Territorial Development – JRC Policy Insights

TERRITORIAL DEVELOPMENT INSIGHTS SERIES - June 2024

RESEARCH AND INNOVATION COLLABORATION NETWORKS ACROSS EU REGIONS OVER 2014-2020

MARIE LALANNE AND NIELS MEYER

- Co-patents data show that Research and Innovation (R&I) collaborations are fragmented nationally and with a strong cross-border effect in the EU.
- The two main EU R&I policies (Framework Programme and Interreg Europe Programme) help overcoming these effects by steering R&I collaborations across Europe.
- Additionally, the two EU R&I policies seem to display some synergies: participation in Interreg 2014-2020 Europe Programme is positively correlated with participation in Horizon 2020 (H2020).
- Finally, being well-positioned in the network of R&I collaborations created through the Framework Programme has a positive impact on the patenting activity of EU regions.

1. CONTEXT

Collaborative research has steadily increased over time (Wuchty et al., 2007). It aims at solving complex problems but also saving research costs, avoiding duplicated research efforts, enhancing knowledge spillovers and minimising the fragmentation of research (Katz and Martin, 1997; Jones, 2009). The EU R&I policy could benefit from these advantages to build a strong R&I environment.

Two programmes of the EU R&I policies play an important role in increasing the connectivity of EU R&I environment by funding organisations: the Framework Programme, which aims to support and foster research in the European Research Area, and the Interreg Europe Programme, whose objective is to help reduce disparities in the levels of development, growth and quality of life in and across Europe's regions. Co-patents and co-publications data can additionally serve as good indicators of collaboration in the field of R&I and partially reflect outcomes of the two EU R&I programmes.

The policy impact of this research

The analysis included in this Policy Insight is featured in the 2024 Science, Research and Innovation Performance of the EU (SRIP) report (European Commission, 2024).

This policy brief provides an overview of the connectivity of the EU R&I environment across EU regions for the period 2014-2020, by focusing on these four networks of collaborative research. To do so, it collapses the data at the regional level and focuses on connections across regions. It further investigates the potential synergy between the two EU R&I policies for the 2014-2020 period (Horizon 2020 (H2020) for the Framework Programme and Interreg 2014-2020 for the Interreg Europe Programme) and the impact of the different Framework Programmes over time (and the network of collaborations they produce) on the patenting activity of regions.

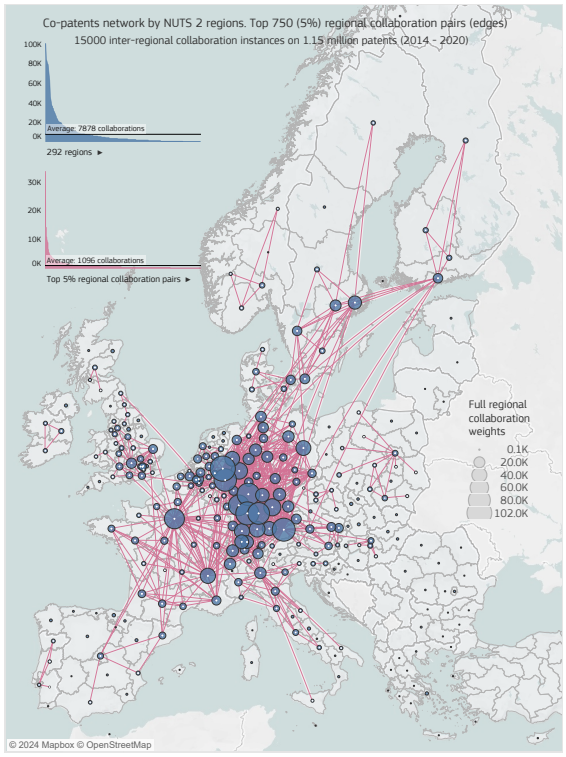
2. THE FOUR NETWORKS OF R&I COLLABORATIONS

We first display the different R&I collaborations networks for the 2014-2020 period over the European map. Even if the four networks display the usual geographical concentration of R&I activity – mainly along the Rhein Valley connecting German, French, Belgian and Swiss regions, and in capital cities - some differences can be highlighted, in particular between the co-patents network and the two networks created by the EU R&I policies (H2020 and Interreg 2014-2020). A large majority of co-patenting collaborations occur within regions and, if inter-country, they mostly involve cross-boarder regions, notably along the Rhein Valley, see Figures 1 and 2). To some extent, this is also true for co-publications (see Figure 3).* By contrast, the EU R&I Programmes (H2020 and Interreg 2014-2020) seem to be able to overcome these country and cross-border effects by steering collaboration across the EU (see Figures 4 and 5).

