Formation dynamics and distribution function of cities population

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From the data analysis we defined distribution function against the population with 10.000 people or more in the different year's consensuses on the level of various structure units, namely regions, federal districts and the country on the whole. We have studied peculiarities of the distribution function deformation due to the structure units' enlargement. The results show that the population distribution in RF cities does not follow a power-law similar to the ones found in the other countries. We analyze time dependences of population in separate cities and define empiric time behaviors. Using the master equation in the continuous approximation, we obtain the Fokker-Plank equation for the distribution function [1]. In addition, we offer a model where transitions only between neighbour states are possible. Moreover in this case it is proposed the in and out transition probability rate for any states are different. We define condition for the formal equivalence of both models to the problem that is described by the stochastic differential equation with additive and multiplicative white noises [2]. We have analyzed the corresponding Fokker-Plank equation in the Ito and Stratonovich calculus, and obtained a solution of the Tsallis distribution type. On the basis of the time dependences data analysis, we have come to a conclusion that the discussed process can be considered in the framework of network approach, namely, fitness model [3]. It leads to the integral equation for the distribution function whose specific type depends on the fitness parameters distribution. We have compared this result with those of superstatistics and hidden-parameter distribution approach. We have determined the conditions when population distribution function is described by the Tsallis distribution. The authors demonstrate a comparison of theoretical results with those of the data analysis on the cumulative distributions level. We have used the maximum likelihood method for fitting. The obtained results allow us to attribute the specific value of the Tsallis distribution nonextensivity parameter to the empiric curves. We compare the acquired data with analogous results obtained for other countries, where other approaches to the problem analysis under discussion have been applied.

[1] L. E. Reichl, A Modern Course in Statistical Physics. 2ed, Wiley (1998).
[2] C. Anteneodo and C. Tsallis, Journal of Mathematical Physics **44**, 5194 (2003).
[3] G. Bianconi and A.-L. Barabasi, Europhysics Letter **54**, 436 (2001).