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Laurea University of Applied Sciences
Ratatie 22, 01300 Vantaa, Finland
Phone +358 (0)9 8868 7150
Fax +358 (0)9 8868 7200
firstname.surname@laurea.fi
www.laurea.fi
Business ID 1046216-1
Domicile Vantaa

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SOCIAL NETWORK ANALYSIS OF ERDF-PROJECTS IN FINLAND 2007-2013

Teemu Santonen

Laurea University of Applied Sciences,
Vanha maaantie 9, O2650 Espoo, Finland.
E-mail: teemu.santonen@laurea.fi

Abstract: The aim of the European Regional Development Fund (ERDF) is to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. Therefore, ERDF-projects can be considered as an important tool for implementing National and Regional Innovation strategies across the Europe. By utilizing Social Network Analysis (SNA) methods and popularity based scientometrics approach, this study evaluates what kind of collaboration relationships are existing between Finnish ERDF-project actors and who are the leading ERDF-actors in Finland. The dataset covering the latest fully implemented EDRF program period (2007-2013) included 10.913 projects and 5.991 different organizations. Results revealed that great majority (67.6%) of all organizations had participated only in one project and only small portion (5.9%) of all projects included multiple beneficiaries. The list of most active organizations was heavily dominated by universities, which typically operated in multiple regions.

Keywords: European Regional Development Fund, ERDF, Social Network Analysis, Scientometrics, Finland, Regional Innovation System (RIS), National Innovation System (NIS)

1 Introduction

EU-countries receives assistance from the following two structural funds in the EU (European Parliament and Council of the European Union, 2006): the European Regional Development Fund (ERDF) and the European Social Fund (ESF). In this study we are evaluating ERDF projects in which “Innovation and research” theme is one of key priority areas. The main aim in ERDF projects is to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. As a result ERDF-project networks are admittedly important tools for implementing National Innovation System (NIS) and Regional Innovation System (RIS) goals at national and regional levels (Lundvall, 2007; Godin 2009; Fritsch, 2001). In this study ERDF-projects are investigated especially from university-industry-government collaboration point of view. Therefore this study can also be considered as a contribution to Triple Helix theories (Etzkowitz and Leydesdorff, 2000) which typically have not extensively utilized Social Network Analysis (SNA) methodologies or scientometrics. SNA studies can investigate social structures such as project consortium composition through the use of networks and graph theory (Wasserman and Faust, 1994), whereas scientometrics can be defined as quantitative research method for evaluating science and innovations (adapted from Van Raan, 1998).

Using secondary empirical data derived from Structuralfunds.fi – an online service for those interested in ERDF- or ESF-funding information in Finland – by utilizing SNA and scientometrics methods in combination one can identify 1) who are the key actors and 2) how these actors are collaborating. Since ERDF-projects are tool to implement regional development strategies in this study the regional viewpoints are emphasised alongside of organizational viewpoint.

2 Literature review –Social Network Analysis in Regional Innovation Systems

There are not many studies available which have evaluated EU-funding instruments or National Innovation Systems from SNA point of view. Recently European Commission (2015) released a SNA study which evaluated 7th Framework Programme Participation and found evidence for core-periphery structure in national level networks. Graf (2010) SNA study based on patent data on Regional Innovation System (RIS) in German revealed that public research organizations have higher tendency to act as a gatekeeper than private organizations. Furthermore, Fritsch and Graf (2011) argued that focusing on region dimension alone is not sufficient and there is a need to understand wider spatial environment and the macroeconomic conditions. Montresor and Marzetti (2008) compared the structural similarities and dissimilarities among 15 OECD countires technological systems and found that hierarchical structures grouped into clusters with different density and composition. Shapiro et al. (2010) confirmed that that the density of scientific communication flows has deepened in Korea in terms of the inter-connectedness of networks, but Seoul centrality as the primary research hub has declined. Grasenick et al. (2008) demonstrates how SNA can be applied on automatic retrieved data to help regional decision makers to strengthen the strategic intelligence and better manage the challenges of the networked economy. In Finnish context, Santonen (2016) evaluated collaboration networks in ESF-programs at the regional level. The study suggested that about half of the organisations had participated only in one project and less than firth in two projects and as a result only handful of organisations are actively collaborating and taking part in Finnish ESF-programs. In the nationwide funding program the collaboration appeared to be more widespread, which outperform clearly all four regional programs, in which collaboration is characteristics by fewer but more intensive collaboration.

