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EDITORIAL

SPECIAL FOCUS: THE GLOBAL COVID-19 CHALLENGE

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This number of the ISSI newsletter comes out with considerable delay. There were and still are severe reasons for that delay: The collection and preparation of the contributions for the present number was accompanied and overshadowed by the outbreak and spread of the COVID-19 pandemic. Therefore, we decided to put a relevant article – on modelling the diffusion patterns of COVID-19 and a scenario-driven thinking in forecasting the course of the pandemic – at the heart of the present issue of the Newsletter. The paper by Decock et al. (p. 2–6) is co-authored by our colleagues at KU Leuven. Extended versions and follow-ups of this contribution will be published in international scientific journals very soon.

In this context we would like to mention, that in a further article on COVID-19 (Zhang, L., Zhao, WJ., Sun, BB., Huang, Y., Glänzel, W. (2020), *How scientific research reacts to international public health emergencies: a global analysis of response patterns*, *Scientometrics*, in press), the two authors of this editorial jointly study with their co-workers how scientific research reacts to international public health emergencies. The article, which is to come in one of the next issues of the journal *Scientometrics*, provides the bibliometric characteristics and a comparative analysis of global academic response patterns to global public-health emergencies in previous pandemics/epidemics of this century with that experienced in the present situation of COVID-19.

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A MULTILAYER NETWORK ANALYSIS OF MOBILITY AND COLLABORATION IN EUROPEAN UNIVERSITY RESEARCH



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ABSTRACT: The present report gives an overview of a recent joint Hungarian-Flemish project funded by the Research Foundation - Flanders (FWO). The project aimed to study European university research from the viewpoint of scientists' mobility and collaboration patterns of the most important universities of selected countries.

INTRODUCTION

A two-year joint research project between the ECOOM team at KU Leuven and the Budapest Ranking Research Group at Hungarian Academy of Sciences were conducted during 2018 and 2019. This project aims to provide a high level of analytic and visualization system to explore the scientific contribution of European universities. Based on its capacities the parties studied and developed fine-tuned, targeted university multilayer networks. In short, the partners created a database which is basically a multi-labelled graph in which vertices are institutions and edges are citations. Institutions carry some feature describing labels while edges carry labels describing the citation relation in details (publication time, citation time, subject classification etc.). Unlike other endeavours, this project did not aim to conduct any ranking exercise, which provided us the liberty to choose appropriate data sources and to select European countries and universities for a more complex multilayer exercise. In particular, we have selected the following data sources to highlight on essential aspects in researchers' mobility and collaboration.

The Erasmus mobility network – used to investigate spatial characteristics for geocoded institutes – was enriched with the integration of mobility data and three databases: the institutional socio-economic data of the European Tertiary Education Register (ETER)¹, the Global Research Identifier Database (GRID)² as well as points of interest concerning surrounding institutions. The network provides relevant information of the mobility patterns and the attractiveness of the institutions. A publication network for the 2013 data with weighted links was based on bibliographic coupling and conducted to further university clustering. The Academic Space Explorer (ASE) system was then adapted with some filtering, clus-

tering and analytic tools to illustrate the evaluative profiles of European countries and the interconnections between universities in Belgium, Germany and Hungary.

RESULT SUMMARY

The project cooperated by two institutions, KU Leuven and Hungarian Academy of Sciences, generated several national and international research outputs, for a national conference (Csányi, 2019), three contributions for international conferences (Kosztján et al., 2018a, 2018b; Fehérvölgyi, et al, 2019), four papers for international peer-reviewed journals (Gadár et al., 2018; Gadár & Abonyi, 2019; Gadár et al., 2019; Kosztján et al., 2019) and six research seminars organised in Budapest and Leuven. In what follows, we introduce and summarise the main findings of these results.

The Erasmus activity network served as the main source of tracking mobility and analysing European networks from this perspective. The student and teacher mobility patterns based on 2013/2014 Erasmus data are somewhat different (see Figure 1; top: students, bottom: teachers). This is to a certain extent due to the different motivations for and durations of their stays abroad. Generally Spanish universities attract more students and academic teachers compared to their outgoing ones. By contrast, Turkish and Polish universities have a disproportionate number of outgoing teachers as compared with the incoming ones, whereas German and Italian universities have much more outgoing students than incoming ones. Figure 1 also illustrates the active participation of Spanish universities in the Erasmus project.

