

Scientific cooperation in times of unrest: A network-based approach to former Yugoslavia

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Introduction

It is generally accepted that scientific work and scientific cooperation are sensitive to their societal and economic environment. But how strong are they affected by the outbreak of social, economic or ethnic crises? In a recent paper (Jovanovic et al., 2010) we have considered the temporal evolution of scientific cooperation between the successor republics of the former Yugoslavia. Furthermore we have analysed how they were affected by the civil wars and social crises, which took place in that region during the last 20 years. In the present contribution we extend and deepen our previous work by applying methods from network-analysis and a gravity model to the internal and external cooperation network of the republics of former Yugoslavia.

Method

As described in the aforementioned publication we have established a search strategy for the databases *Science Citation Index* and *Social Science Citation Index* which is based on the names of cities within former Yugoslavia. Using the revisited data we analyse the cooperation pattern and their temporal evolution using the *cooperation matrix* C_{ij} , which defines a *weighted network*. We extend the discussion presented in Jovanovic et al. (2010) by additionally considering cooperation with other states all over the world. In doing so, we take into account the different political blocs, viz. western (nations of NATO, EU etc.), socialistic (nations of the former Warsaw Pact) and the Non-Aligned Nations. With this we aim to answer the question whether the scientific communities within the different republics have reorientated themselves in the course of the crises. The time-dependent (weighted) network is analysed by means of standard techniques from network analysis. In particular, we evaluate different measures for the dominance within a network and compare these quantities with our recently introduced *dominance factor* (see Jovanovic et al., 2010).

Furthermore we investigate whether it is possible to quantify the qualitatively observed impact of the civil wars on publication and collaboration activities of the republics of the former Yugoslavia. The first aspect is analysed by defining a suitably chosen trend line for the number of publications as a function of time. This serves as a reference concerning the publication numbers observed for Yugoslavia's successor states. The observed deviation leads to a quantitative measure for the impact of the civil wars on their scientific activities. The second aspect, scientific cooperation, is investigated by means of a gravity model for cooperation as it has been previously introduced by Frenken et al. (2009). We modify this

model in order to take into account tensions between the different republics, by interpreting them as repulsive forces.

Finally the impact of the civil wars on the scientific community in former Yugoslavia is compared with that of other historical events like World War II (see e.g. Cardona & Marx, 2005) or the embargo against South Africa from the mid-1980s to 1994 (Ingwersen & Jacobs, 2004, or Sooryamoorthy, 2010).

References

- Jovanovic, M., John, M., and Reschke, S. (2010). Effects of civil war: Scientific cooperation in the republics of the former Yugoslavia and the province of Kosovo. *Scientometrics* 82: 627-645.
- Frenken, K., Hoekman, J., Kok, S., Ponds, R., van Oort F., and van Vliet, J. (2009). Death of Distance in Science? A Gravity Approach to Research Collaboration. in: *Innovation Networks*. (eds. Pyka, A. & Scharnhorst, A.) p.43–58 (Springer, Berlin).
- Cardona, M. & Marx, W. (2005). The disaster of the Nazi-power in science as reflected by some leading journals and scientists in physics. *Scientometrics* 64: 313–324
- Ingwersen, P. & Jacobs, D. (2004). South African research in selected scientific areas: Status 1981–2000. *Scientometrics* 59: 405–423
- Sooryamoorthy, R. (2010). Science and scientific collaboration in South Africa: apartheid and after. *Scientometrics* 84: 373–390