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Evaluation of the post-crisis EU banking network connectedness in the global context

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Keywords: *network analysis; financial connectedness; regionalization; EU banking network; global banking network*

Abstract

Research background: The global banking network has been undergoing structural changes since the recent financial crisis. Previous studies on connectedness of global banking network during post-crisis period revealed the trends of regionalization and segmentation. Our previous research has also shown that during post-crisis period the level of regionalization within the EU banking network has increased; the network became more clustered and more decentralized. This paper continues our research of structural changes of EU banking network during post-crisis period by adding a global context and questioning the connectedness of EU banking network within global banking system.
Purpose of the article: The aim of the paper is to evaluate the EU banking network's connectedness in the global context during the post-crisis period.

Methods: network analysis method and data on yearly flows of BIS bilateral interbank cross-border claim were used to evaluate the connectedness of global and EU banking systems.
Findings & Value added: Evaluation of the global banking network's connected-ness revealed that global banking network density decreased by 4.50%, suggesting that connectedness is decreasing, but it is happening slowly. Structural changes in the global banking network did happen during post-crisis period with regards to out-degree, betweenness and closeness centrality indicators. In the global context, the EU banking network became more connected during post-crisis period. The EU banking network was regionalized in 2011, but this regionalization disappeared in 2015, as the level of intraregional density decreased in 2015 and became lower than the interregional density. This research contributes to previous research in a way that it applies intraregional and interregional network density measures for evaluation of the EU banking network's connectedness, and analyses it as a subset of the global banking network.

Introduction

The financial crisis of 2007–2008 has revealed the importance of banking system in the financial system and the weaknesses of highly connected networks, i.e. how failures are transmitted from one entity of the system to another and contagious defaults of banks has threatened the stability of the entire financial system. These events attracted attention of many researchers regarding the topics of banking networks' formation (Garratt *et al*., 2011), systemic risk (Duan & Zhang, 2013), regionalization of banking networks (Claessens & van Horen, 2015; Lambert *et al*., 2015) etc. Connectedness within the global banking network has also been a topic of numerous scientific research. Whether the global banking system's connectedness will succeed or fail depends on many factors, such as the structure and characteristics of the system (Ho *et al*., 2013; Čihák *et al*., 2011), the nature of interactions among members of network (Caccioli *et al*., 2013; Philippas *et al*., 2015). It was extensively argued in previous research that the connectedness within the global banking network has decreased since the last financial crisis of 2007–2008 and cross-border banking claims have not increased significantly during the recovery of the economy (Bremus & Fratzscher, 2015). International banks have shifted their international business models towards more local operations (Lambert *et al*., 2015) suggesting regionalization and segmentation trends in the global interbank market. Interestingly, Lambert *et al.* (2015) argue the reduction in cross-border lending was largely due to euro area banks and banks from other areas have only partially offset that reduction. In general, since cross-border claims are considered riskier than domestic claims (Bremus & Fratzscher, 2015), it may be meaningful to withdraw assets from international markets in order to limit risks and the spread of contagion within the banking network.

The EU banking system is a very interesting object of network analysis. In the contemporary global economy — it is inevitably a part of the global banking network. On the other hand, it is a formal union with common regulatory and supervisory environment, designed to benefit from single market and monetary union. Also, historical formation of the EU (with multiple accessions of new members) and development of its banking system resulted in formation of core and periphery countries and distinctive banking network indicators. Therefore, it is relevant to analyse the EU banking network, its characteristics and trends both from the intra-EU and global perspectives. Our previous research (Gaigaliene *et al.*, 2018) concentrated on the assessment of intra-EU banking network and has shown that during the post-crisis period the level of regionalization within the EU banking network had increased; the network became more clustered and more decentralized. This paper continues our research on structural changes of the EU banking network during post-crisis period by adding a global context and questioning the connectedness of the EU banking network within the global banking system.

The aim of this research is to evaluate the EU banking network connectedness in the global context during post-crisis period.

The major contribution of this research is application of network analysis method for evaluation of connectedness and structural changes of the EU banking systems within the global context. In addition, it provides new insights into the EU banking network's intraregional and interregional connectedness in the global context during the post crisis period. The research is conducted for a total of 37 countries using Bank of International Settlements (BIS) bilateral interbank cross-border claim yearly flows data.

