

Benchmarking Value Networks against the Golden Proportion

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Executive Summary

An analysis was performed to determine the extent that the average proportion of a value network¹ in the value network benchmarking database² maintained by the author is equal to the golden proportion³ of 1.618. The database contains detailed information on 36 value networks. As a statistical conclusion we could state with 95% confidence that the average proportion of a value network will fall within 1.4 standard deviations of the hypothesized proportion of 1.62. As an operational conclusion we could expect that the proportions of a value network tend towards the golden proportion, hence evidencing attributes of a self-organizing system. Since the free market economy, as an example of self-organization in the economy, is considered to be the most superior form of economy in respect to the effectiveness with which resources are used, we can surmise that value networks are an economically superior form of economic organization than the hierarchy.

Introduction

The purpose of this research is to evaluate whether value networks, as mapped by experienced practitioners, show evidence of proportions related to the golden proportion. The assumption is that if this evidence can be determined, then value networks are an example of self-organization based upon the principles of living systems, therefore a natural process. In economics, the theoretical free market is self-organizing⁴. If the free market is assumed to be that economical state where resources are most effectively used, then this research could be considered as providing evidence for the economic value that can be created by structuring organizations along value network principles. To some extent it is also the opinion of the author that if the proportions of a value network tend towards those of the golden proportion, and the previous arguments are solid, then a similarity arises with the story of the discovery of the DNA double helix structure by Watson and Crick⁵; "Whatever the sources of Watson and Crick's preferences for helices, it is clear that in the event their aesthetic appreciation for that form played a critical role in their decision to go with the double-helical model. As Watson himself said on numerous occasions and in various permutations, the double helix "was too pretty not to be true."

Two quantities are said to be in the golden ratio if "the whole (that is, the sum of the two parts) is to the larger part as the larger part is to the smaller part", stated mathematically as:

$$\frac{a+b}{a} = \frac{a}{b}$$

¹ A value network is any web of relationships that generates economic or social value through complex dynamic exchanges of both tangible and intangible benefits. Any purposeful organization, company or network functions only through its internal and external value networks.

² Version dated 090806

³ The golden proportion, also known as the golden ratio, golden mean, golden section, golden number, divine proportion or sectio divina, is an irrational number, approximately 1.618, that possesses many interesting properties. Shapes proportioned according to the golden ratio have long been considered aesthetically pleasing in Western cultures, and the golden ratio is still used frequently in art and design, suggesting a natural balance between symmetry and asymmetry. The ancient Pythagoreans, who defined numbers as expressions of ratios (and not as units as is common today), believed that reality is numerical and that the golden ratio expressed an underlying truth about existence. (http://en.wikipedia.org/wiki/Golden_ratio)

⁴ http://en.wikipedia.org/wiki/Self_organization

⁵ http://www.findarticles.com/p/articles/mi_m0425/is_n1_v55/ai_18299592/pg_6

where a is the larger part and b is the smaller part. This ratio, denoted φ ([phi](#)), is an [irrational number](#) with value

$$\varphi = \frac{1}{2}(1 + \sqrt{5}) \approx 1.618033989$$

For all variables gathered in relation to value networks (see appendix 1) three basic attributes were available:

1. All transactions
2. Only tangible transactions
3. Only intangible transactions

Points 2 and 3 were considered since they provide the comparative data required for a proportional analysis. The sample was equal to the whole population. The variables are quantitative.

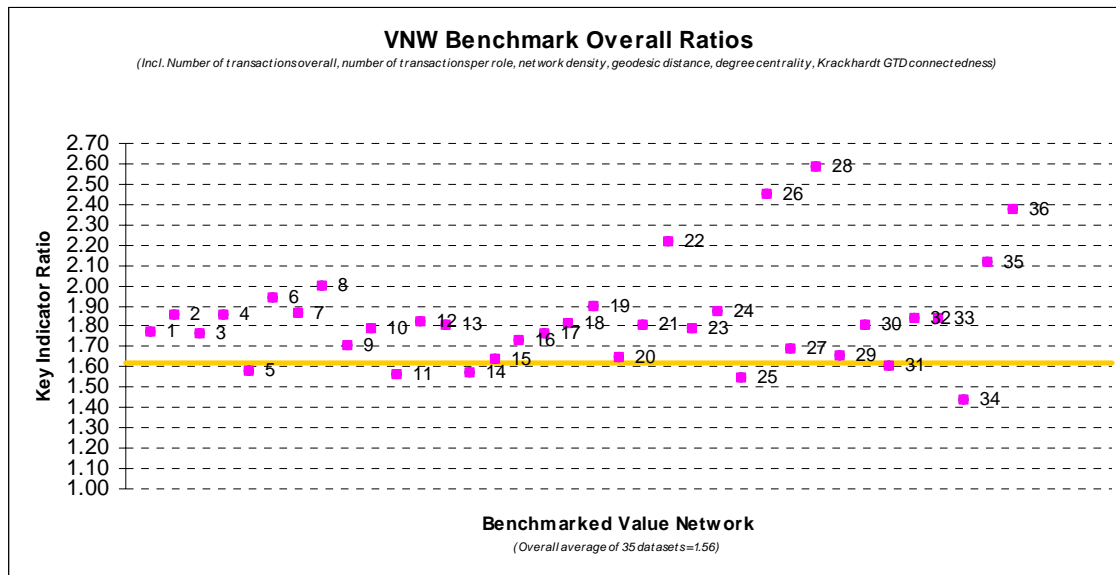
The larger figure was considered as a , the smaller figure was considered as b . The left hand side of the equation was used to calculate the relevant proportion. Once these proportions were calculated for all sample data sets, the results were added together and divided by the number of value networks being evaluated. The resulting base data is available in appendix 2. The descriptive statistics of this data set are:

<i>Indicator</i>	<i>Overall ratio</i>	<i>Indicator</i>	<i>Overall ratio</i>
count	36	population standard deviation	0.2111
mean	1.5700	standard error of the mean	0.0357
sample variance	0.0458	confidence interval 95.% lower	1.4976
sample standard deviation	0.2141	confidence interval 95.% upper	1.6424
minimum	1.23331597	half-width	0.0724
maximum	2.21614022	tolerance interval 95.45% lower	1.1419
range	0.98282424	tolerance interval 95.45% upper	1.9982
population variance	0.0446	half-width	0.4281



Analysis and methods

When evaluating the data provided in appendix two, the individually calculated proportions were mapped against the golden proportion (heavy horizontal golden line in graph). The results are as follows:

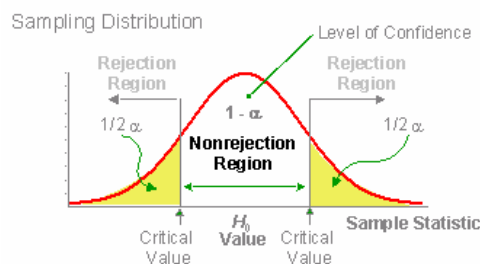


The null hypothesis as stated in the introduction is that the average proportion of value networks is equal to the golden proportion. $H_0: \mu = 1.62$

The alternative hypothesis is that the average proportion of value networks is not equal to the golden proportion. $H_a: \mu \neq 1.62$

A two tailed test was performed

Rejection Regions



- $H_0: \mu = 1.62$.
- $H_1: \mu \neq 1.62$
- $\alpha = 0.05$.
- $n = 36$.
- z chosen.
- Confidence level chosen: 95%
- Critical $Z = 1.96$ because $\alpha = 0.05$ ($0.5/2 = 0.25$) and a two-tailed Z test.

The results were as follows:

Hypothesis Test: Mean vs. Hypothesized Value

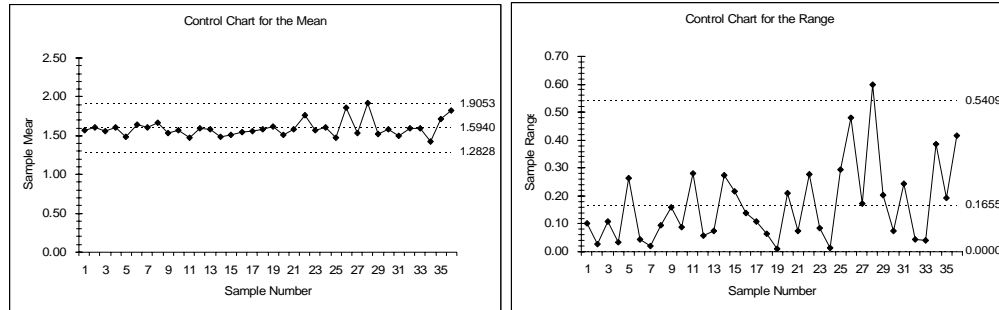
1.62000	hypothesized value
1.57002	mean Overall ratio
0.21407	std. dev.
0.03568	std. error
36	n
-1.40	z
.1612	p-value (two-tailed)
1.51133	confidence interval 90.% lower
1.62870	confidence interval 90.% upper
0.05869	half-width

Since the Z test statistic of -1.4 is between the critical Z values of +1.96 and -1.96, and falls in the region of non-rejection, we do not have sufficient data to reject the null hypothesis.

The p-value of 0.1612 is greater than the α of 0.05 chosen. The p value is the probability of obtaining a test statistic equal to or more extreme than the result obtained from the sample data, given that the null hypothesis is really true. It is called the observed level of significance, or the smallest level at which the null hypothesis can be rejected for a given set of data. Since the p value calculated from the sample is greater than α , the null hypothesis is not rejected.

At this point the question must be raised whether the existing data contained data sets that might not be valid due to significant deviation from the norms identified and hence have an undue influence on the statistical results identified above. The quality control process chart feature of Megastat was therefore used to evaluate the overall ratio of the 36 data sets against the golden ratio. The following results were obtained:

Sample size	2	
Number of samples	36	
	Mean	Range
Upper Control		
Limit, UCL	1.9053	0.5409
Center	1.5940	0.1655
Lower Control		
Limit, LCL	1.2828	0.0000



Interesting to note in this respect is that especially point 28 exceeds the control ranges in both control charts. Since this statistical evaluation is exploratory, point 28 was removed and the above two-tailed test repeated with the following results:

Hypothesis Test: Mean vs. Hypothesized Value

1.62000	hypothesized value
1.55155	mean Overall ratio
0.18586	std. dev.
0.03142	std. error
35	n
-2.18	z
.0294	p-value (two-tailed)
1.48998	confidence interval 95.% lower
1.61313	confidence interval 95.% upper
0.06157	half-width

In this specific case we recognize that the Z test statistic of -2.8 is NOT between the critical Z values of +1.96 and -1.96, and hence does NOT falls in the region of non-rejection, it would appear we have sufficient data to reject the null hypothesis.