* Because the co-patents data include both academic and private firms co-patenting, they appear more spatially concentrated than the co-publications data, which reflect the higher mobility of academics.

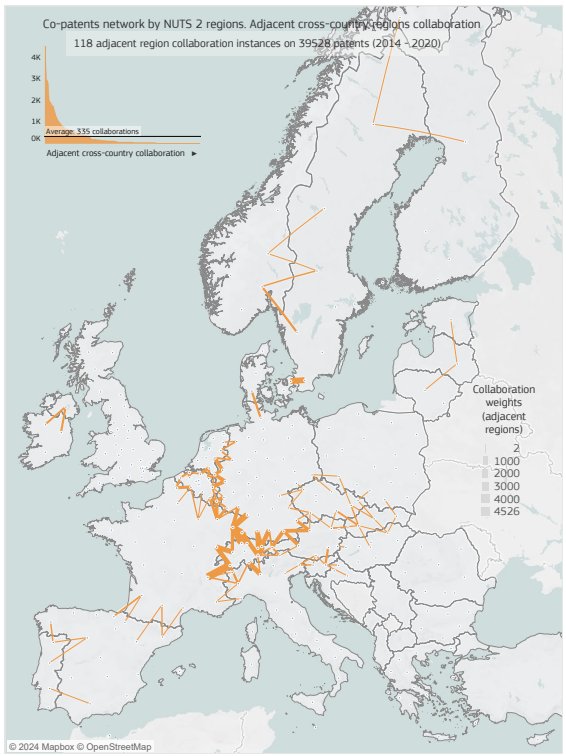
JRC136781 - Seville, Spain: European Commission, 2024 - © European Union, 2024

Figure 1. Co-patents network of R&I collaborations across EU28 + EFTA regions for the period 2014-2020



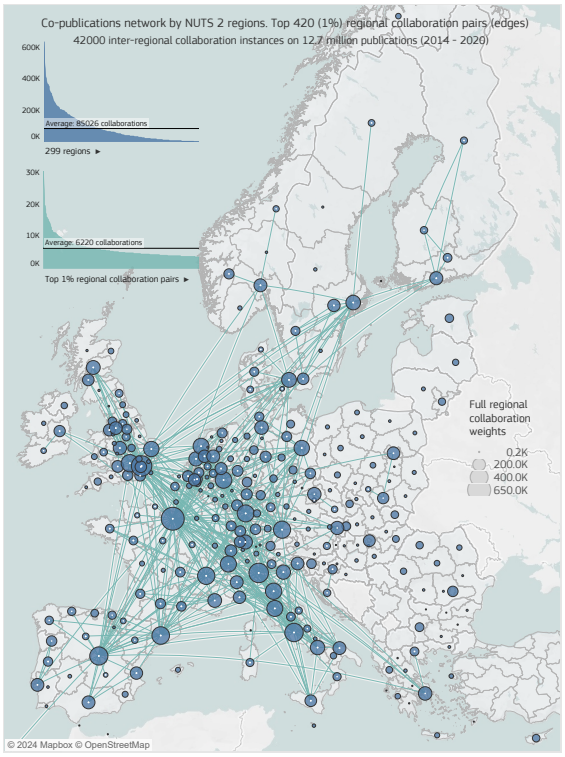
Source: Own elaboration based on REGPAT data. For more details see methodological note in Box 1.

