



Network Science Center
at West Point 

A Comparison of Frontier and Emerging Capital Market Networks

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Why Capital Market Networks?

- Developed capital markets are correlated with improved economic performance
 - Levine and Zevros (1996)
- Macroeconomic theory needs to incorporate:
 - The network of interacting individuals
 - The structure of their interactions
 - The consequences of network activity
 - Kirman (2010)
- Network structure affects individual behavior and social welfare



- Goyal (2007)



Research Objectives

- Develop Topologies of Capital Market Networks
- Quantitatively Determine Differences Between Networks



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“If we wish to influence a capital market’s efficiency, are there specific organizations, agents, or functions on which we should focus in order to bring about the desired outcome?”

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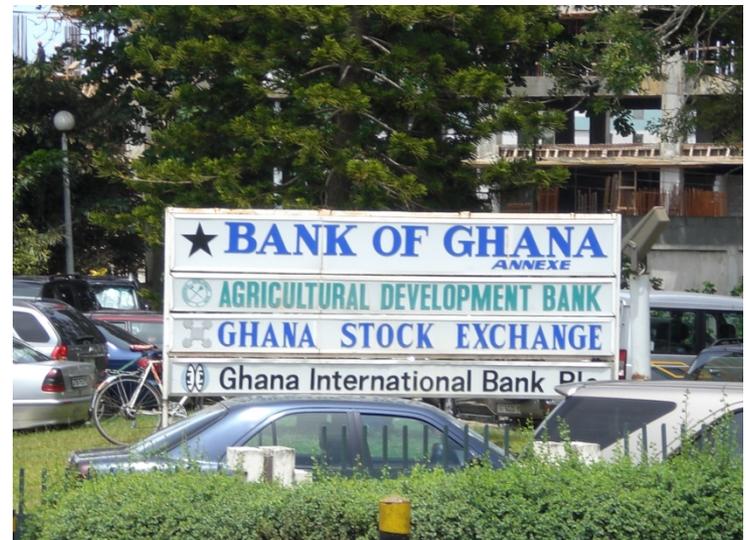
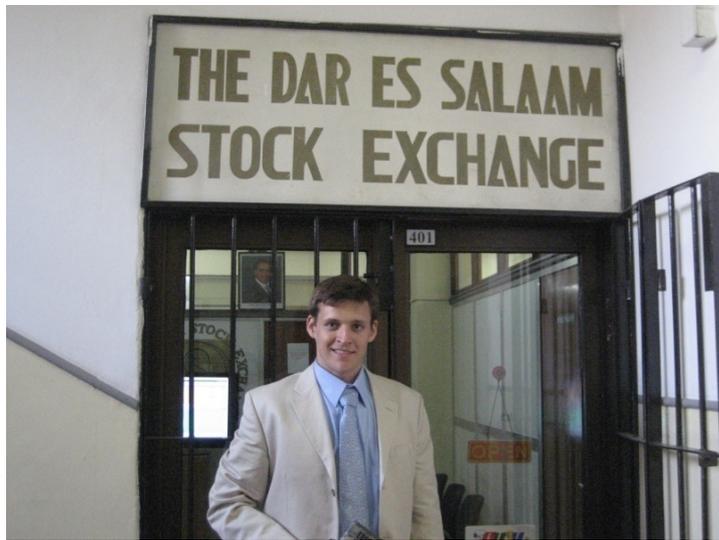
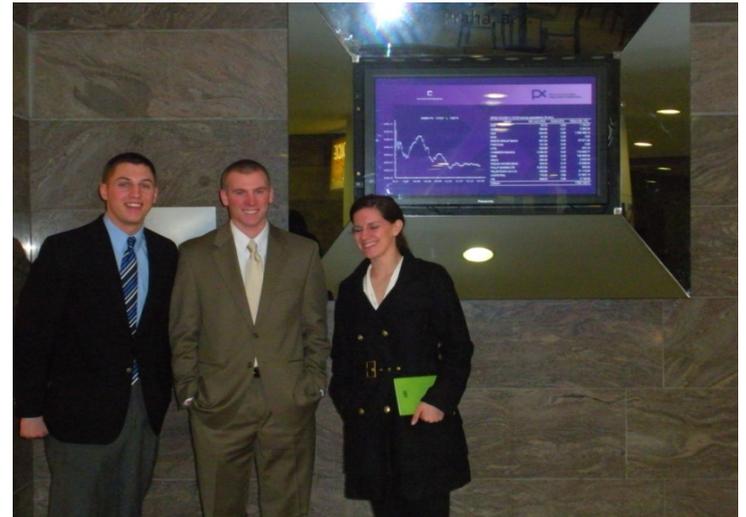
and the steering wheel. Although control theory is a mathematically highly developed branch of engineering with applications to electric circuits, manufacturing processes, communication systems⁴⁻⁶, aircraft, spacecraft and robots⁷, fundamental questions pertaining to the controllability of complex systems emerging in nature and engineering have resisted advances. The difficulty is rooted in the fact that two independent factors contribute to controllability, each with its own layer of

controlled using the time-dependent input vector $u(t) = (u_1(t), \dots, u_M(t))^T$ imposed by the controller (Fig. 1a), where in general the same signal $u_i(t)$ can drive multiple nodes. If we wish to control a system, we first need to identify the set of nodes that, if driven by different signals, can offer full control over the network. We will call these ‘driver nodes’. We are particularly interested in identifying the minimum number of driver nodes, denoted by N_d , whose control is sufficient

