

# **Student and Teaching Mobility & Knowledge Transfer: a social network analysis study**

*Zsolt T. Kosztyán, László Gadár, András Telcs*

*(MTA-PE Budapest Ranking Research Group, Hungary)*

**Abstract:** The third mission of universities focuses on the social impacts of the higher education. However, the social impacts are very hard to measure. One of the most promising quantitative method is the social network analysis which can be applied to the network of university collaboration and the student mobility. The student mobility is a kind of cultural exchange, still, student or faculty members' mobility may promote collaborations. We investigate correlation and overlaps of Erasmus mobility network of students and researchers and the collaboration network of EU-funded projects. We found that there are moderate positive correlation between Erasmus faculty mobility and the collaboration in EU-funded projects while almost non between the former one and scientific collaboration.

**Keywords:** Multi-Network Analysis, Collaboration Networks, Mobility Networks

## **1. Introduction**

The first collaborative scientific paper was published in 1665 (Luukkonen et al., 1992). In 1984 the European Union launched the First Framework Programme with the aim of coordinating individual research activities and enhancing cooperation between researchers (Georghiou, 2001). Since then, in their highly cited paper, Katz and Martin (1997) gave a definition of research collaboration as researchers working together to accomplish the common goal of creating new scientific knowledge. From the beginning, scientific research went through three periods and now we are living in the fourth one where research is driven by collaborations between international elite research groups (Adams, 2013). The formulation of these groups gives an excellent opportunity to study the networks emerge from their activity. Until now, to our best knowledge, most of the studies focused only on the collaboration networks and the connection between collaboration and mobility networks is not investigated.

In 1987 the European Union (EU) launched the Erasmus program, which allowed more than three million European students to open up a part of their studies to other European higher education institution or to a European organization. 28 member states of the European Union and 6 non-EU countries joined to program in different dates from 1987 to 2009 with the aim of creating "European dimension" of education. As stated by the European Commission, Erasmus students exchange reflects several important features, equally contributing to strengthen the existing relations between the European peoples, the institutional integration among European countries, the openness of national tertiary systems and the relative attractiveness of a country, either in terms of its culture or in terms of reputation of its tertiary education system (Waibel et al., 2017).

Both properties of mobility and collaboration can be a good proxy of the social impact of the universities. While collaboration networks contain direct connections between non-university organizations, mobility network shows the "attractiveness" both the universities and the location of the universities.

## 2. Data sources

### 2.1. Mobility networks

We investigated the Erasmus mobility of students, researchers and staff using database of travels between 2008 - 2014 from EU Open Data Portal (<https://data.europa.eu/euodp/data/>). The network nodes are the universities and two type of edges we have: 1.2M student and 180k teacher travels between 3,200 institutes in 8 subject areas.

### 2.2. Collaboration network

The collaboration database (<https://data.europa.eu/euodp/data/dataset/cordisfp7projects>) of EU funded projects of 7-th Framework Program consists of 30k organizations from 163 countries and more than 100k projects, which started between year 2007-2014. The collaboration network also consists non-EU countries, therefore, in order to compare mobility and collaboration networks only the organizations of EU28 countries are included in our study. The Higher Education Institutes (HEI) represent only 31% of all the collaboration network, we also include only that part of the database.

However, while the collaboration database are restricted, node (i.e. organization) properties, such as number of connections (i.e. node degrees) are retained.

## 3. The studied multi-layer network

Our multi-layer network consisted on three non-interconnected layers. Layer 1 and layer 2 consist of organizations in Erasmus student and teacher's mobility network. While the layer 3 consists of the organizations in the collaboration network (see Figure 1).

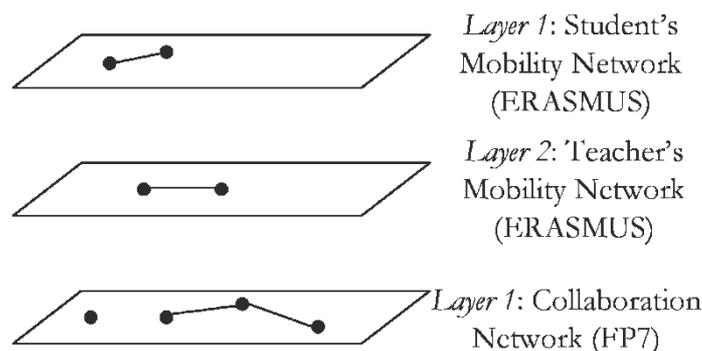


Figure 1. The structure of the multi-layer network

## 4. Results

Due to the page limit in this section we demonstrate a few key results of our study only.

#### 4.1. Attractiveness of HEIs

The weak connection between the number of incoming students and scientific and collaboration excellence, measured by Leiden's Ranking (see Table 1), demonstrates that the attractivity of the location plays superior role to the excellence of the university, which is a consequence of motivations of Erasmus students mobility (Lesjak et al., 2015).