The paper is structured as follows. The first chapter presents research methodology, including the research logics, research methods and the data used. The second chapter focuses on presentation of the results showing global banking network mapping, analysis of global banking network indicators; analysis of connectedness of the global banking network and assessment of intraregional and interregional connectedness of the EU banking network in the global context. The third chapter presents discussion of the results. Conclusions provide the general summary of the article, research limitations, and suggested areas for future research.

Research methodology

Research logics and methods

The research is performed in *2 stages*, as presented in Table 1, and is in line with our previous research on the EU banking network (Gaigaliene *et al*., 2018).

Stage 1 is aimed at mapping the global banking network using a network mapping method, as presented in detail in our previous research (Gaigaliene *et al*., 2018), which is in line with Minoiu and Reyes (2013) and Paltalidis *et al.* (2015). In the network analysis, each country in the dataset is a node within the network, and links between nodes represent cross-border banking claim flows, by constructing matrices W^t for every time period t where rows represent lender countries, and columns represent borrower countries. Each cell w_{ij}^t represents the value of the flow from country i to country j at time t. Then, these matrices are transformed into their binary matrices $A^t = \{a_{ij}^t\}$, where each cell a_{ij}^t takes value 1 if $w_{ij}^t > 0$ and 0 otherwise. Visual images of banking networks are drawn using network analysis software Gephi (in line with Feng *et al.* (2014) and Feng and Hu (2013)). Countries are classified into communities using community detection algorithm in Gephi — modularity class, created by Blondel *et al.* (2008).

In *Stage 2* the analysis of the structure and connectedness of the global banking network is conducted using the methodology similar to our previous research on the EU banking network's regionalization (Gaigaliene *et al*., 2018). Firstly, to conduct the global network analysis, the most commonly referred to *network indicators*: degree, in-degree, out-degree, strength, strength in-degree, strength out-degree, degree centrality, betweenness centrality, closeness centrality and clustering coefficient were calculated as in Gaigaliene *et al.* (2018). *Connectedness* of global banking network is assessed by using network density indicators. Based on Hale *et al.* (2011), network density is equal to the number of links as a share of all possible links in the network. The density of a network is calculated using the following formula used by Martinez-Jaramillo *et al.* (2014):

$$d = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} x_{ij}}{N(N-1)} \tag{1}$$

where N is the number of nodes and $d \in [0, 1]$. Comparison of density in different points in time allows to measure whether connectedness within the network increased or decreased.

To assess *structural changes* of global banking network, calculations of Pearson correlation coefficients, ANOVA and Levene tests are performed. The choice to use correlation coefficients is based on previous research by Fagiolo (2009), where correlation among network indicators was used to determine structural differences. Furthermore, ANOVA test for equality of means and Levene's test for equality of variances between the same type of indicators are performed. ANOVA F-values and Levene statistics between the same type of indicators in 2011 and 2015 must reveal non-equality of means and variances, respectively, so that reliable conclusions on the connectedness of global network could be made.

For the analysis of the EU banking network's connectedness in the global context, *intraregional* and *interregional adjacency matrices* are used. This is in line with the research by Kim and Shin (2002), who created socio-matrices in which countries of the same region are adjacent, and then calculated intraregional and interregional densities in different points in time. Intraregional density is calculated as a simple density of a network, which consists only of a certain region's countries' cross-border claim flows, while interregional density — as a simple density of a network, which consists only of cross-border claim flows between countries within the same region. For the whole network interregional density calculation, all between region matrices are treated as one network. The regionalization is considered to exist when intraregional network density is higher than interregional network density — i.e. cross border flows are more intense among countries within the region than with countries from the other regions. In this research, regional classification of sample countries is simplified up to 2 regions (EU 28 and Rest of the world (RoW) or 3 regions (EU 12, EU 16 and RoW) due to the unavailability of data from other countries.