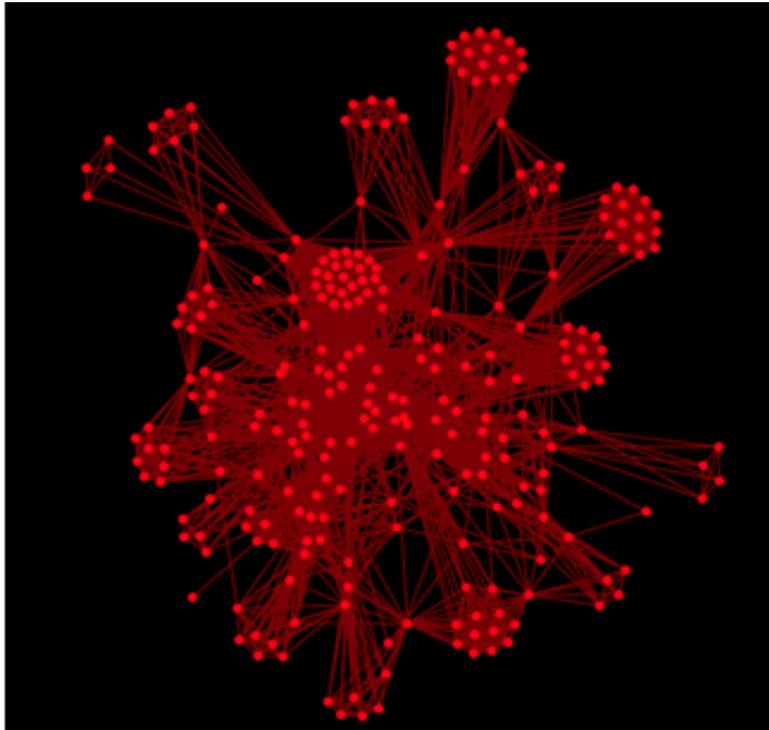


Frontier & Emerging Capital Markets

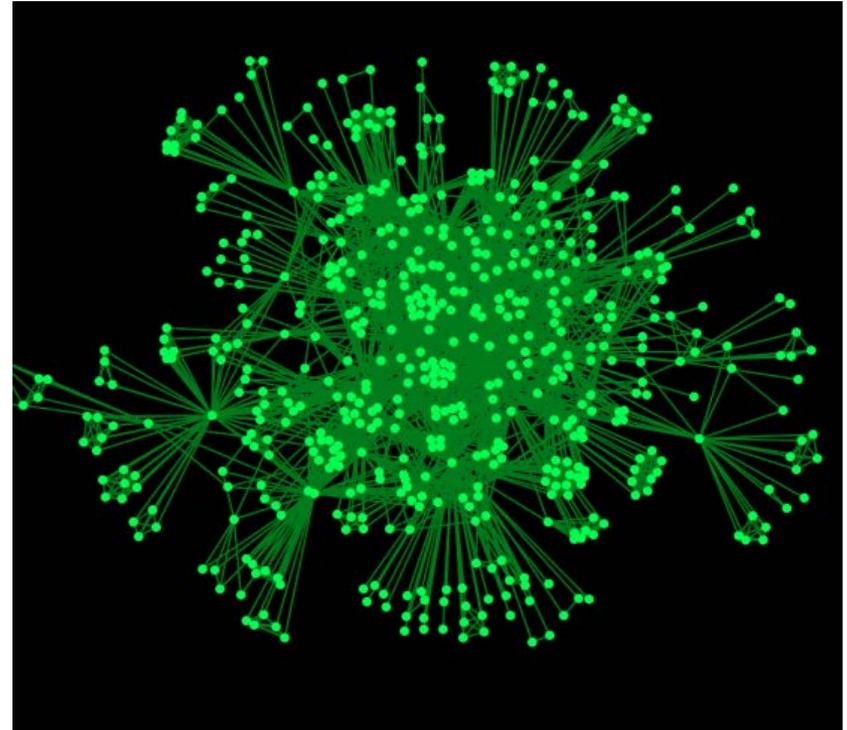
- Tanzania
- Ghana
- Trinidad & Tobago
- Czech Republic



