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DISCUSSION PAPER SERIES NO. 2024-46

Probing Sectoral Networks of Ownership in Publicly Listed Financial Companies in the Philippines

Aubrey D. Tabuga, Ramonette B. Serafica, and Madeleine Louise S. Baiño



Philippine Institute for Development Studies

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18th Floor, Three Cyberpod Centris - North Tower EDSA corner Quezon Avenue, Quezon City, Philippines Probing Sectoral Networks of Ownership in Publicly Listed Financial Companies in the Philippines

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PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES

December 2024

Abstract

This paper aims to explore ownership networks of publicly listed financial institutions in the Philippines. It covers the second phase of a research project on financial networks and builds on the analyses done in Tabuga, Ruiz, Serafica and Baiño (2024) which aims to provide an understanding of the underlying network structure that may influence financial sector development and stability in the Philippines. The current paper further expounds on the connections examined in the first paper – focusing on the extent of financial institutions' network in other sectors, assessing connection roles in the network. In this report, the network which illustrates ownership and investment relationships has been expanded to include entities with relatively smaller shares emphasizing possible importance of relatively weaker ties. By identifying the sectors and subsectors of nodes in the network, this paper aims to provide a deeper understanding of the extent of network of the country's publicly listed financial institutions. Furthermore, it aims to draw useful knowledge that may be useful for policy formulation and financial supervision/regulation.

Keywords: ownership networks, publicly listed financial institutions, financial networks, network structure, investment relationships, inter-sector connections, network analysis

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Probing Sectoral Networks of Ownership in Publicly Listed Financial Companies in the Philippines

Aubrey D. Tabuga, Madeleine Louise S. Baiño and Ramonette B. Serafica¹

1. Introduction

In a continuing effort to understand structures of economic relations, this paper probes more deeply into the sectoral linkages of financial companies in the Philippines. This paper marks the second phase of the study on economic networks in the Philippines. The first phase is reported in a PIDS Discussion Paper titled "Network structure of financial institutions in the Philippines: Insights on corporate control and competition" by Tabuga, Ruiz, Serafica and Baiño (2024). In that paper, we analyzed linkages of financial institutions listed in the Philippine Stock Exchange (PSE). Links were defined via ownership of stocks. In the network graph, we drew a connection between any two entities if one has at least 5 percent ownership in the other. We distinguished subsidiary networks, ownership networks and networks created by board interlocks using data from the PSE on publicly listed financial companies and their networks. We found fragmented subsidiary networks but the connections among members of a business group are tightly knit. Such networks exhibit a hub and spoke structure where a parent company is situated in the center and the subsidiaries hang around it. This centralized structure is said to be typical of investment companies as they pool assets, cut costs and improve their efficiency. The paper likewise found that financial institutions diversify their portfolio by venturing into other sectors.

The current paper further expounds on the connections examined in the first paper – focusing on the extent of financial institutions' network in other sectors, assessing any bridging links and identifying core actors in the network. But unlike the previous paper which uses links from at least 5 percent company stake, this paper uses the network of at least 1 percent company ownership, yielding a much bigger network. By identifying the sectors and subsectors of nodes in the network, we also obtain a richer dataset that can provide a deeper understanding of the extent of network of the country's publicly listed financial institutions. For instance, this paper can show where these financial institutions are investing in the real sector, or in other financial institutions such as rural banks or investing companies. By identifying sector's connection roles in the bounded network of publicly listed financial supervision/regulation. The analytical intent of this paper is exploratory owing to the limitations of the data. In an ideal analysis of networks of financial institutions in the Philippines, all financial companies (or all major players, at least) must be included. Nonetheless, analyzing the case of publicly listed financial companies would suffice for now in exploring sectoral reach.

¹ The team acknowledges the excellent research assistance of Maria Blesila Mondez in both the current and previous papers, and Mark Gerald Ruiz for his assistance in building the database for this current paper. The usual disclaimer applies.

Specifically, the study aims to:

- 1. To illustrate the extent of sectoral linkages that financial companies have using network lens,
- 2. To characterize sectoral roles in the network of ownerships, and
- 3. To draw insights based on the findings and present opportunities for future research in this area.

This paper contributes to the body of knowledge that seeks to examine complex relationships within the economy via network science. Global studies on this topic and approach are rare. Engel, Nardo, and Rancan (2021) applied network analysis using 2016 worldwide ownership data retrieved by Orbis.² They found that the ownership data yield a giant component where a significant number of nodes are connected to each other. They further showed that a limited number of shareholders control many firms which reveals a substantial concentration of power. With respect to the financial sector, much of the interesting recent works are within the realm of systemic risks. For instance, in Asgharian, Kyygier and Vilhelmsson (2021)³, the need for incorporating centrality of firms in analyzing firm-specific characteristics' importance in explaining systemic risks was highlighted. They noted that the importance of firm characteristics in systemic risks assessment varies with centrality. Notably, both firm size and centrality are shown to be important variables to consider when analyzing systemic importance. Furthermore, while these two variables are correlated, the inclusion of centrality gives additional and valuable data for assessing the determinants of systemic risk.