Besides these empirical studies, conceptual models have been proposed to analyse evolutions of national innovation systems from SNA point of view (Agapitova, 2005). As a result the prior studies indicate that networks studies should be grounded on multiple measures in order to reveal the comprehensive understanding of collaboration relationships between various actors.

3 Research methodology

3.1 Research design

Recently, Santonen, and Conn (2015) illustrated a comprehensive framework for classifying various types and combinations of scientometric studies when studying actors and/or contents within a particular community such as ERDF funding program.

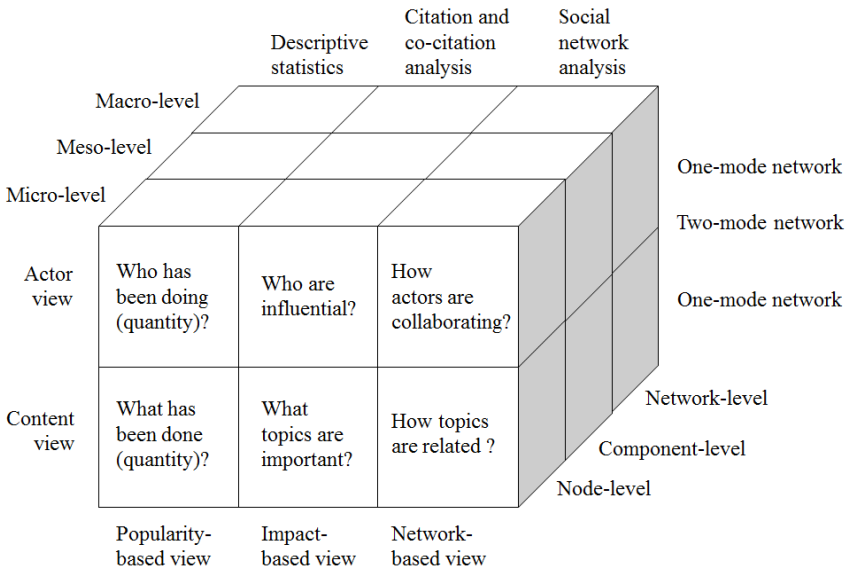

Figure 1: Comprehensive framework for classifying Scientometric studies, (modified from Santonen and Conn, 2015)

The suggested framework includes three main research approaches:

1) **"popularity-based"** studies focusing on frequencies of people and other content driven meta-terms such as organization type or funding program (Choi et al, 2011)

2) **"impact based"** studies which for example in the case of scientific communities are evaluating how much (popularity approach) or by whom (network approach) the particular study is cited (Pilkington and Meredith, 2009) or in context of funding programs could evaluate how many new business have been established or how many new jobs have been created and

3) **social network analysis (SNA)** studies (Wasserman and Faust, 1994) focusing on the collaboration patterns of network actors which in the case of scientific community typically includes co-authorship (e.g. Su and Lee, 2012) or keywords (Yi and Choi, 2011) or in the case of funding programs the project consortium members

These research viewpoints can be applied at the micro-level (e.g. individual project) or the meso-level (e.g. one regional funding program) or at the macro-level (e.g. the whole EARDF-program in Finland or at EU-level) (Gupta and Bhattacharya, 2004). Respectively, SNA studies can focus on node-level (i.e. any kind of actor within a network) component-level (a combination of nodes which are directly or indirectly connected by at least one connection) or network level analysis where the unit of analysis is the whole network.

Networks can be one- or two-mode network in which one-mode network refers to a distinct set of entities (e.g. consortium member), whereas two-mode network as the name indicates includes two (or more) set of entities (e.g. consortium member and subtheme in funding program). Each of these studies can either focus on a snapshot of given time or

include temporal data which can be used to evaluate the evolution of the given community. This study identifies the key ERDF-actors in Finland and analyse what kind of ties have been constructed among various project actors and combined actor groups which are defined by various project related meta data such as organization type. The main research question can be defined as following:

> *"What kind of collaboration relationships are existing among ERDF-project actors and actor groups in terms of popularity and network ties".*