Social Network Development



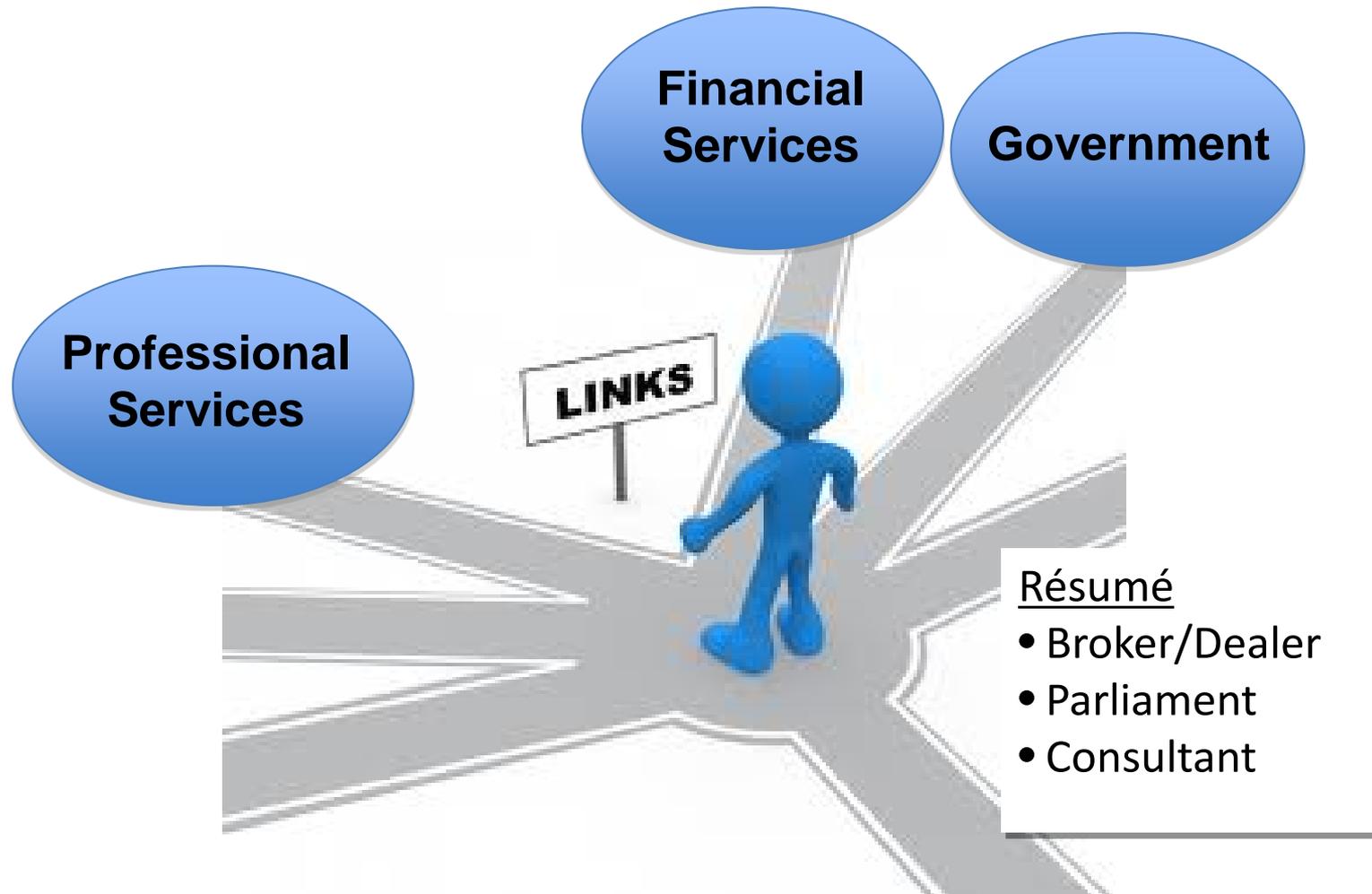
Agent Network



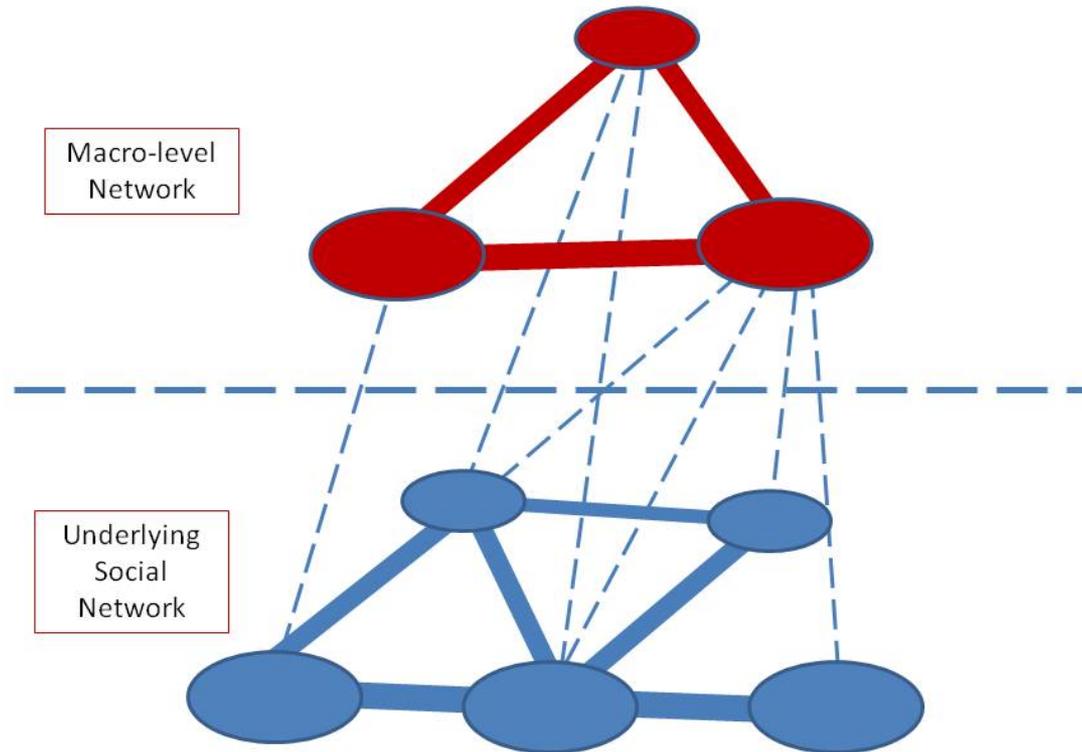
Organization Network



Social Network Development



Developing a Functional Network

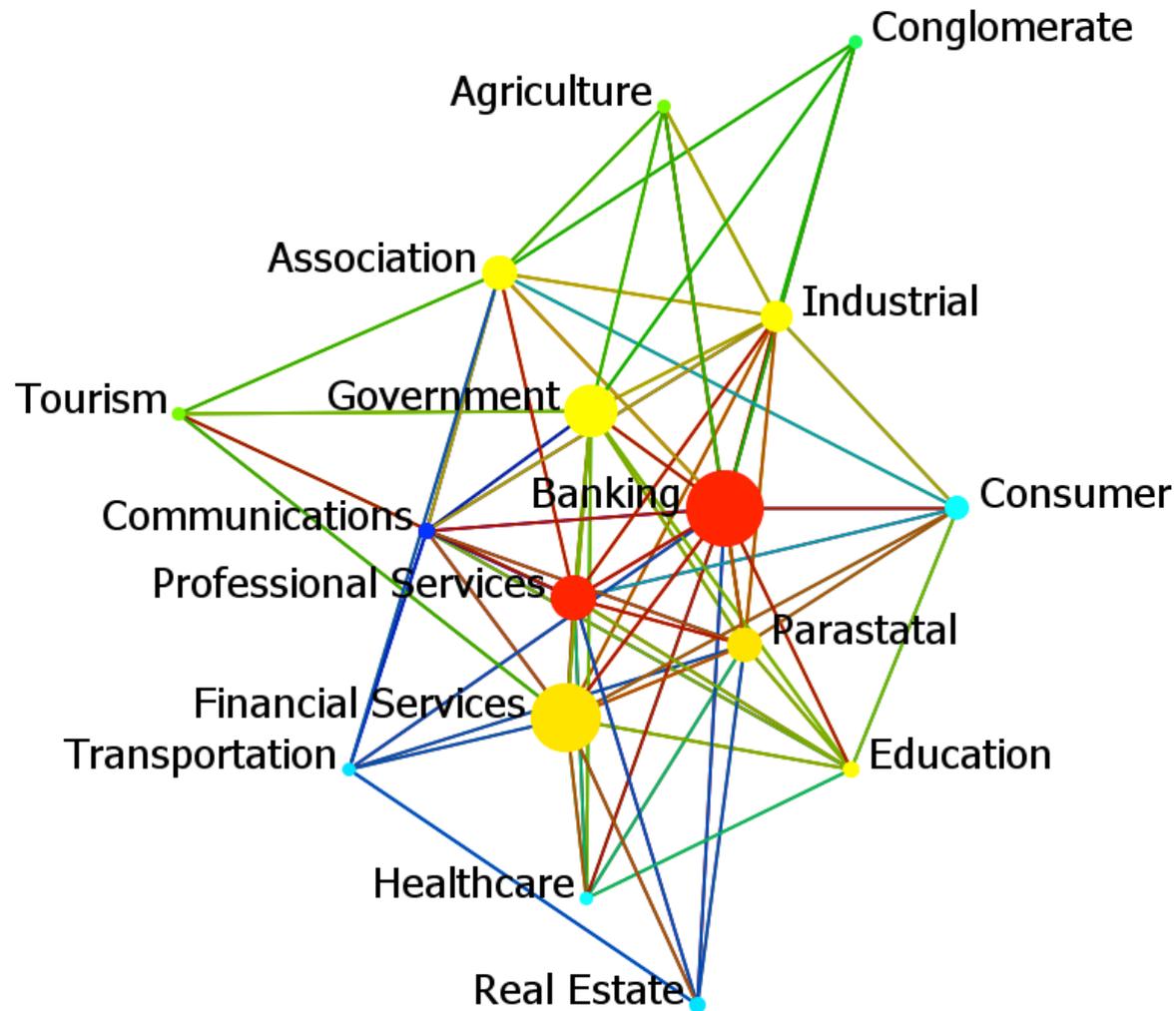