The p-value of 0.0294 is less than the α of 0.05 chosen. The p value is the probability of obtaining a test statistic equal to or more extreme than the result obtained from the sample data, given that the null hypothesis is really true. It is called the observed level of significance, or the smallest level at which the null hypothesis can be rejected for a given set of data. Since the p value calculated from the sample is less than α , the null hypothesis is rejected.

The data provided in appendix 2 was gathered through an analysis of 36 value networks created in the last 24 months. The analysis was performed during this course. The data for the individual indicators was gathered through the application of value networks and social networks methodologies.

Conclusion and summary

As a statistical conclusion based upon the original evaluation, that included data set number 28, we could state with 95% confidence that the average proportion of a value network in the evaluated database will not fall within 1.4 standard deviations of the hypothesized proportion of 1.62.

Closer examination of the data however reveals that a few data sets (esp. data set number 28) deviate sufficiently from the mean of the remaining data sets to raise p above the α of 0.05 chosen. If only data set 28 is removed, then p drops below the α of 0.05 and the null hypothesis must be rejected.

As an operational conclusion we should be hesitant to assume that the expectation of proportions of a value network tending towards the golden proportion based on the Central Limit theorem (null hypothesis) are met with a conclusiveness that allows "common sense" assurance of the null hypothesis being valid.

The null hypothesis was developed based on the intuition of the author that has developed over time in working with the relevant methodologies. The need for such an evaluation was driven by increasing acceptance of value networks as a valid manner of understanding organizational dynamics and the need to explore how economic value of value network patterns could be evidenced. While the correlation between value network proportions and the golden proportion could be considered as having been disproved based upon the available data sets, practitioners and researchers who have been consulted in the importance of this question believe that further research into this perspective will be of value. The fundamental question of whether this organizational form could perform economically in a superior manner to traditional organizational contexts hence still relies on analogy and demands independent research proof. This small evaluation marks the very first evaluation of its kind and has resulted in the proportion indicator being continuously tracked in future value networks analyses.

What is important to recognize as well, is that there is to date no conclusive evidence that the golden proportion is related to value conversion capability in value networks. Due to this further value network analyses will rigorously focus on the following questions in order to begin correlating (subjective) performance of a value network with its proportions. The questions are:

- How would you evaluate the overall current performance of this value network in terms of achieving individual and network goals?
- How efficiently is the network converting tangible and intangible inputs to financial and non financial value?
- How quickly and efficiently is the network converting financial and non-financial assets into tangible and intangible value outputs?

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Appendix 1: Selection of benchmarking database indicators

The existing value network benchmarking database contains the analysis of 36 value networks according to the following indicators:

- Number of roles
- Number of transactions
- Number of tangible transactions
- Number of intangible transactions
- Percentage tangible transactions
- Percentage intangible transactions
- Ratio intangible / tangible transactions
- Transactions per role (All)
- Transactions per role (tangible)
- Transactions per role (intangible)
- Network density: All transactions
- Network density: Tangible transactions
- Network density: Intangible transactions
- Network density average (Intangible density/Tangible density)
- Reciprocity: All transactions
- Reciprocity: Tangible transactions
- Reciprocity: Intangible transactions
- Geodesic distance (average): All transactions
- Geodesic distance (average): Tangible transactions
- Geodesic distance (average): Intangible transactions
- Degree Centrality: All transactions
- Degree Centrality: Tangible transactions
- Degree Centrality: Intangible transactions
- Betweenness Centrality: All transactions
- Betweenness Centrality: Tangible transactions
- Betweenness Centrality: Intangible transactions
- Krackhardt GTD – Connectedness: All transactions
- Krackhardt GTD – Connectedness: Tangible transactions
- Krackhardt GTD – Connectedness: Intangible transactions
- Krackhardt GTD – Hierarchy: All transactions
- Krackhardt GTD – Hierarchy: Tangible transactions
- Krackhardt GTD – Hierarchy: Intangible transactions
- Krackhardt GTD – Efficiency: All transactions
- Krackhardt GTD – Efficiency: Tangible transactions
- Krackhardt GTD – Efficiency: Intangible transactions

The choice of tracking these indicators in the benchmarking database was influenced by the first 10 indicators being typical value network indicators as propagated by Verna Allee, and the remaining indicators being commonly used in the field of social network analysis.

Since the formula for calculating the golden proportion does not allow for a "0" value of any portion, a review of the data available for the indicators resulted in the need to reduce the above indicator set to:

- Number of transactions
- Transactions per role (All)
- Network density: All transactions

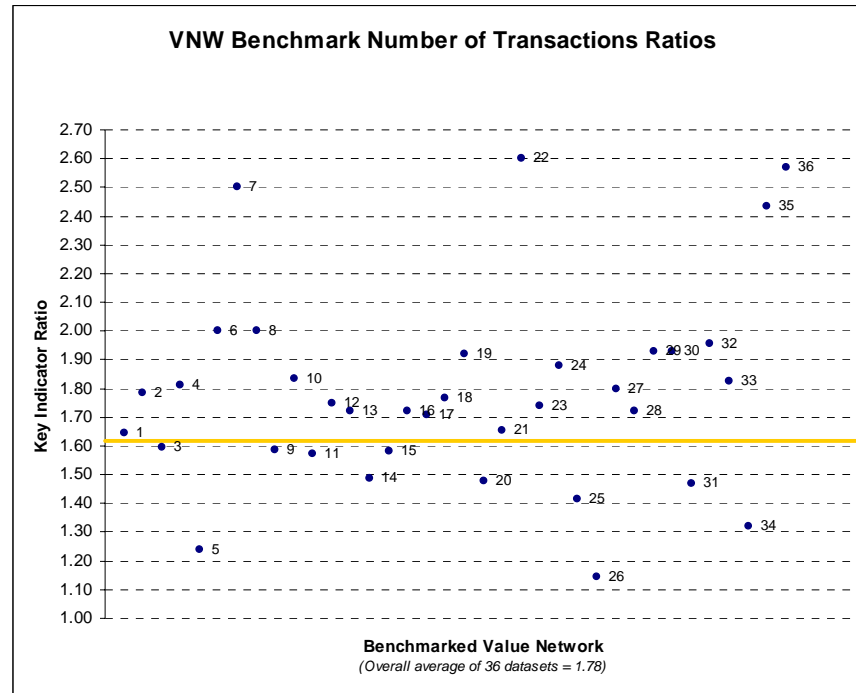
- Geodesic distance (average): All transactions
- Degree Centrality: All transactions
- Krackhardt GTD – Connectedness: All transactions

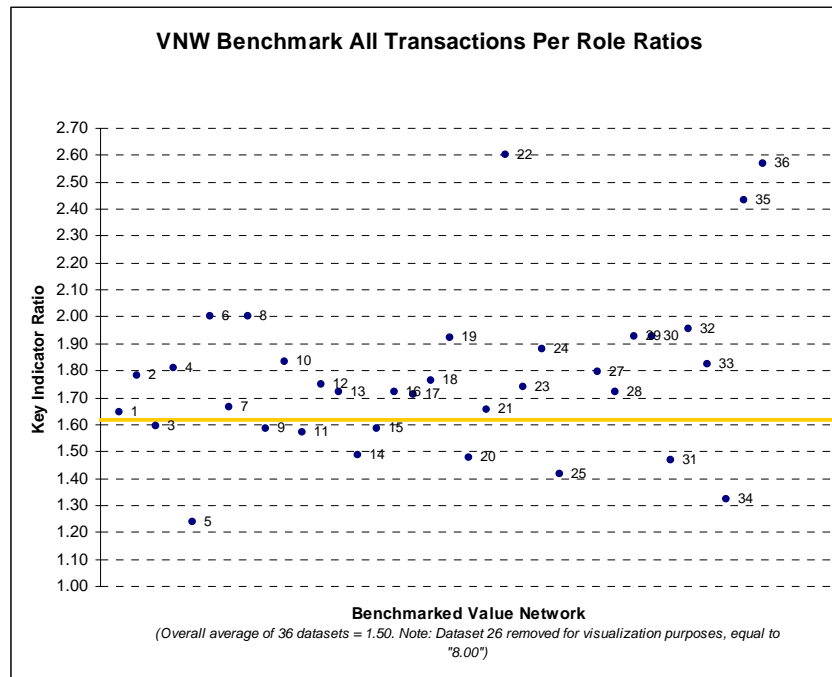
Appendix 2: Base data

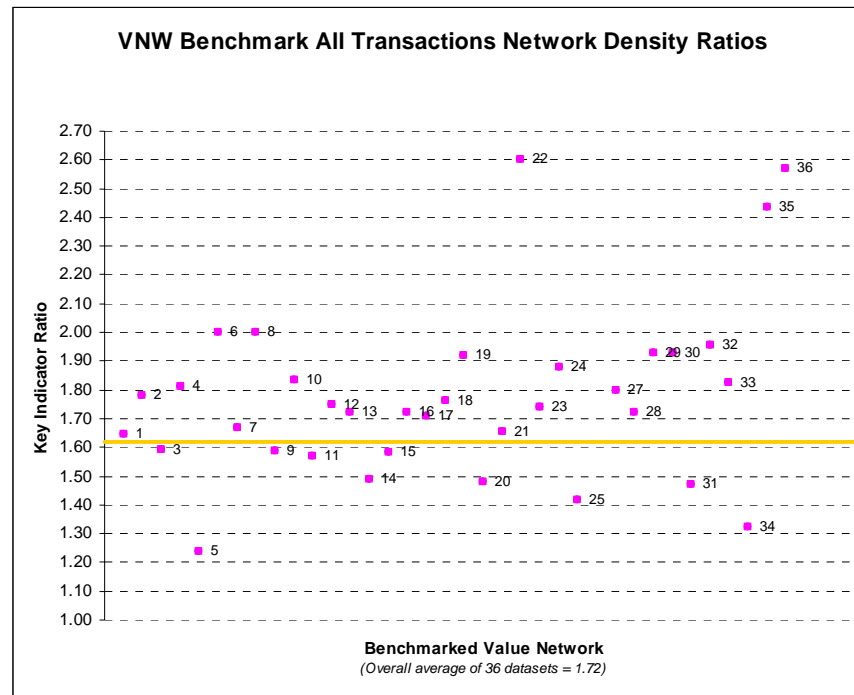
For each indicator the proportion was calculated based on the comparison of indicator data for the tangible and for the intangible network. An average was then drawn across the above indicators for every single value network to determine the proportion of the value network.