Figure 2. Co-patents network of R&I collaborations across EU28 + EFTA regions for the period 2014-2020 – the cross-border effect



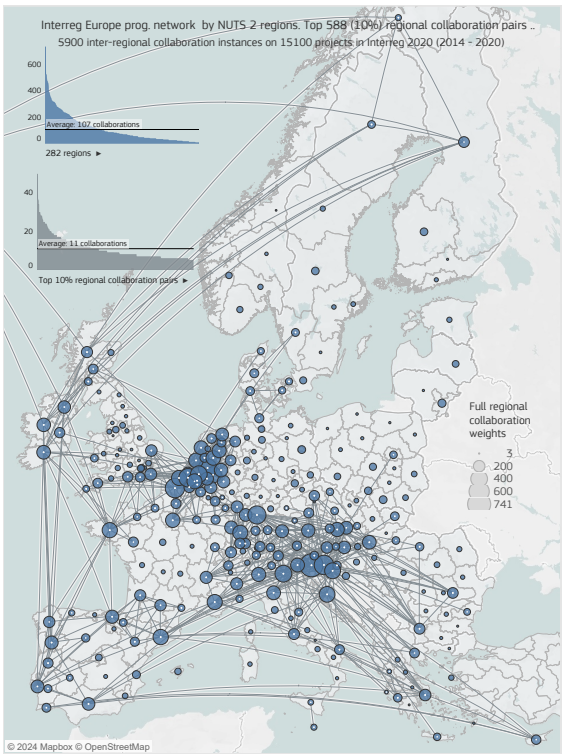
Source: Own elaboration based on REGPAT data. For more details see methodological note in Box 1.

Figure 3. Co-publications network of R&I collaborations across EU28 + EFTA regions for the period 2014-2020



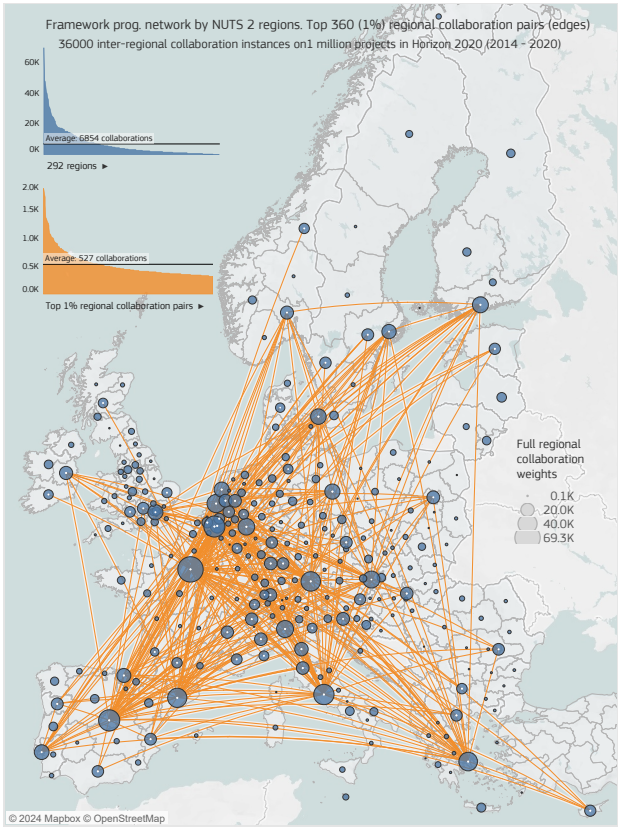
Source: Own elaboration based on REGPAT data. For more details see methodological note in Box 1.

Figure 4. Interreg Programme network of R&I collaborations across EU28 + EFTA regions for the period 2014-2020



Source: Own elaboration based on keep.eu data. For more details see methodological note in Box 1.

Figure 5. Framework Programme network of R&I collaborations across EU28 + EFTA regions for the period 2014-2020 (Horizon 2020)



Source: Own elaboration based on eCorda API v.6 of the European Commission (date of extraction 06/10/2023). For more details see the methodological note in Box 1.