Network Functions

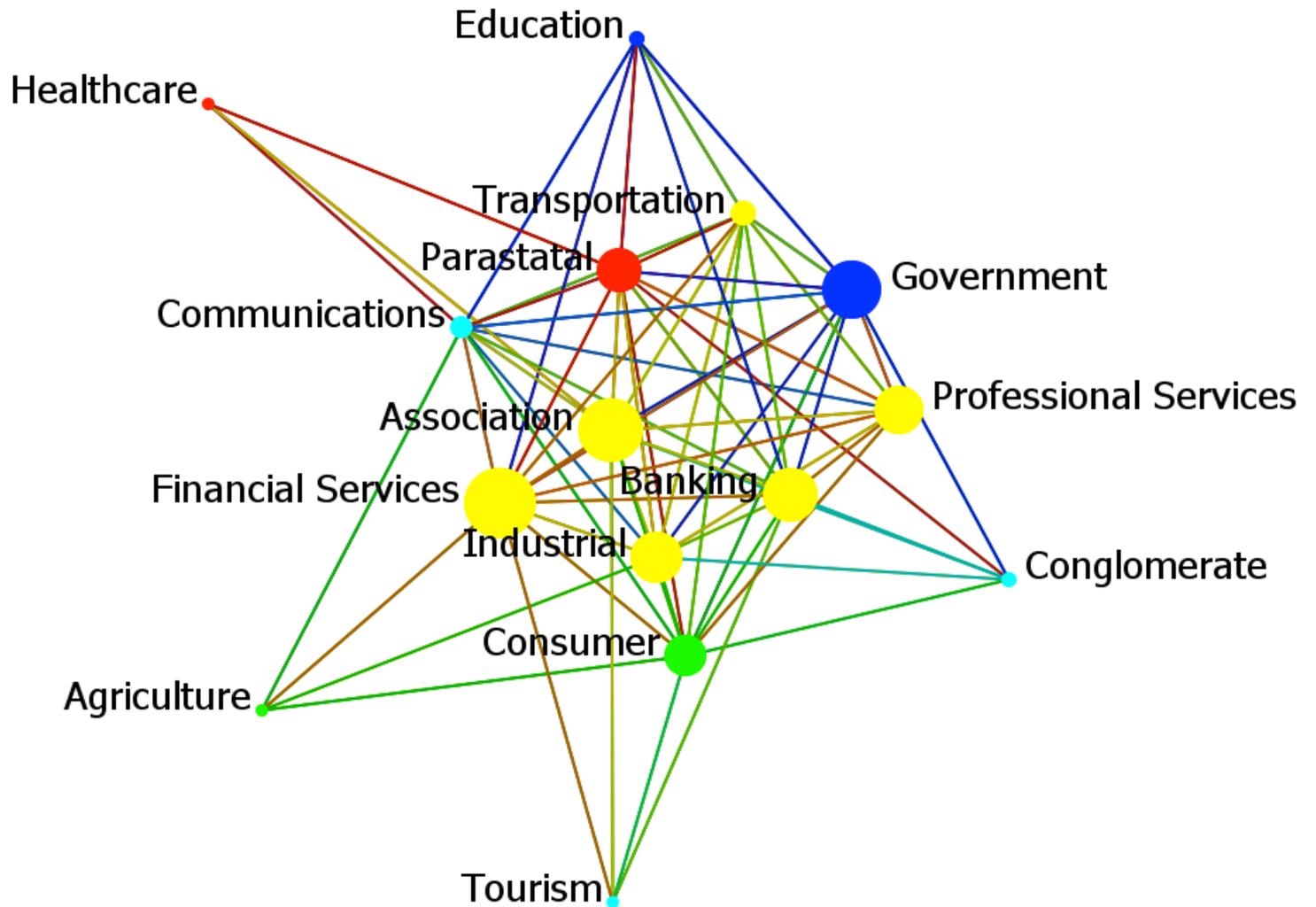
Agriculture	Government
Association	Healthcare
Banking	Industrial
Communications	Parastatal
Conglomerate	Professional Services
Consumer	Real Estate
Education	Tourism
Financial Services	Transportation



