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DETERMINATION OF SIFIS (SYSTEMATICALLY IMPORTANT FINANCIAL INSTITUTIONS) AMONG INDONESIAN BANKS USING NETWORK ANALYSIS APPROACH

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ABSTRACT

This study aims to measuring systemic risks using network analysis method to obtain the SIFI rating of Indonesian banks. The author analyzes the systemic risk implied in the Indonesian interbank network during the period from 2011 through 2015 based on various network measures such degree centrality and betweenness centrality. The main findings are as follows: First, interconnectedness in the interbank market is increasing. However, a different condition was significantly found in 2013, where the interconnectedness in the interbank market went downwards compared to the previous year. Second, the degree centrality score showed that government-owned and national private banks tend to be in-degree while foreign private banks tend to be out-degree. Third, there was no bank that consistently continued to have a high betweenness centrality score during the study period.

Keywords: Interconnectedness, Systemic risk, Network centrality, Network analysis, SIFI

JEL Classification: G01, G41

INTRODUCTION

The global financial crisis cropped up in August 2007 when one of French major bank, BNP Paribas, declared its inability to liquidate several securities associated with subprime mortgage from the United States. This event triggered huge losses suffered by banks and other financial institutions due to the subprime mortgage ownership. Later in the third quarter of 2008, the crisis grew in line with the collapse of the largest US investment bank, Lehman Brothers, followed by an increasingly severe liquidity crisis in financial institutions in the United States, Europe and Japan. After the crisis, the topic of financial system stability

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obtained growing attention from national and international regulators, academicians and players in the financial industry.

As a part of the economic system, financial system plays an important role as it serves to allocate funds from those surplus units to deficit units. Failure to maintain the stability of the financial system, especially when it leads to a crisis, can hamper the economic growth and its recovery efforts will undoubtedly be costly. Batunanggar (2003) suggested there are three main reasons why financial system stability is important. First, it will create confidence and supportive atmosphere for depositors and investors to invest in financial institutions. Second, it will encourage efficient financial intermediation that can ultimately promote investment and economic growth. Third, it will encourage market operation and improve the allocation of resources in the economy.

Indonesian banking industry in the financial system is believed to have a significant contribution to the national economy as a whole. Based on Bank Indonesia data in 2015, the banking sector dominated the financial sector in Indonesia with 76.4% asset proportion. Besides, Indonesian banking activity is still more dominant than its capital market activity. As of July 2016, the Indonesian Central Securities Depository (KSEI) recorded that in total, there were only 491,116 total investors as shown by the Single Investor Identity (SID). Unlike the capital market, banking services have a relatively larger number of customers. Based on the data of the Deposit Insurance Corporation (LPS), in July 2016, the data shows that there were 185,076,206 accounts of savings with the maximum balance of 2 billion rupiahs, and 227,358 accounts of savings with the balance above 2 billion rupiahs.

In line with the growing product innovations in the banking industry, the financial sector has become dynamic, with inter-sectoral linkages in terms of business activities and institutions that have become increasingly complex. Given the closer interconnection between financial sectors, banking as the sector that has major contributions to the financial system has an important role in maintaining the overall financial system stability. The failure of a bank can result in systemic and contagious impacts on other banks and financial institutions in the system ultimately threatening the stability of the entire financial system.

Regarding to systemic risk issues, the determination of a financial institution as a Systemically Important Financial Institution (SIFI) is fundamental, in order to mantain the

financial system stability. There are several theories used as references in determining the banks having systemic impacts (SIFI). Various parties believe that too-big-to-fail (TBTF) financial institutions can pose excessive risks and may potentially cause crisis (Boyd and Heitz, 2016). However, from the onset of the 2008 global crisis, there has been a shift of paradigm from too-big-to-fail (TBTF) theory to too-interconnected-to-fail (TITF) theory (Cole, 2013).

Various studies have resulted in market-based systemic risk measurement, in which the data used is the market capitalization and banking stock returns data. The studies focus on the probability of default and correlation between financial institutions. However, the method is unable to adequately describe interconnection because it does not take into account interactions, such as contagious defaults or the relevance between interconnection and SIFI (Kanno, 2015).

In contrast to previous studies, this study will assess systemic risk from financial network perspective with structural network analysis model using the financial data of each bank. The focus of this study is the banking system network on the interbank placement instrument which includes time deposit and interbank call money. Interbank placements are considered to illustrate the short-term liquidity market condition of the Indonesian banking industry.

Indonesia experienced liquidity crisis in 1997-1998 which was triggered by the volatility of the rupiah exchange rate due to the financial crisis that struck almost all countries in East Asia region in July 1997. The crisis began when Thailand declared its inability to repay its enermous foreign debts which rapidly affected other Asian countries as foreign investors lost confidence in Asian markets and sold their Asian currencies and assets as quickly as possible - resulting in weakened currency, decreased values of stock exchange and decreased value of other assets in numerous Southeast Asia countries.

At that time, in order to deal with that condition, the government tightened liquidity as part of contractionary policy. The condition resulted in poor public confidence on the national banking system, especially after the revocation of the business licenses of several banks. This in turn triggered the public distrust in Indonesian banks. The crisis eventually led to massive withdrawal of public funds resulting in many banks suffering from severe liquidity mismatch,

followed by an overall liquidity crunch. This condition was further exacerbated by the interbank money market interest rate (PUAB) reaching 300% per annum.

The decision to liquidate banks during the 1997-1998 crises was seen as the trigger of the damage of the banking sector. However, the effort originally intended to prevent the widespread of banking crisis was responded negatively by the people that made massive bank runs - leaving numerous banks to experience liquidity mismatch and negative demand deposits at Bank Indonesia. Given the importance of short-term liquidity factor to the potential systemic risks in Indonesian banks, this study measures systemic risk using interbank placement network to obtain the SIFI ratings of banks in Indonesia.

LITERATURE REVIEW

De Bandth and Hartmann (2000) suggested that systemic risk consists of two important elements, shock and contagion mechanisms. Shocks can be idiosyncratic or systematic. In idiosyncratic shocks, the incidence of a shock only affects the soundness of a financial institution or the price of a financial asset, while systematic shocks will affect the economy as a whole. The second important element is the shock contagion mechanism from one financial institution to the others. In De Bandth and Hartmann (2000) view, these elements are the most important in the concept of systemic risk.

Billio et al. (2012) noted that systemic risk events involve financial systems and a group of interconnected institutions, in which on the event of crisis, the iliquidity, bankruptcy, and loss of an institution can rapidly be contagious to other institutions. This fits the study of Acharya (2009) which stated that a financial crisis can be considered "systemic" when many banks fail at the same time or when a bank's failure has contagious effects that ultimately leads to the failure of many banks.

Bluhm and Krahnen (2014) proved that interconnection among financial institutions is a dominant component that encourages systemic risk, in which increased interconnection is linked with the increased systemic risk level and bank's contribution to the systemic risk. As the consequence, interbank market needs to be comprehensively observed in every systemic risk analysis. In accordance with the studies of Bluhm and Krahnen (2014), Paltalidis et al. (2015) proved that shocks on interbank loans are the major driver of losses in the banking

system. Furthermore, the transmission of systemic shocks and rapidness of contagion depend on the size of the national banking sector and the interconnection degree. However, in terms of the number of banks affected by the contagion, interconnection between banks - in this case the interbank loan network structure is a significant factor in systemic risk measurement.