3.2 Data collection and construction of key measures

In this study we are covering 2007-2013 period, which is the latest EDRF-program period in Finland which has been fully implemented. In all the dataset included 18.132 projects, but out of these 7.219 projects (39.8 percent) were Finnvera's "investment and development" decisions for individual persons (1.560) or individual companies (5.659). Therefore, these were omitted from the final dataset. After this filtering process the dataset included 10.913 projects and 5.991 different organizations. The available project related meta data included, project code (acting as a unique ID for a project), funding authority, project name, region (South, West, East and North), thematic stream (6 themes), start date, end date, operational status, actor type (coordinator/partner), actor name, organisation type (15 different types) and business ID (acting as a unique ID for an organization participating in a project). In Table 1 the division of number of projects based on thematic and regional funding streams is presented, which indicates that (T1) promotion of business had clearly the greatest number of projects

Table 1 The number of regional and thematic funding streams projects

Name of the Thematic Stream	*South FIN*	*West FIN*	*East FIN*	*North FIN*	*Grand Total*
(T1) Promotion of business	1059	1689	1991	2679	7418
(T2) Promotion of innovation activity and networking and strengthening of skill structures	241	465	659	663	2028
(T3) Improvement of the accessibility of regions and of the operating environment	271	277	281	317	1146
(T4) Development of major urban areas	34	64			98
(T5) Large regions - Thematic concentration of measures	76				76
(T6) Technical support	32	41	39	35	147
Total (N)	1713	2536	2970	3694	10913

First, various "popularity-based" research methods (Choi et al, 2011) were applied to analyse descriptive profiles and distributions of meta data related variables. Next in order to execute SNAs, the original dataset was re-formatted into various one-mode and two-mode adjacency matrices (Borgatti et al., 1991), which consisted the above defined meta data variables names as columns and rows. An entry in a matrix row "i" and column "j" represented either a binary or a valued tie between the given meta data variables (e.g. business ID which indicated how many times these organization had been participating in

a same project). Hereafter, the standard SNA measures including "Degree centrality" and "Betweenness centrality" (Freeman, 1979) were analysed to determine the importance of a particular node (e.g. organization or organization type) in the network. The centrality measures were defined as follows (Santonen and Ritala, 2014):

Degree centrality = "Calculates how many direct connections each node has with other nodes in the network showing how linked each node is to other nodes. Basically this measure can be seen as a measure for analysing node's activity or involvement in a network. A high degree centrality indicates that the node has a central position in the network among other nodes (indicating e.g. a "hub" or otherwise relevant position)."

Betweenness centrality = "is used for investigating the structural position of a particular node between clusters of nodes in a network. Therefore it can be interpreted as measuring the nodes based on their position and role as a gatekeeper between two or more independent components. Such nodes may be in a structurally powerful position because they might be able to exploit their gatekeeper role for the purposes of knowledge and resource sharing between the separate parts of the network, for example."

Network component = An analysis of network components were also conducted. According to Hawe et. al. (2004), a component is a part of a network in which all nodes are directly or indirectly connected by at least one connection. Thus, the component analysis will reveal those organizations within the whole network which are internally connected, but separate from each other.

4 Results

4.1 Most active organizations

The Figure 2 is revealing the distribution of organizations which have participated from 1 to 20 projects.

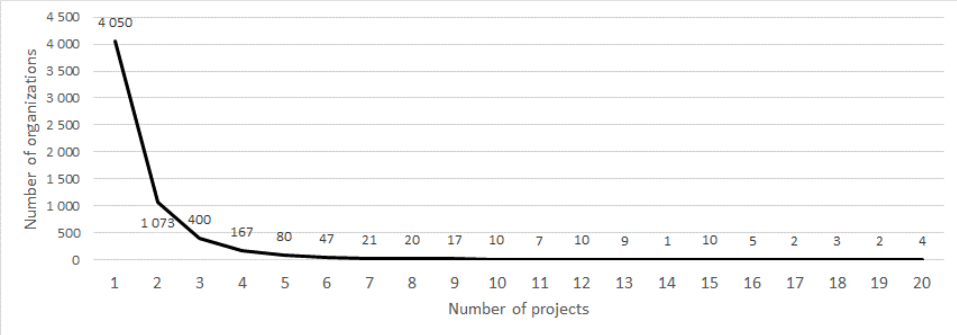

Figure 2 Number of projects (from 1 to 20) per organization.

As a result 4.050 organization (67.6%) had participated only in one project, 1.074 organizations (17.9%) in two projects, 400 organizations (6.7%) in three projects and 167 organizations (2.8%) in four projects. In all these organizations are already covering 95%

share of all organizations. In addition there was 53 organizations (0.88 % of all organizations) which had participated more than 20 projects.