Empirical research data and research sample

The data used in this research consists of Bank of International Settlements (BIS) Locational banking statistics (LBS) of the break- and exchange rate-adjusted yearly changes in cross-border banking claims in millions of US dollars, and is in line with the data used in our previous research (Gaigaliene *et al*., 2018). BIS LBS statistics provide quarterly information about the geographical breakdown of banks' cross-border claims by residence of their counterparties' country, including intragroup positions vis-à-vis banking offices of the same banking group. Thus, the country level data is gathered after bank-level positions have been aggregated up. Also, quarterly flows for each country are added up in order to get yearly flows. Changes in cross-border bank claims are calculated by subtracting changes in cross-

border non-bank sectors' claims from changes in cross-border all sectors' claims, because the data of solely banking sector claims is unavailable. A full set of data (i.e. incoming and outgoing cross-border banking claims) is only available for the BIS reporting countries. Such countries report their outgoing bilateral cross-border claim flows to the BIS. Incoming bilateral cross-border claim flows of BIS reporting countries have to be collected from the data of other BIS reporting countries. In this research, the data from year 2011 and year 2015 is used to map the global banking network and to conduct its connectedness analysis. The decision to fill this gap is based on the research by Kim and Shin (2002), and is grounded on the rationale that network structures are inert and do not change considerably in a relatively short period of time. The above-mentioned incompleteness of data and assumptions imply the limitations of the research data; therefore, the results should be used with caution.

As presented in Table 2, empirical research sample consists of a total of 37 countries, which together constitute 45% of G20 (2015) or 77% of OECD (2016). Out of this number, 12 EU countries were classified as belonging to the core of EU and remaining 16 countries — to the periphery of EU. Outgoing flows data is unavailable for Cyprus, Italy, Portugal and Spain; therefore, these countries were relatively added to the EU periphery (even though they are BIC reporting countries) to assure the consistency of data. Out of 9 countries, referred in this paper as the Rest of the world (RoW), 3 countries are offshore financial centres (OFCs) — territorial entities that are not states as understood by international law and practice but for which data are separately and independently maintained (BIS Statistical Bulletin, 2016).

Research results

Mapping of the global banking network

The global banking network includes EU 28 countries plus 9 additional countries as described in the research methodology. Graphical visualisations of global directed and weighted cross-border banking claim flows' network for 2011 is provided in Figure 1 and for 2015 — in Figure 2. As exhibited in Figures 1 and 2, the global banking network reveals no changes in the number of communities — 6 in both periods. Although the number of clusters remained the same, a comparison of global banking networks for 2011 and for 2015 reveals visible changes within clusters. This suggests that some structural changes in the global banking network had

occurred. Moreover, according to the node degree metric, it could be observed that overall in 2011 the mostly interconnected countries considering incoming and outgoing relations were South Korea (degree — 30), Finland (degree — 29), Australia (degree — 28) and Chinese Taipei (Taiwan) (degree — 28). In 2015, number of connections fell, while mostly interconnected countries changed as well into Chinese Taipei (Taiwan) (degree — 28), South Korea (degree — 27) and Japan (degree — 26).

Analysis of global banking network's indicators

Descriptive statistics of 10 network indicators for 2011 and 2015 are presented in Table 3. The analysis includes just EU 12 and 9 RoW countries, since network indicators cannot be computed for EU 16 countries, whose data set includes only their incoming flows.

As presented in Table 3, according to the mean values in-degree, out-degree and degree metrics were on average higher in 2011 than in 2015 indicating that the number of interconnections of global banking network countries decreased. In-degree, out-degree and degree metrics' lower maximum values and higher minimum values in most cases suggest that the most interconnected countries decreased the number of their interconnections while the least interconnected countries increased their number of interconnections during the post-crisis period, which may reveal changing claims' destination countries, i.e., structural changes, within global banking network and decentralization trends. Degree, betweenness and closeness centrality metrics allow evaluating the importance of certain countries within the network. It is observed that 2 (degree and closeness centrality) out of 3 centrality measures' mean values decreased in 2015. Lower degree centrality metric reveals that the popularity of the most interconnected countries decreased, thus, they became less important to the network, according to the number of interconnections, compared with less interconnected countries. A decrease in closeness centrality metric indicates that the average distance from a given country to all other countries in the network decreased, which reveals that periphery countries are becoming slightly more interconnected and central to the network. However, the difference between degree centrality and closeness centrality metrics in 2011 and 2015 is very small, revealing that these decentralization processes in the global banking network are happening very slowly during the post-crisis period. On the contrary, the mean value of betweenness centrality metric increased in 2015 compared with 2011 with more countries becoming central to the network.

Analysis of the connectedness of global banking network

In order to assess the connectedness of the global banking network, network density indicators for 2011 and 2015 were calculated (see Table 4), revealing how many actual connections in a network exist of all possible connections.