Krause and Giansante (2012) showed that network structure is the determining factor for predicting banking crisis possibility. This is in line with Lee (2013) which suggested that interconnection, in terms of interbank placement, makes liquidity systemic risk. When a bank faces mass withdrawal, it will use its interbank claim before start liquidating the assets, which in turn may result in the contagion of liquidity problems throughout the financial system.

The global financial crisis in the United States in 2007 proved that failure in financial institution interconnection and complexity can threaten the stability of the global financial system as a whole and negatively affects the economy. The bigger a financial institution in terms of size and interconnection complexity, the more market players expect that the institution will not be allowed to collapse. If the institution is in trouble, the government will intervene by giving financial assistance (Bongini et al., 2015).

Based on this explanation it is important to observe banks categorized as SIFIs. Markose (2012) noted that the current statistical model for systemic risk measurement has failed to identify threats to financial network stability, often called too-interconnected-to-fail (TITF), in which the problem arises because of the concentration of financial networks in several major players. The use of network analysis can help us identify the SIFIs in a network interconnection, assess the effects of contagion, and monitor the resilience of existing financial networks.

Basically network analysis consists of a set of "nodes" which are financial institutions and links between financial institutions, either directly or indirectly, such as the relationship of credit exposure and liquidity flow in the payment system (Frait and Komárková, 2011). As a consequence of the current financial crisis, the too-interconnected-to-fail (TITF) paradigm has come to surface as an alternative to the traditional too-big-to-fail (TBTF) paradigm. The concept of network analysis in identifying "important nodes" is increasingly believed to be a measure of systemic risk. Rokhim et al. (2010) explained that the important characteristic of

network analysis is centrality, which explains the relevance of a node's position in the network. Centrality may provide an indication of a "node" that has a potential systemic impact.

Kanno (2015) analyzed systemic risk in the global banking system by taking into account bilateral exposure in an interbank network. Out of a total sample of 202 banks from 34 major countries, including G20 countries, Kanno (2015) ranked 30 banks based on the interconnection as measured by the degree of "node" of each sample. These banks are mostly G-SIB (Global Systemically Important Banks) banks. Another research conducted by Hattori and Suda (2007) also used network analysis to illustrate the shape of inter-institutional financial flows to assess the financial system's resilience and its developments in international financial markets. Hattori and Suda (2007) used banking consolidated loan exposures statistical data from 215 countries published by BIS. In the study, Hattori and Suda (2007) revealed that interbank exposure network has a closer relationship between times. Out of the 5 regions surveyed, Hattori and Suda (2007) found that Europe contributes significantly to the overall regional financial network, followed by the Asia Pacific region as the second largest contributor.

RESEARCH METHODS

This study aims to analyze SIFI which has the potential to create systemic risk in the interbank network in Indonesian banks. Therefore, the banks sampled in this study should be able to represent the conditions of interbank transaction risk in the banking industry in Indonesia. The banks selected as the samples of this study are banks with total assets of more than 15 trillion rupiahs. Based on the data of each bank's financial statements in 2015, the overall samples of the study represent about 65% of the total assets of the banking industry of Indonesia. In addition, the sample selection is also based on the availability of the detailed data on interbank placement transactions.

This study used secondary data obtained from the audited financial statements of the banks published on their official website. The data period used is annual data with the study period from 2011 to 2015. The variable used in this study is interbank placement, which includes the placement of time deposit and call money. The selection of interbank placement

variables is considered to reflect the condition of bank interconnection in Indonesia because the banking exposure in time deposit and call money instruments are relatively higher compared to current and savings instruments. In addition, in the event of liquidity crisis, the instrument is a more prominent liquidity buffer than any other instruments like securities or loan exposures.

In this study, interbank network analysis is done by using Network Centrality Measure method. To assess the systemic potential, the main data used is the exposure of interbank placements within a banking system. After that, the interbank placement exposure data is used to build the matrix of financial relations between a financial institution and other financial institutions. Kanno (2015) explained that interbank relations can be represented in the following X matrix (N x N):

$$X = \begin{array}{cc} \begin{bmatrix} x_{1,1} & \cdots & x_{1,j} & \cdots & x_{1,N} \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ x_{i,1} & \cdots & x_{i,j} & \cdots & x_{i,N} \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ x_{N,1} & \cdots & x_{N,j} & \cdots & x_{N,N} \end{bmatrix} & \begin{matrix} \sum_j \\ a_1 \\ \vdots \\ a_i \\ \vdots \\ a_N \end{matrix} \\ \sum_i \quad l_1 \quad \cdots \quad l_j \quad \cdots \quad l_N & \end{array} \qquad \text{.....} \quad (1)$$

where $x_{i,j}$ denotes the interbank placement exposure granted by bank *i* to bank *j*. The sum of row *i* denote the value of interbank placement asset owned by bank *i*, while the sum of column *j* is the value of interbank bank placement liabilities of bank *j*, as shown by the equation below:

$$a_i = \sum_j x_{i,j}, \quad l_j = \sum_i x_{i,j} \qquad \text{.....(2)}$$

Furthermore, once the interbank matrix is established, the next step is to measure how banking institutions are interconncected, in which the Network Analysis produces a statistical

measurement to see the interconnection or centrality of a financial institution. Each of the banks sampled in this study will be given a centrality score. Certain financial institutions with high centrality score can be categorized as financial institutions having systemic impacts.

In conducting interbank network analysis, this study used two types of centrality measurement, Degree Centrality and Betweenness Centrality. Below is the explanation for both types of measurements:

a. *Degree Centrality*

In a financial network, a node represents a financial institution, while edges represent the connections between nodes. In this study, edges describe the interbank placement connections in the Indonesian banking system while node degree represents the number of connections among nodes. This study used the concept of directed network recognizing two types of degree, which are out-degree and in-degree. Out-degree is measured by totaling the edge from a node, while in-degree represents the number of edges received by a node.

b. *Betweenness Centrality*

In addition to analyzing interbank network interconnection using degree centrality, this study also measured interconnection based on betweenness centrality. Through betweenness centrality, the measurement is done by observing how often a bank acts as a bridge or intermediary along the shortest path between two other banks. Banks with high betweenness centrality have the potential to influence the dissemination of information along the banking network. When a bank with high betweeness centrality is in default, the clearing payment system in the interbank network will be disrupted (Kanno, 2015).

Kanno (2015) measured the betweenness centrality of bank i in the system with the formula as follows:

$$B(b_i) = \sum_{j<k; i \notin \{k,j\}} \frac{g_{j,k}(b_i)}{g_{j,k}} \qquad \text{..... (3)}$$

where $g_{j,k}$ is the number of shortest paths between banks *j* and bank *k*, and $g_{j,k}$ (b_i) is the number of shortest paths between banks *j* and *k*, along which bank *i* acts as a bridge.

After obtaining the SIFI rating by using Network Centrality calculation based on the structural data in the form of interbank placements, robustness checking is done as a validation of consistency and reliability of the measurement of Network Centrality in describing the systemic risk contribution of individual banks against the systemic risk of banks in Indonesia. The analysis is done by using different weight calculations based on the total assets.

FINDINGS OF THE STUDY

Descriptive Analysis

The data used in this study is interbank placement, such as the placement of time deposit and call money. The financial information obtained from the financial statements published by each bank collected on a monthly basis for the study period from 2011 to 2015. The study samples consist of 21 commercial banks with the total assets of more than 15 trillion rupiahs with complete breakdown of the balance sheet data. TheTable 1 is the total assets and interbank placements owned by the banks sampled in this study based on the 2015 financial statements.