In Table 2 the TOP10 organization based number of different projects are presented, which reveals that the list is heavily dominated by education sector actors (7 Universities and 2 University of Applied Sciences). List includes also one state authority organizations and one economic developed company which however is mainly owned by a group of municipals. The leading organizations in terms of number of projects were University of Oulu and University of Eastern Finland which both had participated in 177 projects. State authority "Centre for Economic Development, Transport and the Environment" state author was in the second position with 160 projects and Lapland University of Applied Sciences third with 130 projects.

Table 2 TOP10 organisations by the number of projects

	Organisation name	*Organization type*	*Number of projects*
1	University of Oulu	EDU-University	177
	University of Eastern Finland[1]	EDU-University	177
2	Centre for Economic Development, Transport and the Environment	PUB-State authority	160
3	Lapland University of Applied Sciences[2]	EDU-University of Applied Sciences	130
4	Lappeenranta University of Technology	EDU-University	105
5	South-Eastern Finland University of Applied Sciences[3]	EDU-University of Applied Sciences	101
6	University of Jyväskylä	EDU-University	76
7	Tampere University of Technology	EDU-University	75
8	Cursor Oy	PUB-Company, but municipals as main stakeholders	74
9	University of Turku[4]	EDU-University	61
10	University of Helsinki	EDU-University	56

4.2 Organizations activities across the regions

Nearly all organizations (N=5898, 98.5 %) had received funding only from one region. Table 3 presents the distribution of 92 organizations and 9 organization types which have receiving funding from multiple regions. Most of these organizations (N=65, 70.7 %) had received funding only from two regions. Organizations which got funding from three regions (N=14, 15.2 %) or four regions (N=13, 14.1 %) were rare. This comparison

[1] a merger of University of Kuopio and University of Joensuu.

[2] a merger between Rovaniemi University of Applied Sciences and Kemi-Tornio University of Applied Sciences.

[3] a merger of Mikkeli University of Applied Sciences and Kymenlaakso University of Applied Sciences

[4] a merger of University of Turku and Turku school of Economics

indicates that most of Finnish universities (60 % of all universities in Finland) are operating in multiple regions, whereas University of Applied Sciences (UAS) are more clearly characterized as single region actors. Only 20 percent of UASs[1] had received funding from multiple regions, although all but two[2] of them had got ERDF-funding.

Research institutes were also well represented in the multiple region funding list (N=9), since four of them had funding from four regions, four from three regions and one from two regions. In all 16 research institutes had received ERDF-funding. However, four of them were operating as a part of university and therefore classified as "University". As a result also research institutes could be considered as multi regional actors, since 75 percent of those research institutes which had received funding were operating in more than one region. Significantly, only 21.6 percent of all research institutes in Finland had received ERDF-funding.

Only three private companies got funding from three regions, but 42 had received funding from two regions. Typically these companies appeared to have offices in multiple regions. Also three local authorities, regional councils and registered associations had received funding from two regions. As a result these organizations as well as private companies are mainly operating in one region while cross-region collaboration appears to be rare. Also 12 state authorities and 2 state enterprises received funding from multiple regions.

Table 3 Distribution of 92 organizations and 9 organization types which have receiving funding from multiple regions

Organisation type	*Funding from 4 regions (N)*	*Funding from 3 regions (N)*	*Funding from 2 regions (N)*	*Total (N)*
Local authority			3	3
Private company		3	42	45
Regional council			3	3
Registered association			3	3
Research institute	4	4	1	9
State authority	6	1	5	12
State Enterprise	1		1	2
University	2	5	3	10
University of Applied Sciences[3]		1	4	5
Total	13	14	65	92

4.3 Multi vs. single stakeholder project distribution

Interestingly, 94.1% percent (N=10.274) of the 10.913 projects were conducted by single organization resulting only 639 multi-stakeholder ERDF-projects (5.9% of all

[1] comparison was made to current total number of University of Applied Sciences in Finland, which at the time of the study was 25.

[2] Åland University of Applied Sciences is operating in Åland island which is autonomous region and realise their own ERDF-programme, Police University College operates under the Ministry of the Interior

[3] Two University of Applied Sciences which had received funding from two regions were owned by the municipal union which also provide vocational education

projects). In Figure 3 the distribution of number of participants in multi-stakeholder projects is presented.