Identifier	Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD – Connectedness: All transactions	Overall ratio
1	1.65	1.65	1.63	1.91	1.78	2.00	1.52
2	1.78	1.78	1.78	1.90	1.89	2.00	1.59
3	1.59	1.59	1.59	2.00	1.78	2.00	1.51
4	1.81	1.81	1.80	1.88	1.79	2.00	1.59
5	1.24	1.24	1.23	2.00	1.77	2.00	1.35
6	2.00	2.00	2.00	1.92	1.71	2.00	1.66
7	2.50	1.67	1.66	1.98	1.64	1.75	1.60
8	2.00	2.00	2.00	2.00	2.00	2.00	1.71
9	1.59	1.59	1.58	1.89	1.83	1.75	1.46
10	1.83	1.83	1.85	1.86	1.63	1.71	1.53
11	1.57	1.57	1.57	1.90	1.34	1.42	1.34
12	1.75	1.75	1.75	1.95	1.73	2.00	1.56
13	1.72	1.72	1.72	1.98	1.67	2.00	1.55
14	1.49	1.49	1.52	1.73	1.43	1.75	1.34
15	1.58	1.58	1.56	1.97	1.25	1.86	1.40
16	1.72	1.72	1.74	1.85	1.43	1.89	1.48
17	1.71	1.71	1.81	1.92	1.93	1.49	1.51
18	1.76	1.76	1.71	1.97	1.98	1.69	1.55
19	1.92	1.92	1.93	2.00	1.63	2.00	1.63
20	1.48	1.48	1.46	1.85	1.97	1.62	1.41
21	1.65	1.65	1.71	2.00	1.79	2.00	1.54
22	2.60	2.60	2.60	1.97	1.50	2.00	1.90
23	1.74	1.74	1.73	1.66	1.86	2.00	1.53
24	1.88	1.88	1.87	1.99	1.61	2.00	1.60
25	1.42	1.42	1.41	1.82	1.53	1.67	1.32
26	1.14	8.00	1.13	1.55	1.66	1.21	2.10
27	1.80	1.80	1.26	1.35	1.90	2.00	1.44
28	1.72	1.72	1.72	1.92	6.43	2.00	2.22
29	1.93	1.93	1.11	1.67	1.69	1.58	1.42
30	1.93	1.93	1.93	1.84	1.51	1.67	1.54
31	1.47	1.47	1.47	1.96	1.91	1.36	1.38
32	1.95	1.95	1.97	1.93	1.44	1.78	1.57
33	1.83	1.83	1.82	1.80	1.76	2.00	1.58
34	1.32	1.32	1.32	1.87	1.56	1.25	1.23
35	2.43	2.43	2.41	1.89	1.90	1.62	1.81
36	2.57	2.57	2.57	2.12	2.4	2	2.03
Average	1.78	1.95	1.72	1.88	1.85	1.81	1.57

Appendix 3: Data visualizations, drill-downs and correlations

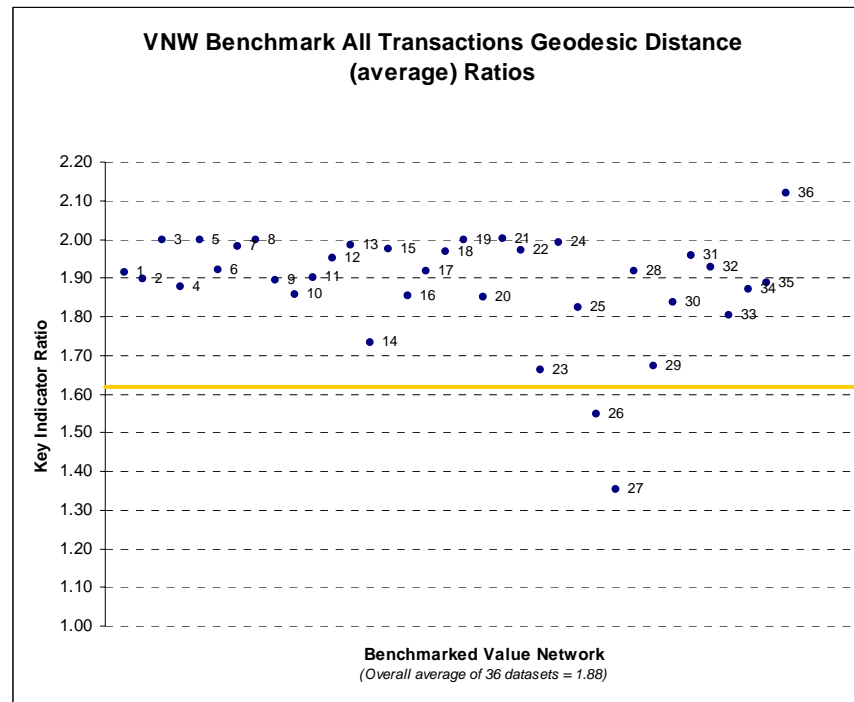






The density of a network is the number of actual connections between members divided by the number of possible connections. Density values range from 0 to 1. Higher density indicates a greater degree of interaction.
<http://www.annfammed.org/cgi/content/full/3/5/443#T1>

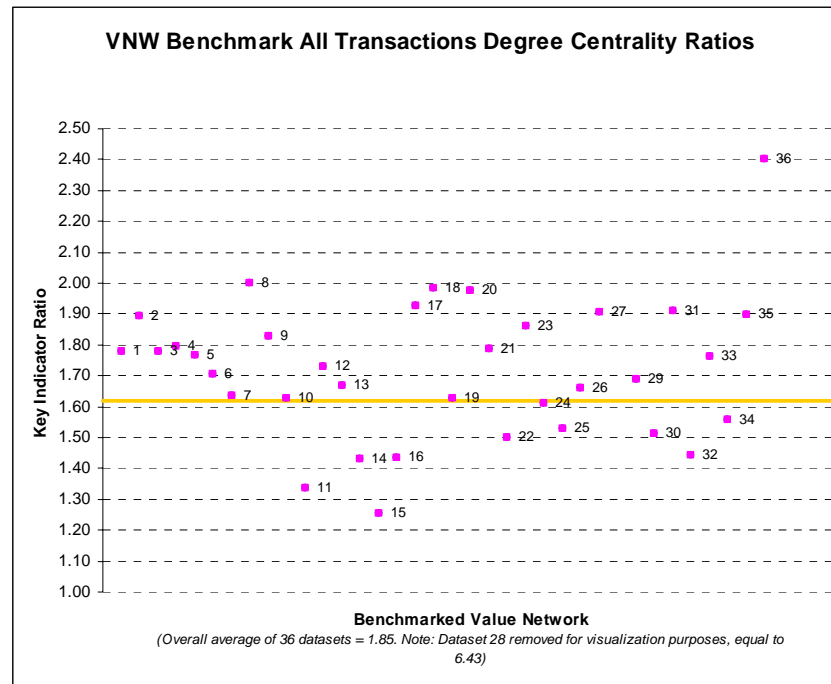




The geodesic path (or paths, as there can be more than one) is often the “optimal” or most “efficient” connection between two actors (directly or via other actors). Therefore, the geodesic distance is the number of relations in the shortest possible walk from one role to another.

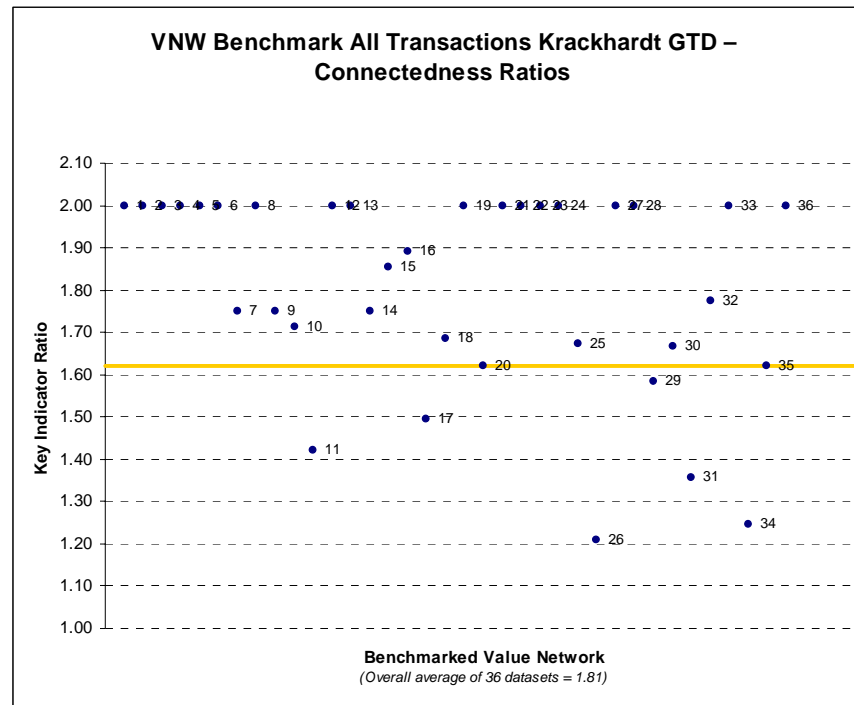
http://faculty.ucr.edu/~hanneman/nettext/C7_Connection.html#density





A very simple, but often very effective measure of an actor’s centrality and power potential is their degree. This means actors who have more ties have greater opportunities because they have choices. This autonomy makes them less dependent on any specific other actor, and hence more powerful. Combined with directional value flows, centrality measures looking at in-coming and outgoing links can determine whether an actor is a value “sink” or truly a value hub that provides or conveys value to the network. The centralization percentage thus indicates the degree of asymmetry in the distribution of connections in the network. A high centralization score indicates that some members have many more connections than others. http://faculty.ucr.edu/~hanneman/nettext/C10_Centrality.html The values range from 0 (every member is connected to every other member) to 100 (all members are connected to only 1 member (like in a star configuration)).