We then present some comparative analysis of the general characteristics of the four networks (see Table 1). While the four networks include most of the EU28+EFTA regions†, the number of inter-regional collaborations is higher for the co-publications and the H2020 networks. This is also reflected in the average number of collaborations per region (between some 250 and 300 for co-publications and H2020 versus circa 100 for co-patents and less than 50 for Interreg 2014-2020). The geodesic distance represents the length of the shortest path between any two regions in a network and is relatively short for Interreg 2014-2020, H2020 and the co-publications networks: each region is only two steps away from any other EU region. On the contrary, this distance doubles for the co-patents network, reflecting the fact that co-patents collaborations are harder to achieve and more selective. As can be also seen in the maps, the networks' densities are higher for H2020 and the co-publications networks and is the smaller for Interreg 2014-2020. Finally, the clustering coefficient gives the probability that two partners of a region are themselves partners together and this again occurs with a higher probability for H2020 and the co-publications networks, as compared to co-patents and Interreg 2014-2020 networks.

Table 1. General characteristics of the four networks of R&I inter-regional collaborations (Interreg 2014-2020, H2020, co-publications and co-patents, EU28+EFTA regions, 2014-2020).

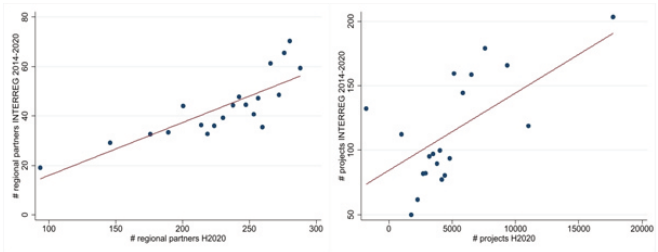
	Interreg Europe Programme (Interreg 2014-2020)	Framework Programme (H2020)	Co-publications	Co-patents
Number of regions	283	297	298	297
Number of collaborations	5883	35985	41596	15101
Average (standard deviation) number of collaborations per region	41.576 (25.963)	242.32 (54.27)	278.234 (33.243)	101.690 (59.799)
Geodesic distance	2.14	1.94	1.97	4.65
Density	0.147	0.75	0.819	0.344
Clustering	0.401	0.852	0.892	0.599

Source: Own elaboration based on eCorda, keep.eu and REGPAT data.

3. SYNERGY BETWEEN INTERREG 2014-2020 EUROPE PROGRAMME AND H2020

A strong synergy between EU R&I policies can further enhance the connectivity of the EU R&I environment. Figure 6 suggests that the participation of a region in Interreg 2014-2020 (as evidenced by the number of projects in which it is involved or by the number of regional partners) is positively correlated with its participation in H2020.

Figure 6. Correlation between the number of regional partners (of projects) in Interreg 2014-2020 and the number of regional partners (of projects) in H2020



Source: Own elaboration based on keep.eu data for Interreg 2014-2020 and on eCorda API v.6 of the European Commission (date of extraction: 06/10/2023) for H2020.

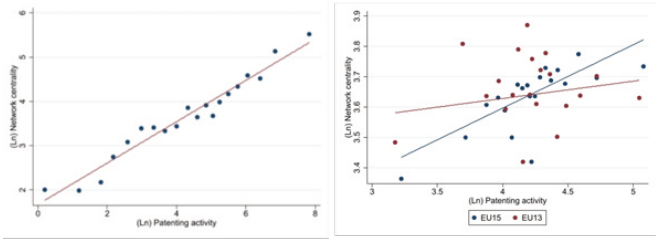
Note: For more details see the methodological note in Box 1.

† The number of regions participating in the Interreg Europe Programme is smaller due to the participation requirements of the programme.

4. IMPACT OF FRAMEWORK PROGRAMMES ON REGIONAL PATENTING ACTIVITY

R&I collaborations created by the Framework Programmes can enhance the patenting activity of EU regions. Figure 7 shows a positive correlation between the centrality of a region in the network created by the Framework Programme and its patenting activity (left figure). A subsequent heterogeneity analysis comparing EU15 and EU13 regions (i.e. those regions who join the EU before and after 2004) shows that, while both types of regions benefit from being central in the network of R&I collaborations, EU15 regions benefit relatively more as compared to EU13 regions.

Figure 7. Correlation between network centrality of a region in R&I collaborations networks created by the EU Framework Programmes and patenting activity of the region, overall (left figure) and distinguishing EU13 and EU15 regions (right figure).



