.

Fujita, M., Krugamn, P., Venables, A. J., 2001. *The Spatial Economy*. Massachusetts: the MIT Press.

Hsiao, C., 2004. *Analysis of Panel Data*. Cambridge: Cambridge University.

Kuntjoro, M., 2002. *Analisis Spasial and Regional*. Yogyakarta: AMP YKPN.

McCAnn., 2001. *Urban and Regional Economics*. Oxford: Oxford University Press.

Mulatip, I., B.P.S. Brodjonegoro., 2004. *Determinan Pertumbuhan Kota di Indonesia. Jurnal Pembangunan dan Ekonomi Indonesia*, 5 (1), 61-82.

Overman, H. G., Ioannides, Y. M., 2000. *Cross-Sectional Evolution of the US City Size Distribution*. Department of Geography and Environment London School of Economics. Draft.

Prabatmodjo, H., 2000. *Perkotaan Indonesia pada Abad ke-21: Menuju Urbanisasi Menyebar? Jurnal Perencanaan Wilayah Kota*, 2 (1), 30-40.

Rosen, K. T., M. Resnick., 1980. 'The Size Distribution of Cities: Ana Examination of

Pareto Law and Primacy'. *Journal of Urban Economics*, 8, 165-186.

Soo, A.O., 2000. *Zipf's Law for Cities: A Cross Country Investigation*. London School of Economics and Political Sciences.

Verbeek, M., 2004. *Modern Econometrics*. New York: John Wiley & Sons Inc.