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Spatial Justice In South Asia
A Zipf's Curve Approach

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This paper aims at demonstrating how regional governance plays a crucial role on urban concentration and spatial justice. The paper presents the The Zipf's Curve estimates for the South Asian countries and maps for India and Pakistan the various city regions in relation to the estimated Curve. The analysis of the results indicate that the spatial distribution of rents of natural resources and from public transferences do have a role in the spatial distribution of wealth. Summing up, there are signs that governance influences spatial justice governance specifically by the spatial allocation of property rights over natural resources and by the spatial distribution of public spending.

I. Introduction

Development of each person, assessed by the enlargement of freedom (Sen, 1999), cannot be detached from the development of the places and networks where persons are embedded (Castells, 2012). Being so spatial justice is the analytical framework that makes space a central category for understanding different levels of development (Williams, 2013).

The criterion to evaluate spatial justice proposed by Nuno Martins (2013) and implicit in (Krugman, 1991) are accessibility (Rawls, 1971), capability very much associated to scale (Sen, 1992), or both. The combination of the two criteria generates four interaction possibilities: low accessibility and low capability (poor regions); low accessibility and high capability (emergent regions); high accessibility and low capability (dependent regions); and high accessibility and high capability (development) (Dentinho, 2012, 2017).

There are not only poor and developed regions. Due to unilateral permanent transferences, it is possible to have emergent regions that can send the profits and rents of external investments to the outside and dependent regions that continuously receive from the outside unilateral

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transferences from rents from natural resources, from governmental transferences and from migrant remittances. These unilateral and enduring transferences create persistent multiplier effects that accumulate in an uneven concentration of production and expenditure, employment and population.

Regional development results from the social, cultural, human, productive and natural capital of the region and from its relative accessibility to markets. Nevertheless, location of the ownership of those various types of capital do play a role in regional development, urban concentration and spatial justice. The aim of this paper is to understand how governance influences the spatial profile of regional development and spatial justice looking at the countries of South Asia.

To achieve that we present in Point 2 a conceptual regional economic model with four regions which simulation demonstrate that urban concentration and spatial justice are the outcome not only of the availability of different forms of capital but also results of the relative accessibility and the public and private interregional transferences. In Point 3, data on the population by city in each country is used to estimate the Zipf's curves for each one of the countries in South Asia and for the whole region. The relative dimension of each city and its position regarding the estimated curves serves to identify developed, dependent, emerging and poor cities and, through geographical interpolation between the city locations, the general maps of the countries with developed, dependent, emerging and poor regions (Point 4). Point 5 proposes some conclusions and recommendations for policy makers.

II. Regional Development and Spatial Justice

The world's fastest growing cities are located in Africa and Asia (United Nations, 2014). Notwithstanding this, urban concentration in the developing world is not necessarily a good thing because, in the one hand, it brings congestion, environmental disturbances and social problems and, on the other hand, can be the result of biased allocation of rents from natural resources and public spending (Dentinho, 2017) usually associated with income spatial redistribution rising concerns of spatial justice.

The hierarchy of cities proposed seminally by (Gibrat, 1931; Zipf, 1949) is quite resilient (Black and Henderson, 2003; Loannides and Overman, 2003; Nitsch, 2005; Newman, 2005; Anderson and Ying, 2005; Benguigui and Blumenfeld-Lieberthal, 2007; Bosker et al, 2008; Jiang et al, 2015; Peng, 2016); Giesen et al, 2010; Gómez-Déniz et. Al. 2014, 2015; Shujuan , 2016; Morudu , 2016; Luckstead and Devadoss, 2017). Nevertheless the particular shape of the Zipf's functions can be influenced by various factors many of them manageable by governments. Ades and Glaeser (1995) found that political factors do influence urban concentration. Krugman (1996) suggests that cities rooted in natural capital have also a strong hierarchy. Duranton (2002) links the city hierarchy with a set of indicators related to innovation. (Bertinelli and Strobl, 2007) show that there might be an optimal level of urban concentration that can be influenced by policy makers (Henderson, 2003; Brülhart and Sbergami, 2009) opening the connection between urban concentration and spatial justice. In a recent work (Dentinho, 2017) we proved that there is a close relationship between urban

concentration and the distribution of rents from natural resources and other unilateral transferences.