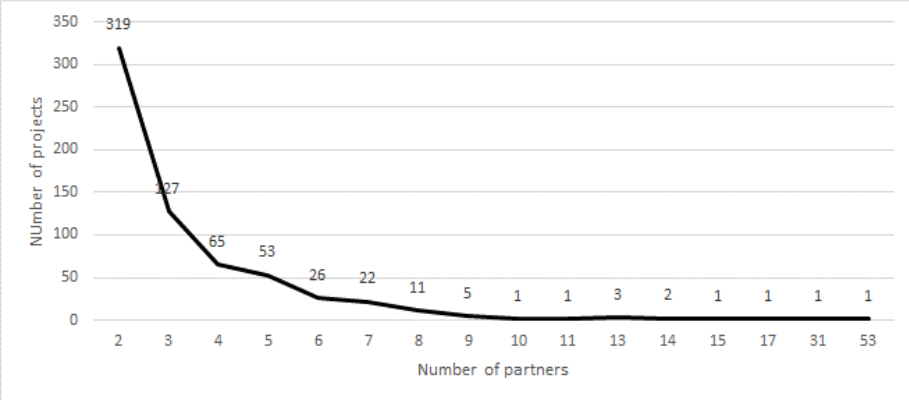

Figure 3 Distribution of number of partners in multi-stakeholder projects

Nearly half (49.9%, N=319) of the multi-stakeholder projects included only two actors and nearly fifth (19.9 %, N=127) three actors. Only handful projects had very high partner count (highest being 53, second highest 31 and third highest 17). The average partner count per multi stakeholder project remained low (N=3.42).

In Table 4 the comparison between single vs. multi stakeholder projects is presented between regions and thematic research streams.

Table 4: The multi stakeholder projects relative share comparison between themes and regions.

Name of the Thematic Stream	*South FIN*	*West FIN*	*East FIN*	*North FIN*	*Grand Total*
(T1) Promotion of business (%)	0.9	0.7	0	0.3	0.4
(T2) Promotion of innovation activity and networking and strengthening of skill structures (%)	18.7	28.1	15.6	24.4	21.5
(T3) Improvement of the accessibility of regions and of the operating environment (%)	16.3	19.9	17.1	14.0	16.7
(T4) Development of major urban areas (%)	54.5	23.1	-	-	32.4
(T5) Large regions - Thematic concentration of measures (%)	442.9	-	-	-	442.9
(T6) Technical support (%)	0	0	0	0	0
All (%)	10.2	7.3	4.6	5.1	6.2
SINGLE stakeholder projects (N)	1 554	2 364	2 840	3 516	10 274
MULTI stakeholder projects (N)	159	172	130	178	639
ALL projects (N)	1 713	2 536	2 970	3 694	10 913

As a result it indicates that the different regions have followed different strategies relating the project group composition. Oneway ANOVA test (sig. 0.000) verified this assumption, while the Tukey's HSD test revealed that in practice only South Finland had followed different strategy than the other regions. South Finland emphasised more the multi stakeholder projects than the other regions. However, the Oneway ANOVA test (sig. 0.000) on the thematic streams revealed also different project group composition strategies in the case of all themes.. (T1) "Promotion of business" and (T6) Technical support thematic streams were both basically grounded on single beneficiary projects. On the contrary, (T5) "Large regions - Thematic concentration of measures" which was executed only in South-Finland was the only theme were multi stakeholder projects dominated (62 vs. 14 projects). The second highest multi stakeholder theme which was (T4) Development of major urban areas, which was executed in South and West Finland. In all this theme included 24 multi stakeholder projects and 74 single stakeholder projects.

4.4 Social Network Analysis results

First, in order to understand how tightly connected the organizations are within the Finnish ERDF-actor network, the component ratio was measured. Component ratio achieves its maximum value of 1.0 when every node is an isolate, and its minimum value of 0 when there is just one component. In all there was 21 components while the component ratio was closing to zero (0.032) and the average degree was 12.57. Basically this means that in Finland nearly all ERDF-actors are connected to each other and only few organizations remains outside the main component. In Table 5 the organizations having the most connections are listed (i.e. they have the highest degree centrality). In the Table 6 the organization having structurally the most powerful location in the ERDF-network are listed (i.e. they have the highest betweenness centrality measure).