This addresses the proportion of actors that cannot be reached by other actors. Where a graph has multiple components – multiple un-connected sub-populations – the proportion not reachable can be high and therefore, the connectedness would be very low. Values range between 0 (low connectedness) and 1 (all actors can be reached by other actors).
<http://www.annfamned.org/cgi/content/full/3/5/443#T1>

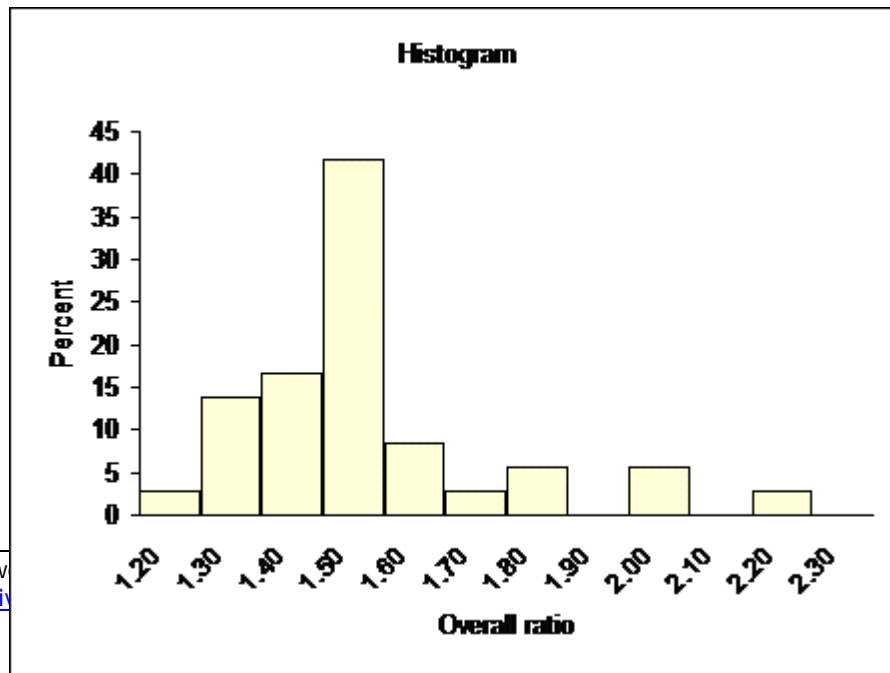


Overall ratios

Frequency Distribution – Quantitative

<i>Overall ratio</i>		<i>cumulative</i>					
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>
1.20	< 1.30	1.25	0.10	1	2.8	1	2.8
1.30	< 1.40	1.35	0.10	5	13.9	6	16.7
1.40	< 1.50	1.45	0.10	6	16.7	12	33.3
1.50	< 1.60	1.55	0.10	15	41.7	27	75.0
1.60	< 1.70	1.65	0.10	3	8.3	30	83.3
1.70	< 1.80	1.75	0.10	1	2.8	31	86.1
1.80	< 1.90	1.85	0.10	2	5.6	33	91.7
1.90	< 2.00	1.95	0.10	0	0.0	33	91.7
2.00	< 2.10	2.05	0.10	2	5.6	35	97.2
2.10	< 2.20	2.15	0.10	0	0.0	35	97.2
2.20	< 2.30	2.25	0.10	1	2.8	36	100.0

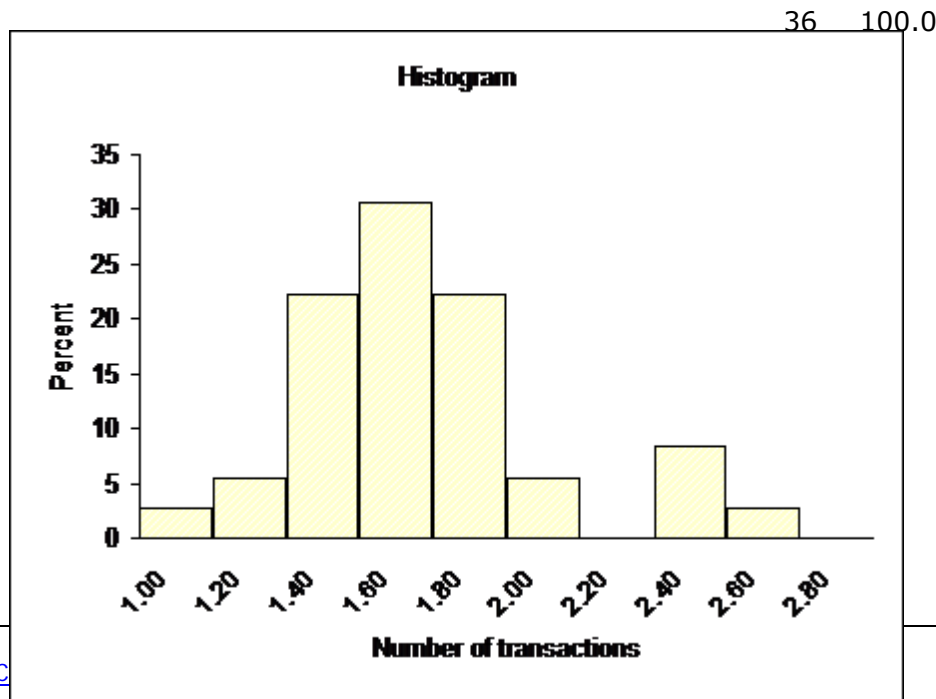
36 100.0



Number of transactions

Frequency Distribution - Quantitative

<i>Number of transactions</i>						<i>cumulative</i>	
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>
1.00	< 1.20	1.10	0.20	1	2.8	1	2.8
1.20	< 1.40	1.30	0.20	2	5.6	3	8.3
1.40	< 1.60	1.50	0.20	8	22.2	11	30.6
1.60	< 1.80	1.70	0.20	11	30.6	22	61.1
1.80	< 2.00	1.90	0.20	8	22.2	30	83.3
2.00	< 2.20	2.10	0.20	2	5.6	32	88.9
2.20	< 2.40	2.30	0.20	0	0.0	32	88.9
2.40	< 2.60	2.50	0.20	3	8.3	35	97.2
2.60	< 2.80	2.70	0.20	1	2.8	36	100.0



Transactions per role (All)

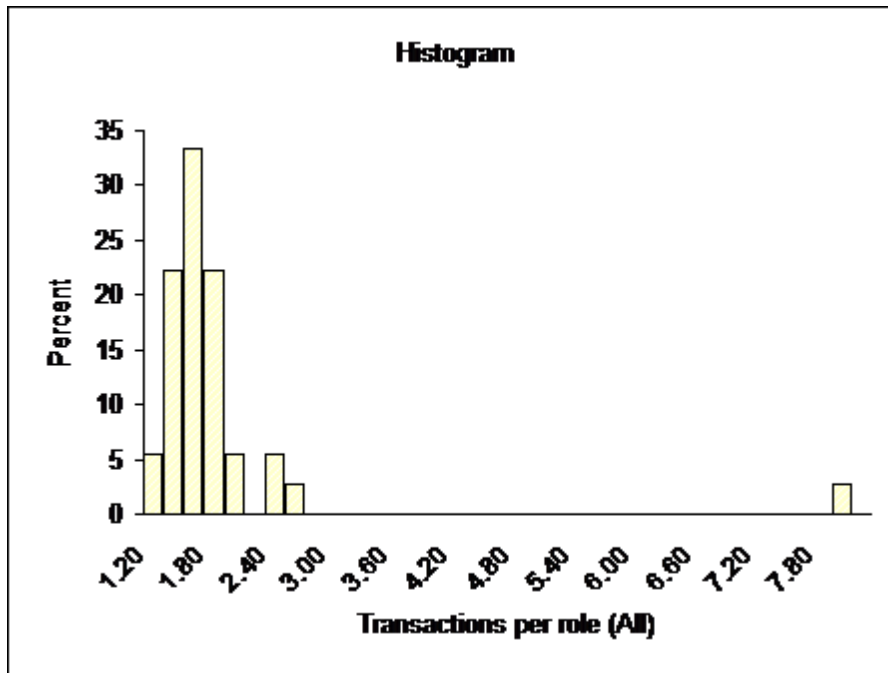
Frequency Distribution - Quantitative

<i>Transactions per role (All)</i>						<i>cumulative</i>	
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>
1.20	< 1.40	1.30	0.20	2	5.6	2	5.6
1.40	< 1.60	1.50	0.20	8	22.2	10	27.8
1.60	< 1.80	1.70	0.20	12	33.3	22	61.1
1.80	< 2.00	1.90	0.20	8	22.2	30	83.3
2.00	< 2.20	2.10	0.20	2	5.6	32	88.9
2.20	< 2.40	2.30	0.20	0	0.0	32	88.9
2.40	< 2.60	2.50	0.20	2	5.6	34	94.4
2.60	< 2.80	2.70	0.20	1	2.8	35	97.2
2.80	< 3.00	2.90	0.20	0	0.0	35	97.2
3.00	< 3.20	3.10	0.20	0	0.0	35	97.2
3.20	< 3.40	3.30	0.20	0	0.0	35	97.2
3.40	< 3.60	3.50	0.20	0	0.0	35	97.2
3.60	< 3.80	3.70	0.20	0	0.0	35	97.2
3.80	< 4.00	3.90	0.20	0	0.0	35	97.2
4.00	< 4.20	4.10	0.20	0	0.0	35	97.2
4.20	< 4.40	4.30	0.20	0	0.0	35	97.2
4.40	< 4.60	4.50	0.20	0	0.0	35	97.2
4.60	< 4.80	4.70	0.20	0	0.0	35	97.2
4.80	< 5.00	4.90	0.20	0	0.0	35	97.2
5.00	< 5.20	5.10	0.20	0	0.0	35	97.2
5.20	< 5.40	5.30	0.20	0	0.0	35	97.2
5.40	< 5.60	5.50	0.20	0	0.0	35	97.2
5.60	< 5.80	5.70	0.20	0	0.0	35	97.2
5.80	< 6.00	5.90	0.20	0	0.0	35	97.2
6.00	< 6.20	6.10	0.20	0	0.0	35	97.2
6.20	< 6.40	6.30	0.20	0	0.0	35	97.2
6.40	< 6.60	6.50	0.20	0	0.0	35	97.2



6.60	< 6.80	6.70	0.20	0	0.0	35	97.2
6.80	< 7.00	6.90	0.20	0	0.0	35	97.2
7.00	< 7.20	7.10	0.20	0	0.0	35	97.2
7.20	< 7.40	7.30	0.20	0	0.0	35	97.2
7.40	< 7.60	7.50	0.20	0	0.0	35	97.2
7.60	< 7.80	7.70	0.20	0	0.0	35	97.2
7.80	< 8.00	7.90	0.20	0	0.0	35	97.2
8.00	< 8.20	8.10	0.20	1	2.8	36	100.0