The analytical formulation proposed in this essay to related regional development with the Zipf's Curve of the model starts with a simple Solow type growth model for each one of the four regions with a single production function:

(1) $Y_{ti} = A_i (N_{it}X_t)^{\alpha} K_{it}^{(1-\alpha)} L_i^{\rho}$

Where Y_{ti} = product of region (i) in time (t); N_{it}= labor of region (i) in time(t); X_t= technological progress associated with labor in time t; K_{it} = capital of region (i) in time (t); 1-a= product/capital elasticity; a= product / labor with technical progress elasticity; L_i = land of region (i). Technological progress grows at a constant rate (g): $X_{t+1} = g\ X_t$. Capital evolves with the investment net from capital depreciation (d): $K_{t+1} = I_t + (1\text{-}d)\ K_t$. And investment is equal to savings that are a portion s of the product: $I_t = sY_t$. $A_i = \sum_j \exp(-\beta d_{ij}) / Max_i (\sum_j \exp(-\beta d_{ij}))$ is economic potential that depends on the relative accessibility of each region, being β=parameter for attrition and d_{ij}= distance between region (i) and region (j).It is possible to design different accessibility topologies: Circular, Linear, Weighted (calibrate to lead to a Zipf's coefficente = 1).

Dij (Circular) =					D(Linear) =					Dij(Weighted) =				
	0,	1,	1,	1,		0,	1,	2,	3,		0,	3,	4,	5,
	3	0	0	4		3	0	0	0		1	8	8	3
	1,	0,	1,	1,		1,	0,	1,	2,		3,	2,	3,	4,
	0	3	4	0		0	3	0	0		8	1	4	3
	1,	1,	0,	1,		2,	1,	0,	1,		4,	3,	2,	3,
	0	4	3	0		0	0	3	0		8	4	2	3
	1,	1	1,	0,		3,	2,	1,	0,		5,	4,	3,	2,
	4		0	3		0	0	0	3		3	3	3	4

Nevertheless land rents (L'_{ti})(2) can be distributed throught distribution matrix [V] and the same can happen with wages (N'_{ti})(3) through [W] – associated with remittances - creating redistribution effects if those matrices differ from identity matrices while keeping the sum of each line equal to the unity.

(2) $L'_{ti} = (\rho A_i (N_{it}X_t)^{\alpha} K_{it}^{(1-\alpha)} L_i^{(\rho-1)}) L_{ti}$

(3) $N'_{ti} = (\alpha\ A_i (N_{it}^{(\alpha-1)} X_t)^{\alpha} K_{it}^{(1-\alpha)} L_i^{\rho}) N_{ti}$

(4) $K'_{ti} = ((1\text{-}\alpha)\ A_i (N_{it}^{\alpha} X_t)^{\alpha} K_{it}^{(-\alpha)} L_i^{\rho}) K_{ti}$

The Disposable Income Yd_{ti} of each region (i) at time (t) is equal to the product of the region (i) Y_{ti} plus the net land rent transferences and net wage transferences.

(5) $Yd_{ti} = Y_{ti} + [L'_{ti}]V - L'_{ti}V_i + [N'_{ti}]W - N'_{ti}W_i$

$$V = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{vmatrix} \quad W = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{vmatrix}$$

$$\begin{vmatrix} 0 & 0 & 0 & 1 \end{vmatrix} \qquad \begin{vmatrix} 0 & 0 & 0 & 1 \end{vmatrix}$$

Each disposable income generates savings (5) that are targeted to investment in the different regions according to the weight of the capital productivity of the region in the total capital productivity (6).

(6) $S = \sum_i s.Yd_{ti}$

(7) $I_{ti} = S\ (K'_{ti} / \sum_i K'_{ti})$

Finally, each year, a proportion (μ) of labor can migrate been attracted to the various regions according to the weight of the Disposable Income per capita of the region in the total Disposable Incomes per capita.

(8) $N_{(t+1)i} = N_{ti}\ (1-\mu) + (\mu \sum_i N_{ti})\ [(Yd_{ti}/N_{ti})/(\sum_i Yd_{ti}/N_{ti})]$

Conecting to the Zipf's Curve the population of each region(i) (N_i) is divided by the total population of the country (N) obtaining the weight of each city in the total population of the country. Then the coefficent of the Zipf's Curves by Country (μ) is estimated regressing the Logarithm of the Weight of the City Population with the Logaritm of the rank order of the city (9).

(9) $Ln\left(\frac{N_i}{N}\right) = C - \mu.Ln(r_i)$

What is interesting to see is that different spatial income redistributions leads to completely different Urban Hierarchies even assuming similar technologies. This is shown in four numerical derived scenarios.