Out of the three banks sampled in this study, Bank Rakyat Indonesia (BRI), Bank Negara Indonesia (BNI) and Bank Tabungan Negara (BTN) are banks whose majority shares are owned by the Indonesian government. With the total assets reaching 878.4 trillion rupiahs, BRI has 5.67% of its total assets interbank placement. BNI with 478.7 trillion rupiahs total assets has 6.98% of its total assets interbank placement. On the other hand, BTN with 171.8 trillion rupiahs total assets only has 4.56% of total assets interbank placement. BRI and BTN have very focused main business in which BRI's business is focused on microcredit and BTN's business is focuses on housing loans making the portion of the interbank placements against the total assets owned by BRI and BTN relatively low.

From Table 1 it can be seen that banks having the highest interbank placement exposure are dominantly BUKU 4 and BUKU 3 banks. Bank Central Asia (BCA) as a BUKU 4

has the highest interbank placement amount at 56.2 trillion rupiahs. BCA has a very strong deposits structure so that places its liquidity surplus on interbank instruments. In similarity with BCA, Danamon and Panin as BUKU 4 also have a relatively high interbank placement exposure. Furthermore, Maybank, Bukopin, OCBC NISP, and Mega as BUKU 3 have relatively high interbank placement exposure.

Table 1. Total Assets and Interbank Placements

No.	Bank Name	Assets (in billion rupiahs)	Interbank Placements (in billion rupiahs)	% Interbank to Assets	Net Worth (in billion rupiahs)	BUKU category
1	BRI	878,426	49,835	5.67%	113,127	BUKU 4
2	BCA	594,373	56,259	9.47%	89,625	BUKU 4
3	BNI	478,716	33,417	6.98%	78,438	BUKU 4
4	CIMB	233,236	5,899	2.53%	28,679	BUKU 3
5	Permata	182,689	8,291	4.54%	18,813	BUKU 3
6	BTN	171,808	7,839	4.56%	13,860	BUKU 3
7	Panin	169,140	8,475	5.01%	30,806	BUKU 4
8	Danamon	157,969	17,983	11.38%	34,215	BUKU 4
9	Maybank	157,619	13,949	8.85%	15,743	BUKU 3
10	OCBCNISP	120,480	9,278	7.70%	16,411	BUKU 3
11	Bukopin	89,587	10,075	11.25%	7,535	BUKU 3
12	BJB	88,697	3,743	4.22%	7,757	BUKU 3
13	UOB	86,618	2,856	3.30%	10,268	BUKU 3
14	BTPN	81,040	6,206	7.66%	13,924	BUKU 3
15	Mandiri Syariah	70,799	193	0.27%	5,614	BUKU 3
16	Mega	68,469	8,673	12.67%	11,517	BUKU 3
17	Muamalat	57,803	23,290	40.29%	3,551	BUKU 2
18	Mayapada	47,306	5,607	11.85%	4,587	BUKU 2
19	Sinarmas	27,869	2,273	8.15%	3,670	BUKU 2
20	Victoria	23,251	1,837	7.90%	2,114	BUKU 2
21	Resona	16,981	3,634	21.40%	2,579	BUKU 2

Source: Bank Annual Report (data processing, 2017)

However, uniquely, there is a BUKU 2 bank which has high interbank placement exposure. Muamalat has 23.29 trillion rupiahs interbank placement exposures with the ratio of interbank placement to total assets reaching 40.29%. Based on the balance structure of

Muamalat, it is known that the majority of interbank placements owned by Muamalat are placed in *sharia* rural banks (BPRS) in the form of *mudharabah* time deposits. Unlike Muamalat, although classified as a BUKU 3 bank, Mandiri Syariah has a very small interbank placement exposure at only 193 billion rupiahs in the form of certificates of *mudharabah* deposits. In managing its liquidity surplus, Mandiri Syariah puts the majority of its funds in state sharia securities (SBSN) instruments owing to the fact that it is a bank owned by Mandiri which in fact is a state-owned bank and it is running its business under sharia principles resulting in a risk profile to be risk-averse.

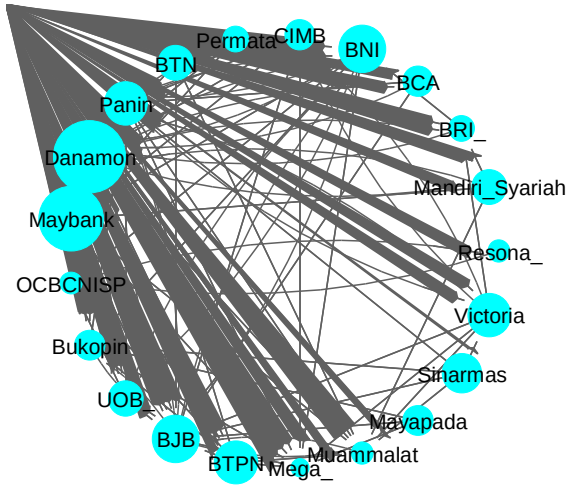
Viewed from the ratio of interbank placements to total assets, national private banks have relatively high ratios. Resona Perdania with only 16.98 trillion rupiahs total assets has an interbank placement reaching 21.4% of its total assets. On the other hand, Mega with 68.4 trillion rupiahs has an interbank placement at 8.67 trillion rupiahs or 12.67% of its total assets. Furthermore, Mayapada, Danamon, and Bukopin also have relatively high interbank placement ratios to total assets. Based on this condition, it can be concluded that those banks are risk takers as they place their liquidity surplus on interbank placement instruments rather than investing it in government securities.

From the explanation of the descriptive analysis, it can be seen that national private banks belonging to BUKU 2 and BUKU 3 categories are considered to have a greater potential default than BUKU 4 banks because national private banks belonging to BUKU 2 and BUKU 3 categories have relatively higher interbank placement to total assets ratios, so that in the event of depreciation of asset value from their interbank placements, it will greatly affect their soundness. In contrast to BUKU 4 banks such as BRI, BNI, and BCA, although their interbank placement exposures are nominally high, their ratios of exposure to assets are low. However, such condition will be studied more comprehensively using Network Analysis method.

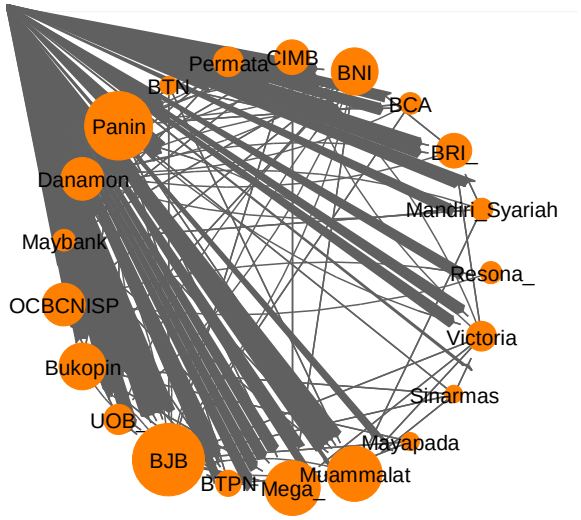
Network Analysis

Network analysis used to estimate the systemic risk potential that may occur in the banking industry in Indonesia. In this study, network analysis performed using network centrality measure that assesses the out-degree and in-degree of a node. Out-degree represents the

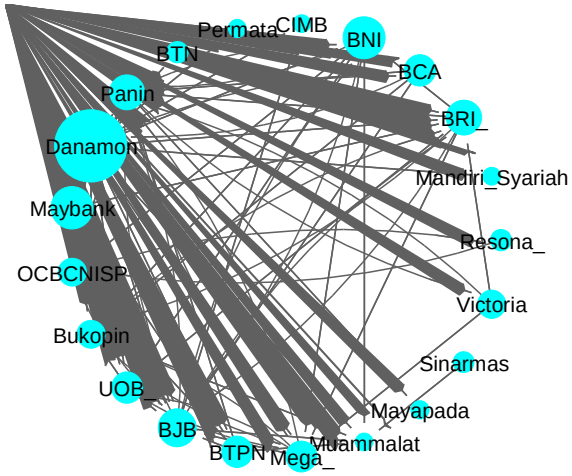
number of edges coming from a node while in-degree represents the number of edges received by a node. Figure 1 is the interbank network chart from 2011 to 2015.