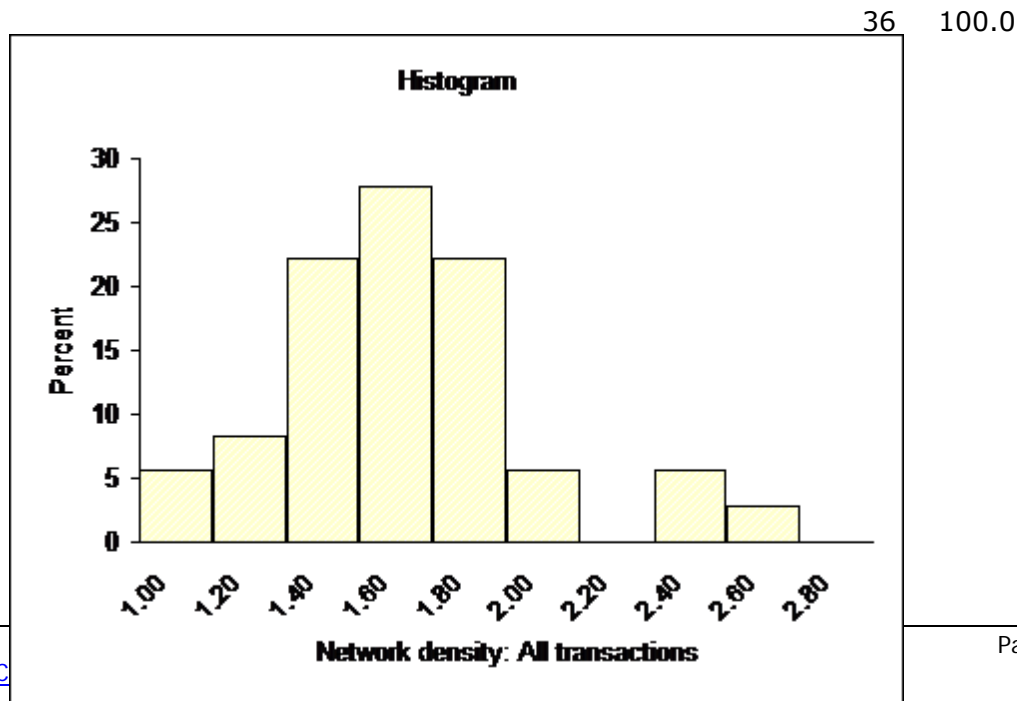
36 100.0



Network density: All transactions

Frequency Distribution - Quantitative

<i>Network density: All transactions</i>						<i>cumulative</i>	
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>
1.00	< 1.20	1.10	0.20	2	5.6	2	5.6
1.20	< 1.40	1.30	0.20	3	8.3	5	13.9
1.40	< 1.60	1.50	0.20	8	22.2	13	36.1
1.60	< 1.80	1.70	0.20	10	27.8	23	63.9
1.80	< 2.00	1.90	0.20	8	22.2	31	86.1
2.00	< 2.20	2.10	0.20	2	5.6	33	91.7
2.20	< 2.40	2.30	0.20	0	0.0	33	91.7
2.40	< 2.60	2.50	0.20	2	5.6	35	97.2
2.60	< 2.80	2.70	0.20	1	2.8	36	100.0

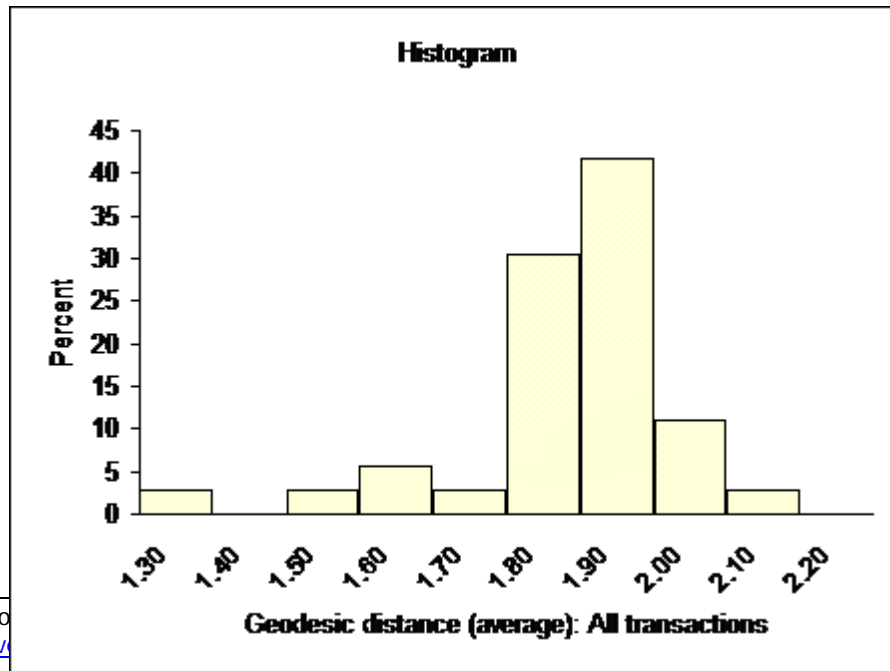


Geodesic distance (average): All transactions

Frequency Distribution - Quantitative

<i>Geodesic distance (average): All transactions</i>							<i>cumulative</i>	
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>	
1.30	< 1.40	1.35	0.10	1	2.8	1	2.8	
1.40	< 1.50	1.45	0.10	0	0.0	1	2.8	
1.50	< 1.60	1.55	0.10	1	2.8	2	5.6	
1.60	< 1.70	1.65	0.10	2	5.6	4	11.1	
1.70	< 1.80	1.75	0.10	1	2.8	5	13.9	
1.80	< 1.90	1.85	0.10	11	30.6	16	44.4	
1.90	< 2.00	1.95	0.10	15	41.7	31	86.1	
2.00	< 2.10	2.05	0.10	4	11.1	35	97.2	
2.10	< 2.20	2.15	0.10	1	2.8	36	100.0	

36 100.0



Degree Centrality: All transactions

Frequency Distribution - Quantitative

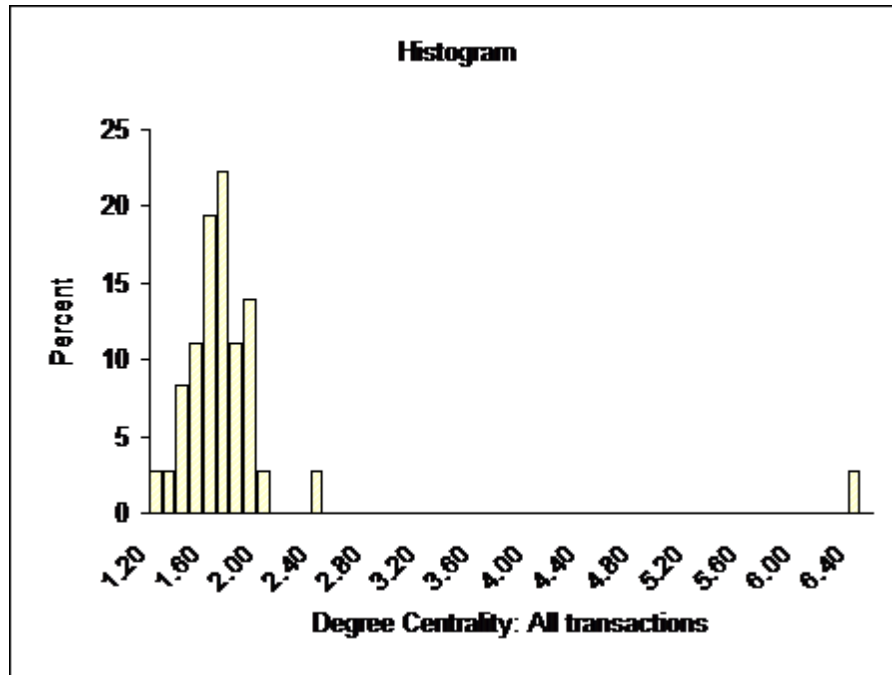
<i>Degree Centrality: All transactions</i>							<u><i>cumulative</i></u>	
<i>lower</i>		<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>frequency</i>	<i>percent</i>
1.20	<	1.30	1.25	0.10	1	2.8	1	2.8
1.30	<	1.40	1.35	0.10	1	2.8	2	5.6
1.40	<	1.50	1.45	0.10	3	8.3	5	13.9
1.50	<	1.60	1.55	0.10	4	11.1	9	25.0
1.60	<	1.70	1.65	0.10	7	19.4	16	44.4
1.70	<	1.80	1.75	0.10	8	22.2	24	66.7
1.80	<	1.90	1.85	0.10	4	11.1	28	77.8
1.90	<	2.00	1.95	0.10	5	13.9	33	91.7
2.00	<	2.10	2.05	0.10	1	2.8	34	94.4
2.10	<	2.20	2.15	0.10	0	0.0	34	94.4
2.20	<	2.30	2.25	0.10	0	0.0	34	94.4
2.30	<	2.40	2.35	0.10	0	0.0	34	94.4
2.40	<	2.50	2.45	0.10	1	2.8	35	97.2
2.50	<	2.60	2.55	0.10	0	0.0	35	97.2
2.60	<	2.70	2.65	0.10	0	0.0	35	97.2
2.70	<	2.80	2.75	0.10	0	0.0	35	97.2
2.80	<	2.90	2.85	0.10	0	0.0	35	97.2
2.90	<	3.00	2.95	0.10	0	0.0	35	97.2
3.00	<	3.10	3.05	0.10	0	0.0	35	97.2
3.10	<	3.20	3.15	0.10	0	0.0	35	97.2
3.20	<	3.30	3.25	0.10	0	0.0	35	97.2
3.30	<	3.40	3.35	0.10	0	0.0	35	97.2
3.40	<	3.50	3.45	0.10	0	0.0	35	97.2
3.50	<	3.60	3.55	0.10	0	0.0	35	97.2
3.60	<	3.70	3.65	0.10	0	0.0	35	97.2