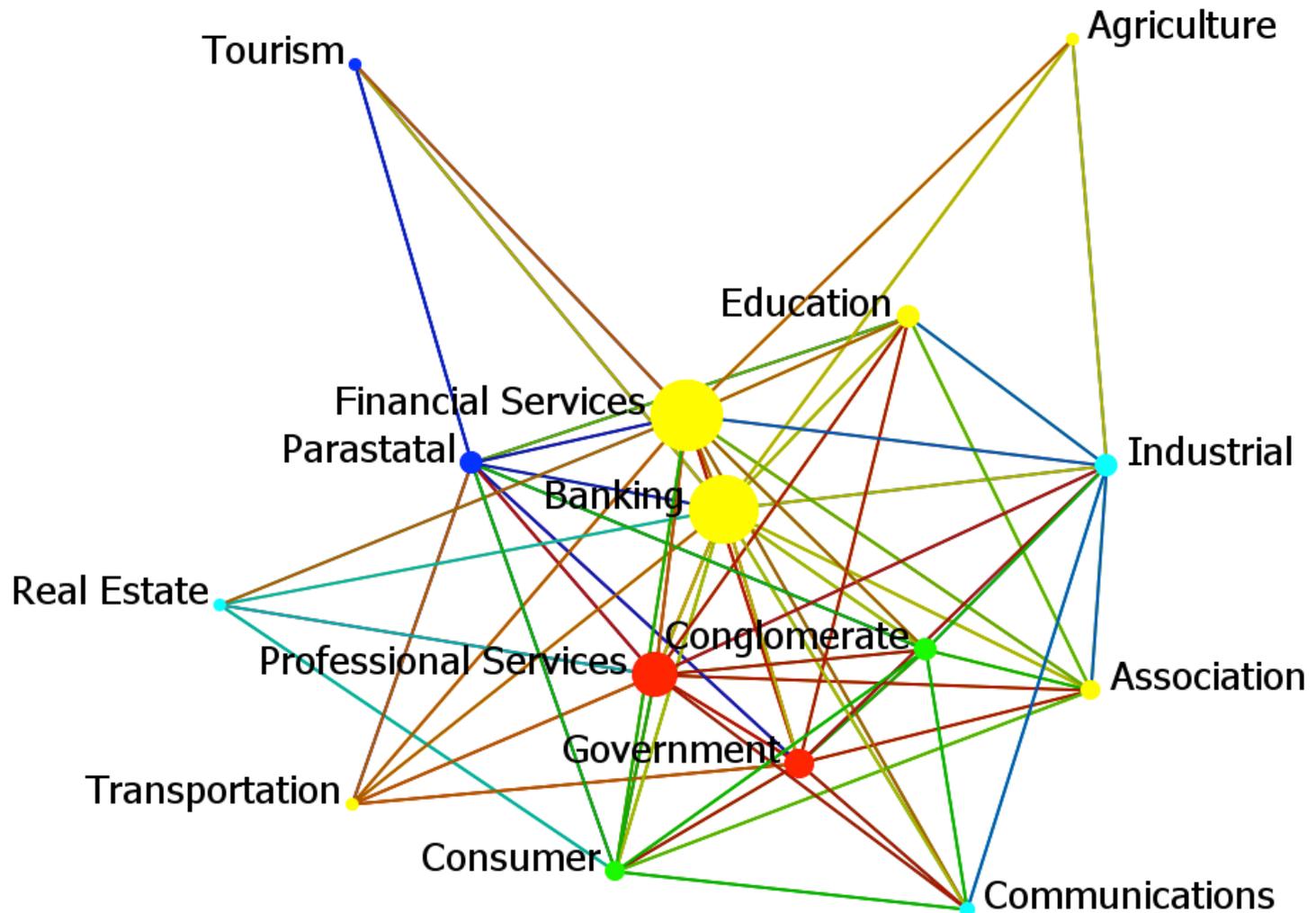
Ghana Functions Network



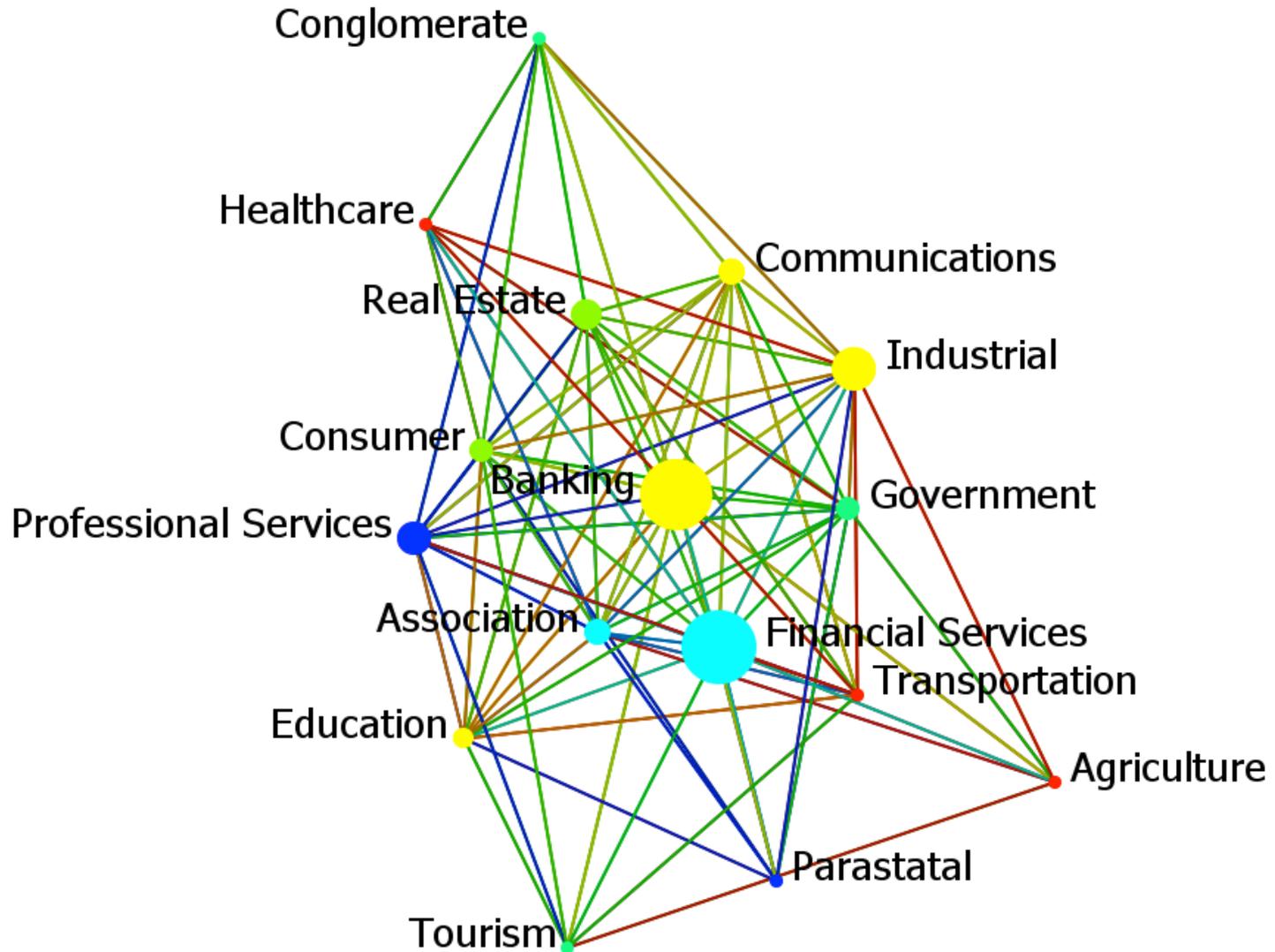
Tanzania Functions Network



Trinidad & Tobago Functions Network



Czech Republic

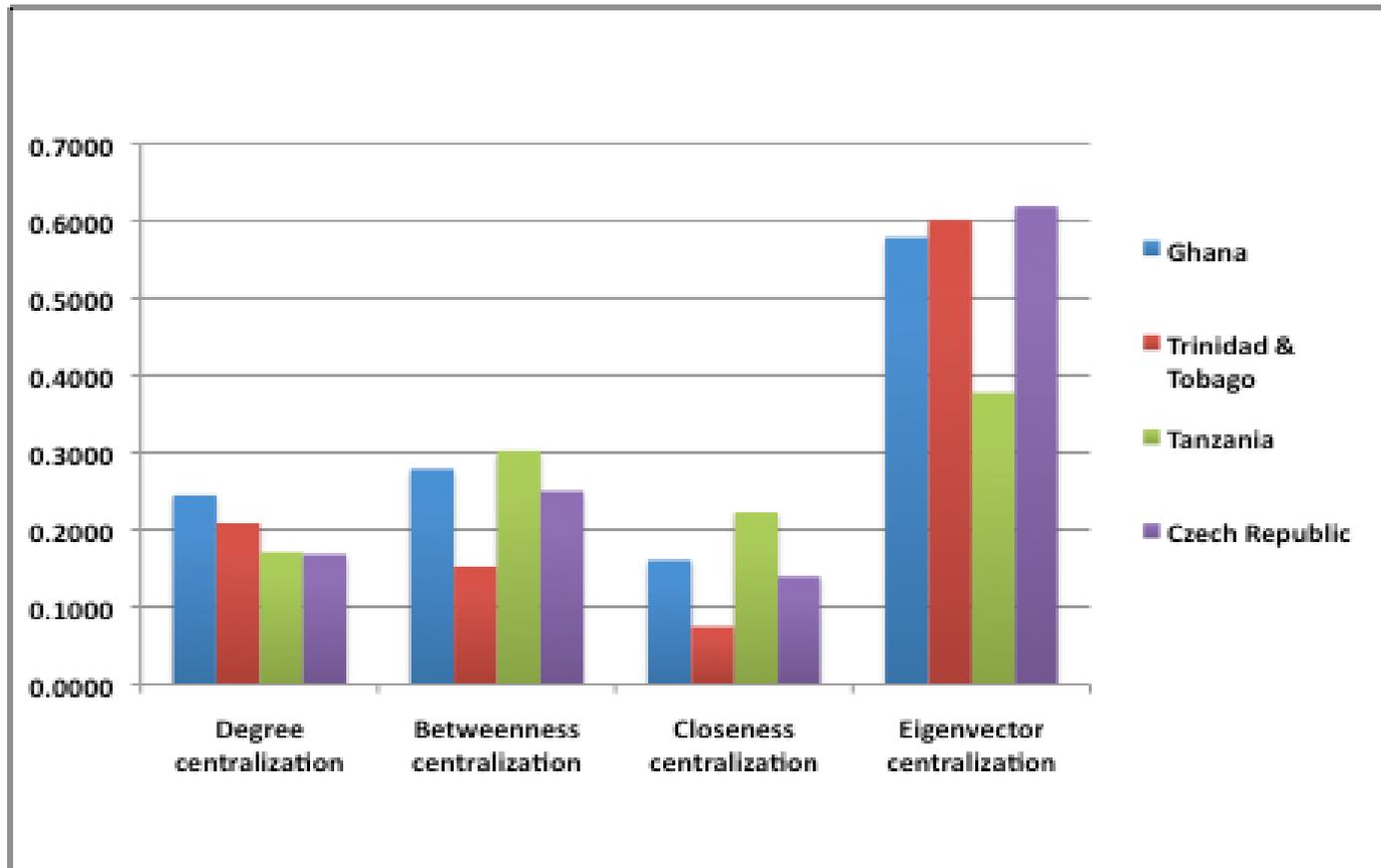


Network Level Comparison

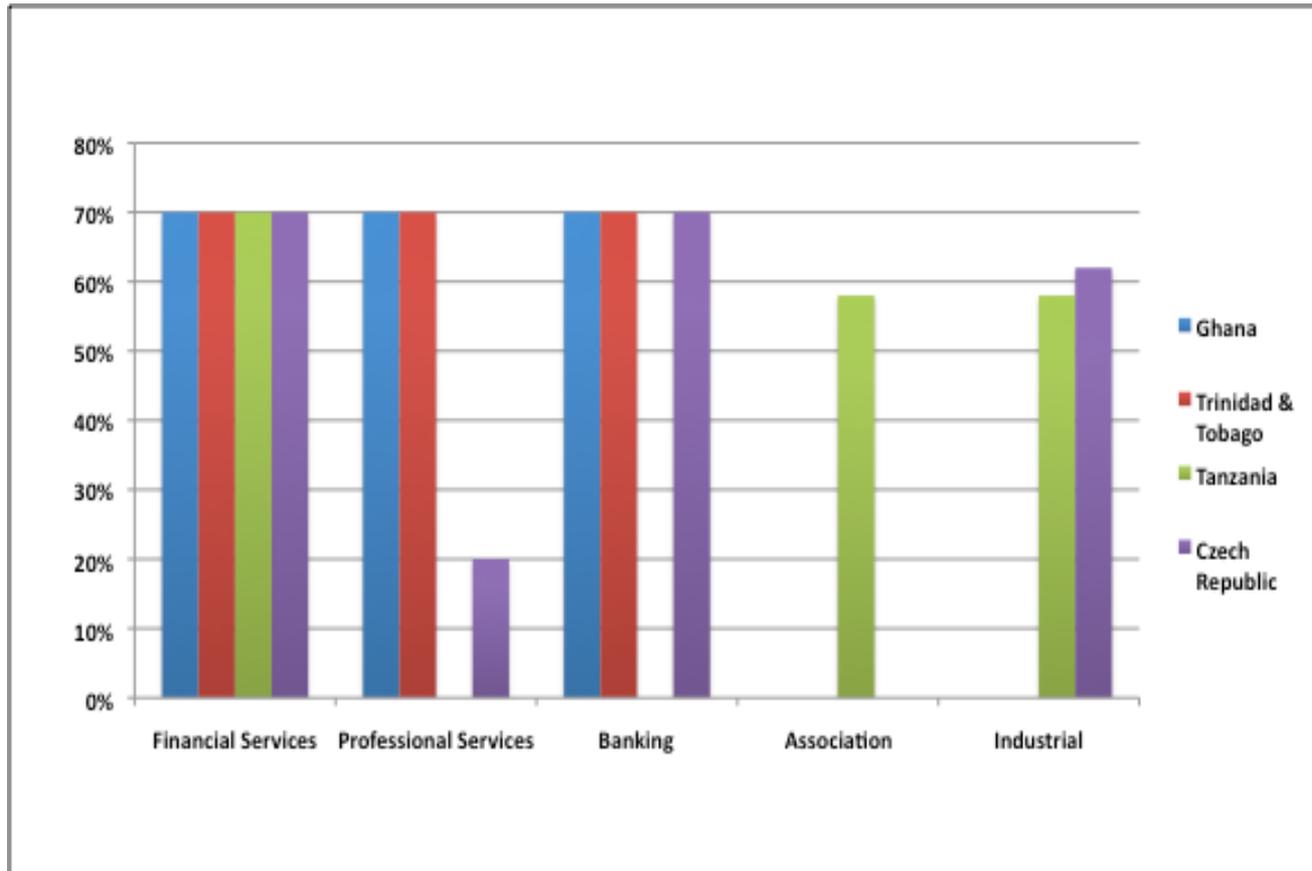
Network Level Measures	Ghana	Trinidad and Tobago	Tanzania	Czech Republic
Row and column count	16	15	15	16
Link count	67	62	68	84
Density	0.558	0.590	0.648	0.700
Characteristic path length	5.467	7.352	7.800	4.925
Network Diameter	10	15	14	10
Degree centralization	0.245	0.209	0.171	0.168
Betweenness centralization	0.279	0.152	0.302	0.250
Closeness centralization	0.161	0.075	0.223	0.140
Eigenvector centralization	0.578	0.601	0.378	0.619