Scenario 1: Similar geographical conditions and no transferences

With constant returns on scale, without technological progress and without population growth population will increase more in the more central regions. In the steady state, and throught the calibration of Dij we obtained a Zipf's Curve with elasticity = 1,00 (Figure 1) and a total income = 8,5. This is the base scenario that will be used to analyse what will happen when some redistribution spatial measures are introduced.

$$\text{Dij(Weighted)} = \begin{vmatrix} 0{,}1 & 3{,}8 & 4{,}8 & 5{,}3 \\ 3{,}8 & 2{,}1 & 3{,}4 & 4{,}3 \\ 4{,}8 & 3{,}4 & 2{,}2 & 3{,}3 \\ 5{,}3 & 4{,}3 & 3{,}3 & 2{,}4 \end{vmatrix} \qquad V = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \quad W = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

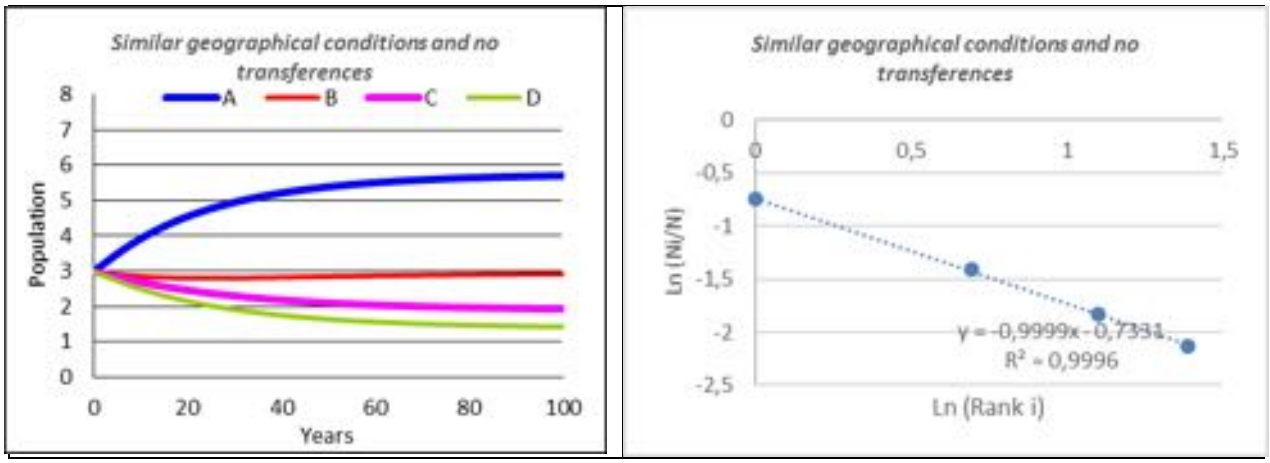

Figure 1: Similar geographical conditions and no transferences

Scenario 2: Similar geographical conditions and concentration of rents in region A

With constant returns on scale, without technological progress and without population growth and with the concentration of rents in Region A the population in Region A and B will increase and Zipf's Curve elasticity will also increase to 1,13 (Figure 2). Total Income will also be bigger then in the base scenarion and equal to 8,8.

$$\text{Dij(Weighted)}=\begin{vmatrix} 0{,}1 & 3{,}8 & 4{,}8 & 5{,}3 \\ 3{,}8 & 2{,}1 & 3{,}4 & 4{,}3 \\ 4{,}8 & 3{,}4 & 2{,}2 & 3{,}3 \\ 5{,}3 & 4{,}3 & 3{,}3 & 2{,}4 \end{vmatrix} \quad V=\begin{vmatrix} 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{vmatrix} \quad W=\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