In 2011 the density of the global banking network was equal to 37.30%, but in 2015, it decreased up to 32.80%. Decrease of the density of the global banking network by 4.50% within the analysed period reveals lower number of interconnections within the global banking network and refers to the decrease in the level of globalization within this network.

To collect the evidence on the structural changes in the global banking network's correlation analysis, ANOVA test for equality of means and Levene's tests for equality of variances of global network indicators in 2011 and 2015 is performed. Correlation coefficients between the same type of 4 indicators of the global banking network (out-degree, betweenness centrality, closeness centrality and clustering coefficient) in 2011 and 2015 are below 0.5 and statistically insignificant, implying that structural changes happened in global banking network with respect to these indicators. ANOVA F-values and Levene statistics between 4 global banking network indicators (out-degree, strength in-degree, betweenness and closeness centrality) in 2011 and 2015 reveal non-equality of means and variances, respectively. Therefore, the results confirm that structure of global banking network changed during post-crisis period and is reflected by out-degree, betweenness and closeness centrality network indicators.

Analysis of EU banking network connectedness level in the global context

In this part of the research, the EU banking network connectedness level is evaluated using intraregional and interregional density indicators, which allow for measuring the density of connections within regions and between regions, as presented in Table 5.

Computed intraregional density indicators in 2011 for EU 12, EU 28 and RoW regions reveal that RoW region is the most densely interconnected within itself with 55.56% actual connections existing of all possible connections; while the least densely interconnected is EU 28 intraregional banking network showing (36.73% of connections). In 2015 interconnections inside the analysed regions decreased as the intraregional density of EU 12, EU 28 and RoW regions was considerably lower (EU 12 decreased by considerable 17.42%, EU 28 — by 6.17%, and RoW — by 9.72%.).

Intraregional density values do not indicate certain region's interconnections with other regions, for this purpose interregional densities are calculated. As shown in table 5, in 2011 directional one-way interregional density was the highest for RoW to EU 12 network (48.48% increase), while EU 12 claims increase on RoW network had 37.50% density. The scores of EU 12 claims increase on EU 16 and RoW claims increase on EU 16 networks had 30.00% and 28.89% densities, respectively. This shows that EU 12 core and RoW had more interconnections between themselves comparing with their interconnections with periphery region EU 16. In 2015, the situation slightly changed but the trend of EU 12 and RoW to have more interconnections between themselves continued.

Analysis of 2 regions, i.e., EU 28 and RoW reveal that EU 28 countries' banks had more banking claims, increased connections on RoW countries' banks and, hence, invested more into RoW than RoW into EU 28. On the contrary, RoW on EU 12 and RoW on EU 16 interregional density indicators in 2011 and 2015 indicate that the number of connections either decreased by 9.09% (RoW on EU 12) or did not change (RoW on EU 16). The same trends are observed when comparing EU 28 and RoW regions interregional density indicators in 2011 and 2015. An analysis of the whole network interregional densities for either 2 or 3 regions reveal that the number of connections among different regions decreased by 0.78% in 3 regions case and by 2.06% in 2 regions case.

To assess if the intraregional density of EU 28 banking sector's network is higher than interregional EU 28 and RoW banking network density, EU 28 intraregional densities in 2011 and 2015 are compared with the interregional densities of 2 regions' whole network in 2011 and 2015. An analysis reveals that the EU was regionalized in 2011 (36.73% > 36.28%), but this regionalization disappeared in 2015, as the level of intraregional density decreased in 2015 (-6.17%) and became lower than the interregional density (30.56% < 34.22%). Interregional interactions of the EU and RoW decreased in 2015 as well (-2.06%).

Discussion

The results of our research identified that during post-crisis period the level of global banking sector connectedness decreased implying that the level of globalization within global cross-border banking sector network has also decreased. These results are in line with the results of Claessen and van Horen (2015), who identified that banking in terms of foreign bank presence has become less global after the recent financial crisis. This is also

supported by Minoiu and Reyes (2012), who revealed that network density co-moves with the global cycle of private capital flows, i.e., country-level connectedness tends to increase before the onset of financial crises and to decrease afterwards.

This study has shown that between 2011 and 2015 the density of the global banking network decreased by 4.50%, what gives on average 0.9% yearly decrease. It supports the findings of Lambert *et al.* (2015) who state that cross-border claims as a share of the total banking assets have not recovered to the pre-crisis level yet, and implies that the cut-off in cross-border interbank lending, which started after the crisis, is still ongoing.