3.70	<	3.80	3.75	0.10	0	0.0	35	97.2
3.80	<	3.90	3.85	0.10	0	0.0	35	97.2
3.90	<	4.00	3.95	0.10	0	0.0	35	97.2
4.00	<	4.10	4.05	0.10	0	0.0	35	97.2
4.10	<	4.20	4.15	0.10	0	0.0	35	97.2
4.20	<	4.30	4.25	0.10	0	0.0	35	97.2
4.30	<	4.40	4.35	0.10	0	0.0	35	97.2
4.40	<	4.50	4.45	0.10	0	0.0	35	97.2
4.50	<	4.60	4.55	0.10	0	0.0	35	97.2
4.60	<	4.70	4.65	0.10	0	0.0	35	97.2
4.70	<	4.80	4.75	0.10	0	0.0	35	97.2
4.80	<	4.90	4.85	0.10	0	0.0	35	97.2
4.90	<	5.00	4.95	0.10	0	0.0	35	97.2
5.00	<	5.10	5.05	0.10	0	0.0	35	97.2
5.10	<	5.20	5.15	0.10	0	0.0	35	97.2
5.20	<	5.30	5.25	0.10	0	0.0	35	97.2
5.30	<	5.40	5.35	0.10	0	0.0	35	97.2
5.40	<	5.50	5.45	0.10	0	0.0	35	97.2
5.50	<	5.60	5.55	0.10	0	0.0	35	97.2
5.60	<	5.70	5.65	0.10	0	0.0	35	97.2
5.70	<	5.80	5.75	0.10	0	0.0	35	97.2
5.80	<	5.90	5.85	0.10	0	0.0	35	97.2
5.90	<	6.00	5.95	0.10	0	0.0	35	97.2
6.00	<	6.10	6.05	0.10	0	0.0	35	97.2
6.10	<	6.20	6.15	0.10	0	0.0	35	97.2
6.20	<	6.30	6.25	0.10	0	0.0	35	97.2
6.30	<	6.40	6.35	0.10	0	0.0	35	97.2
6.40	<	6.50	6.45	0.10	1	2.8	36	100.0

36 100.0



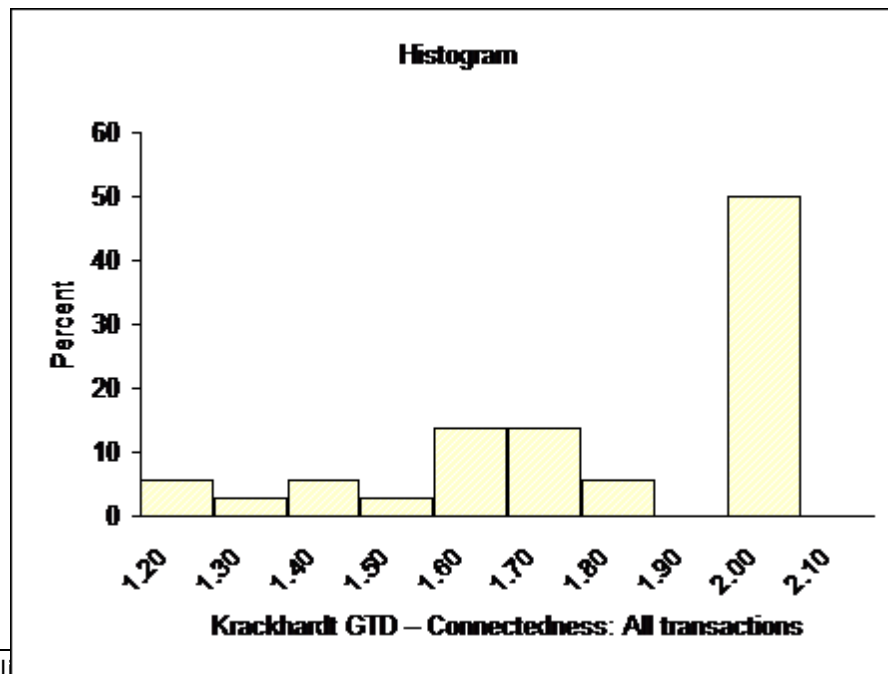


Krackhardt GTD – Connectedness: All transactions

Frequency Distribution - Quantitative

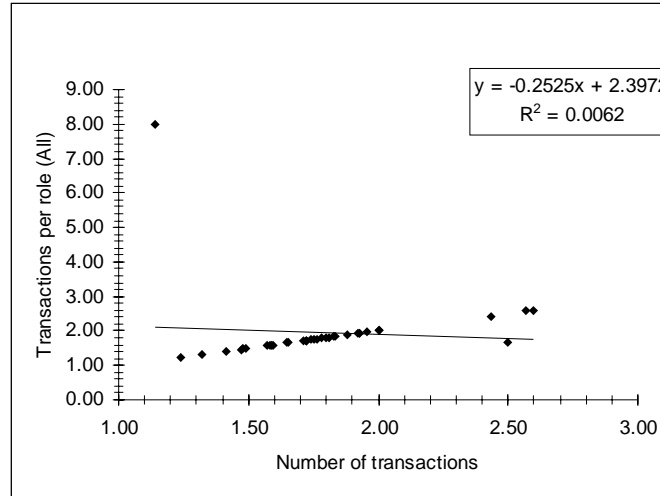
<i>lower</i>	<i>upper</i>	<i>midpoint</i>	<i>width</i>	<i>frequency</i>	<i>percent</i>	<i>cumulative</i>	
						<i>frequency</i>	<i>percent</i>
1.20	< 1.30	1.25	0.10	2	5.6	2	5.6
1.30	< 1.40	1.35	0.10	1	2.8	3	8.3
1.40	< 1.50	1.45	0.10	2	5.6	5	13.9
1.50	< 1.60	1.55	0.10	1	2.8	6	16.7
1.60	< 1.70	1.65	0.10	5	13.9	11	30.6
1.70	< 1.80	1.75	0.10	5	13.9	16	44.4
1.80	< 1.90	1.85	0.10	2	5.6	18	50.0
1.90	< 2.00	1.95	0.10	0	0.0	18	50.0
2.00	< 2.10	2.05	0.10	18	50.0	36	100.0

36 100.0



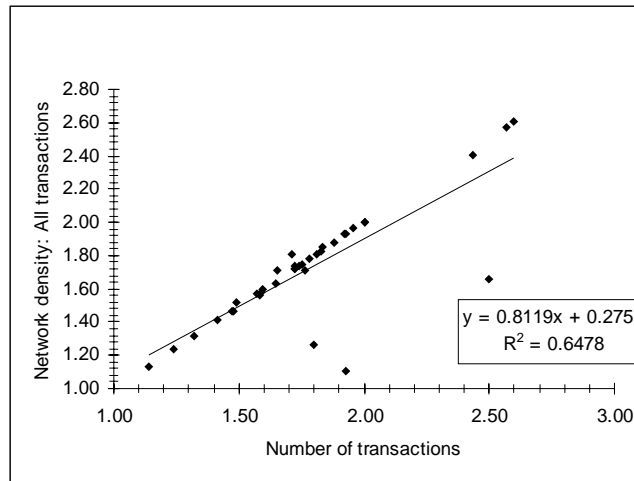
Correlation scatterplots

Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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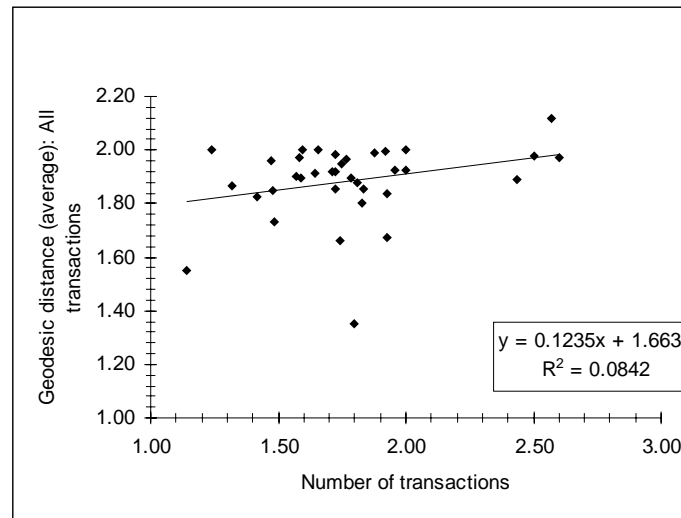


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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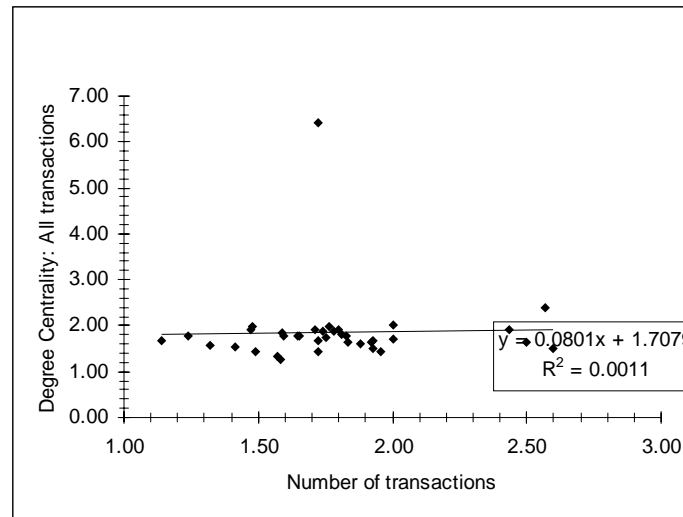


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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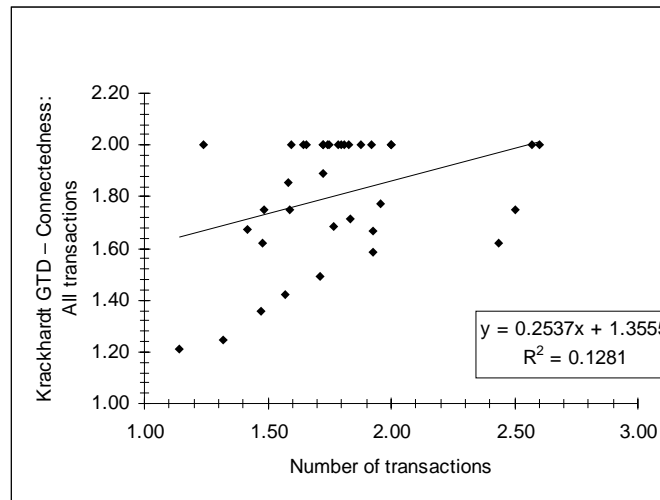


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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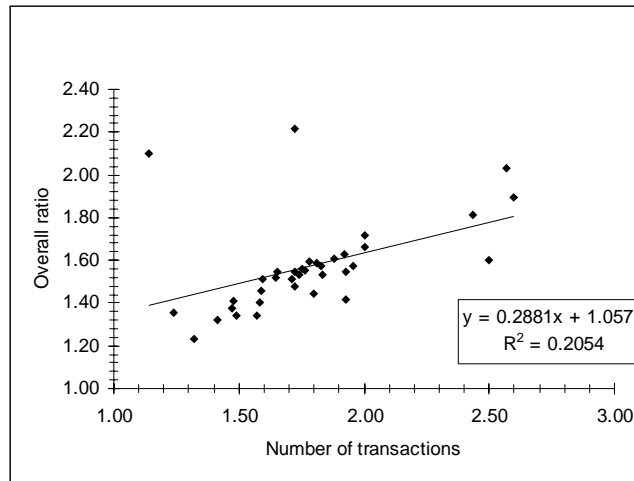