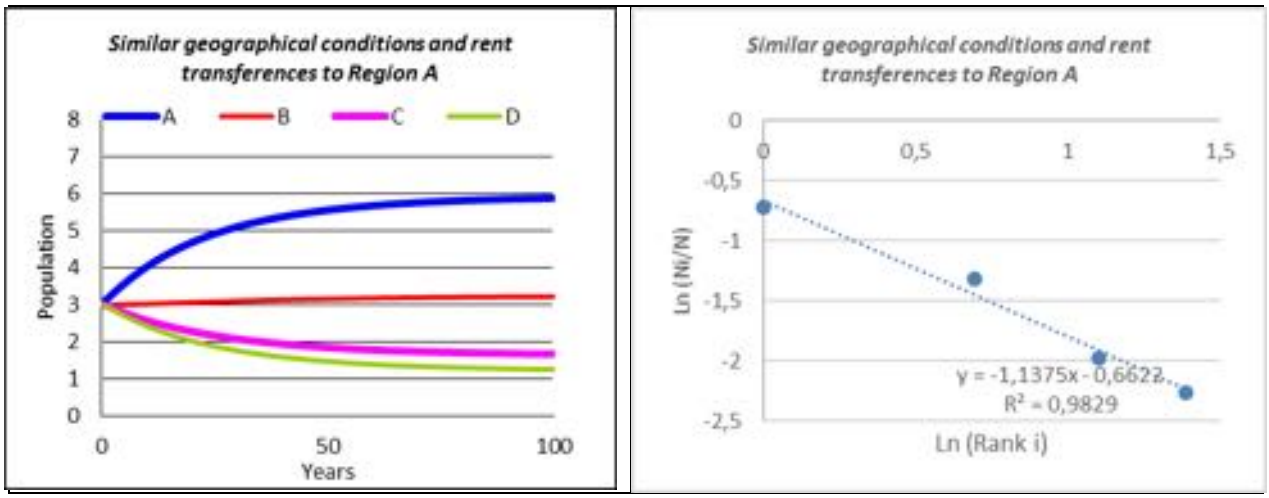

Figure 2: Similar geographical conditions and concentration of rents in region A

Scenario 3: Similar geographical conditions and 50% of Income Transference to Region A

With constant returns on scale, without technological progress and without population growth and

with 50% income transference to Regiona A the population in Region A will increase and Zipf's Curve elasticity will also increase to 1,24 (Figure 3). Total Income will also be bigger then in the base scenario and equal to 9,2.

$$Dij(Weighted)=\begin{vmatrix} 0,1 & 3,8 & 4,8 & 5,3 \\ 3,8 & 2,1 & 3,4 & 4,3 \\ 4,8 & 3,4 & 2,2 & 3,3 \\ 5,3 & 4,3 & 3,3 & 2,4 \end{vmatrix} \quad V=\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \quad W=\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0,5 & 0,5 & 0 & 0 \\ 0,5 & 0 & 0,5 & 0 \\ 0,5 & 0 & 0 & 0,5 \end{vmatrix}$$

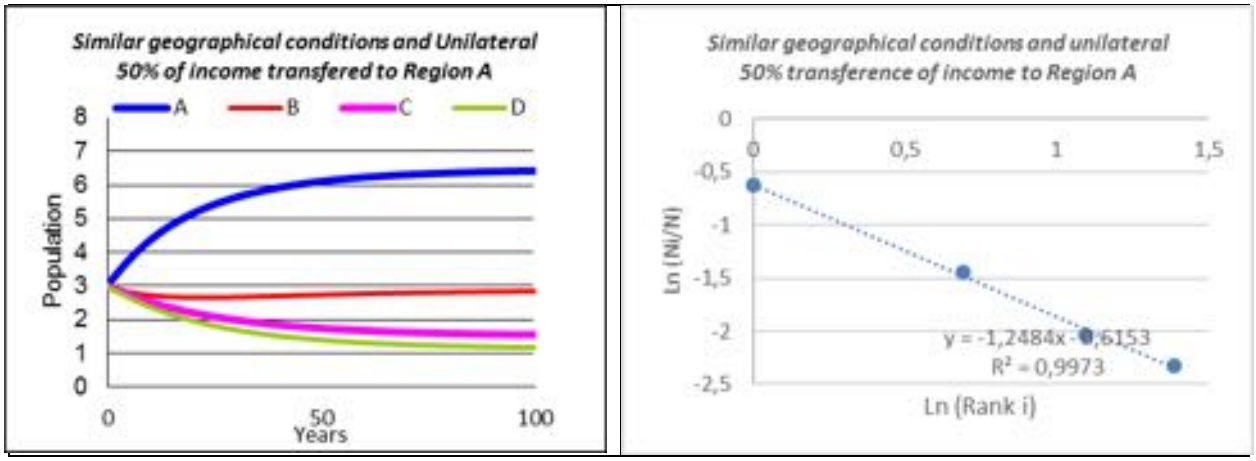

Figure 3: Similar geographical conditions and no transferences

Scenario 4: Similar geographical conditions and redistribution scenario

With constant returns on scale, without technological progress and without population growth and with string redistributive policies the populations of all regions will stay around 3, the Zipf's Curve elasticity will decrease to 0,08 1,24 (Figure 4) and the Total Income will be reduced to 6,3.

$$Dij(Weighted)=\begin{vmatrix} 0,1 & 3,8 & 4,8 & 5,3 \\ 3,8 & 2,1 & 3,4 & 4,3 \\ 4,8 & 3,4 & 2,2 & 3,3 \\ 5,3 & 4,3 & 3,3 & 2,4 \end{vmatrix} \quad V=\begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \quad W=\begin{vmatrix} 0,47 & 0,12 & 0,15 & 0,21 \\ 0 & 0,90 & 0 & 0,10 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