Aldasoro, Huang, and Kemp (2020) conducted a global mapping of the cross-border links connecting banks and non-bank financial institutions (NBFIs). They noted that while "non-bank financial intermediation provides additional sources of financing for households and corporates", it can also "contribute to systemic risks through links with the banking system" (see Box A in Aldasoro, et al 2020).⁴ They found that banks and NBFIs are connected directly and indirectly and that cross-border links with such grew substantially and in combination with the rise of NBFIs around the world. Furthermore, the COVID-19 pandemic's market shock revealed the vulnerabilities associated from the links that banks have with NBFIs.

In the Philippines, however, there is a dearth of scholarship focusing on the same topic perhaps due to past challenges in collecting and collating the data necessary for this kind of research. In terms of the meso-level perspective of analyzing networks of financial institutions in the country, we do not know of any prior study that has been published so far.

The rest of the paper is structured as follows. Section II briefly presents the methodology and data which have been extensively discussed in the previous paper. Section III discusses the main findings on the sectoral linkages of financial institutions while IV reports the analysis

² Engel, J., M. Nardo, and M. Rancan (2021). Network analysis for economics and finance: An application to firm ownership. In S. Consoli et al. (eds.), Data Science for Economics and Finance. <u>https://doi.org/10.1007/978-3-030-66891-4_14</u>

³ <u>https://onlinelibrary.wiley.com/doi/10.1111/eufm.12340</u> (accessed on December 1, 2024)

⁴ <u>https://www.bis.org/publ/qtrpdf/r_qt2009e.htm</u> (accessed on December 1, 2024)

about the sector's network roles in the system. In Section V, we summarize these findings and provide some concluding remarks including areas for future research.

2. Methodology and data

To analyze the networks of publicly listed financial institutions, we define the links as ownership or investment links. These relationships are illustrated by a *nxn* binary adjacency matrix G, with the following elements:

 $g_{i,j} = \begin{cases} 1 & \text{if the } j-\text{th company is a subsidiary of or owned by the } i-\text{th company} \\ 0 & \text{otherwise} \end{cases}$ (Equation A)

The units in the network (totaling to n) are companies, persons, and even estates which are called *nodes* or *vertices*. We call each link an *edge*. As shown in Equation A, the value in the matrix is 1 whenever there exists a link between any pair of nodes – that is, one is a parent company or stockholder of the other. The matrix data were analyzed using the UCINET software package including the Netdraw for illustrating the network graphs.

To analyze the network, we look at it as one system, but we also examine its parts. Whole network analysis is about characterizing the network in terms of cohesion or how the elements are connected to one another. Cohesion also indicates a system's ability to facilitate interaction among the nodes. Creating a visual illustration of the network is a standard part of network analysis and it helps in understanding network cohesion. A common measure of network cohesion⁵ is *density*, D, which is calculated for a directed graph as:

$$D = \frac{m}{N(N-1)}$$
 (Equation B)

Where m is the number of edges in the graph and N is the number of nodes in the network. In addition to generating the graphs of the network, marking or coloring the entities by sector provides a richer and nuanced understanding of the networks. This enables one to obtain knowledge of the linkages between and among entities like banks and non-banks, financial companies and the real sector, among others. D's value is between 0 and 1 with 0 pertaining to a situation where there is no link at all (i.e. the network is totally fragmented) while 1 is a fully connected network (that is, every node is connected to all other nodes in the network). The higher D is, the more cohesive the network. Another network parameter that indicates cohesion is average *geodesic distance* which is the average the length in terms of the number of edges of the shortest path between the nodes.

⁵ https://www.sciencedirect.com/topics/computer-science/network-density (accessed on December 1, 2024)

The network position of each node in the network can also be translated into objective parameters or scores that indicate popularity and network power. Degree is such a measure. Degree is the total number of nodes directly connected to the *ego*, the node of interest. The outdegree refers to the number of direct links emanating from a node, while the in-degree centrality pertains to the number of links going to the node of interest. The higher the degree, the more popular and connected one is. If we look at banks for instance, a higher out-degree centrality means that these are investing in many different entities because the links are ownership links. Another way to measure reach is the out-k-step, which measures the number of nodes that one can reach in k number of steps. Concentrating the analysis on a particular node of interest and its direct connections is called an ego network analysis.