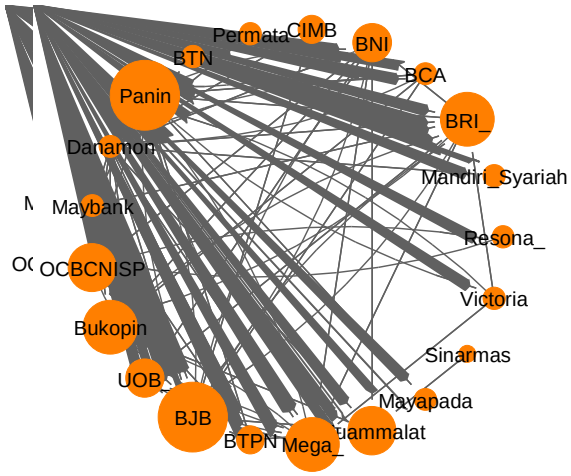
Out Degree (2011)



In Degree (2011)



Out Degree (2013)



In Degree (2013)

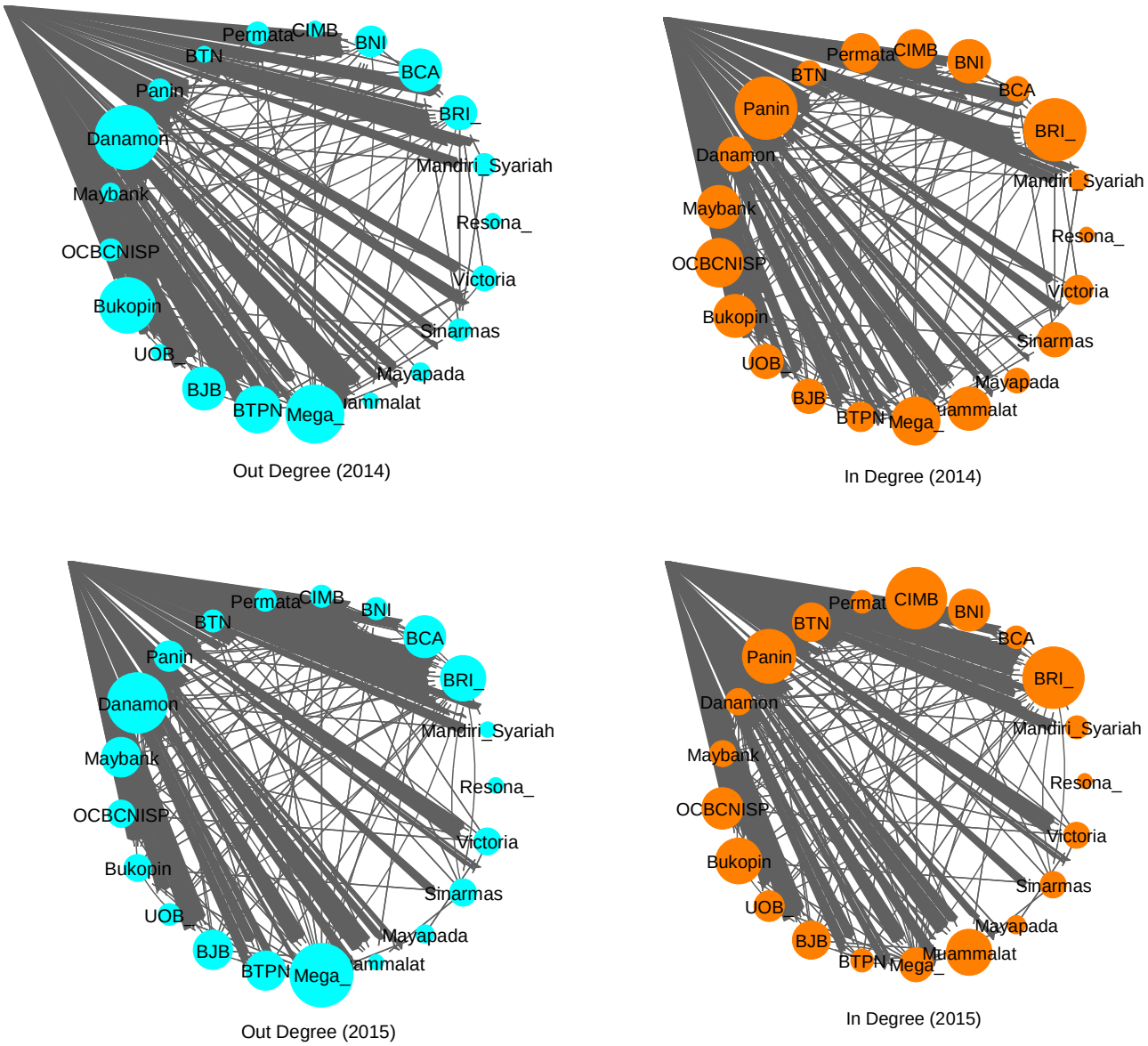


Figure 1. Interbank Network Chart from 2011-2015
Source: data processing

Based on Figure 1, it can be seen that bank interconnection has increased from 2011 to 2015. However, a significant different condition took place in 2013 as the interconnection network decreased compared to the previous years due to the existence of contractionary monetary policies made by Bank Indonesia in response to Indonesia economic performance in the year. In 2013 the global financial market was uncertain due to the tapering off plan in

the United States (US). In line with the expected rise in US interest rates, foreign capital flows might potentially be relocated from emerging market countries to the United States.

Indonesia as a foreign portfolio investment location was also affected by the tapering off plan. In addition, the outflow of foreign capital from Indonesia was also triggered by the negative perception of foreign investors on high inflationary pressures due to subsidized fuel price hike and increased food prices. In response to these circumstances, Bank Indonesia increased the BI rate aimed at reducing the inflationary pressure and increasing rupiah exchange rate value. These conditions ultimately affected the increased interest rate and returns on the interbank money market. With the increased interest rate on the interbank money market, banks dominantly reduced their exposure to interbank placements as the risks were relatively higher.

In addition, in line with the economic slowdown in 2013, the banking industry adjusted the pace of credit growth to reduce the ratio of Non Performing Loan (NPL) due to the economic slowdown. To support the expansion of its loan portfolio, banks disbursed their liquid assets placed in other banks. These conditions explain the decrease in interbank exposure in 2013.

The node size shown in Figure 1 indicates the out-degree and in-degree size of each bank. It can be seen that Danamon is a bank with relatively high and stable out-degree exposure throughout the study period. The result of observation indicates that systemic risk phenomenon occurring in the banking system in Indonesia includes TBTF and TITF paradigms as the banks categorized as SIFIs are large banks with many interconnections within the banking system.

An interesting finding from the out-degree network is that Maybank is experiencing an annual out-degree decline, but on contrast Mega has experienced a significant increasing out-degree exposure. The increased out-degree exposure experienced by Mega is in line with the change of Mega's BUKU category from BUKU 2 in 2011 to be BUKU 3 in 2012.

