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SCIENTOMETRICS ANALYSIS OF ESF-PROJECTS IN FINLAND: FUNDING PERDIOD 2007-2013

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Abstract: European Social Fund (ESF) is among the largest funding instruments in the EU. However, less is known how collaboration networks in ESF-programs are formed at the regional level. Therefore, this Finnish case study evaluates what kind of collaboration relationships are existing among ESF-project actors in Finland during the funding period 2007-2013. In all the dataset included 2.773 ESF-projects and 1.092 different business IDs in four regional and one nationwide programs in five thematic topics areas. In all only 2 percent of organisations have had funding to 40 or more projects, whereas about half of the organisations had participated only in one project and less than firth in two projects. As a result only handful of organisations are actively collaborating and taking part in Finnish ESF-programs. Nationwide funding program has most widespread collaboration, which outperform clearly all four regional programs, in which collaboration is characteristics by fewer but more intensive collaboration.

Keywords: European Social Fund, ESF, Social Network Analysis, Scientometrics, Finland, Regional Innovation System

1 Introduction

Scientometrics can be defined as the quantitative study of science and technology (Van Raan, 1998). Recently Santonen and Conn (2015) illustrated a comprehensive framework for classifying various types and combinations of scientometrics studies and there has been also other similar attempts by other management scholars (Zupic and Čater, 2014). Most commonly scientometrics studies are classified as "popularity-based" and social "network-based" studies (later also SNA) (Choi et al, 2011). Popularity-based studies are analysing frequencies (e.g. organizations) whereas SNA-studies are instead focusing on the collaboration relationships between various actors. Overall, SNA studies have been successfully used to study different kind of communities (Newman 2001, Morlacchi et. al. 2005, Vidgen et. al. 2007) including innovation communities such as global open innovation research (Su and Lee 2012) or International Society of Professional Innovation Management (ISPIM) community (Santonen and Ritala, 2014). These studies have demonstrated the usefulness of SNA to reveal underlying structures of communities by providing relevant relational information beyond typical non-network-type of empirical studies (Yan and Assimakopoulos, 2009). However, less is known about how co-operation

networks are formed around public project funding instruments at the national or regional level.

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). The aim of the ERDF is to increase employment and strengthen the competitiveness and vitality of regions by focusing on regions with the lowest employment rates whereas the ESF is supporting employment by developing skills, innovating service structures and helping organization with new ways of working. ESF has been described as 'the financial backbone of EU social and regional policies' (Geyer, 2000) and it is among the largest funding instruments in the EU. Furthermore, compared to ERDF, ESF is not as strongly limited by regional conditions and therefore providing a better foundation to reveal how individual nations are implementing EU innovation policies in their regions.

As a results in this scientometrics study we are focusing on the ESF-project networks which are admittedly important tools for implementing National Innovation System (NIS) goals at national and regional levels (Lundvall, 2007; Godin 2009; Fritsch, 2001). Since ESF-projects can include actors from university-industry-government sectors, our study also can be considered as a contribution to Triple Helix theories (Etzkowitz and Leydesdorff, 2000) which typically have not extensively utilized SNA methodologies.

2 Literature review –Social Network Analysis in Regional Innovation Systems

The network and open innovation theories associate business success with the ability to co-operate with external resources and the circulation of know-how (Chesbrough, 2006; Pöyhönen and Smedlund, 2004). In principal, network theorists of innovation see inter-organizational and cross-sectoral networks as a key strategy (Miozzo and Dewick, 2004) or the main source of innovation (Von Hippel, 2007) and argue that organizations are rarely capable to innovate independently (Snehota and Hakansson, 1995). Thus, innovation is defined as an interactive process between various subsystems, which are interrelated while including various actors and functions (Teece, 1996; Doloreux, 2004). In an era of open innovation strategies, there is a greater need for understanding and optimizing the partner (Howells et al. 2003) and network (de Man and Duysters, 2005) selection. Partners should provide the resources and capabilities, which their own organization is lacking in order to gain the suggested positive effects of collaborating and additional capabilities (Gulati, 1995; Becker and Dietz, 2004).

However, there are not many scientific 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 (2011) 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. 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

By applying popularity-based bibliometric analysis (Choi et al, 2011) and the standard methodology of the social network analysis (SNA) (Borgatti et al., 1992) as suggested by Santonen and Conn (2014), in this scientometrics study we identify the key ESF-actors in Finland and analyse what kind of ties have been constructed among various project actors and combined actor groups which are defined by project related meta data such as organization type and funding program defined by region or theme. Furthermore by applying SNA to temporal data (e.g. Motter et. al. 1999, Hori et. al, 2004), we are explicitly modelling the different collaboration networks and their inter-linkage with each other over time. Our main research question can be defined as following:

RQ: What kind of collaboration relationships are existing among ESF-project actors and actor groups and how these are evolving over time and how they differ between regions.