An important network centrality measure for individual nodes is *betweenness*. This measure indicates a node's bridging or, go-between ability, as the name implies. Betweenness score measures how often a node sits along the shortest path between any two nodes, other than itself. The betweenness score⁶ of a node $y \in N$, where N is the set of all nodes in the network is:

Betweenness (y) =
$$\sum_{i \neq b \neq j \in N} \frac{b_{i,j}(y)}{b_{i,j}}$$
 (Equation C)

Where the denominator $b_{i,j}$ is the sum of paths between node pairs *i* and *j* (that excludes y); and $b_{i,j}(y)$ is the number of paths between *i* and *j* that pass-through *y*. A node or entity with a high betweenness score is a strategically positioned node with the ability to connect otherwise separate network segments. The removal of an entity with very high betweenness score will alter network connections in a significant way.

Another important connectedness measure is the average reciprocal distance or ARD (which is a measure of reach). Unlike degree which focuses on the node of interest's immediate connections, ARD captures the node's reach across the entire network of interest.

Closeness centrality is another measure of reach that computes how close each entity or node to all other nodes in the network. It is useful for identifying nodes that can influence the entire network in an efficient way. ARD, closeness and betweenness are global measures of connectedness, these measures relate to a node's position within the whole network while degree is a mere local measure of centrality. In a directed graph, we can calculate these measures accounting for their direction. For example, out-ARD pertains to the ARD score emanating from the node of interest. These measures are used to identify the sectoral network roles of financial institutions.

This study uses data from company profiles and documents from the official website of the Philippine Stock Exchange (PSE). We obtained company name, parent companies, subsidiaries, affiliates, associates, and stockholders with minimum ownership of 1 percent. Sectors and subsector information were obtained from the same PSE filings and online sources.

⁶ <u>https://www.sciencedirect.com/topics/computer-science/betweenness-centrality</u> (accessed on December 1, 2024)

All financial companies listed under the PSE (July 2023 to January 2024) were included in the analysis.⁷ To verify the data collected from the PSE website, the team gathered information from official websites of companies of interest to ensure the completeness of their ownership links. The data used in this study is limited to publicly listed companies. Nonetheless, it covers 70%⁸ of the Top 20 Universal and Commercial Banks per Bangko Sentral ng Pilipinas (BSP) and 45%⁹ of Top 20 Thrift Banks. For a complete discussion on the PSE data used, please refer to Tabuga et al 2024.

3. Sectoral linkages of financial institutions¹⁰

The ownership network of publicly listed financial institutions yields 532 nodes and 1120 connections. When link direction is ignored, the density is at 0.004 which means that it is a fragmented network. The average degree is 2.105 and the network is made up of 21 components or separate groups. Figure 1 shows the directed graph for visual appreciation with the nodes colored according to their component/group. The biggest of the groups, called main component, contains nodes in red color. The hub and spoke structure of network components is noticeable. This same centralized system shown in the first paper is typical of financial institutions because of the need to pool assets and reduce costs. The network is also considered as a sparsely connected network with the various centrality measures exhibiting a power-law distribution where most have very low centrality scores and only very few have very high scores (see Figure 2). This indicates a relatively unequal influence within the network as only very few entities can maximize their network positions. A more densely connected network would have a relatively normal distribution.

This paper's focus is on the sectoral profiles of the connections. The network of financial institutions is comprised of mostly non-bank financial institutions at 37 percent and holding companies with nearly 16 percent (see Table 1). Banking institutions constitute 10 percent and individuals/estates form 12 percent. Other services comprise 9 percent while the property sector comprises 8 percent. Only very few companies from the industrial sector (5%) and rural banks (1%) are included in the network of publicly listed financial companies.

⁷ The original planned data sources are SEC company filings. However, due to difficulty of getting data from SEC, the team decided to use PSE data instead. Company disclosures such as the public ownership reports and stockholder data as of December 31, 2023, were then obtained.

⁸ Ranking of Universal and Commercial Bank Group as to Total Assets as of December 30, 2023.

⁹ Ranking of Thrift Bank Group as to Total Assets as of December 30, 2023.

¹⁰ As in the first paper, the network graphs exclude PCD Nominee Corporation (both Filipino and non-Filipino) as this company is not the beneficial owners of the shares shown in the PSE company disclosure documents.



Figure 1. Directed graph of ownership links of financial institutions by component

Source: Authors' computation. Source of basic data: Philippine Stock Exchange document



Figure 2. Histograms of selected normalized centrality scores.