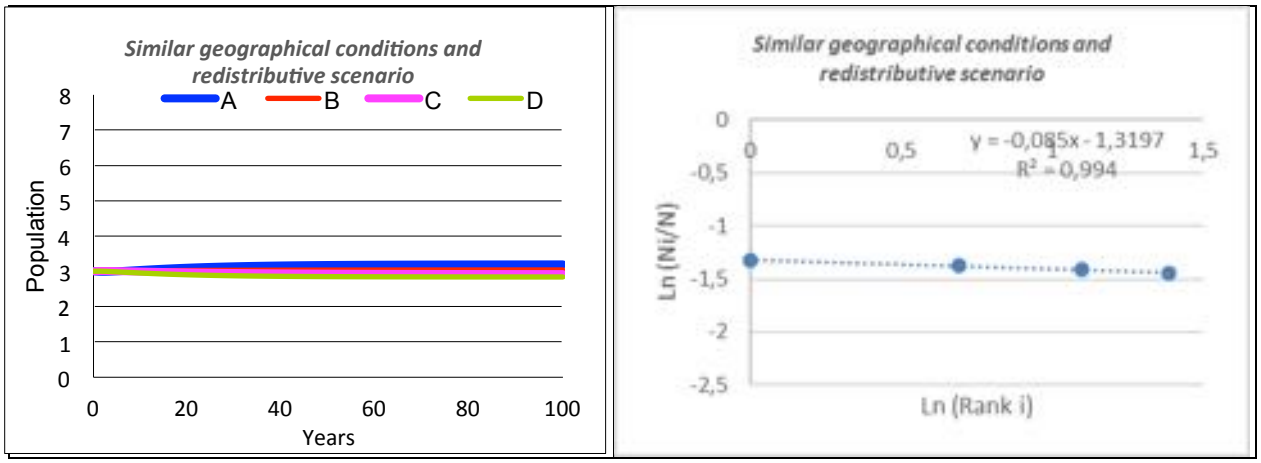

Figure 4: Similar geographical conditions and redistributive scenario

Summing up , based on this model it is possible to understand better how human, productive and natural capital of different regions and the relative accessibility between them influences spatial profile of regional development and spatial justice. Nevertheless, these profiles can be influenced by the location of the ownership of those various types of capital and by unilateral transferences private and public. Next point we will use this understanding to better analyse the spatial profiles in South Asia.

III. Spatial Justice in South Asia

The Zipf's Curves for South Asian Countries show tails in the distribution of cities indicating that parts of the countries are very depopulated due to mountain areas (Pakistan and Nepal) or by long lasting conflicts (Sri Lanka) (Figure 5).

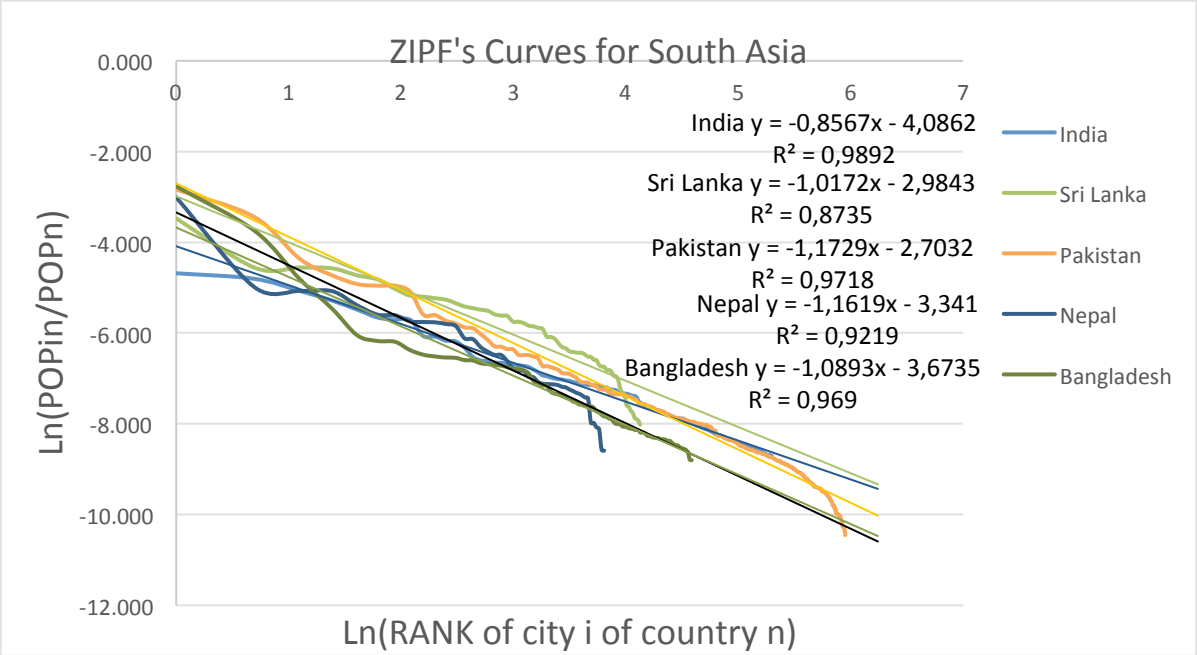

Figure 5: Zipf's Curve by Country (South Asia)