3.2 Data collection

Structural fund activities began in Finland when Finland joined the European Union in 1995 and there have been four programming periods: 1995-1999, 2000-2007, 2007-2013 and currently active 2014-2020 period. In this study we are covering funding period 2007-2013 which in all included 2.773 ESF-projects and 1.092 different organizations when business ID is used as unique identifier (note: this funding period had actual activities between year 2007-2015). The available project related meta data included, project code (acting as a unique ID for a project), funding authority, project name, regional program streams, thematic streams, 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). However, the dataset was partially incomplete relating *"organisation type"* variable even if was provided by state authority who is responsible for ESF- project database in Finland. Only coordinator *"actor type"* variable included *"organisation type"* information, leaving 48.4 percent of business IDs without that particular information. Furthermore, *"organisation type"* classification was also partially inconsistent since 6.6 percent of business IDs had multiple

organisation types. This indicates that multiple organisation are operating under same unique business ID. For example business ID which officially belongs to City of Turku included City of Turku, Turku University of Applied Sciences and vocational school organisations. Also the project partner information has some irregularities which is reflecting e.g. what kind of agreement funder and project coordinator had made. As a result at least some of single stakeholder project, might actually include multiple partners, but the registrar have only reported the coordinator organisation to official records. Therefore, in the result section part of the analysis are conducted including only the projects which includes multiple business IDs, which are furthermore interpret as different organisations.

In Finland ESF-funding instrument was divided in four regional (North-East-South-West) and one nationwide program. These programs included five thematic topic areas. In Table 1 we have presented the cross table for the number of regional and thematic funding program project.

Table 1 The number of regional and thematic funding streams projects

Funding program name	*South-FIN*	*East-FIN*	*West-FIN*	*North-FIN*	*Nationwide*	*Total*
(T1) Development of organisations and workforce including entrepreneurship	181	218	107	102	209	817
(T2) Promoting employment and remain in the workforce, as well as exclusion prevention	178	174	120	92	217	781
(T3) Labor market activities that promote knowledge, innovation and service system evolution	176	281	148	165	184	954
(T4) Cooperation between Member States and regions in ESF programs	16	26	17	17	47	123
(T5)Technical support		31			67	98
Total	551	730	392	376	724	2773

For the purposes of the present study, 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 and to enhance the visualization of our results (Wassermann and Faust, 1994). Furthermore, "popularity-based" research methods (Choi et al, 2011) are also applied to analyse descriptive profiles and distributions of meta data related variables.

4 Results

4.1 Popularity-based viewpoint

In the following we will apply the "popularity-based" research method and present various descriptive statistics relating to ESF projects in Finland when all (N=1092) organisation which have got funding are included into analysis. The Table 2 presents the regional and thematic funding streams percentage allocation by unique business ID.

Table 2 Regional and thematic funding streams percentage share of all (N=1092)

	The number unique business ID (percentage share of all)								
Funding program name	*0 no funding*	*1*	*2*	*3*	*4*	*5*	*6-10*	*>10*	*Getting funding total*
South-FIN	78.8	9.6	4	1.5	1.6	1.1	1.8	1.6	21.2
East-FIN	76.6	12.5	3.8	1.1	1.4	0.8	1.6	2.1	23.3
West-FIN	83.1	7.7	3.3	1.3	1.3	0.6	1.5	1.3	17
North-FIN	86.4	7.5	2.2	1.1	0.8	0.3	0.4	1.3	13.6
Nationwide	44.1	31.7	10.9	3.6	2.9	1.5	2.8	2.5	55.9
Theme 1	46.2	31.3	9.2	3.8	3.1	1.7	2.2	2.4	53.7
Theme 2	57.8	21.1	8.5	3.5	2.7	1.3	3.7	1.5	42.3
Theme 3	54.9	25.9	6	3	1.6	1.2	3.1	4.1	44.9
Theme 4	88.8	7.5	1.5	1.1	0.3	0.5	0.2	0.1	11.2
Theme 5	97.8	1.1	0.5	0.1	0.2	0	0.2	0.1	2.2

In regional review the most populated funding stream is nationwide funding stream, which includes over half (55.9 %) of all organisations who in the first place have got funding from ESF-program. East--Finland funding stream contains the second highest (23.3 %) amount of organisations whereas South-Finland is following close by with 21.2 % share. West-Finland (17 %) and North-Finland (13.6 %) falls clearly behind in term of number of different organisations. The thematic funding stream T1 (53.7%) *"Development of organisations and workforce including entrepreneurship"* is the most popular while T2 (42.3 %) *"Promoting employment and remain in the workforce, as well as exclusion prevention"* and T3 (44.9 %) *"Labor market activities that promote knowledge, innovation and service system evolution"* are closely following the T1. The thematic funding streams T4 (11.2 %) *"Cooperation between Member States and regions in ESF programs"* and especially T5 (2.2 %) *"Technical support stream"* have included only a limited number of organisations.