Source: Authors' computation. Source of basic data: Philippine Stock Exchange document

Table 1.	Frequency	v distribution	of network	elements	or nodes b	v sector.
		,	••••••••			,

Sectors/sub-sector	Frequency	Percent
Banks	55	10.34
Non-bank FIs	199	37.41
Rural banks	5	0.94
Holding companies	85	15.98
Industrials	26	4.89
Other services	49	9.21
Real estate/property sector	43	8.08
Others (individuals/estates)	66	12.41
Unknown	4	0.75
Total	532	100

Source: Authors' computation.

Source of basic data: Philippine Stock Exchange document

In Figure 3, the nodes are colored based on their sector/subsector. Note that the links are directed with the direction emanating from the parent company or stockholders to the direction of the entity being owned and controlled. If we look at each of the 21 network components or clusters, the sectors of the nodes are varied as shown by the varied node colors. There is no component wherein all the nodes belong to only one or two sectors. This illustrates diversity in the investment portfolio of business groups.

The same network graph has been drawn but the node sizes were adjusted based on the degree centrality of each node as calculated by the UCINET software package using the ownership network data. If we use it as measure of assessing centrality within the network, Figure 4 shows that banking institutions are the central actors as shown in the larger sized, pink-colored nodes. However, if we use the betweenness score which indicates the ability to bridge segments of the network, there are also non-bank financial institutions, apart from banking institutions that hold central and strategic positions within the network as shown by bigger nodes in red color (see Figure 5). This approach of comparing the sizes based on centrality scores may be quite subjective but proved to be useful for determining the sectors of focus in more formal analytical methods such as test of means. The succeeding section shows the outcome of these formal analyses.



Figure 3. Directed graph of ownership links of financial institutions by sector.

Figure 4. Directed graph of ownership links of financial institutions by sector, size is proportional to degree.



Figure 5. Directed graph of ownership links of financial institutions by sector, size is proportional to betweenness.

OTHERS, NEC

HOLDING COMPANIES



Looking at the main component of the graph (i.e. the biggest connected cluster), we can observe that government entities like the GSIS, SSS and NRCP, equities and holding companies and services companies act as connectors that bridge otherwise separate business groups. Another observation is that banks mainly relate to NBFIs around them as owners/investors (with arrows coming from banks going to NBFIs) rather than as recipients of investments. Banks receive investments from holding companies and individual investors.





4. Roles of sectors in the financial networks

The usefulness of network science in understanding varying roles of network elements comes from its ability to provide objective centrality or connectedness measures depending on the network positions of nodes or network members. Since the data provides a way to identify sectors, we can say something about network roles at the sectoral level by comparing the network attributes of sectors. For instance, the sector that has higher betweenness centrality than others are in a strategic position of brokering or bridging the network of interest. The removal of entities with high betweenness score is likely to disrupt the system. Additionally, it is interesting to obtain which sectors are more likely to diversify their investment portfolio by having higher outdegree or which are more popular by having higher indegree centrality than others. Outdegree (indegree) measures centrality by obtaining the total number of outward (inward) direct connections. We use simple t-test to obtain whether the means of centrality of sectors are statistically different.

Since the initial graphs illustrate that banks and non-bank financial institutions comprise the most central entities, we conducted test of means for these subsectors. The comparison of centrality scores is made between banks and others. Given the non-normal distribution of the centrality scores as shown in Figure 2, we also conducted the *ranksum* test via Stata (which is an alternative approach when the variable of interest is not normally distributed) to examine differences in the central tendencies between the two groups (i.e. banks and others). The *ranksum* test is also called the Wilcoxon or Mann-Whitney rank-sum test.

The results, presented in the Annexes, show that banking institutions (including rural banks) have statistically higher betweenness and indegree centrality than the other sectors/subsectors – as shown by significant outcomes of both t-test and *ranksum* test. Banking institutions, therefore, have crucial roles of bridging otherwise separate network segments with the financial system. The high betweenness centrality emanates from the fact that many banks are parent companies of subsidiaries and affiliates. Many entities are also investing in banking institutions as shown by their significantly higher in-degree centrality. We extended the analysis to 2-step reach, and we found that banks also have high in-2-step centrality. In fact, banks can be reached by an average of 8.6 nodes while the rest can only be reached by 3.1 nodes within 2-steps. With this combination of scores (high betweenness, in-degree and in-2-step centrality), a removal of any of these banking institutions is likely to disrupt the system in a significant way. Interestingly, banks do not have significantly different score in terms of out-degree and out-2-step centrality with the rest of the sectors. Higher outdegree and out-2-step centrality scores indicate that banking companies invest in more companies than others. We did not find that banks have this network role.