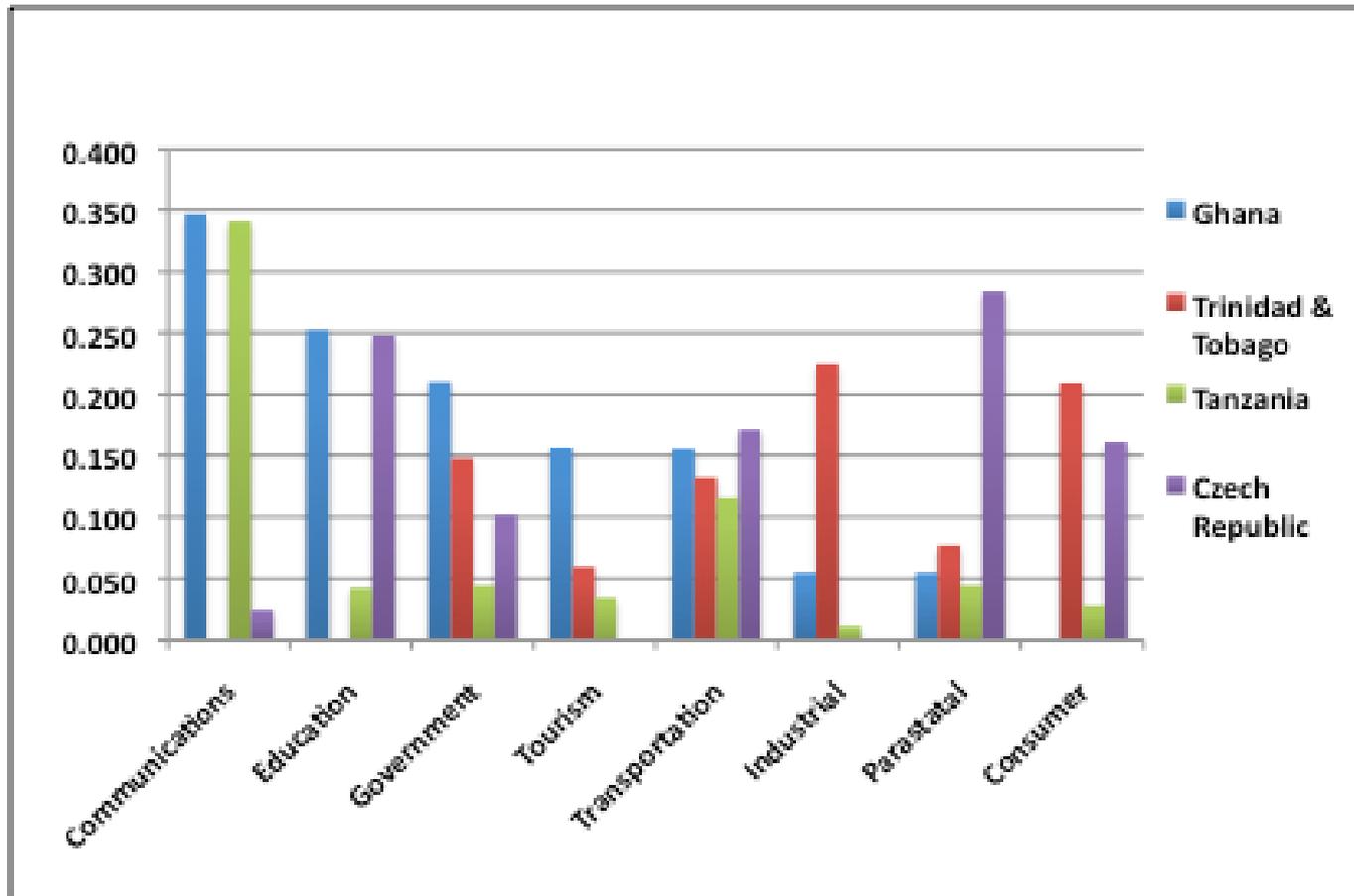
Network Level Centralization Measures



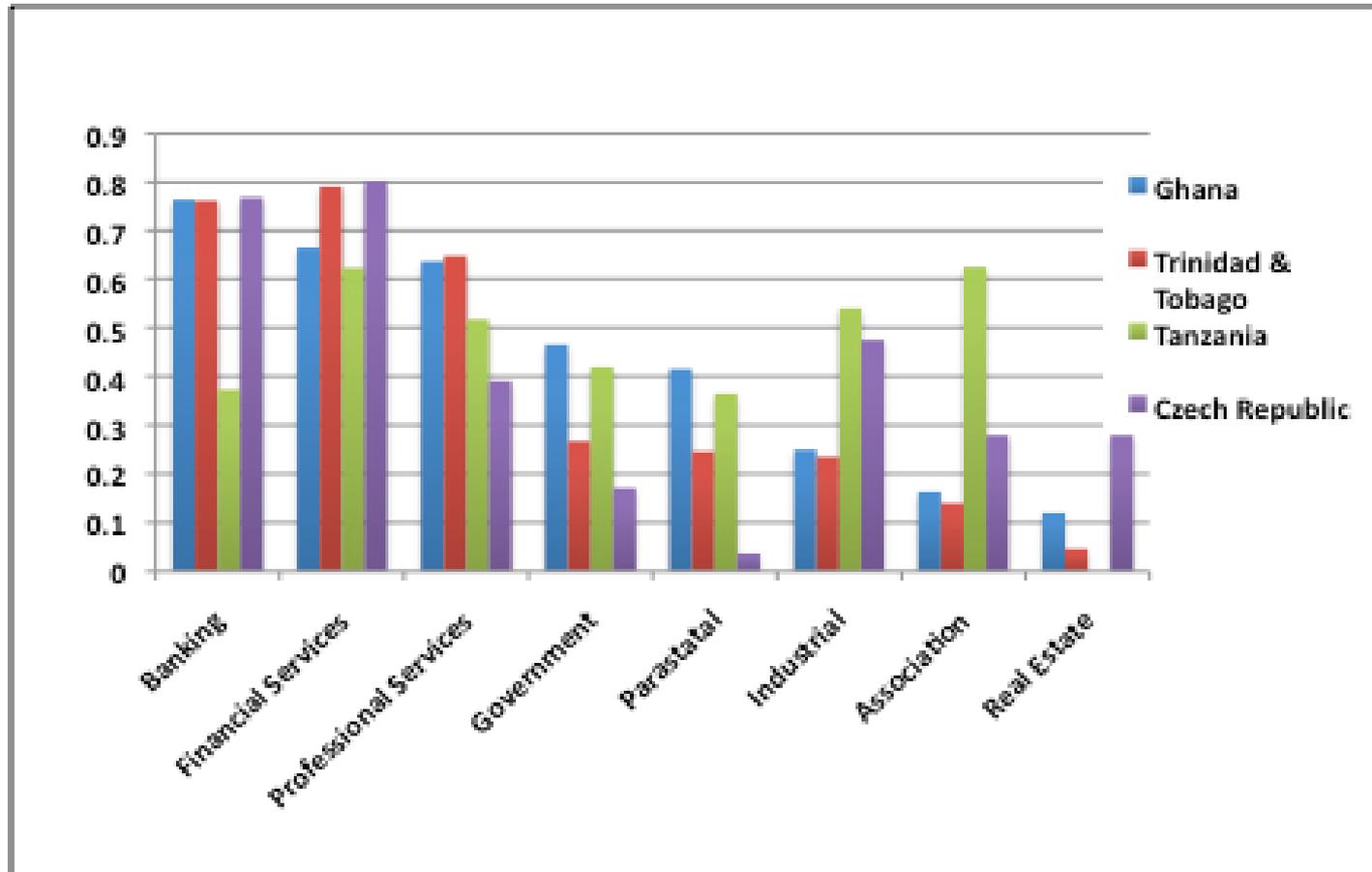
Most Prominent Functions Comparison



Betweenness Centrality Comparison



Eigenvector Centrality Comparison



Results

- Financial Services prominent in all networks
- Professional Services and Banking not prominent in Tanzania
- Tanzania's functions network was distinct
 - Functions more interconnected & exert indirect influence
 - Fewer cliques & more clustered
 - Banking not as important, but Industrial and Association functions quite important
- Czech Republic's market was most dense and had more cliques and shorter paths



Implications - Tanzania

- Link between well-functioning capital markets and development
- Tanzania has least developed capital market; Czech Republic & Trinidad are more developed
- Requirements for investors - information availability, contract rights, liquidity
- To attract investors, Tanzania could:
 - Expand professional services & banking functions
 - Reduce role of associations
 - Increase information flows (reduce importance of gatekeepers and friendship ties)