The Zipf's Curve coefficients indicate that Pakistan and Nepal are countries with much higher concentration of population than the other countries in the region that is associated with a higher dependence on rents from Natural Resources, and governmental concentration of fiscal resources (Dentinho, 2017). This study demonstrates that urban concentration is influenced by the Total natural resources rents as a percentage of Gross National Income and by the amount of education expenditure as a percentage of Gross National Income. Figures 6 show the Kernel Density of the Logarithm of the Relative Size of the Cities by Country. Looking closer it is possible to identify various groups of countries. Some Asian countries like India and Bangladesh behave like European and North American countries with more small cities than big ones. A second group of countries do not have a mode in the cities with lower size; this happens with countries that have some remote and detached small cities like Sri Lanka, Pakistan and Nepal.

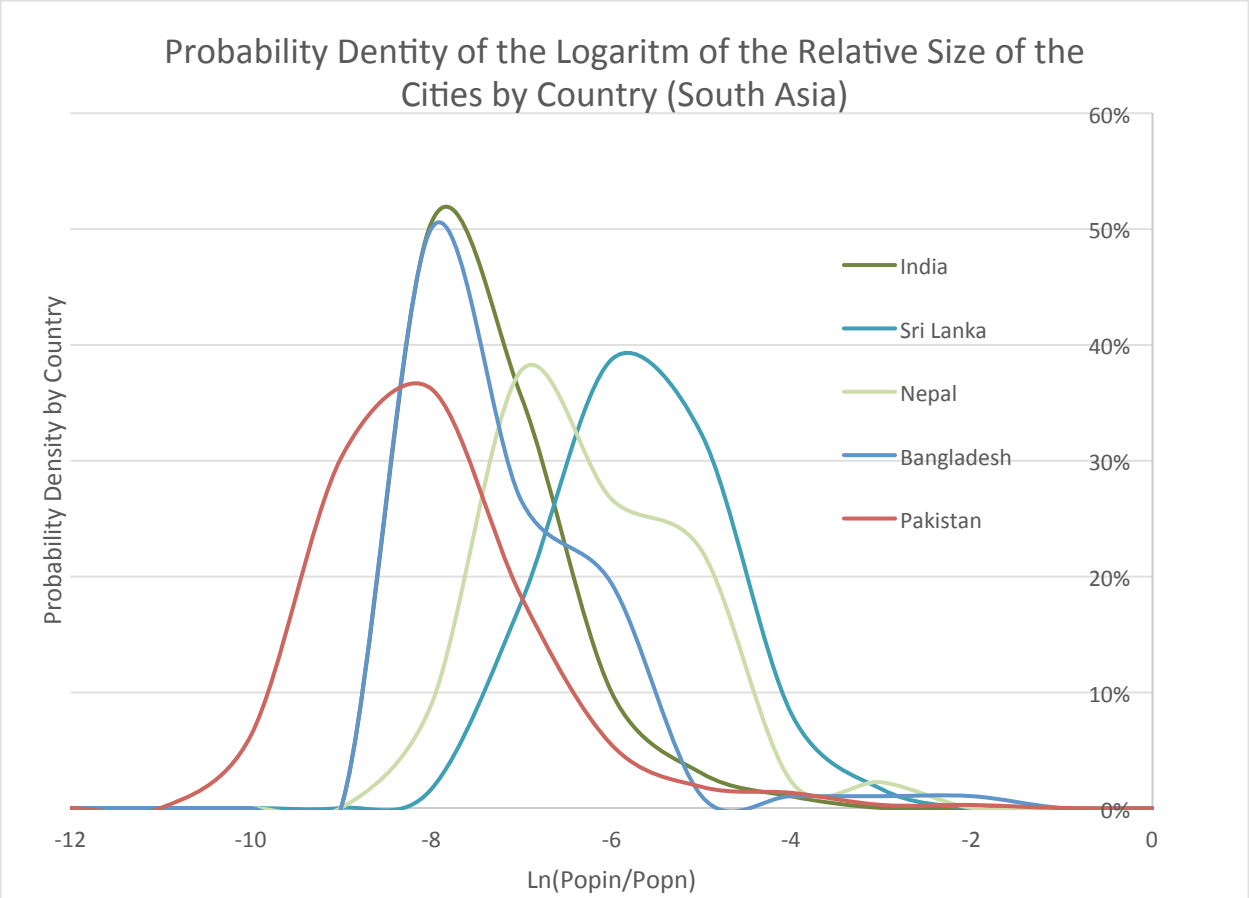

Figure 6: Kernel Density of the Logarithm of the Relative Size of the Cities by Country (South Asia)