The structure of global banking sector connectedness was proved to change during the post-crisis period in this research with respect to out-degree, betweenness and closeness centrality network indicators. These results are in line with the results by Claessen and van Horen (2015) and Lambert *et al.* (2015), who revealed that global banking is going through some important structural transformations. Our findings show that even though periphery countries are becoming more important, thus, increasing the network indicators' average, core countries importance' decrease is much higher to offset stronger periphery effect, resulting in a lower average overall. This is again supported by Minoiu and Reyes (2012), who report that core binary network density experienced a downward adjustment during the last financial crisis and was deeper than during other crises.

Analysis of the EU banking network's connectedness in the global context revealed that in 2011 the EU was regionalized in the global context, but this regionalization diminished in 2015 as the level of intraregional density decreased and became lower than interregional density. Interregional interactions of the EU and RoW decreased as well in 2015. Such results suggest that cross-border linkages within EU 28 (especially EU 12) banking network decreased during post-crisis period, but interregional EU 28 and RoW linkages also diminished but in a smaller pace. This may appear surprising due to insights based on cross-border claims structure and correlation analysis by Lambert *et al.* (2015) that intraregional linkages increased in Europe, Middle East and Africa, but not as much as in Asia and Pacific during post-crisis period. In addition, such results appear to be contrary to Claessen and van Horen (2015), who claim that global banking is gaining a more regional focus.

Conclusions

In this paper, an evaluation of the EU and global banking network connectedness during the post-crisis period was performed for a total of 37 countries using network analysis methodology and BIS bilateral interbank cross-border claim yearly flows data. The analysis involved identification and mapping of global banking network, analysis of global network's structure and connectedness level; and analysis of the EU banking network's regionalization in the global context, based on the density indicators of the intraregional and interregional network.

Assessment of the connectedness of the global banking network revealed that global banking network density decreased by 4.50%, suggesting that connectedness is decreasing, but it is happening slowly. The results also confirm that structural changes in the global banking network did happen during the post-crisis period with regard to out-degree, betweenness and closeness centrality indicators.

Regarding the analysis of the EU banking network connectedness in the global context during the post-crisis period, it was identified in this study that the EU was regionalized in the global context in 2011, but this regionalization disappeared in 2015, as the level of intraregional density decreased in 2015, and became lower than the interregional density. In 2015, the number of interregional interactions of the EU and RoW decreased as well. Two tendencies emerged: the same or increased banking claim flows to EU 16 (periphery), and decreased lending to core countries, i.e., EU 12.

This research contributes to previous research in a way that it applies intraregional and interregional network density measures for evaluation of the EU banking network's connectedness and analyses it as a subset of the global banking network. It also continues our previous research on the EU banking regionalization during the post crisis period. Hence, this research adds to the knowledge of regional and global banking network's relations during the post-crisis period. The practical value of this study lies in its systemic view on the global and the EU banking networks and the assessment of connectedness changes during the post-crisis period using network methodology. With respect to reliability of the results and the restrictions of application, it should be noted that our conclusions should be interpreted with caution due to the fact that the global banking network is not full, and the availability of data limitations exist (as discussed in research methodology section).

Further research in global banking network field could enhance sample geographical coverage allowing for better understanding of the EU connectedness trends with regions such as Asia, where most international busi-

ness is concentrated. Secondly, the possibility to use cross-border banking claim flows data straight, without having to derive it from all sector and non-banking sector data, would also improve research reliability. Finally, further research could aim to investigate the causes of the increased globalization of the EU banking network in the global context when the rest of the world's banking network is in de-globalization trend during the post-crisis period.

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Annex

Table 1. Logics of the research

Stages	*Stage 1*. Identification of the global banking networks	*Stage 2.* Analysis of the structure and connectedness of EU banking network in the global banking network
Steps	Mapping of global banking networks	2.1. Analysis of network indicators 2.2. Analysis of connectedness of the global banking network 2.3 Analysis of EU banking network connectedness in the global context
Methods	Mapping of networks	Structural and comparative network analysis
Data	Bilateral cross-border claim flows	Intraregional and interregional banking network matrices

Table 2. Main characteristics of research sample

Scope of network	**Countries**	**BIS Reporting / non-reporting**	**Legal status**	**Type of flows**
EU 12 (core)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Sweden, United Kingdom	Reporting	State	Incoming and outgoing
EU 16 (periphery)	Cyprus, Italy, Portugal, Spain	Reporting	State	Incoming*
	Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia	Non-reporting	State	Incoming
RoW (rest of the world)	Australia, Chinese Taipei (Taiwan), Japan, Switzerland, South Korea, United States	Reporting	State	Incoming and outgoing
	Guernsey	Reporting	Offshore Financial centres	
	Isle of Man, Jersey			

Note: * Even though Cyprus, Italy, Portugal and Spain are BIS reporting countries, their outgoing flows data is unavailable. Therefore, these countries are relatively added to EU periphery to keep coherency.