When viewed from the in-degree network, Panin is a relatively stable bank with high in-degree exposure. An interesting finding of in-degree network is that Mega's in-degree exposure has decreased continuously over the study period, in addition BJB as a regional

state-owned bank also experienced a significant in-degree exposure decrease in 2014. However, CIMB Niaga and BRI's in-degree exposures increase every year.

Systematically Important Financial Institution (SIFI)

This study identified financial institutions with potential systemic impact by using network analysis method. As stated by Markose (2012), the use of network analysis can help identify SIFIs in relation to network interconnection and threat to financial network stability, often called too-interconnected-to-fail (TITF). This study used degree centrality and betweenness centrality as the interconnection proxies.

Degree Centrality

Degree centrality assesses how interconnected a bank is with other banks in the banking network. In this study, out-degree measures the interbank placement exposure originating from a bank, while in-degree measures the interbank placement exposure received by a bank. Table 2 shows the rating of banks with the highest interconnection score, as measured by degree centrality.

Table 2. Top 10 Banks with the Highest Degree Centrality

Rank	2011			2012			2013			2014			2015		
	Out	In	Total	Out	In	Total	Out	In	Total	Out	In	Total	Out	In	Total
1	Danamon	BJB	BJB	Danamon	Mega	Mega	Danamon	BJB	Danamon	Danamon	BRI	Mega	Mega	BRI	BRI
2	Maybank	Panin	Danamon	Maybank	BJB	Danamon	BNI	Panin	BJB	Mega	Panin	Danamon	Danamon	CIMB	Mega
3	BNI	Muammalat	Panin	BJB	Bukopin	BJB	Maybank	BRI	Panin	Bukopin	Mega	Bukopin	BRI	Panin	Danamon
4	BJB	Mega	BNI	BRI	Panin	Panin	BJB	Mega	BRI	BTPN	OCBCNISP	BRI	BCA	Bukopin	Panin
5	Panin	BNI	Maybank	Panin	BNI	BNI	BRI	Bukopin	Mega	BCA	Bukopin	BJB	Maybank	Muammalat	CIMB
6	BTPN	Bukopin	Muammalat	Mega	OCBCNISP	BRI	Panin	OCBCNISP	BNI	BJB	BNI	BTPN	BJB	OCBCNISP	BJB
7	Victoria	Danamon	Bukopin	BNI	BRI	Bukopin	BCA	Muammalat	Bukopin	BRI	Maybank	Panin	BTPN	BNI	Bukopin
8	Sinarmas	OCBCNISP	Mega	Mayapada	Muammalat	Maybank	Mega	BNI	OCBCNISP	BNI	Muammalat	BNI	Panin	BJB	OCBCNISP
9	UOB	CIMB	Victoria	BCA	UOB	OCBCNISP	UOB	UOB	UOB	Victoria	Permata	BCA	OCBCNISP	BTN	Maybank
10	BTN	BRI	BTPN	UOB	Danamon	UOB	BTPN	BTPN	Maybank	Panin	CIMB	OCBCNISP	Bukopin	Mega	BCA

Source: Data processing

Based on Table 2 it can be seen that BRI is the bank with the highest interconnection score in 2015, with the total degree centrality of 22. BRI's interbank placement exposure began to increase in 2012, with out-degree exposure tendency. Furthermore, the exposure

continued to increase, but the nature changed to be in-degree, where BRI ranked the first highest in-degree centrality since 2014. BRI's in-degree exposure is mostly the placement of call money in the form of foreign currencies from several private banks.

Mega and Danamon ranked the second and the third degree centrality in 2015, respectively. In recent years, Mega always has relatively high degree centrality. However, unlike BRI with the trend of becoming in-degree centrality, since 2014 the tendency of Mega tended to be out-degree. It ranked the first with the highest out-degree centrality in 2015 in which from its 21 total degree centralities, there were 16 out-degree centralities. Meanwhile, Danamon has 18 degree centralities in total with 15 out-degree centralities. Similar to Mega, Danamon had out-degree tendency interconnection from 2011 to 2015.

Meanwhile, Panin as the fourth highest degree centrality bank in 2015 consistently has high in-degree interbank placements exposure every year. Like Mega, BJB has in-degree tendency from 2011 to 2013 which then turned into out-degree. An interesting finding is that CIMB Niaga which was previously not categorized as a SIFI, in 2014 ranked the tenth highest in-degree centrality, and in 2015, it ranked the fifth highest degree centrality.

The observation outcomes indicate that throughout the sample analysis period, the SIFI cluster is relatively stable with dynamic bank ratings. Throughout the five periods of sample analysis, Danamon consistently scored high SIFI rating with out-degree exposure. On the other hand, Panin is also a bank that consistently had high SIFI rating but its exposure is in-degree in nature. In his study, Kanno (2015) suggested that in relation to contagious default, out-degree exposure has higher risks compared to in-degree. In the event of a banking crisis within the system, the bank facing the highest risk of being subject to contagion is the bank with high out-degree exposure, which can be a significant trigger of the contagion effect to other banks. Based on this explanation, it is important for the regulator to make microprudential policies that are specifically applied to a number of SIFI banks with the highest out-degree rating in order to improve the stability of the financial system.

Figure 2 demonstrates that state-owned banks tend to be in-degree. In addition to BRI, BNI and BTN also have in-degree interbank placement exposure trend. The explanation of these conditions is that state-owned banks tend to be encouraged to perform optimal intermediary functions resulting in most of their assets be heavily focused on loan expansion.

BRI and BTN have very focused main business in which BRI's business is focused on microcredit and BTN's business is focuses on housing loans making the portion of the interbank placements against the total assets owned by BRI and BTN relatively low. In addition, state-owned banks tend to have high in-degree exposure due to the trust of other banks against state-owned banks in placing their liquidity surplus. Interestingly, BJB as a regional state-owned bank has in-degree tendency from 2011 until 2013 which then turned into out-degree in 2014.