Figure 7 presents the profile of the deviation from the estimated Zipf's function. Interestingly patterns show correlation between deviations and, based on the Conceptual Model presented in Point 2 it is possible to hypothesize possible redistribution policies for each country.

In India, beyond very stable coefficients of Spatial Justice, localized redistribution measures reduce the importance of the center of Mumbai in favor of surrounding cities. There seem to be some degree of relative spatial injustice in Punjab, Assam, Gujarat and Uttar Pradesh to the benefit of regions like West Bengal, Kashmir and Kerala (Figure 8)

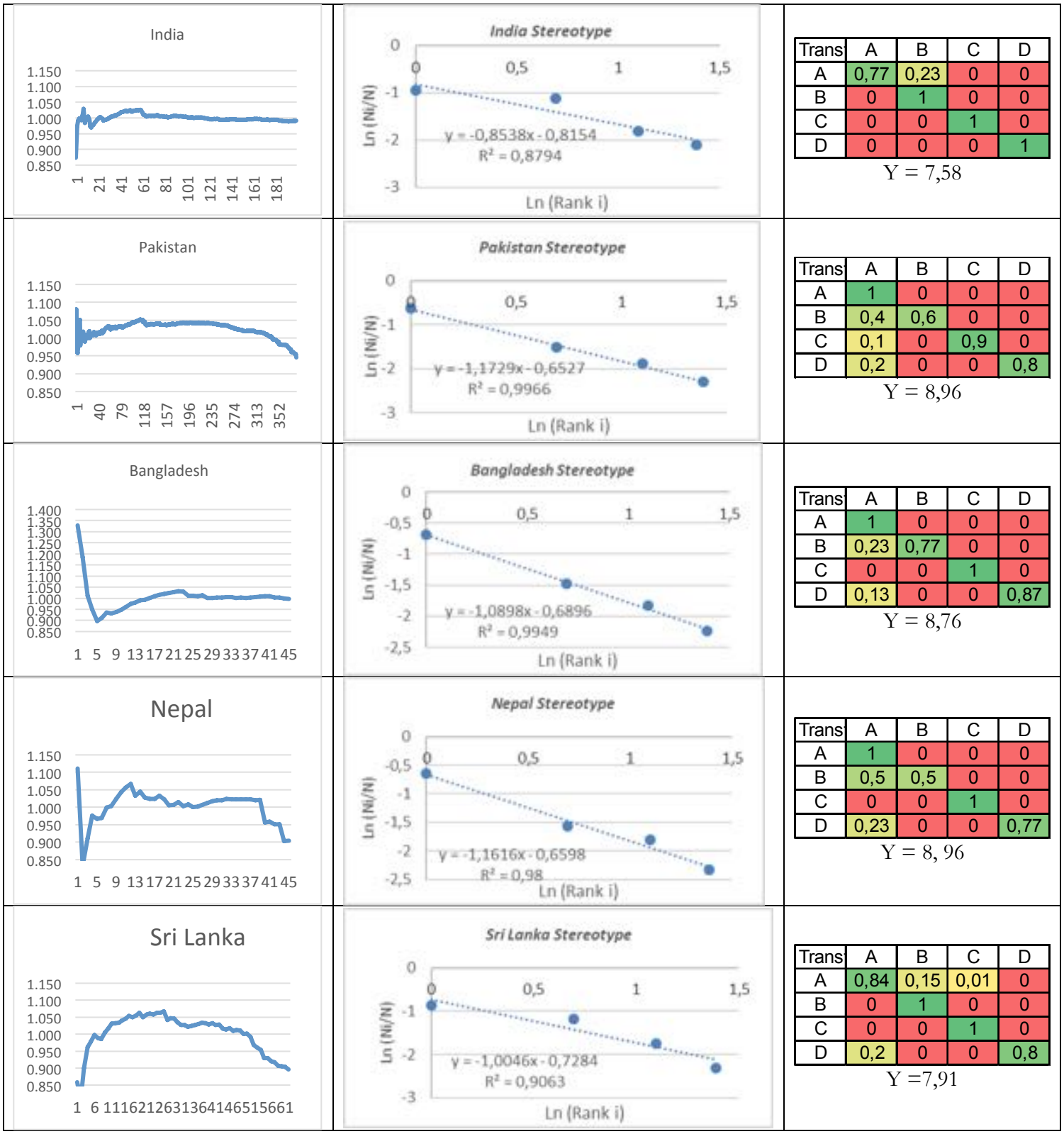

Figure 7: Deviations from the standard distribution and hypothetical causes consistent with the Model

