

# The Scientific Competitiveness of Nations: a network analysis

Andrea Gabrielli <sup>1,2</sup>, Giulio Cimini <sup>2,1</sup>, Francesco Sylos Labini <sup>3,1</sup> and Andrea Zaccaria <sup>1</sup>

- 1. Istituto dei Sistemi Complessi (ISC) – CNR, Rome, Italy
- 2. Institute for Advanced Studies – IMT, Lucca, Italy
- 3. Centro Studi e Ricerche “Enrico Fermi”, Rome Italy

We use citation data of scientific articles produced by individual nations in different scientific domains to build a bipartite country - scientific domains network to determine the structure and efficiency of national research systems [1]. We characterize the scientific fitness of each nation—that is, the competitiveness of its research system—and the complexity of each scientific domain by means of a non-linear iterative algorithm [2] able to assess quantitatively the advantage of scientific diversification. We find that technological leading nations, beyond having the largest production of scientific papers and the largest number of citations, do not specialize in a few scientific domains. Rather, they diversify as much as possible their research system. On the other side, less developed nations are competitive only in scientific domains where also many other nations are present. Diversification thus represents the key element that correlates with scientific and technological competitiveness. A remarkable implication of this structure of the scientific competition is that the scientific domains playing the role of “markers” of national scientific competitiveness are those not necessarily of high technological requirements, but rather addressing the most “sophisticated” needs of the society. We complement this analysis with a correlation study between the scientific impact of a nation with a normalized measure of RD funds and the level of internationalization [3].

[1] G. Cimini, A. Gabrielli, F. Sylos Labini (2014), PLoS ONE **9**(12), e113470.  
[2] A. Tacchella et al. (2013), Sci. Rep. **2**, 723.  
[3] G. Cimini, A. Zaccaria, A. Gabrielli (2016), J. of Informetrics **10**, 200.

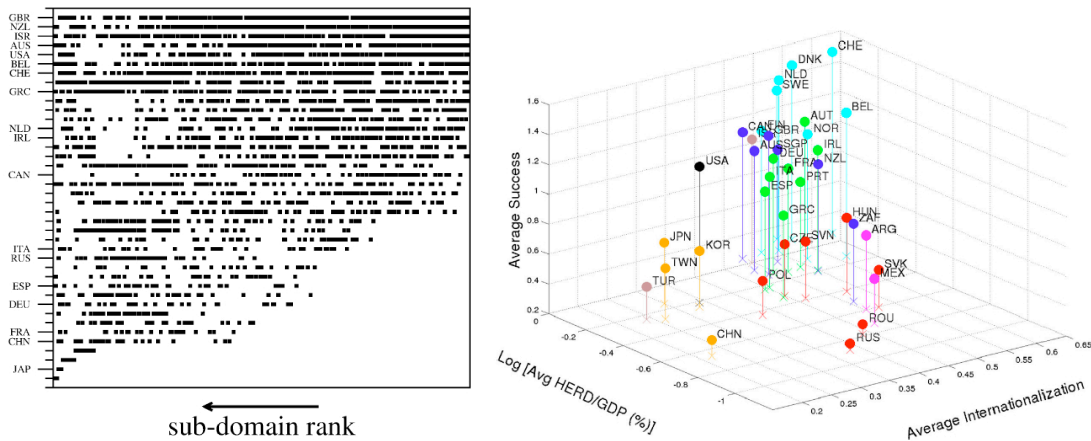


Figure 1: (a) Countries ordered by decreasing scientific fitness vs scientific domains ordered by increasing complexity as defined in [1]: black dots indicates that a country is a “good” scientific producer in that domain; (b) 3-d scatter plot of scientific success of nations as defined in [3], HERD/GDP and Internationalization level of the national scientific activity