Source: compiled by authors based on BIS Statistical Bulletin (2016).

Table 3. Descriptive statistics of global banking network indicators

Network indicator	Min	Max	Mean	Std. Dev.	Variance
2011					
In-degree	3.000	15.000	9.000	3.082	9.500
Out-degree	6.000	22.000	13.430	3.682	13.557
Degree	11.000	30.000	22.430	5.335	28.457
Strength in-degree	0.016	3.427	0.942	0.945	0.893
Strength out-degree	0.998	1.002	1.000	0.001	0.000
Strength degree	1.016	4.427	1.943	0.945	0.893
Degree centrality	0.280	0.75	0.561	0.133	0.018
Betweenness centrality	3.630	51.32	24.381	13.390	179.297
Closeness centrality	0.490	0.72	0.601	0.054	0.003
Clustering coefficient	0.274	0.468	0.347	0.046	0.002
2015					-
In-degree	3.000	10.000	7.240	1.998	3.990
Out-degree	7.000	20.000	11.810	3.250	10.562
Degree	12.000	28.000	19.050	4.165	17.348
Strength in-degree	0.002	3.257	0.822	0.830	0.689
Strength out-degree	0.982	1.001	0.999	0.004	0.000
Strength degree	1.002	4.256	1.821	0.831	0.690
Degree centrality	0.300	0.700	0.476	0.104	0.011
Betweenness centrality	7.420	57.970	26.476	13.561	183.901
Closeness centrality	0.490	0.690	0.560	0.047	0.002
Clustering coefficient	0.167	0.377	0.256	0.057	0.003

Table 4. Global banking networks density indicators

	Network density, %			
	2011	**2015**	**Average**	**Change**
Global banking network*	37.30	32.80	35.05	-4.50

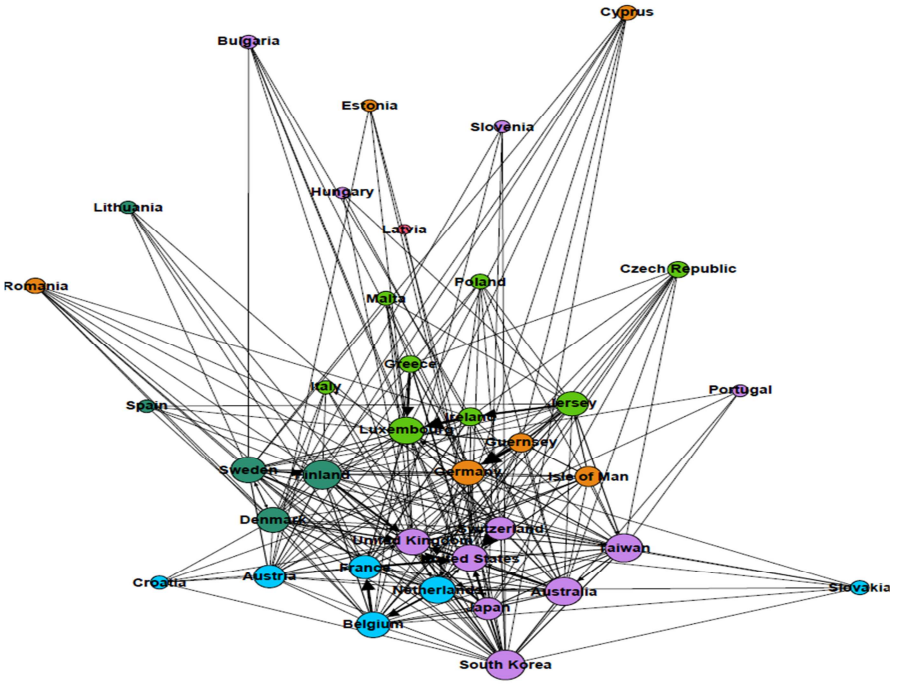
Note: * The network is represented by 21 (EU 12 and RoW) countries, since EU 16 outgoing flows data is unavailable.,