Table 3 reveals how focused or scattered strategy organisations were following when getting ESF-funding by presenting cross table of Number of Regional programs x Number of Themes programs by unique business ID. As a result about two thirds (62.4%) of all organisation have got funding only from one thematic/regional funding stream, which indicates a strong focus on single ESF-funding instrument. Furthermore, substantially high share (96.4%) of all organisation were getting funding only from one or two regional ESF-funding instrument. The thematic program reviewing is resulting almost as high share, since 85.1% of all organisation were getting funding from one or two thematic instrument. Only two organisation had got funding from all regional and thematic programs but both

of these organisation were "state authorities" and therefore are not fully comparable to other organisation types. The following three organisations had got funding from nine out of ten programs: 1) Diaconia University of Applied Sciences (Diak), which has campuses located in all four regions, 2) University of Helsinki which is the largest university in Finland and 3) Humak University of Applied Sciences which at the time was operating in all four funding regions.

Table 3 Cross table of Number of Regional programs x Number of Themes programs by unique business ID (N=1092)

	Number of Regions (by Business ID)											
Number of Themes	*1* *N*	*2* *N*	*3* *N*	*4* *N*	*5* *N*	*Total* *N*	*1* *%*	*2* *%*	*3* *%*	*4* *%*	*5* *%*	*Total* *%*
1	681	48	2	1	0	732	62.4	4.4	0.2	0.1	0.0	67.0
2	96	97	5	0	0	198	8.8	8.9	0.5	0.0	0.0	18.1
3	24	54	10	4	1	93	2.2	4.9	0.9	0.4	0.1	8.5
4	13	40	7	3	3	66	1.2	3.7	0.6	0.3	0.3	6.0
5	0	0	1	0	2	3	0.0	0.0	0.1	0.0	0.2	0.3
Total	814	239	25	8	6	1092	74.5	21.9	2.3	0.7	0.5	100.0

Apparently, only handful of all organisation have a long term and active ESF funding strategy, since about half of the organisations (50.6 %, N=553) had participated only in one project, less than firth (17.7%, N= 193) had participated in two projects. In all organisations who had participated in four or less projects are covering 80.4 percent of all organisations. By far the highest number of projects per one business ID was 266. This business ID belonged to "Centre for Economic Development, Transport and the Environment" state authorities, which had multiple regional offices. University of Eastern Finland had the second highest project count (115) and University of Helsinki the third highest (105) project count. All other organisation remained clearly under hundred projects, Savonia University of Applied Sciences having fourth highest project count (87). In all only 2 percent of organisation had 40 or more projects.

4.2 Social Network Analysis (SNA) viewpoint

In Table 4 we continue by presenting "degree centrality" measures for unique business IDs in order to identify how many collaboration partners each organisation had. Importantly "degree centrality" measure takes into count also multiple links between business IDs therefore higher measures indicate higher intensity and deeper collaboration between organisations.

As a result business ID which belongs to City of Turku is clearly the number one with 333 total connections. Most of Turku's connections (77.8 percent, N=259) are generated from nationwide funding program. However, as already indicated in research design sections City of Turku business ID has applied funding on the behalf of several organisations: Naturally this is not fully comparable those business ID which are representing only one organisation. In all business IDs which are representing multiple organisation are taking about half of the positions in TOP10 ranking list. This finding

makes robust comparison between different business ID difficult. Therefore it is suggested that registrar should keep also records which unequivocally separate different organisation and organisation types.

The second highest ranking with 231 connections belongs to University of Helsinki which is the largest university in Finland. Interestingly, their ESF-funding strategy differ clearly from City of Turku, since nearly half (47.2 percent, N= 109) of their connection are coming from South-FIN funding program, while nationwide program is covering only 35.1 percent (N=81), East-FIN 16 percent (N=37) and West-FIN 1.7 percent (N=4). This could be partially explained by the fact that this business ID includes also "The University of Helsinki Centre for Continuing Education" organisation which operates in multiple locations as well as the University of Helsinki itself has strong presence both in South and East Finland. City of Tampere is also following similar strategy as City of Turku, since most of their connection (86.7 percent, N=182) are coming from nationwide funding program and only 13.3 percent (N=28) from their home region West-Finland program.