	Student	Teacher
Biomedical and health sciences	0.41	0.15
Life and earth sciences	0.31	0.12
Mathematics and computer science	0.63	0.12
Physical sciences and engineering	0.36	0.02
Social sciences and humanities	0.53	0.04

Table 1. Kendall  $\tau$  values of Erasmus network centrality based rank and the number of cross-border co-authorship publication based rank from Leiden rankings by subjects

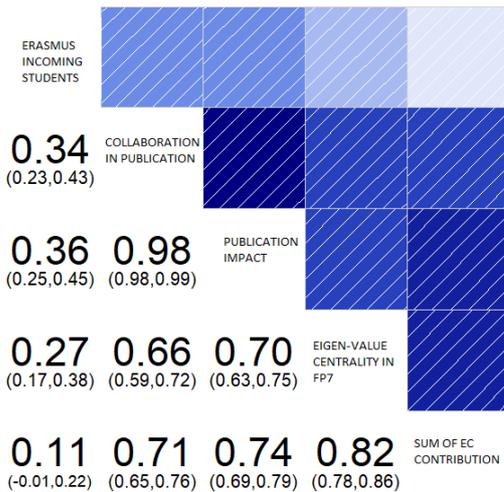
#### 4.2. Main network properties of the collaboration network

The degree distribution of nodes follow power-law in all sub-programs. It is worth to observe that the probability of connection depends from the geographic distance, and as a consequence several non-connected subcomponents (clicks) are emerged. The collaboration network is disassortative for all countries and for all sub-programs. Results reflect a hierarchical structure of network with horizontally sparse connections, which does not really help the knowledge transfer.

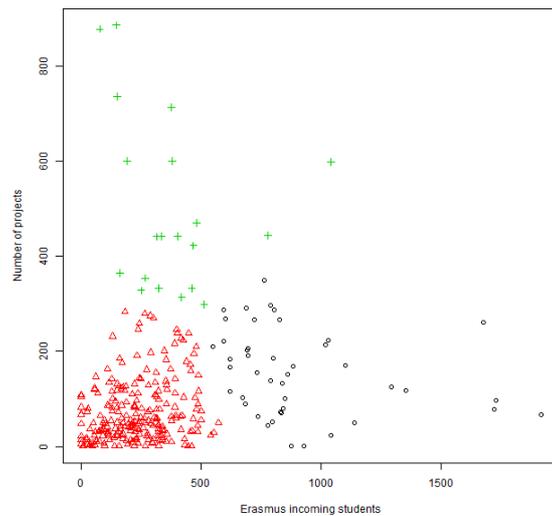
### 5. Results

The intersect of data sources consists of 300 HEIs. Our calculations showed, that there are strong positive rank correlation between the collaboration properties, such as Leiden rankings of collaborated publication and the embeddedness in a collaboration network (measured by eigen-vector centrality). Meanwhile, positive but weaker correlation are observed between the rate of mobility and collaboration (see Figure 2(a)).

We performed clustering of HEIs with respect the mobility and collaboration rate. The result of clustering shows that 3 clusters can be identified (see Figure 2(b)). One can immediately notice that the "lower left, third quadrant" where both rate of visits and projects are low is well populated, while the "upper right, first" quadrant almost empty. The second and fourth are moderately populated, showing also that if there is any correlation between the indicators, it is resulted only by the elements of the third quadrant. Despite of the fact that we incorporated into the study those HEIs which are in the Leiden's ranking system, and therefore, have considerable publications with collaborations, the participation in the Erasmus program and EU-funded FP7 programs are low. Several universities concentrate on participating EU-funded projects, but other ones are more attractive for students. It is interesting to observe that very few organizations can be found, for which, both the number of incoming Erasmus students and the number of earned projects are high.



(a) Rank correlations between node properties



(b) Results of k-means clustering between node properties

Figure 2. Relationships collaboration and mobility network properties

## 6. Summary and conclusions

The study of social impact of the universities is an emerging field. In this short report we tried to demonstrate that social network analysis may contribute to such investigation. In particular the study of multi-layer networks such as mobility, scientific and project collaborations can provide a new insight to the patterns and consequences of students' and teachers' activity. We found that one can't find strong impact of Erasmus mobility on scientific and FP7 project collaborations.

## References

- T. Luukkonen, O. Persson, G. Sivertsen, Understanding patterns of international scientific collaboration, *Science, Technology, & Human Values* 17 (1992) 101-126.
- L. Georghiou, Evolving frameworks for European collaboration in research and technology, *Research Policy* 30 (2001) 891-903.
- J. Katz, B. R. Martin, What is research collaboration?, *Research Policy* 26 (1997) 1 - 18.
- J. Adams, The fourth age of research, *Nature* 497 (2013) 557560.
- S. Waibel, H. Rüger, A. Ette, L. Sauer, Career consequences of transnational educational mobility: A systematic literature review, *Educational Research Review* 20 (2017) 81-98.
- M. Lesjak, E. Juvan, E. M. Ineson, M. H. T. Yap, E. P. Axelsson, Erasmus student motivation: Why and where to go?, *Higher Education* 70 (2015) 845865

**Zsolt T. KOSZTYÁN** is Associate Professor and head of the Department of Quantitative Methods, University of Pannonia and Senior Research Fellow in MTA-PE Budapest Ranking Research Group.

His research interest is the development of methodologies to manage complex management problems relating to mathematical models and algorithms of project management, production and maintenance. This research area is on the frontier between Management Science and Applied Informatics.

He has won award of Best Researcher of the Year 2013; he is the winner of the Regional Committee of the Hungarian Academy of Sciences in Veszprém.

In 2013 he won Zoltán Magyary and in 2013 and 2015 he won János Bolyai post-doctoral research fellowships.

He is a Board member of the Forum of Business Information Systems, a professional working group of John von Neumann Computer Society.