Zipfs Law and city development

Background

Economic activity is geographically extremely concentrated in cities, and even more, in the big cities. At present, competition between countries to a large part amounts to competition between their cities. This notion is starting to be embedded in, for instance, Dutch economic policy thinking.

Most countries have a city that is by far the biggest and dominant city. For instance, London accounts for about 20% of the UK's GDP and the next biggest city is much smaller. Indeed, it appears that the distribution of city sizes within a country often follows the Zipfian distribution, that is, the size of any city is inversely proportional to its ranking in the list of city ranked by size.[1] So, competition between countries often boils down to competition between their biggest cities.

This is of particular importance in Europe, which is gradually moving from a set of independent countries to an integrated union. Currently, London and Paris have about the same size. This makes sense, since they are the capitals of countries of about the same size. They also are the biggest cities in de EU. If the EU becomes one single country, and the Zipfian distribution of cities would apply to the EU as a whole, an interesting question is which city becomes the dominant city. One would expect London or Paris to be the foremost contenders for the top spot. This would imply that either London becomes twice as big as Paris of vice versa. And what would happen to the Dutch cities? The economic and political implications of such a change would be large.

A second important issue is the empirical fact that the Zipfian distribution does not hold strictly, i.e. with a power coefficient of one, for all countries. The Netherlands is one of those countries, with many cities of more equal size than the Zipfian distribution would predict. Is that a problem or an asset? What can be the reason for this? What mechanisms drive the observed distribution of city sizes?

Within the field of statistics a Zipfian distribution can be generated by several stochastic processes. Abby Ostriker (2014) did some research in this field, but the results didn't provide answers to the questions above.

Two studies (Mansury and Gulyas, 2007, Gaujal et al., 2014) showed that a Zipfian distribution of cities can also be generated with an agent based model. An agent based model tries to explain complex macro patterns, like city size, on the basis of individual decision making. These individuals take account of their preferences and their perceived environment and they possess some heterogeneity in decision making. In comparison with traditional economic methods, the agent based modeling approach is more simulation oriented and less analytical.

Identifying causal mechanisms for city formation is important for policy issues. The studies of and Gulyas, 2007, Gaujal et al., 2014 are based on the forces of agglomeration and disagglomeration, both specified as a function of current city size. Individuals are attracted by large cities, which is a well know phenomenon in urban economic literature, but with growing city size the disadvantages of size increase gradually. Possibly this model can be extended with other relevant causal mechanisms.

In summary, two research questions that seem to be suitable for agent-based modeling are particularly interesting to policy makers. First, what would happen (and why) if the institutional barriers between countries would disappear? This could be the consequence of a further unification of Europe. Will Paris or London be the winner? And what will happen to Amsterdam? Second, what are the driving mechanisms behind deviations from a strict Zipfian distribution. In what respect are these deviations an advantage or disadvantage?

2. References

Gaujal, B, L. Gulyas, Y. Mansury and E. Thierry, 2014, Validating an agent-based model of the Zipf's Law: a discrete Markov-chain approach. Journal of Economic Dynamics & Control 41 38–49.

Mansury, Y., and L. Gulyas, 2007, The emergence of Zipf's Law in a system of cities: an agent-based simulation approach. Journal of Economic Dynamics & Control 31 2438–2460.

Ostriker, A, 2014, Stochastic growth models for city sizes. Internal CPB Memo.

1 Interestingly, this distribution applies to several other fields as well, for instance languages. In fact research on this distribution started in that field.