Figure 8: Patterns of Spatial Justice in India

Pakistan is a very different case. On the one hand, there are remote areas that seem to be deprived from their capacity in Kashmir in the North, Karachi in the South and Quetta in the West of the country. On the other hand, in the axe - Peshawar, Islamabad, Lahore - more resources appear to be dedicated to the border regions of Peshawar and Lahore.

Results in other countries are also quite interesting with Bangladesh showing an exploitation of second cities to the benefit of the capital Dhaka. Nepal shows urban concentration in the capital and some provincial areas compensated by the relative deprivation of second rank cities and remote places. Sri Lanka shows a capital with more reduced population than it should have to the benefit of second cities many times located in the surrounding of the capital but like in Nepal and Pakistan

there is a tail of remote deprived regions.

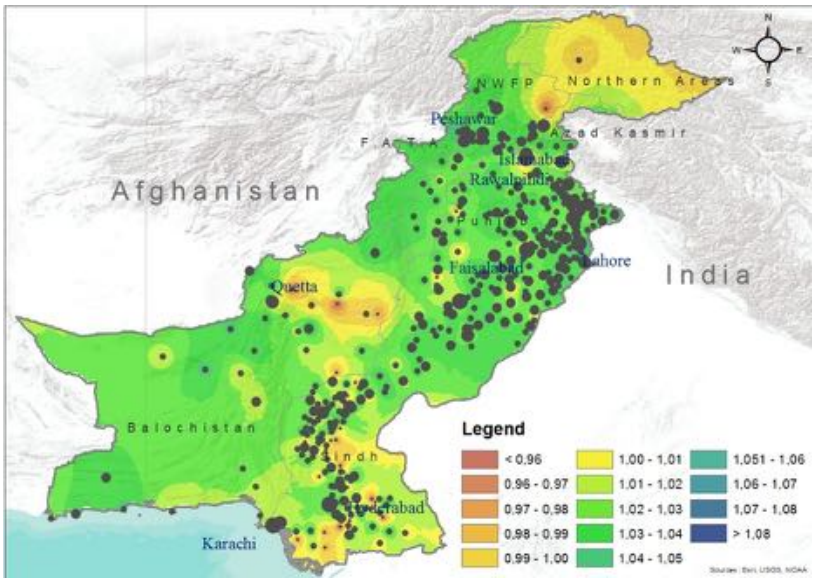

Figure 9: Patterns of Spatial Justice in Pakistan

This is even more important when maps indicate that the areas of conflict are also the regions that are distant from the estimated Zipf's curve. Either up the curve when there is an extra public spending associated to military expenditures as may happen in Peshawar and Lahore in Pakistan and Kashmir administrated by India, or down the curve when conflicts lead to emigration as seems to be the case in Kashmir administrated by Pakistan.

IV. Conclusion

Dentinho (2017) shows that the spatial allocation of property rights over territorial resources has strong effects on the spatial profile of the urban network through the multiplier effects of income associated with rents from natural resources that goes from the places where those resources are located to the places of residence of their owners. The test relates the urban concentration of each country, assessed by the elasticity of the respective Zipf Curve, with the percentage of income coming from the rents of natural resources. These results confirms what Ades and Glaeser (1995) said: Institutions, namely those created by the spatial distribution of property rights over natural resources and by the geographical allocation of public spending, do have a role in the urban concentration throughout space.

The objective of the present essay was to show for the countries in South Asia that there is a spatial profile of justice very much related to governance namely, how policies may influence urban concentration and spatial justice. The paper calculates the The Zipf's Curve estimates for the South Asian countries and maps for India and Pakistan the various city regions in relation to the estimated

Curve. The analysis of the results indicate that the spatial distribution of rents of natural resources and from public transferences may have a role in the spatial distribution of wealth. With other words, there are signs that governance influences spatial justice governance specifically by the spatial allocation of property rights over natural resources and by the spatial distribution of public spending. The issue is very relevant since the maps of spatial justice produced in the essay are also the maps of conflicts.

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