Table 5: TOP5 Degree centrality organizations

Organization name	*Type*	*Degree centrality*
1. State Forest Enterprise	State authority	113
2. Centre for Economic Development, Transport and the Environment	State authority	79
3. Kainuun Etu Ltd.	Development company	65
4. University of Oulu	EDU-University	59
5. University of Jyväskylä	EDU-University	56
5. University of Turku	EDU-University	56

Table 6: TOP5 Betweenness centrality organizations

Organization name	*Type*	*Betweenness centrality*
1. University of Jyväskylä	EDU-University	33 168
2. State Forest Enterprise	State authority	32 038
3. Centre for Economic Development, Transport and the Environment	State authority	20 479
4. University of Oulu	EDU-University	15 650
5. Geological Survey of Finland	Research institute	14 982

State Forest Enterprise (Metsähallitus), which provides natural resources sector services to a diverse customer base, has the most connections (113) and has the second highest betweeness centrality ranking with 32 038 betweeness centrality value. Another state authority in the list is Centre for Economic Development, Transport and the Environment (ELY center), which operates 15 centers across the Finland and is responsible for the regional implementation and development tasks of the central government. Kainuun Etu Oy which owned by the eight municipalities of Kainuu region is the regional development company of the region. Its purpose is to serve the growth of the regional economy. Recent studies indicate that Kainuu region is the worst region in Finland but also in Nordic countries, which kind of justifies their high position in the ERDF-ranking list.

In addition the TOP5 list includes also three universities and one research institute. In all higher education organizations have high presence in degree and betweenness centrality ranking list since the next runners-ups appearing in either one or both the lists are South-Eastern Finland University of Applied Sciences, University of Helsinki, Lappeenranta University of Technology, HAMK University of Applied Sciences and Aalto University. In Finland universities and Applied Science Universities (UAS) have different roles in the national innovation system. UASs are practice-oriented, applied and professional higher education organizations which are intensively collaborating with industries, society and small businesses. Importantly, research, development and innovation activities in UAS are aimed to promote working life and regional development especially at local and regional level. The main mission of universities on the other hand is to conduct scientific research and provide instruction and postgraduate education based on it. Therefore in ERDF-projects universities and UAS roles by definition should be different. The previously presented Table 3 already supported this assumption.

When collaboration patterns between universities and UASs were compared, a different structure was identified. Collaboration between UASs were divided into two separated components in which UASs in the North- and Center-Finland formed one component and UASs from South- and East-Finland formed another component. Universities instead formed basically one component. In the Figure 4 the collaboration patterns relating the ERDF-projects between universities and universities of applied sciences are presented.

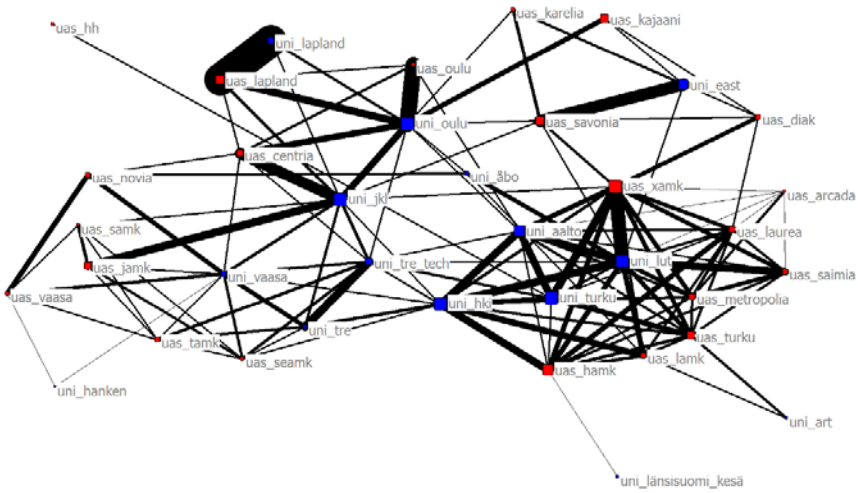

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Figure 4: Universities and Applied Science Universities collaboration relationships

Basically the above figure indicates that there are especially strong collaboration relationships with the North-Finland higher education institutes including Lapland university and Lapland applied science university as well as between Oulu university and Oulu applied science university. Other more intensive relations between University and UASs were also detected, which can be at least partially explained by close geographical distance between the actors.

Furthermore, in the case of economic development companies similar observations can be made. Clearly there are connections between development companies which are located in the same or nearby regions, but also between development companies and UASs sharing the same or close-by economic region (see Figure 5). Contrariwise Universities have clearly more central role (see Figure 6) and many of them can be considered as nationwide actors.