Source: Own elaboration based on on eCorda API v.6 of the European Commission (date of extraction: 06/10/2023).

Note: For more details see the methodological note in Box 1.

Box 1 – Methodological note

- Data: We create four networks of R&I interregional collaborations for EU28+EFTA regions (NUTS2 2021 classification) over the 2014-2020 period. The four networks are based on Interreg 2014-2020 Europe Programme (INTERREG), Horizon 2020 (H2020), co-publications and co-patents data. A R&I interregional collaboration consists in a joint participation in an INTERREG or a H2020 project, in a co-publication or in a co-patent, depending on the network under study.

- For the four networks, we only keep data on EU28+EFTA regions (therefore we discard other regions as nodes) and discard data on EU28+EFTA regions with missing NUTS2 level information (4.82% of all data, representing 11945 observations and coming from H2020). We drop loops (collaborations within a same region between different entities), multi-edges (several collaborations between the same two regions) and transform them into edge weights (the higher an edge weight, the higher the number of collaborations between the two regions).

- Maps (Figures 1, 3, 4, 5): For a better visualisation overview, we only display the top 1%, 5%, or 10% of the regional collaboration pairs with the highest number of connections. For Figure 2 the full dataset is visualised.

- Network descriptive statistics (Table 1): for each network, we compute: (i) the number of nodes (i.e. regions participating); (ii) the number of edges (i.e. whether at least one collaboration exists between any two regions and if yes, the number of such collaborations) and the average and standard deviation of edges per nodes (i.e. the average and standard deviation of collaborations per region); (iii) The geodesic distance (i.e. the length of the shortest path between any two regions in the network); (iv) the density (i.e. the proportion of existing edges over the total number of possible edges); (v) the clustering (i.e. the probability that two neighbouring regions are themselves neighbours where a neighbour region is a region with which a collaboration exists).

- Binned scatter plots (Figures 6-7): Figure 6 presents two graphs that are binned scatter plots of the number of regional partners (of projects) in INTERREG and H2020, i.e. they divide the data into equally sized bins with respect to the number of regional partners (of projects) in H2020 and compute the average number of regional partners (of projects) in INTERREG lying in each bin. The graphs include regional GDP as a control. Similarly, Figure 7 shows two binned scatter plots of the centrality of a region in the networks created by the Framework Programmes and its patenting activity. The centrality of a region is captured by the eigenvector centrality of a region in the network, i.e. it is the eigenvector associated with the largest absolute eigenvalue of the adjacency matrix. In other words, it captures to which extent a region is well-connected and how its partners are themselves well-connected. The patenting activity of a region is measured by the cumulative number of patent applications to the European Patent Office (EPO).

5. CONCLUSION

Evidence from co-patents and co-publications data across EU regions display a geographical concentration of R&I activity, highlighted by a national fragmentation and a cross-border effects. The two main EU R&I policies (Framework Programme and Interreg Europe Programme) can help overcoming these effects by increasing the connectivity of the EU R&I environment across all EU regions.

REFERENCES

European Commission (2024). Science, Research and Innovation Performance of the EU (SRIP) report.

Jones, B. F. (2009). The burden of knowledge and the "death of the renaissance man": Is innovation getting harder? The Review of Economic Studies, 76(1):283–317.

Katz, J. S. and Martin, B. R. (1997). What is research collaboration? Research policy, 26(1):1–18.

Wuchty, S., Jones, B. F., and Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. Science, 316(5827):1036–1039.

Acknowledgment

The authors would like to thank Commission's Directorate-General for Research and Innovation unit G1 and Pierre-Alexandre Balland (Utrecht University) for the data provided, and Federico Biagi, Davide Ceccanti, Tillmann Heidelk and Joachim Maes for their useful comments.

How to cite:

Lalanne, M. and Meyer, N. (2024). *Research and Innovation Collaboration Networks across EU Regions over 2014-2020*. Territorial Development Insights Series, JRC136781, European Commission.

Contact information
Marie Lalanne
European Commission, Joint Research Centre
Email: Marie.Lalanne@ec.europa.eu

REMO

Regional Economic Monitoring

Territorial Data Analysis and Modelling team (TEDAM)
https://europa.eu/!GvwdF4