In order to gain a deeper insight into the Erasmus student mobility, activities in three different subject areas were studied (cf. Figure 2). We have selected applied fields in the sciences along with the humanities based on Erasmus project classification. In particular, in Social science,

¹ <https://www.eter-project.com/>

² <https://www.grid.ac/>



Figure 1. Scatter plots of 2013/2014 Erasmus incoming vs. outgoing staff. Top: students; bottom: academic teachers

Business and Law, Spanish universities attract more students from other universities than their own students who leave for staying at other institutions abroad. In Science, Mathematics and Computing, Nordic and some Belgian and Dutch universities show their advantage to attract more students from other universities than sending out their own students. In Health and Welfare, a few universities from Italy, Czech Republic, Sweden, Denmark and Hungary show their receiving role for unproportionally more incoming than outgoing students. The observed subject-related difference revealed in Figure 2 points us a new direction to dig in from the mobility data. We further looked at the spatial multiplex network of the student mobility based on the determined GPS coordinates in the three main subject areas.

Figure 3 – inspired by Gadár et al. (2019) – linked the data from the Erasmus project, the European Tertiary Education Register (ETER) and the Global Research Identifier Database (GRID) to convert a spatial network on geographical map. It shows different connections in the three subject areas. In Social science, Business and Law, the connections between the UK and European countries are strikingly strong. Universities in Spain, France, Germany, Belgium and Italy are also important contributors in the Erasmus student mobility network. In the field Science, Mathematics and Computing, Nordic universities play a more important role in the network. Finally, in Health and

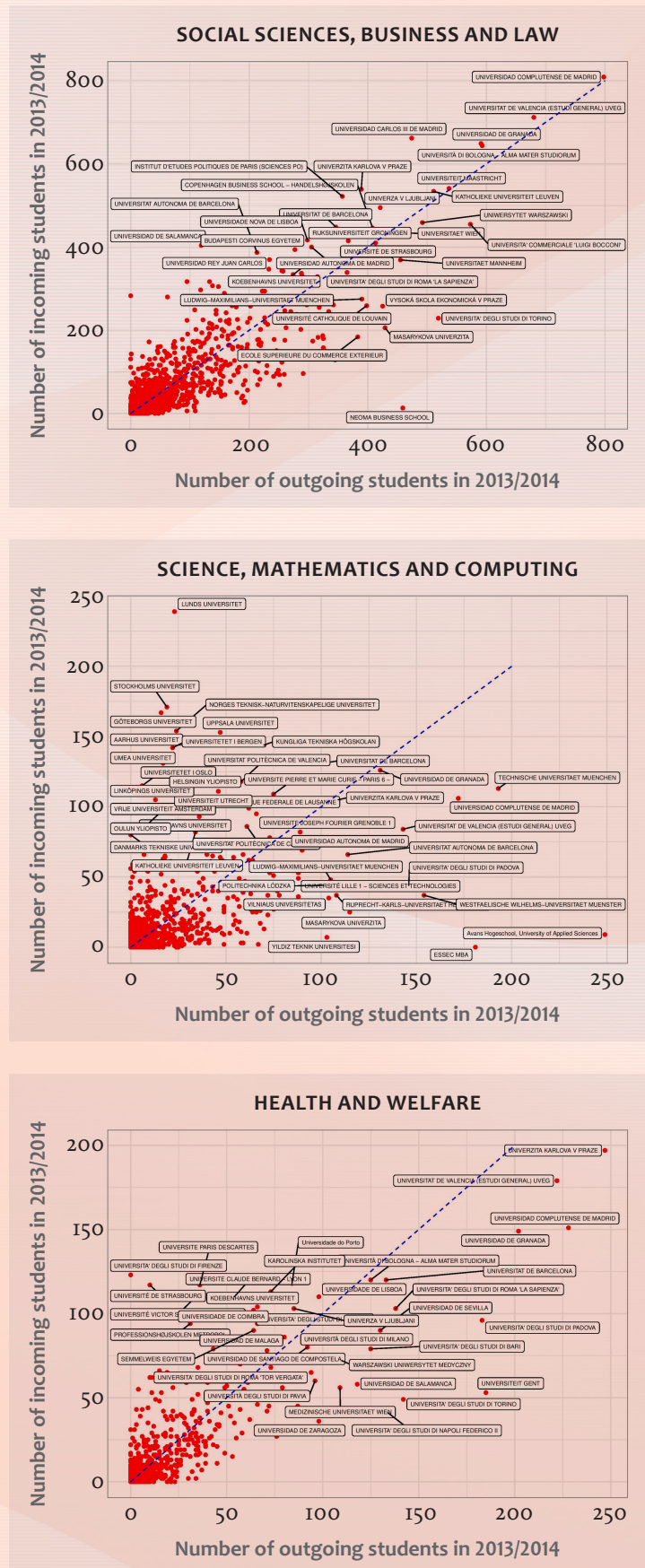


Figure 2. Scatter plots of 2013/2014 Erasmus incoming VS. outgoing students in different fields. Top: Social science, Business and Law; Middle: Science, Mathematics and Computing; Bottom: Health and Welfare