5 Conclusions

Over a decade the open innovation scholars have highlighted the importance of cross-organizational collaboration and multi-actor projects in order to generate novel ideas which could more likely lead to economically successful innovations. By definition ERDF-projects are trying to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. According to findings of this study, Finland is quite clearly following a regional innovation policy in which majority of the ERDF-projects are executed by individual organization and only a fragment (about 6 %) of the projects are based on multi-actor collaboration. Furthermore, almost all organization are receiving funding only from one region and when there is a rare multi-actor project, most likely the consortium includes only actors in the close geographical regions. There was clear strategic difference between universities and university of applied sciences in which the latter can be characterise a regional actor and the first one as national actor. Especially the university of applied sciences appear to follow the role which ministry of education have defined for them, and they are mainly seeking collaboration possibilities within their own region. These findings are very similar to prior suggestion made by Santonen (2016) when analysing ESF-projects in the same time period.

Since research and development project collaboration has already been rather intensive between certain close-by actors, it has been a natural progression that some of the universities of applied sciences as well as few universities and universities of applied sciences have recently merged or informed of a merger. Therefore in this study some of the organization were considered as united even if they were separate during the earlier stages of 2007-2013 ERDF funding period. Basically from research and development activities point of view, these mergers are only consecrating the already existing practice.

Partially the regional development strategy which Finland is following is somewhat contradictory. The organizations which have not previously been able raise the economic wealth of the given region are still given money and encouraged to only limited collaboration with others. Importantly, collaboration with close-by regional actors is seen satisfactory by the state-authority funder. It would be very interesting to evaluate if the ERDF- and ESF-projects which have had national or at least cross-regional focus are leading to higher impact. This is beyond the scope of this study, but could provide valuable information how to structure funding strategy in the following years.

If only regional and local actors are seeking funding from certain regional programs, there is a possibility that the best organisations in nationwide review are not participating in the bidding competition. Therefore, this might leave region without the best possible resources especially if local organization emphasise different things and capabilities which are required by the funding calls. If the regional and/or local presence is precondition for getting funding then the regional innovation policy will become strongly influenced by how much money is allocated to certain region. This might easily lead to biased outcomes and collaboration networks. Therefore it is suggested that state authorities should highlight funding calls which are addressing the multi-stakeholder projects which go beyond single region.

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Appendix:

Figure 5: Applied Science Universities collaboration relationships with development companies

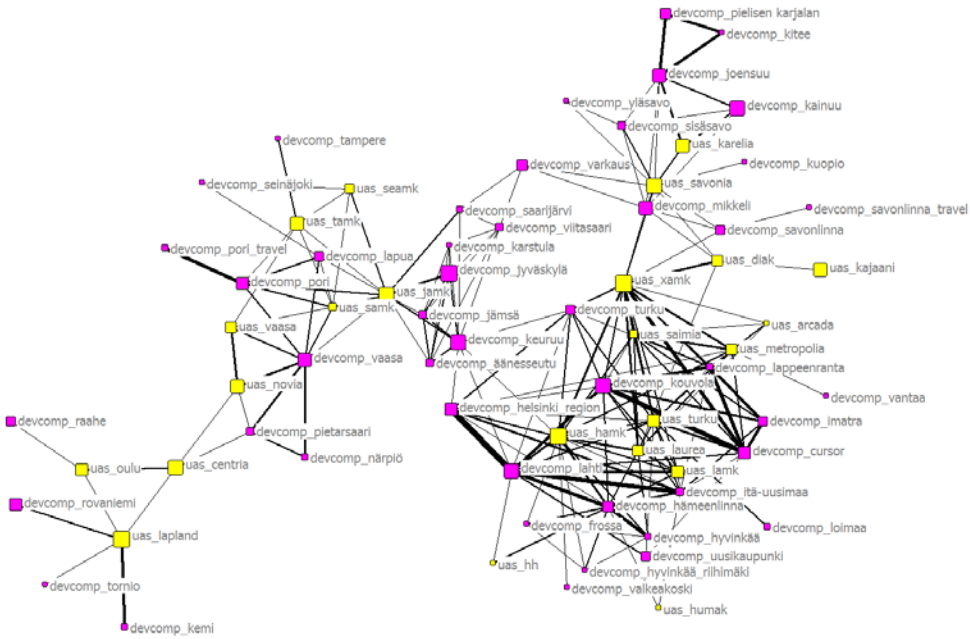

Figure 6: Universities collaboration relationships with development companies