The roles of NBFIs in the network are also of particular interest because of the importance of assessing NBFIs in the systemic risk literature. The comparisons of sample means via T-test and central tendencies via Wilcoxon test of NBFIs versus all other sectors reveal that former are more of a recipient of investments rather than one that invest in other companies based on the bounded network of financial institutions that we are analyzing. We found that NBFIs' in-ARD (out-ARD) mean score is significantly higher (lower) than that in the rest of the sectors. This is also the case for in-closeness (higher than others) and out-closeness (lower than others). These indicate that other nodes in the network are able to reach or invest in NBFIs in a more efficient way; this direction is inward (meaning, approaching NBFIs). The opposite is true for outward investments. NBFIs have statistically significantly lower capacity to invest in the rest of the network. The in-2-step centrality of NBFIs is also statistically significantly higher while its out-2-step centrality is significantly lower. There are no significant differences between NBFIs and the rest with respect to betweenness, in-degree and out-degree.

Another interesting observation is the somewhat bigger sized nodes among holding companies (see yellow-colored nodes), next to banks and NBFIs, in Figures 3 and 4. We examined its centrality scores and found that holding companies have statistically significantly higher centrality measures of reach than others particularly in out-ARD, out-closeness and even out-2-step centrality. This result means that holding companies have significantly higher ability to reach other actors within the network in an efficient way. Out-ARD and out-closeness put premium on distance. Holding companies are in a position that enables them to reach many companies because they are of short distances to these actors. Their power and influence within the network emanating from their positions are fundamental because these are global measures of centrality. Even when we look at the local measure of reach which is the out-2-step score (the total number of nodes that can be reached outward within 2 steps), holding companies have higher scores than other sectors. The significant t-test reveals that on average, holding companies can reach 8.11 nodes within 2 steps while others can reach only 2.9, on average. Various holding companies are therefore highly central and influential owing to their ability to invest in many companies within the financial sector.

5. Summary and concluding remarks

The network approach provides such a unique perspective in understanding economic systems such as the financial sector. Using this unique approach, we characterize the network of publicly listed financial institutions as fragmented and sparsely connected with only very few companies who are in positions of power and influence. Looking at the sectoral connections, we noted the diversity of sectors that financial companies engage with. The network is made up mostly of non-bank financial institutions and holding companies, followed by banking institutions and individuals/estates. Several services companies and property firms are also included. Only very few companies are from the industrial sector which provides evidence that the financial sector (at least the publicly listed ones) have weak connections with manufacturing, mining, and construction sectors.

There are several ways in which this scholarship can be further pursued for it to provide even more useful information. This methodology promises to provide more insights given the availability of data covering several points in time. Such would enable one to examine the role of the evolving network structure through time vis-à-vis the dynamics of the economy and business cycle. Also, if more information is available to further characterize the nodes (such as size and important outcomes like productivity or profitability, access to small customers, sustainable products, etc.), such granularity can be very useful for policymaking purposes. Another fruitful area for future research is that which enables correlations between company performance and their network connectedness or positioning to be examined. With improvements in data collection, future research will benefit from more accurate and granular network data since the network structure lends insights that are useful only when the network data accurately captures the relationship of interest.

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Annexes

Table A.1. Results of T-test and *ranksum* test of normalized centrality scores by sector, banks versus others.

. ttest bet	tween, by	(banks)				
Two-sample	t test wi	ith equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0 1	472 60	2.12e-06 .0000833	2.12e-06 .0000431	.000046 .000334	-2.04e-06 -2.96e-06	6.28e-06 .0001696
Combined	532	.0000113	5.30e-06	.0001222	8.69e-07	.0000217
diff		0000812	.0000164		0001134	000049
diff = H0: diff =	mean(0) · 0	- mean(1)		Degrees	t of freedom	= -4.9544 = 530
Ha: dif Pr(T < t)	Ff < 0 = 0.0000	Pr(Ha: diff != T > t) = (0 0.0000	Ha: d Pr(T > t	iff > 0) = 1.0000

. ranksum betwee	n, by(ba	nks)		
Two-sample Wilco	xon rank-	sum (Mann-Wh	itney) test	
banks	Obs	Rank sum	Expected	
0	472	124873.5	125788	
1	60	16904.5	15990	
Combined	532	141778	141778	
Unadjusted varia Adjustment for t Adjusted varianc	nce 1257 ies -1. e 35	880.00 22e+06 133.83		
H0: between(bank z = -4. Prob > z = 0.0	s==0) = b 879 000	etween(banks	==1)	
Note: Exact p-va Use option	lue is no exact to	t computed b compute it.	y default fo	or sample sizes > 200.