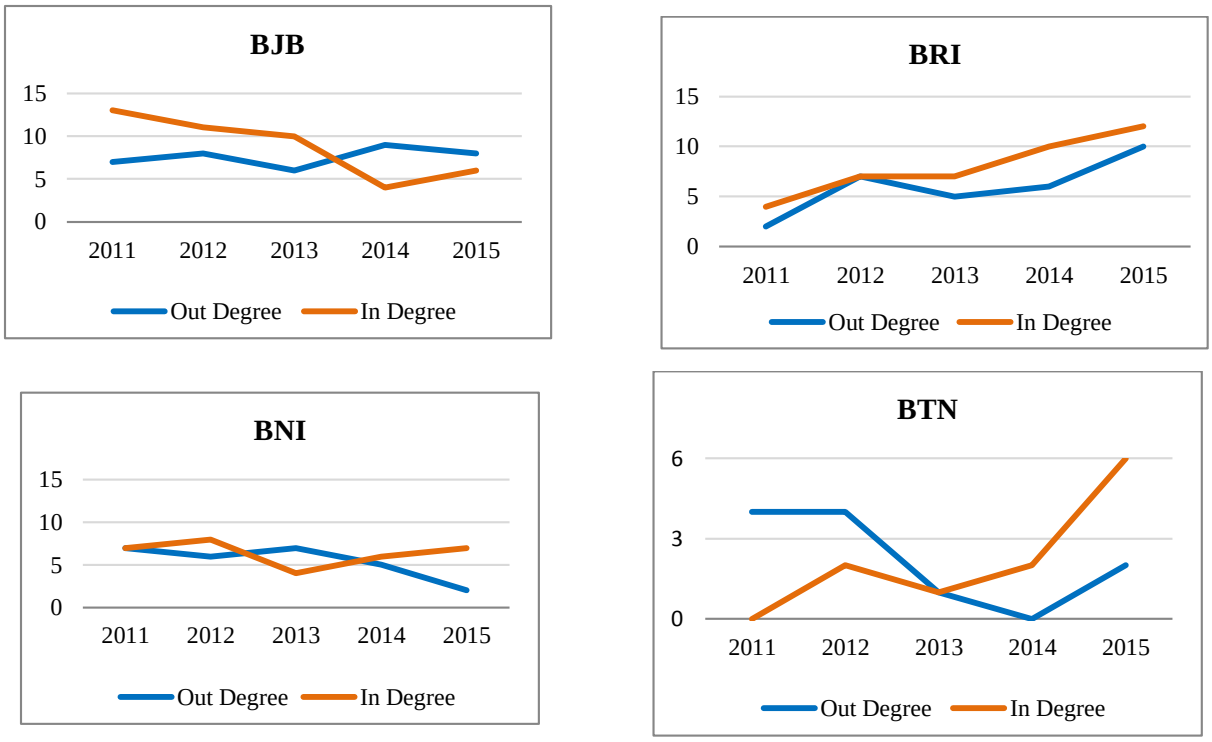


Figure 2. The 2011-2015 Out-degree and In-Degree Centrality Trend of State-owned Banks
Source: Data processing

Unlike state-owned banks, foreign private banks tend to have out-degree interbank placement exposure. As shown in Figure 3, Danamon as a foreign private bank dominantly owned by Singapore has high out-degree centrality every year. Just like Danamon, Maybank as a Malaysian bank also has high out-degree interbank placement exposure every year. In

addition, the BTPN also shows an increasing out-degree tendency since 2013 – the year it was acquired by Japanese bank, Sumitomo.

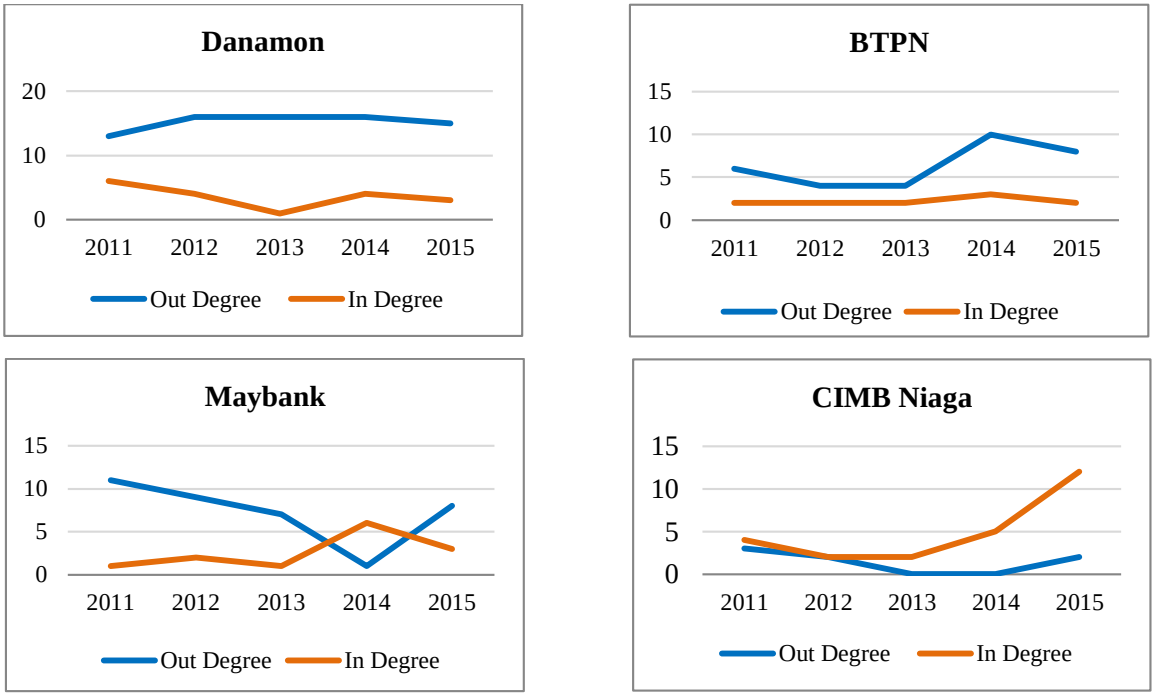


Figure 3. The 2011-2015 Out-degree and In-Degree Centrality Trend of Foreign-owned Banks
Source: Data processing

The out-degree exposure of foreign banks caused by the fact that foreign-owned banks are already have a solid liquidity surplus from their holding abroad. On the other hand, the lending ability by foreign-owned banks has not been so optimal, resulting in the allocation of their liquidity surplus for interbank instruments that promise favorable interest rates. Interestingly, the out-degree trend of CIMB Niaga as a foreign private bank from Malaysia has shown a downward trend and on the other hand its in-degree trend started to show a significant increase in 2014.

Figure 4 shows the degree centrality tendency of sharia bank group taken as samples. This study shows that sharia banks to have relatively small interbank exposures which tend to be out-degree in nature owing to the fact that sharia banks place the most of their funds in

sharia commercial banks and BPRS making it difficult to illustrate the exposure as this study does not include BPRS as samples.

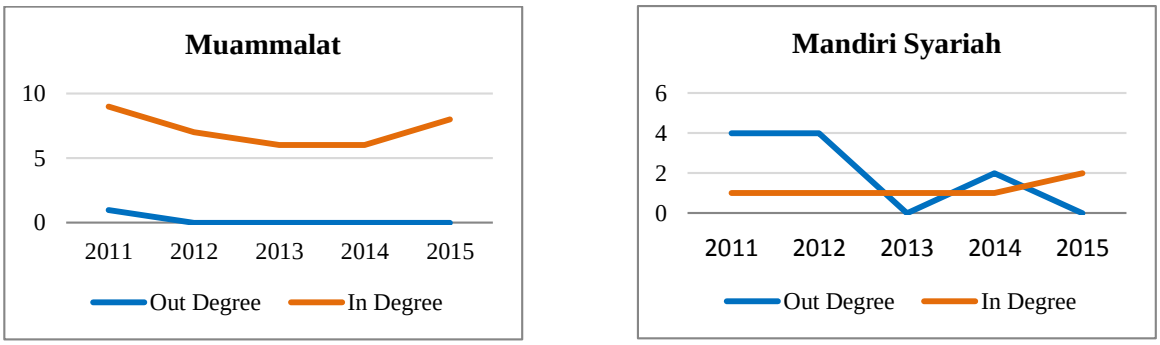
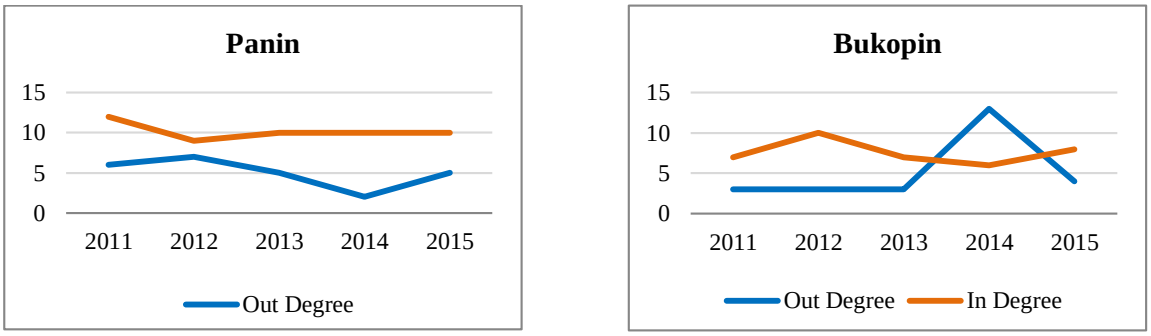


Figure 4. The 2011-2015 Out-degree and In-Degree Centrality of Sharia Bank Groups

The different conditions of foreign private banks are shown by national private banks. Figure 5 shows that most banks belonging to national private banks tend to have in-degree interbank placement exposure. Panin consistently has high in-degree interbank placements exposure from 2011 to 2015 followed by Bukopin that also had relatively high in-degree interbank placement exposure.