Figure 3. Mobility networks with different subject dimensions in the 2013-2014 academic year similarly to Gadár et al. (2019). The size and colour intensity of the nodes are proportional to the number of incoming students. The size and colour intensity of the edges are proportional to the number of students that travel between the connected HEIs. Top: Social science, Business and Law; Middle: Science, Mathematics and Computing; Bottom: Health and Welfare

Welfare sciences, The Netherlands is sending a large number of students to Denmark. Italy, Spain and Czech Republic are central nodes of student mobility in this field.

A further perspective to focus on the countries we are especially interested in, was taken and presented in Figure 4. This new dimension was added on the basis of scholarly collaboration measured by co-authorship of scientific publications indexed in Clarivate Analytics Web of Science Core Collection (WoS). Although the time frames and actors are different in these dimensions, i.e., we have not studied the publication patterns of the Erasmus students but the complete research staff affiliated with the selected universities, at this level of aggregation this approach may add a new dimension not directly linked to the network created by previous actors. To zoom into targeted countries, the student and teacher mobility and scholarly publication collaboration networks were limited into the international connections among Belgium, Germany and Hungary. Regarding the student mobility, universities in Berlin are highly connected with Flemish universities and universities in Budapest. Universities in Cologne area and Munich area received and sent out many students from or to universities in Budapest and Flanders. The teacher mobility was more equally distributed among universities. The connections from Hungary are not as strong as those among Belgium and Germany. In terms of WoS publications in 2013, Belgian universities strongly collaborated with the other two countries, especially with German universities.

DISCUSSION AND FUTURE RESEARCH

The joint project has offered a new perspective. The usual macro and meso bibliometric study of research collaboration and the socio-bibliometric analysis of students' and researchers' mobility could be

combined into a first multi-layer framework, even if only a small number of institutions could be taken into account. Overlapping network layers indicate how correlated (or not) mobility and research collaboration systems are with each other. Based on our preliminary results, there does not appear to be a significant overlap between mobility and research collaborations, due to the different motivations and driving forces of different collaboration.

In the present project we could much benefit from our local knowledge and experience, which was all the more important because we had to clean a large amount of data on the bibliometric part for the integration into the framework. The main objective and achievement of the project was therefore rather the creation of the framework and the elaboration of the possible components of this multi-layer network. Figure 4 has shown that different patterns can be attributed to individual components. Beyond the programmes enabling student and staff mobility, there are different individual interests influencing and shaping the patterns of student mobility particular making destinations attractive on the long-term (education, career) compared to rather short-term teacher mobil-



Figure 4. Mobility and scholarly collaboration international networks between Belgium, Germany and Hungary. Top: students; Middle: academic teachers; Bottom: WoS publications

ity. Collaboration patterns are, by contrast, influenced to a lesser extent by individual interests as those are part of larger, mostly subject-specific, European and even global collaboration frameworks. These patterns can be recognised in Figure 4. The sparser mobility networks top and notably in the centre is contrasted by the denser collaboration networks that are often based multilateral projects. This also implies the involvement of more universities and the higher density of networks. At the future works, subnetworks of subjects can be compared. In addition, further layers can be integrated to the multilayer structure such as co-authorship network of publications and the patents. In this way the mobility and collaboration activities of HEIs can be deeper analysed.

A further recognition in the project is that we found different network patterns in subject area layers, which is mostly related to the characteristics of the institutions. In case of real sciences, the attractiveness of Northern European universities for student mobility is apparent, while in other subject areas Southern European institutions receive the most students. The characteristics of institutions depend on the representation of disciplines moreover the educational and/or research and/or innovation focus of the institution. Different characteristics result different collaboration systems resulting different network patterns. Future research directions could be the examination of correlations between the strength of institutions, the position of higher education rankings and the characteristics of the emerged collaboration networks.

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