Table 4 TOP15 organisations by degree centrality classified by funding program

	Organisation name	South-FIN	East-FIN	West-FIN	North-FIN	Nation-wide	In full network
1	City of Turku*	72		2		259	333
2	University of Helsinki	109	37	4		81	231
3	City of Tampere*			28		182	210
4	Kemi-Tornio koulutuskuntayhtymä*				90	84	174
5	University of Lapland				91	78	169
6	HAMK University of Applied Sciences	48	1			116	165
7	University of Tampere			26		137	163
	City of Pori*	2	7	11		143	163
8	Laurea University of Applied Sciences	46				112	158
9	Rovaniemi koulutuskuntayhtymä*				98	55	153
10	Savonia University of Applied Sciences		142				142
11	City of Jyväskylä*			59		80	139
12	University of Jyväskylä		3	30	10	92	135
13	University of Eastern Finland		124				124
	City of Helsinki*	34				90	124
	City of Joensuu*		124				124
14	University of Turku	18		4		100	122
15	Päijät-Hämeen koulutuskuntayhtymä*	33		10		78	121

*) This business ID incudes multiple organisations

Table 5 presents "Betweenness centrality" measures for TOP15 ranking unique business ID in order to identify the relative importance of each organisation. As a result City of Tampere which also includes multiple organisation types has the highest betweenness centrality (40897), indicating that this particular business ID is the most important gate keeper node in the network. However, City of Turku which has second highest Betweenness centrality (39473) is a very close rival. The third and fourth ranking

business IDs belongs to University of Helsinki (26229) and City of Pori (26136) which are remaining clearly behind.

Table 5 TOP15 organisations by betweeness centrality (ranking order by full network measure)

	Organisation name	South-FIN	East-FIN	West-FIN	North-FIN	Nation-wide	In full network
1	City of Tampere*			1276		20593	40897
2	City of Turku*	3185				20537	39473
3	University of Helsinki	3367	917	1		1213	26229
4	City of Pori*			2690		12751	26136
5	University of Oulu		1258		1496	4986	23444
6	City of Mikkeli*		757			404	20442
7	University of Tampere			411		7334	19992
8	City of Oulu				819	9375	18505
9	City of Jyväskylä			427		4692	17286
10	HAMK University of Applied Sciences	1896				4656	16388
11	DIAK University of Applied Sciences	476	590			1059	15993
12	Rovaniemi koulutuskuntayhtymä*				1601	2748	15907
13	University of Eastern Finland		3979				15299
14	City of Helsinki*	1755				4961	14108
15	Laurea University of Applied Sciences	1749				6040	13774

*) This business ID incudes multiple organisations

Already the above TOP15 ranking lists are indicating that there are significant differences between Nationwide and four regional funding programs cohesion measures. Table 6 reveals that majority of connections in full network are generated by nationwide funding program, in which the average degree is 7.2, number of components 581 and component ratio 0.532. The full network with 44 average degree includes 211 components, which is resulting 0.192 component ratio.

Table 6 Network cohesion comparison between Nationwide, South-, East-, West- and North-Finland funding programs

	South-FIN	East-FIN	West-FIN	North-FIN	Nation-wide	In full network
Avg Degree	0.778	1.813	1.095	0.656	7.212	11.082
Indeg H-Index	13	24	22	14	42	44
Deg Centralization	0.028	0.054	0.034	0.032	0.119	0.130
Density	0.001	0.002	0.001	0.001	0.007	0.010
Components	927	900	955	985	581	211
Component Ratio	0.849	0.824	0.874	0.902	0.532	0.192

Since only handful of organisations were actively participating in ESF-programs, we were interested to evaluate how intense the collaboration between various organisations was. To do that, we constructed 10 additional matrix in which the threshold for a

connection between two organisations varied between 2 to over 11 connections. Network cohesion comparison between for these matrix are presented in Table 7.

Table 7 Network cohesion comparison when threshold for connection is varying between 2 to over 11 connections.

	In full network	> 1	> 2	> 3	> 5	> 10
Avg Degree	11.082	2.538	0.775	0.423	0.147	0.049
Indeg H-Index	44	21	13	9	5	3
Deg Centralization	0.130	0.0555	0.0296	0.0217	0.0109	0.0045
Density	0.010	0.0023	0.0007	0.0004	0.0001	0.0000
Components	211	676	899	973	1035	1068
Component Ratio	0.192	0.619	0.823	0.891	0.948	0.978

As indicated in above in Table 7, increasing threshold to two connection, the average degree drops substantially from 11.082 to 2.538 and Indeg H-index from 44 to 21. Furthermore, increasing threshold to three connections again reduces substantially the Indeg H-index from 21 to 13 and average degree from 2.538 to 0.775. Setting the threshold level above 10 connections, is resulting 0.049 average degree and 3 Indeg H-index. These observations validate that within Finnish ESF-funding program there are only very few partner relationship which are grounded on intensive collaboration relationship.