. ttest ou	utdeg, by(banks)				
Two-sample	e t test wi	ith equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	472	.0017775	.0001462	.0031756	.0014903	.0020648
1	60	.0043167	.0013074	.0101271	.0017005	.0069328
Combined	532	.0020639	.0001986	.0045811	.0016737	.0024541
diff		0025391	.0006187		0037546	0013237
diff = H0: diff =	= mean(0) · = 0	- mean(1)		Degrees	t of freedom	= -4.1038 = 530
Ha: di Pr(T < t)	iff < 0) = 0.0000	Pr(Ha: diff != T > t) = (0 0.0000	Ha: d Pr(T > t	iff > 0) = 1.0000

. ranksum outdeg, by(banks) Two-sample Wilcoxon rank-sum (Mann-Whitney) test banks Obs Rank sum Expected 0 472 127292.5 125788 14485.5 1 60 15990 Combined 532 141778 141778 Unadjusted variance 1257880.00 Adjustment for ties -204992.58 Adjusted variance 1052887.42 H0: outdeg(banks==0) = outdeg(banks==1) z = 1.466 Prob > |z| = 0.1426 Note: Exact p-value is not computed by default for sample sizes > 200. Use option exact to compute it.

. ttest indeg, by(banks) Two-sample t test with equal variances Group Obs Mean Std. err. Std. dev. [95% conf. interval] 0 472 .0016102 .0000894 .001942 .0014345 .0017858 .0011467 .0088825 .0079779 60 .0056833 .0033888 1 Combined 532 .0020695 .0001609 .0037114 .0017534 .0023857 .0004774 -.0050111 diff -.0040732 -.0031353 diff = mean(0) - mean(1)t = -8.5313 H0: diff = 0 Degrees of freedom = 530 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0 Pr(T < t) = 0.0000Pr(|T| > |t|) = 0.0000Pr(T > t) = 1.0000

. ranksum indeg,	by(bank	s)		
Two-sample Wilco	xon rank-	sum (Mann-Wh	itney) test	
banks	Obs	Rank sum	Expected	
0	472	118972.5	125788	
1	60	22805.5	15990	
Combined	532	141778	141778	
Unadjusted varia Adjustment for t	nce 1257 ies -246	880.00 368.47		
Adjusted varianc	e 1011	511.53		
H0: indeg(banks= z = -6. Prob > z = 0.0	=0) = ind 777 000	eg(banks==1)		
Note: Exact p-va Use option	lue is no exact to	t computed b compute it.	y default fo	or sample sizes > 200.

. ttest in2	step_raw	, by(banks)			
Two-sample	t test w	ith equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	472	3.114407	.2258707	4.907168	2.670568	3.558246
1	60	8.583333	1.092422	8.461862	6.397403	10.76926
Combined	532	3.731203	.2464548	5.684512	3.247057	4.215349
diff		-5.468927	.7427889		-6.928098	-4.009755
diff =	mean(0)	- mean(1)			t	= -7.3627
H0: diff =	0			Degrees	of freedom	= 530
Ha: dif	f < 0		Ha: diff !=	0	Ha: d	liff > 0
Pr(T < t)	= 0.0000	Pr(T > t) = 0	0.0000	Pr(T > t	:) = 1.0000

• ttest out	2step_raw t test wi	, by(banks th equal var) iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	472	3.752119	.269662	5.858559	3.222229	4.282008
1	60	3.566667	1.079173	8.359237	1.407247	5.726086
Combined	532	3.731203	.2680057	6.181584	3.204722	4.257684
diff		.185452	.8480056		-1.480413	1.851317
diff = 1 H0: diff = 0	mean(0) - 0	mean(1)		Degrees	t of freedom	= 0.2187 = 530
Ha: dif Pr(T < t)	f < 0 = 0.5865	Pr(Ha: diff != T > t) =	0 0.8270	Ha: d Pr(T > t	iff > 0) = 0.4135

Table A.2. Results of T-test and *ranksum* test of normalized centrality scores by sector, holding companies versus others.

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	447	.004255	.0003808	.0080515	.0035066	.0050035
1	85	.0114353	.0010835	.0099898	.0092805	.01359
ombined	532	.0054023	.0003809	.0087847	.0046541	.0061504
diff		0071803	.0009926		0091302	0052303
1. 66					L	7 2226

 ranksum outard 	d , by(ho	lding)		
Two-sample Wilco	oxon rank-	sum (Mann-Wh	itney) test	
holding	Obs	Rank sum	Expected	
0	447	108595	119125.5	
1	85	33183	22652.5	
Combined	532	141778	141778	
Unadjusted varia Adjustment for t	ance 1687 ties -181	611.25 984.59		
Adjusted variand	ce 1505	626.66		
H0: outard(holdi z = -8. Prob > z = 0.6	ing==0) = .582 3000	outard(holdi	ng==1)	
Note: Exact p-va Use optior	alue is no n exact to	t computed b compute it.	y default f	or sample sizes > 200.