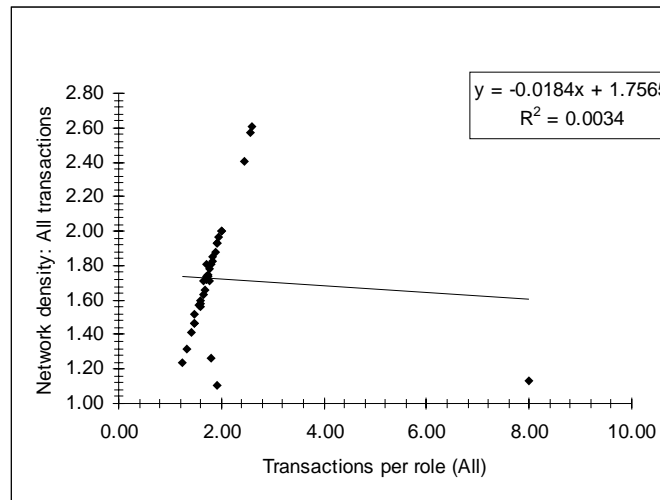
Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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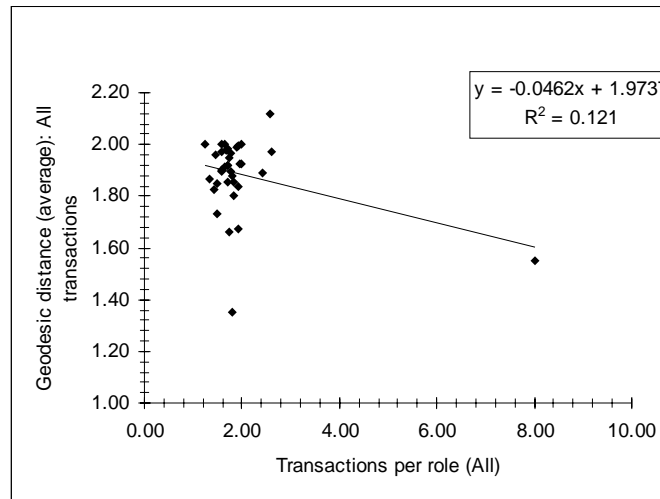


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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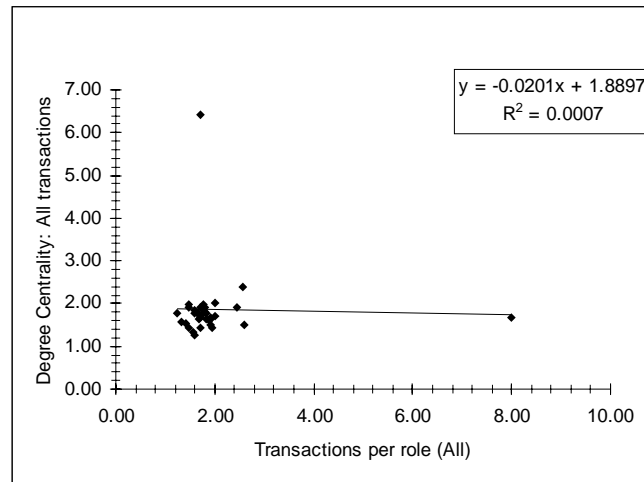


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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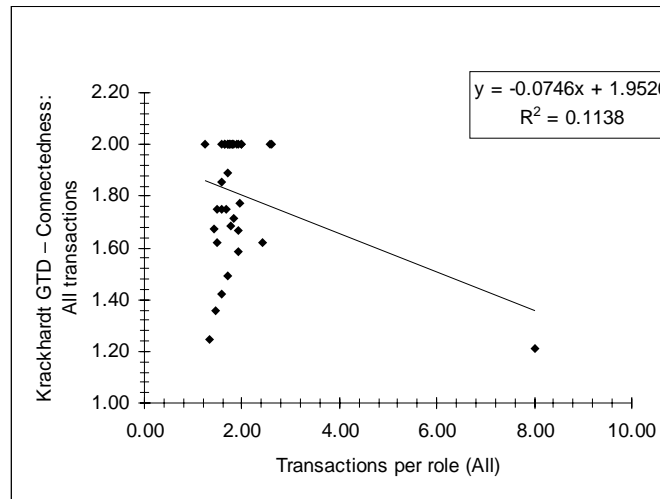


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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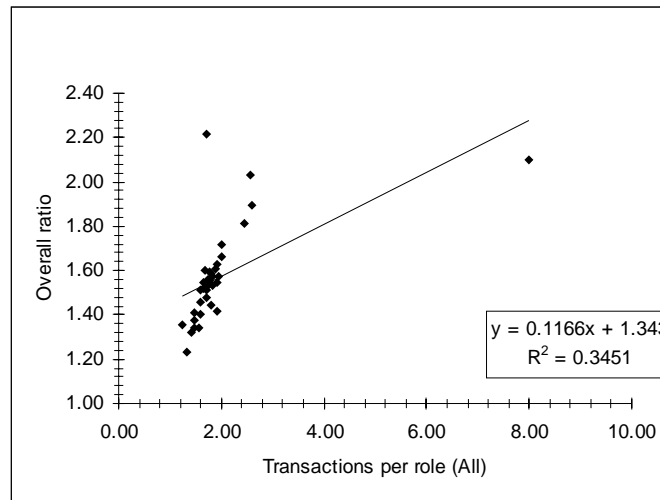


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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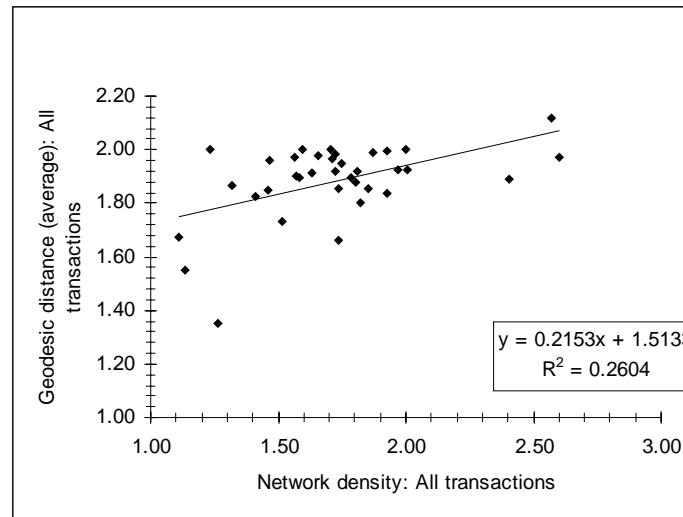


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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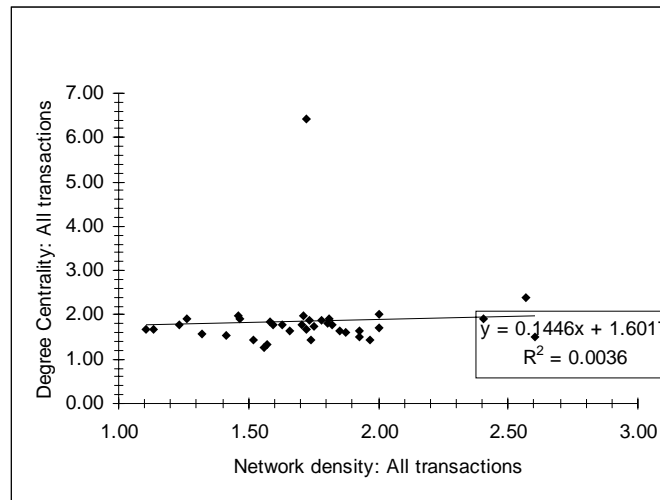


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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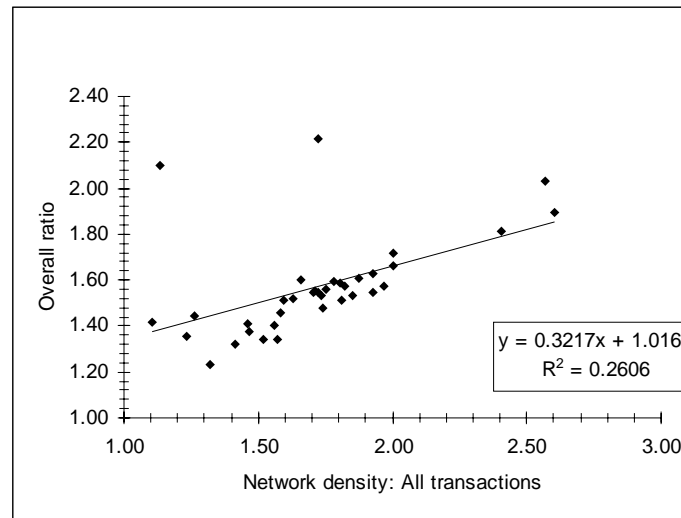
Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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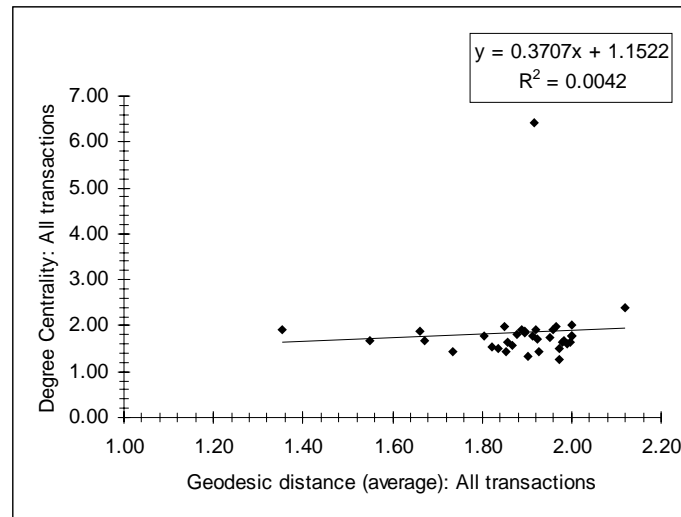