The final analysis was made by revealing what kind of relationships have resulted the most intensive collaboration between two organisations including their organisation type (Table 8).

Table 8 The most intensive collaboration relationships between two partner ranked by number of connections.

Partner 1	*Partner 2*	*Deg.*
1a. Rovaniemi *(VS, UAS, FM*)	1b. Kemi-Tornio *(UAS, FM)*	37
2a. Savonia University of Applied Sciences *(UAS, FM)*	2b. Savon koulutuskuntayhtymä *(FM)*	25
3a. University of Lappland	3b. Rovaniemi *(VS, UAS, FM)*	23
4a. University of Eastern Finland	4b. Savonia University of Applied Sciences *(UAS, FM)*	21
5a. City of Joensuu *(UAS, M)*	5b. Pohjois-Karjalankolutuskunta yhtymä *(FM)*	17
6a. Jyväskylän koulutuskunta yhtymä *(VS, FM)*	6b. Äänekosken ammatillisen koulutuksen kuntayhtymä *(VS)*	17
7a. Ylä-Savon koulutuskuntayhtymä *(FM)*	7b. Savon koulutuskuntayhtymä *(FM)*	16

VC= Vocational school, UAS= University of Applied Sciences, FM = Federation of municipalities and M= Municipality

The geographical proximity appears to be key collaboration drivers, since all seven top ranking collaboration relationships are founded geographical proximity (i.e. organisations are operating in same city or close by region). This observation is in-line with prior studies (for more information see e-g. Santonen and Ritala, 2014). In fact due the structural development of higher education in Finland, the top ranking partners Rovaniemi and Kemi-Tornio have recently actually merged into Lapland University of Applied Sciences. Also from ESF-project collaboration point of view this can be regard as natural development. Moreover, University of Lapland have in late 2015 announced that they would like merge Lapland University of Applied Sciences as a part of University of Lapland. However, this suggestion have raised resistance among some of the owners of Lapland University of Applied Sciences and discussion remains in this respect open. Other collaboration driver seems to be grounded on organisation type diversity. Even if the classification of organisation type was found to be somewhat blurry, there are indications that organisation type is at least partially driving collaboration. This is also in-line with prior suggestions in literature which argue that diversity can stimulate creativity (Santonen, 2016).

4 Conclusion

A great majority of innovation system studies have focused on national level analysis, whereas regional level studies have been limited. This study was trying to fulfil this research cap by analysing ESF-projects in Finland during the funding period 2007-2013. The findings suggest that only a limited number of organisations are actively collaborating and taking part in Finnish ESF-programs. Furthermore, nationwide funding program appears to have the most widespread collaboration patterns whereas in regional programs collaboration is characteristics by fewer but more intensive collaboration. Interestingly, the result also suggest that organisations are not typically seeking funding from multiple regions but are mainly focusing on one region program or nationwide program or their combination. This kind of observation raises some doubts.

Even if ESF-programs have strong regional focus, there are no geographical restrictions who can apply funding from one particular regional program. The geographical location of project's target group is the determinant, not which organisation is seeking the funding. This kind of operating model can have far-reaching impact for whole national innovation system which includes also multiple regional innovation systems. If only regional and local actors are seeking funding from 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. On the other hand if regional and/or local presence is precondition for getting funding (e.g. due the better possibility to find local partners), regional innovation policy will become strongly influenced by how much money is allocated to certain region. For example in Finland ministry of education is giving additional rewards for higher education organisation if they succeed to acquire external funding. This kind of leverage combined with skewed regional funding programs is real threat at national level, if geographical location has high impact on the probability of getting funding. Since regional funding programs are leading smaller collaboration networks, then it is suggested that state authorities should rather highlight funding calls which are addressing the needs of multiple regions in one call, instead of only one region. This kind of regional funding structure could stimulate larger and more diverse collaboration networks should stimulate creativity (Santonen, 2016).

The results of this study should be helpful especially for innovation policy makers who are running ESF-funding programs at National and/or EU-level. With the help of our study, policy makers can critically evaluate if there is a need to introduce improved terms and conditions for getting funding which are highlighting the importance to supporting cooperation among heterogeneous actors from different geographical regions.

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