. ttest out	close , b	y(holding)				
Two-sample	t test wi	th equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	447	.1436868	.0000696	.0014718	.14355	.1438236
1	85	.1452118	.000246	.0022683	.1447225	.145701
Combined	532	.1439305	.0000744	.0017164	.1437843	.1440766
diff		001525	.0001922		0019025	0011474
diff =	mean(0) -	mean(1)			t	= -7.9341
H0: diff =	0			Degrees	of freedom	= 530
Ha: dif	f < 0		Ha: diff !=	0	Ha: d	iff > 0
Pr(T < t)	= 0.0000	Pr(T > t) = (0.0000	Pr(T > t) = 1.0000

holding	Obs	bs Rank sum Expecte	
0	447	110033	119125.5
1	85	31745	22652.5
Combined	532	141778	141778
Unadjusted varianc Adjustment for tie	e 16876 s -3906	511.25 505.58	
Adjusted variance	12976	05.67	

Table A.3. Results of T-test and *ranksum* test of raw centrality scores by sector, holding companies versus others

. ttest out	2step_raw	v, by(holdi	ng)			
Two-sample	t test wi	ith equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	447	2.897092	.2637389	5.576067	2.378766	3.415417
1	85	8.117647	.7918372	7.300378	6.542992	9.692302
Combined	532	3.731203	.2680057	6.181584	3.204722	4.257684
diff		-5.220555	.6961499		-6.588107	-3.853004
diff =	mean(0) ·	- mean(1)			t	= -7.4992
H0: diff =	0			Degrees	of freedom	= 530
Ha: dif	f < 0		Ha: diff !=	0	Ha: d	liff > 0
Pr(T < t)	= 0.0000	Pr(T > t) = (0.0000	Pr(T > t	:) = 1.0000

. ranksum out2st	ep_raw ,	by(holding)			
Two-sample Wilco	xon rank-	sum (Mann-Wh	itney) test		
holding	Obs	Rank sum	Expected		
0	447	108858.5	119125.5		
1	85	32919.5	22652.5		
Combined	532	141778	141778		
Unadjusted varia Adjustment for t	nce 168 7 ies - 18 2	611.25 342.03			
Adjusted varianc	e 1505	269.22			
H0: out2st~w(hol z = -8. Prob > z = 0.0	ding==0) 368 000	= out2st~w(h	olding==1)		
Note: Exact p-va Use option	lue is no exact to	ot computed b compute it.	y default fo	r sample sizes	> 200.



Figure A.1. Histogram of out-2-step centrality scores (raw)

Table A.4. Results of T-test and *ranksum* test of centrality scores by sector, NBFIs versus others

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.0057808	.000549	.0100188	.0047008	.0068608
1	199	.0091307	.0008084	.0114041	.0075364	.010724 9
Combined	532	.0070338	.0004627	.0106717	.0061249	.0079427
diff		0033499	.000946		0052082	0014916
diff =	mean(0)	- mean(1)			t	= -3.5412
10: diff =	0			Degrees	of freedom	= 530

. ranksum in2s	step , by(N	BFIS)				
Two-sample Wilcoxon rank-sum (Mann-Whitney) test						
NBFIS	Obs	Rank sum	Expected			
0	333	78724	88744.5			
1	199	63054	53033.5			
Combined	532	141778	141778			
Unadjusted var Adjustment for	riance 2943 r ties -151	359.25 411.83				
Adjusted varia	ance 2791	947.42				
H0: in2step(NE z = - Prob > z = 0	BFIS==0) = i -5.997 0.0000	n2step(NBFIS	==1)			

. ttest ou	t2step ,b	y(NBFIS)				
Two-sample	t test wi	th equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.0088318	.0006983	.0127427	.0074582	.0102055
1	199	.0042161	.0006386	.0090083	.0029568	.0054754
Combined	532	.0071053	.0005071	.0116953	.0061092	.0081013
diff		.0046158	.0010295		.0025933	.0066382
diff =	mean(0) -	mean(1)			t	= 4.4833
H0: diff =	0			Degrees	of freedom	= 530
Ha: di	ff < 0		Ha: diff !=	0	Ha: d	iff > 0
Pr(T < t)	= 1.0000	Pr(T > t) = (0.0000	Pr(T > t) = 0.0000

. ranksum out2	step , by	NBFIS)	
Two-sample Wil	.coxon rank	-sum (Mann-W	hitney) test
NBFIS	Obs	Rank sum	Expected
0	333	98197.5	88744.5
1	199	43580.5	53033.5
Combined	532	141778	141778
Unadjusted var Adjustment for	ties -31	13359.25 18022.35	
Adjusted varia	ance 262	25336.90	
H0: out2step(N z = Prob > z = 0	IBFIS==0) = 5.834 0.0000	= out2step(NB	FIS==1)