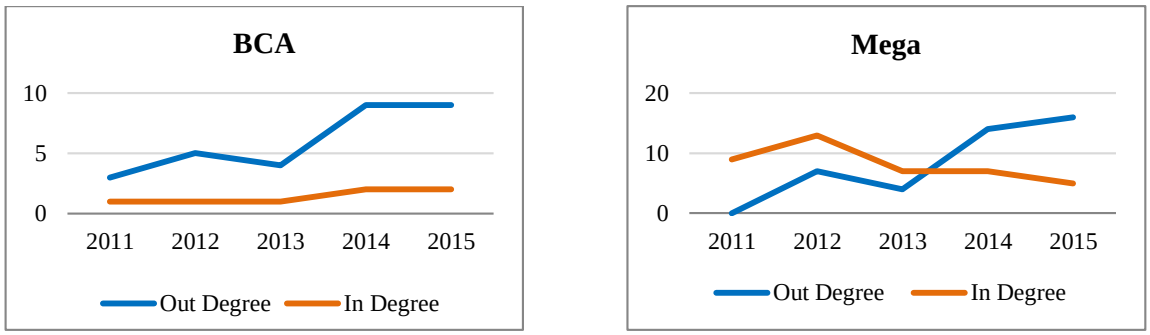


Figure 5. The 2011-2015 Out-degree and In-Degree Centrality of National Private Bank Groups
Source: Data processing

However, interestingly, BCA as Indonesia's largest private national bank has out-degree interbank placement exposure as BCA has a very strong deposits structure motivating BCA to place the liquidity surplus in interbank instruments. In similarity with BCA, Mega also has out-degree interbank placement exposure. Mega as a national private bank experienced a significant out-degree increase since 2014 and in 2015; it ranked the first with the highest out-degree centrality.

Betweenness Centrality

In addition to analyzing the network interconnection among banks using degree centrality, this study also measured interconnection based on betweenness centrality. Through betweenness centrality, the measurement is done by looking at how often a bank acts as a bridge or intermediary along the shortest path between two other banks. Banks with high betweeness centrality have the potential to influence the dissemination of information along the banking network. If a bank with high betweeness centrality is in default, the clearing payment system in the interbank network will be disrupted (Kanno, 2015).

Table 3. Top Ten Banks with the Highest Betweenness Centrality

Rank	Betweenness Centrality				
	2011	2012	2013	2014	2015
1	Danamon	Danamon	BJB	BRI	BRI
2	BJB	BRI	Panin	BNI	Mega
3	BNI	Mega	OCBCNISP	Mega	Panin
4	Panin	BJB	BRI	Danamon	BJB
5	OCBCNISP	BNI	BNI	Bukopin	Victoria
6	Mandiri Syariah	Panin	Mega	Panin	OCBCNISP
7	Victoria	UOB	Danamon	BCA	Danamon
8	Maybank	OCBCNISP	Bukopin	Sinarmas	CIMB
9	BRI	Resona	UOB	BTPN	Sinarmas
10	CIMB	Maybank	Victoria	BJB	BTN

Source: Data processing

Table 3 provides information on 10 banks sampled for this study with the highest betweeness centrality value. Based on the table, it can be seen that there is no bank that consistently has high betweeness centrality score during the study period. BRI and Mega are two banks with the highest betweeness centrality score in the last two research periods indicating that the banks play a role as an interbank network hub banks among Indonesian banks.

BRI and Mega have significantly increased betweeness centrality score in 2012 but the value slightly decreased in 2013, then increased in 2014 until 2015. The decline in the betweenness centrality scores of both banks in 2013 was associated with the decrease of banks' appetite in Indonesia to transact interbank instruments due to Indonesia's economic condition in that year. Figure 6 show that the betweenness centrality of both banks has a similar trend.