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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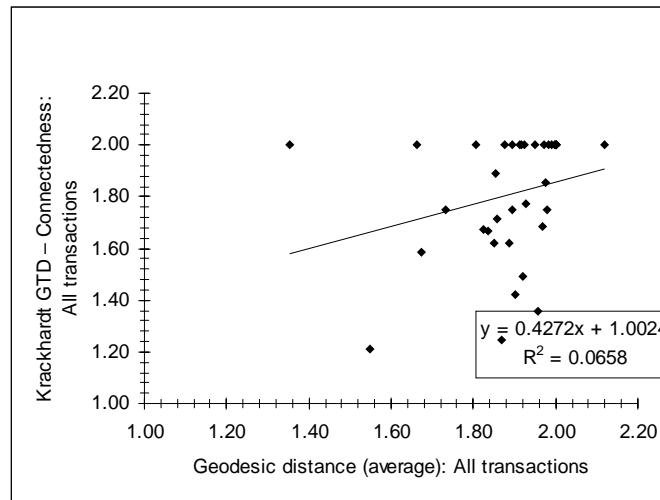


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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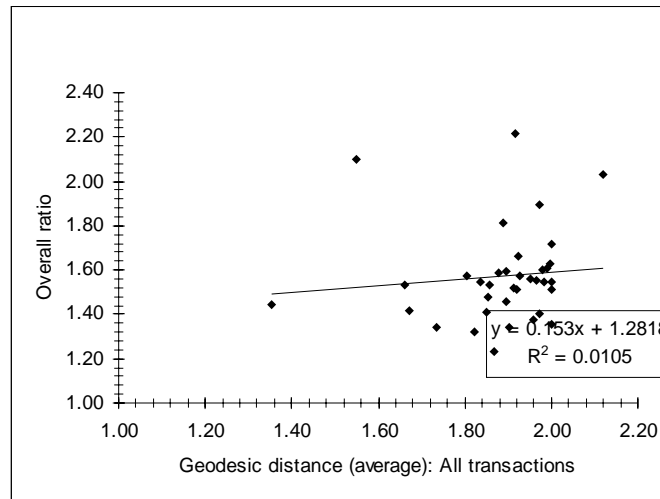


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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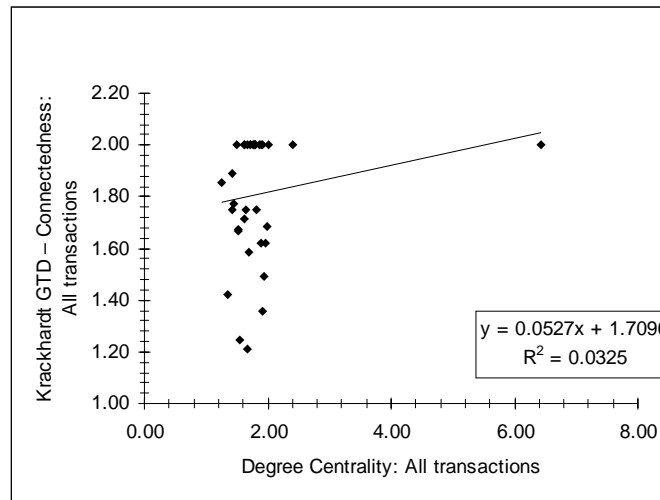


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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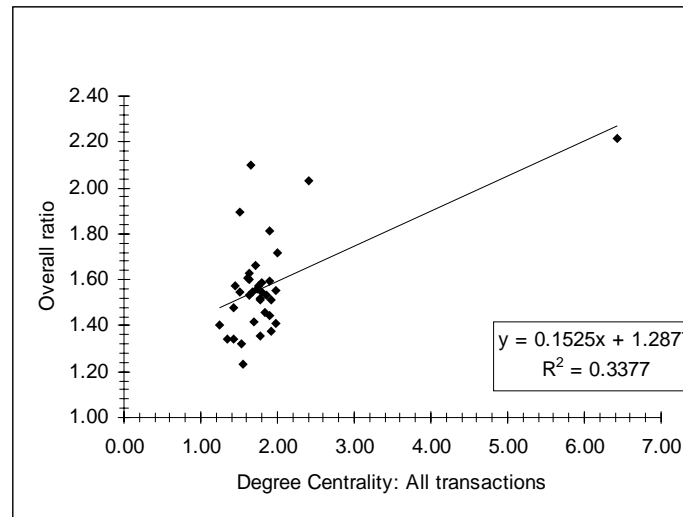


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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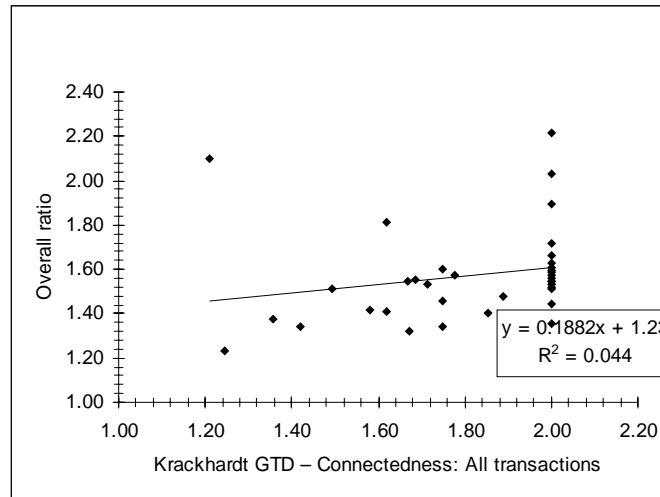


Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD - Connectedness: All transactions	Overall ratio
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Number of transactions	Transactions per role (All)	Network density: All transactions	Geodesic distance (average): All transactions	Degree Centrality: All transactions	Krackhardt GTD Connectedness: All transactions	Overall ratio
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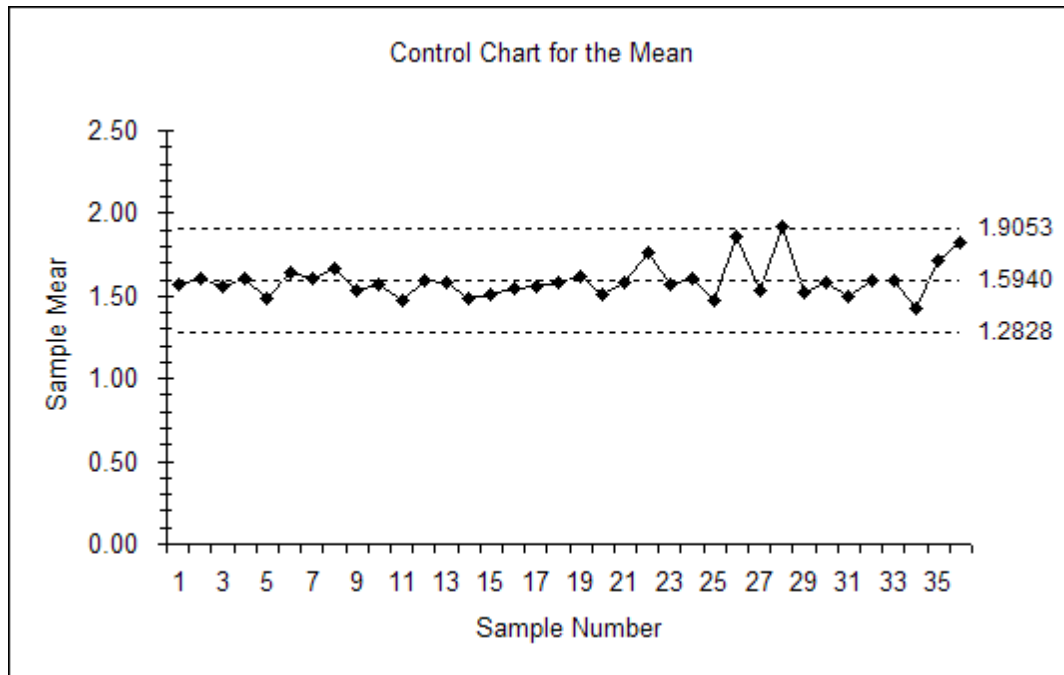


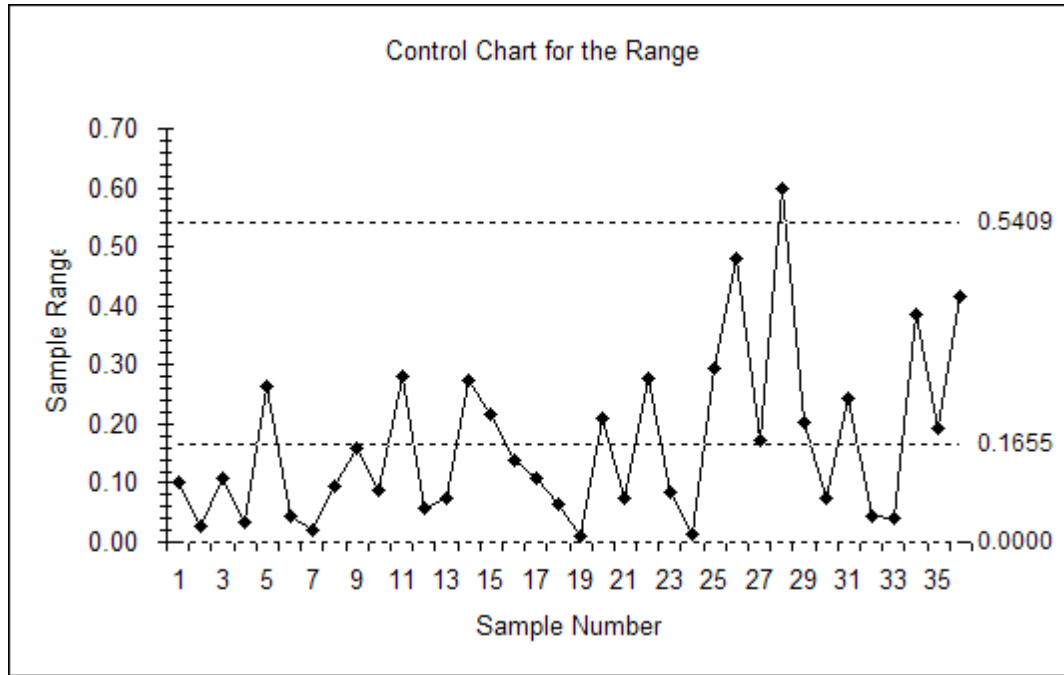
Appendix 4: Quality control process evaluation

Quality Control Process Charts

Sample size 2
Number of samples 36

	Mean	Range
Upper Control Limit, UCL	1.9053	0.5409
Center	1.5940	0.1655
Lower Control Limit, LCL	1.2828	0.0000





8/31/2006
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