. ttest in	ard , by(NBFIS)				
Two-sample	e t test wi	th equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.0044985	.0003682	.0067193	.0037742	.0052228
1	199	.0069095	.0004468	.0063031	.0060284	.0077907
Combined	532	.0054004	.0002889	.0066638	.0048328	.0059679
diff		002411	.0005884		0035669	0012552
diff =	mean(0) -	mean(1)			t	= -4.0977
H0: diff =	0			Degrees	of freedom	= 530
Ha: di	.ff < 0		Ha: diff !=	0	Ha: d	iff > 0
Pr(T < t)	= 0.0000	Pr(T > t) = (0.0000	Pr(T > t) = 1.0000

. ranksum inard	,by(NBF	IS)		
Two-sample Wilco	xon rank-	sum (Mann-Wh	itney) test	
NBFIS	Obs	Rank sum	Expected	
0	333	78714.5	88744.5	
1	199	63063.5	53033.5	
Combined	532	141778	141778	
Unadjusted varia Adjustment for t Adjusted varianc	nce 2943 ies -152 e 2791	359.25 070.65 288.60		
H0: inard(NBFIS= z = -6. Prob > z = 0.0	=0) = ina 003 000	rd(NBFIS==1)		
Note: Exact p-va Use option	lue is no exact to	t computed b compute it.	y default fo	or sample sizes > 200.

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.0066126	.0005146	.0093906	.0056003	.0076249
1	199	.0033769	.0005137	.0072463	.0023639	.0043899
Combined	532	.0054023	.0003809	.0087847	.0046541	.0061504
diff		.0032357	.0007752		.0017129	.0047586
diff = 1	mean(0) -	mean(1)			t	= 4.1740
0: diff = 0	9			Degrees	of freedom	- 530

. ranksum outa	ard , by(NBF	IS)		
Two-sample Wil	lcoxon rank-s	um (Mann-Wh	itney) test	
NBFIS	Obs	Rank sum	Expected	
0	333	97951	88744.5	
1	199	43827	53033.5	
Combined	532	141778	141778	
Unadjusted var Adjustment for	riance 29433 r ties -3173	59.25 98.95		
Adjusted varia	ance 26259	60.30		
H0: outard(NBP z =	IS==0) = out 5.681	ard(NBFIS==	1)	
Prob > z = 0	0000			
Note: Exact p Use opt:	-value is not ion exact to	computed b compute it.	y default fo	or sample sizes > 200.

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.1436426	.0000627	.001144	.1435193	.143766
1	199	.1440553	.0000916	.0012918	.1438747	.1442359
ombined	532	.143797	.0000528	.0012167	.1436934	.1439006
diff		0004126	.0001076		0006241	0002012
diff =	mean(0)	- mean(1)			t	= -3.8335
0: diff = 0	9			Degrees	of freedom	= 530

. ranksum inclose , by(NBFIS)				
Two-sample Wilc	oxon rank-	sum (Mann-Wh	itney) test	
NBFIS	Obs	Rank sum	Expected	
0	333	78757.5	88744.5	
1	199	63020.5	53033.5	
Combined	532	141778	141778	
Unadjusted vari Adjustment for	ance 2943 ties -547	359.25 921.63		
Adjusted varian	ice 2395	437.62		
H0: inclose(NBF z = -6 Prob > z = 0.	IS==0) = i .453 0000	nclose(NBFIS	==1)	

• ttest out	close , b t test wi	o y(NBFIS) .th equal var	iances			
Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	333	.1441502	.0001014	.0018502	.1439507	.1443496
1	199	.1435628	.0000988	.0013944	.1433679	.1437577
Combined	532	.1439305	.0000744	.0017164	.1437843	.1440766
diff		.0005873	.0001518		.0002891	.0008856
diff = 1	mean(0) -	mean(1)			t	= 3.8689
H0: diff = (9			Degrees	of freedom	= 530
Ha: dif	f < 0		Ha: diff !=	0	Ha: d	iff > 0
Pr(T < t)	= 0.9999	Pr(T > t) = (0.0001	Pr(T > t) = 0.0001

. ranksum outclo	ose , by(NBFIS)	
Two-sample Wilco	oxon rank-	sum (Mann-Wh	itney) test
NBFIS	Obs	Rank sum	Expected
0	333	96198.5	88744.5
1	199	45579.5	53033.5
Combined	532	141778	141778
Unadjusted varia Adjustment for t	ance 2943 :ies -681	359.25 254.37	
Adjusted variand	e 2262	104.88	
H0: outclose(NBF z = 4. Prob > z = 0.0	IS==0) = 956 9000	outclose(NBF	IS==1)