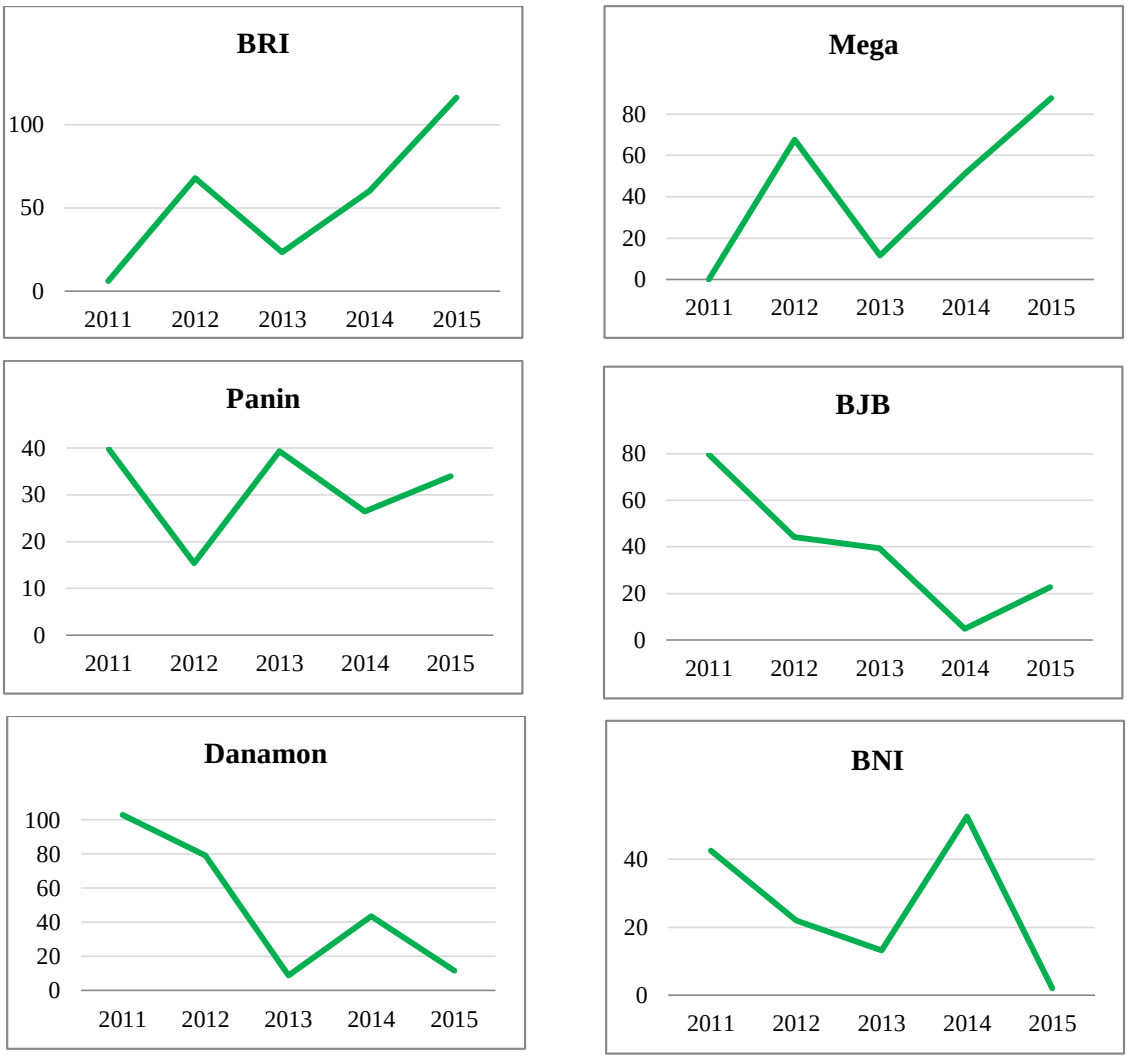


Figure 6. The 2011-2015 Betweenness Centrality Trend
Source: Data processing

In addition to BRI and Mega, Panin and BJB are banks with high betweenesses centrality score. In Figure 6 it can be seen that BJB and Panin are experiencing a trend of declining betweenness centrality score but in 2015 the betweenness centrality scores of both banks bounced back. In contrast to BRI and Mega which tend to experience an upward trend, Danamon and BNI were banks with relatively high betweeness centrality score from 2011 to 2012, but the betweeness centrality scores of both banks tended to decrease from 2013 to 2015. Figure 6 show that the betweenness centrality of both banks has a similar trend.

Interestingly, BUKU 2 banks like Victoria International, ranked the fifth in the list of banks with the highest betweeness centrality score in 2015. In addition to that year, Victoria International was also categorized as a bank with relatively high betweeness centrality score in 2011 and 2013. Other BUKU 2 banks such as Resona Perdania and Sinarmas have managed to enter the cluster of banks with the highest betweeness centrality scores in 2012 and 2014. These results indicate the volatility of the bank's financial conditions. In addition, based on the observation outcome, it can not be denied that the Indonesian banking system applies TITF paradigm.

Robustness Check

In this study, robustness checks were aimed at validating the analysis result. Robustness check was done by comparing the centrality score of non weighted-network obtained from the data processing with weighted-network. The weighted-network estimation measured by weighting the centrality score obtained from the data processing with the total assets owned by each bank in the research sample. The method used in the calculation of degree centrality and betweeness centrality is in line with the measurements done before.

Based on Table 4 it can be seen that throughout the sample analysis period, the SIFI cluster of the total weighting of assets is relatively stable equal to the measurement of centrality score of non-weighted network, except there was a change in the ranking order of some banks. During the five research periods, Danamon and Panin are SIFIs with consistently high total degrees. In addition, the corresponding result is also found on BRI which consistently ranks the first SIFI with the highest degree centrality. However, Mega and BJB's risk contribution decreases, as seen from the bank's downgrading in SIFI cluster. On the other hand, the risk contribution of major banks such as BCA, BNI, and BTN increases significantly compared to the measurement of centrality scores from non-weighted networks.

Table 4. Top Ten Banks with the highest degree centrality (Total Asset Weight)

Rank	2011			2012			2013			2014			2015		
	Out Degree	In Degree	Total Degree	Out Degree	In Degree	Total Degree	Out Degree	In Degree	Total Degree	Out Degree	In Degree	Total Degree	Out Degree	In Degree	Total Degree
1	BNI	BNI	BNI	BRI	BRI	BRI	BRI	BRI	BRI	BCA	BRI	BRI	BRI	BRI	BRI
2	Danamon	BRI	BRI	BCA	BNI	BNI	Danamon	Panin	BNI	BRI	BNI	BCA	BCA	BNI	BCA
3	BCA	Panin	Danamon	Danamon	Panin	BCA	BNI	BNI	Danamon	Danamon	Panin	BNI	Danamon	CIMB	BNI
4	Maybank	Danamon	Panin	BNI	Mega	Danamon	BCA	BJB	BCA	BNI	CIMB	Danamon	Maybank	Panin	CIMB
5	BRI	BJB	BCA	Maybank	BJB	Panin	Maybank	OCBCNISP	Panin	Bukopin	BCA	Panin	Mega	BCA	Danamon
6	Panin	CIMB	CIMB	Panin	Bukopin	BJB	Panin	BCA	BJB	Mega	Permata	Bukopin	BNI	BTN	Panin
7	CIMB	Mega	Maybank	BJB	OCBCNISP	Mega	BJB	Bukopin	Maybank	BTPN	Maybank	Mega	Panin	OCBCNISP	Maybank
8	BJB	BCA	BJB	Mega	Danamon	Maybank	OCBCNISP	Mega	OCBCNISP	BJB	Danamon	Permata	BJB	Bukopin	Mega
9	BTN	Bukopin	Bukopin	BTN	BCA	Bukopin	UOB	CIMB	Mega	Permata	OCBCNISP	CIMB	BTPN	BJB	BTN
10	BTPN	OCBCNISP	Mega	CIMB	Permata	OCBCNISP	BTPN	Muammalat	Bukopin	Panin	Bukopin	Maybank	OCBCNISP	Danamon	OCBCNISP

Source: Data processing

Regarding to betweenness centrality measurement, the weighted-network measurement rank consistently produces the same sequence in which BRI, Bank Mega, and Panin are banks with top three highest betweenness centrality score. It shows that these banks are validly acting as interbank network hubs among Indonesian banks. In addition, banks with relatively small total assets also manage to get into the top ten highest betweenness centrality score. From the robustness test outcome it can be concluded that the Indonesian banking system robustly applies TITF paradigm.

Table 5. Top 10 banks with the Highest Betweenness Centrality

Rank	Betweenness Centrality				
	2011	2012	2013	2014	2015
1	Danamon	BRI	BRI	BRI	BRI
2	BNI	Danamon	BJB	BNI	Mega
3	Panin	BNI	Panin	BCA	Panin
4	BJB	Mega	BNI	Danamon	CIMB
5	BRI	BJB	OCBCNISP	Panin	BJB
6	OCBCNISP	Panin	Danamon	Mega	OCBCNISP
7	Mandiri Syariah	OCBCNISP	Mega	Bukopin	Danamon
8	CIMB	UOB	Bukopin	BTPN	BTN
9	Maybank	Maybank	UOB	BJB	BNI
10	Victoria	CIMB	BTPN	Sinarmas	Bukopin

Source: Data processing

Conclusions

This study indicated that interbank money market interconnection increased from 2011 to 2015. However, a significantly different condition occurred in 2013 in which the interbank network interconnection decreased compared to the previous year. The empirical outcomes

indicate that state-owned banks tend to be in-degree due to the trust of other banks on state-owned banks in placing their liquidity surplus. In addition, state-owned banks are encouraged to perform intermediary function optimally resulting in the proportion of their assets be heavily focused on lending. Unlike state-owned banks, foreign private banks tend to have out-degree interbank placement exposure because foreign owned-banks already have solid liquidity supports from their overseas holdings. Different conditions are shown by national private banks as most of them tend to have in-degree interbank placement exposure.

In the event of a banking crisis within the system, the bank facing the highest risk of being subject to contagion is the bank with high out-degree exposure which can be a significant trigger of the contagion effect to other banks. Based on this explanation, it is important for the regulator to make microprudential policies that are specifically applied to a number of SIFI banks with the highest out-degree rating and betweenness score in order to improve the stability of the financial system.

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