Table 5. Intraregional and interregional banking networks' density indicators, %

Type		Scope / direction	2011	2015	Average	Change
Intraregional density		EU 12 (core)	49.24	31.82	40.53	-17.42
		EU 16 (periphery)	N/A	N/A	N/A	N/A
		EU 28*	36.73	30.56	33.65	-6.17
		RoW	55.56	45.83	50.69	-9.72
Interregional density	3 regions**	EU 12 → EU 16	30.00	31.67	30.83	1.67
		EU 12 → RoW	37.50	39.58	38.54	2.08
		EU 16 → EU 12	N/A	N/A	N/A	N/A
		EU 16 → RoW	N/A	N/A	N/A	N/A
		RoW → EU 12	48.48	39.39	43.94	-9.09
		RoW → EU 16	28.89	28.89	28.89	0.00
	2 regions	RoW → EU 28	35.80	32.10	33.95	-3.70
		EU 28 → RoW*	37.50	39.58	38.54	2.08
	3 regions**	Whole network	34.71	33.92	34.31	-0.78
	2 regions	Whole network	36.28	34.22	35.25	-2.06

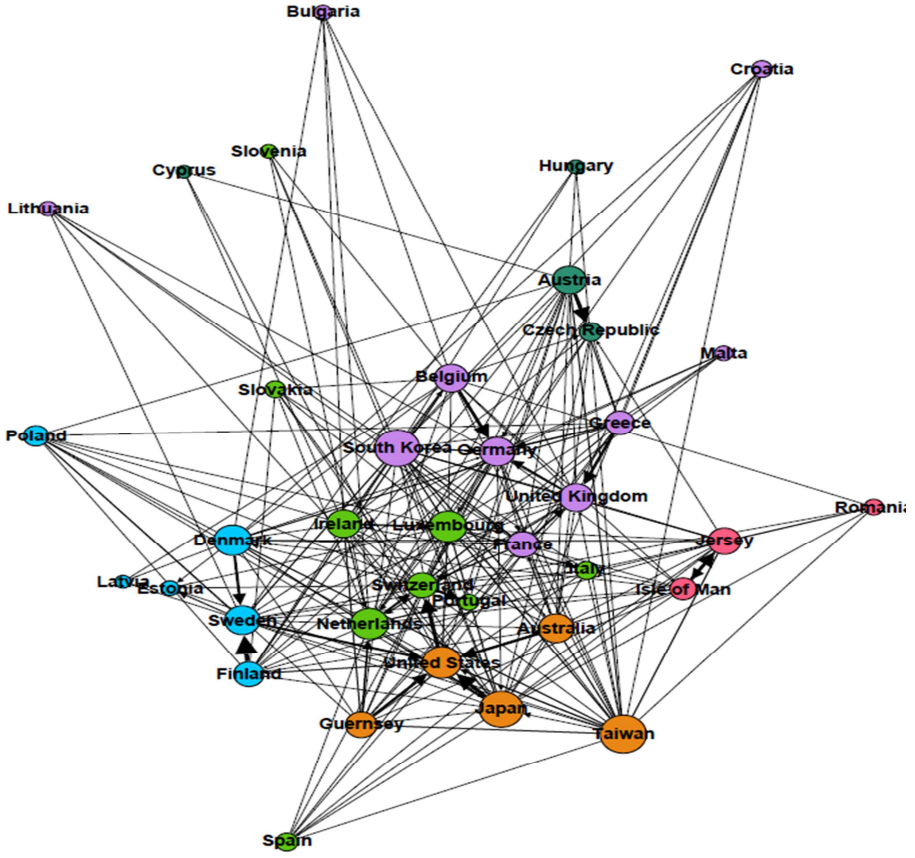
Note: * networks are not full since EU 16 outgoing flows data is unavailable; ** EU 12 and EU 16 are treated as two separate sub-regions within EU 28 in order to analyse interconnections between them.

Figure 1. Global directed and weighted cross-border banking claim flows' network for year 2011



Source: compiled by authors using BIS LBS by residence data (2016) and network software Gephi.

Figure 2. Global directed and weighted cross-border banking claim flows' network for year 2015



Source: compiled by authors using BIS LBS by residence data (2016) and network software Gephi.