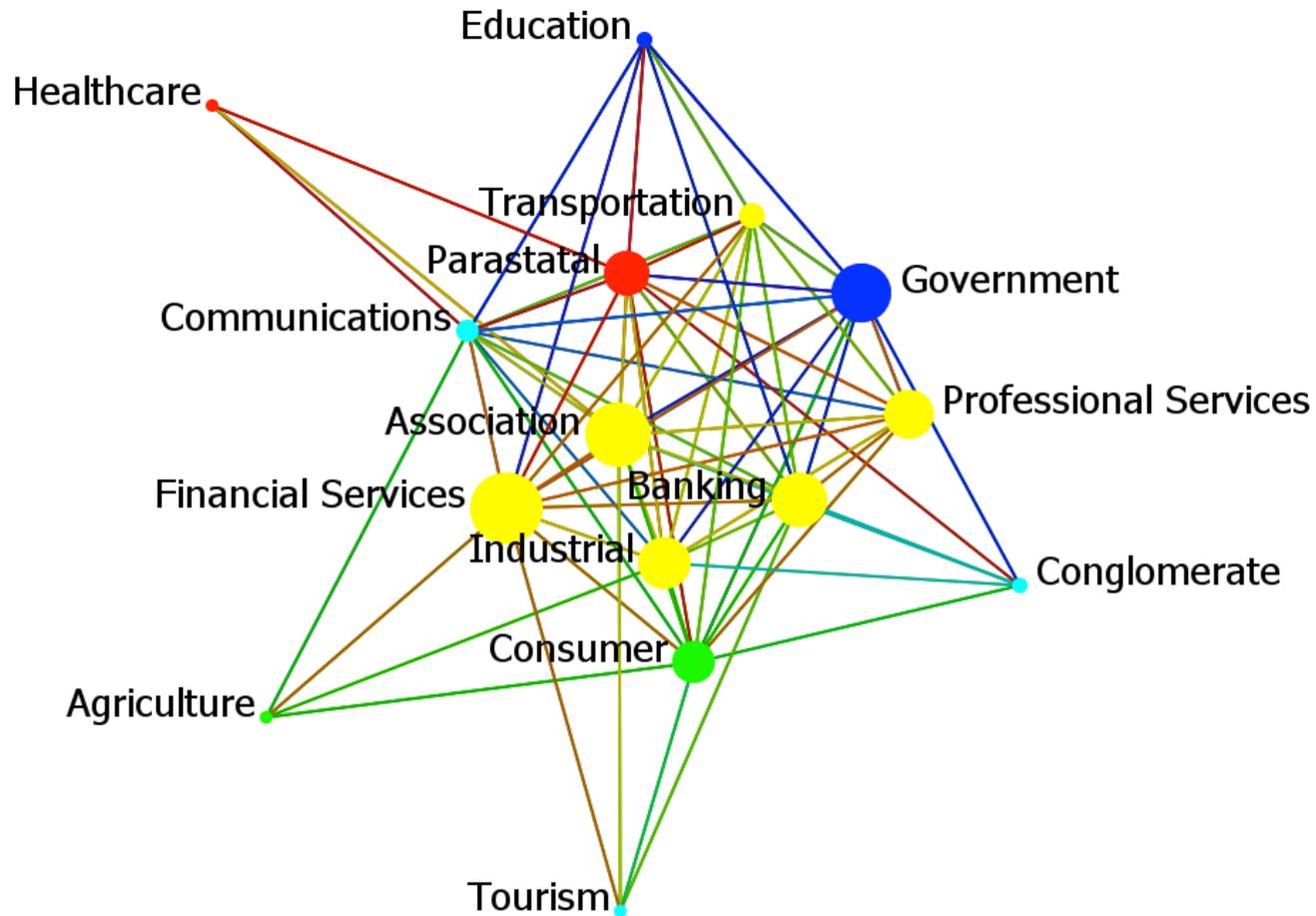


The Way Ahead

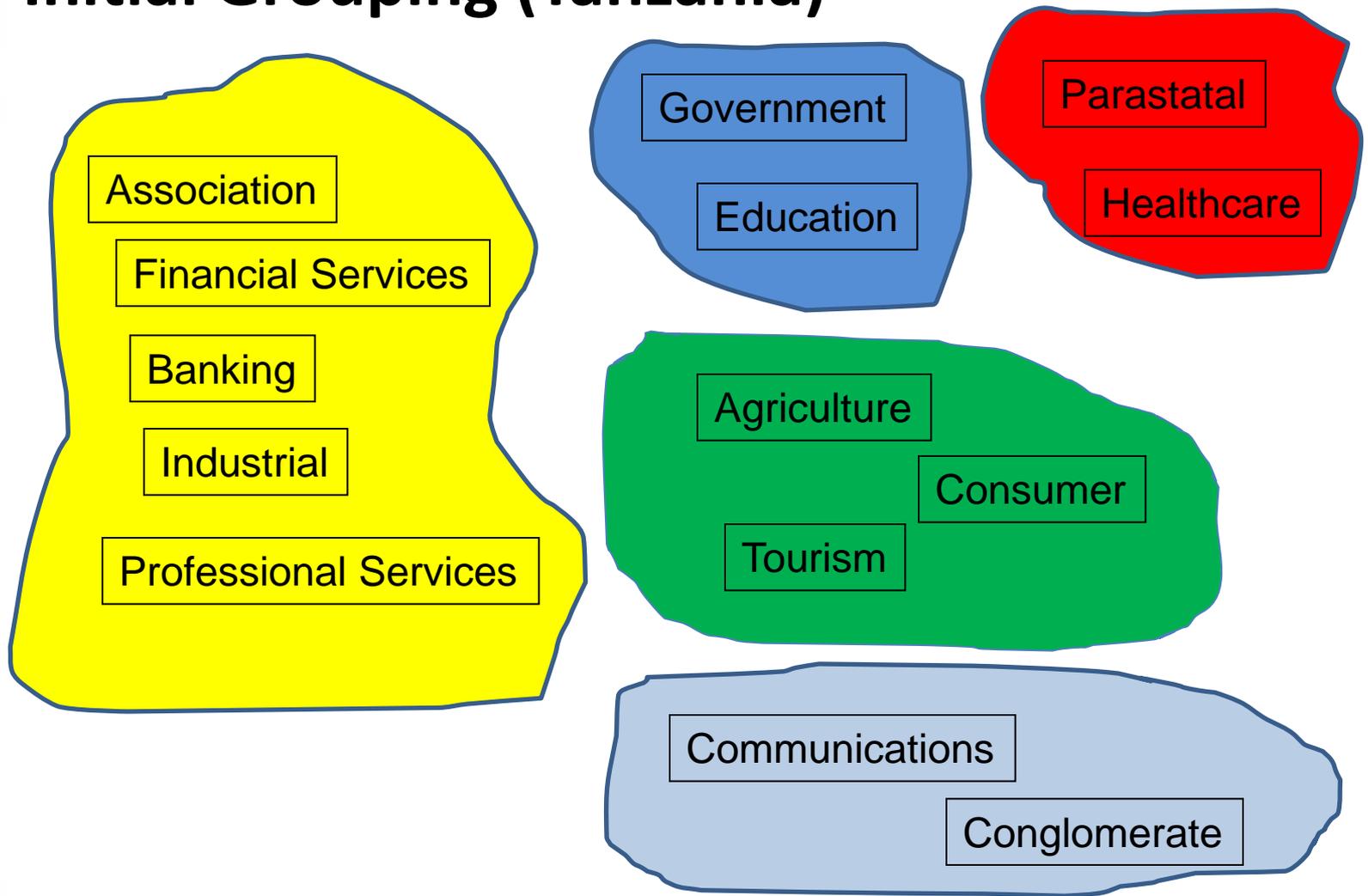
- Clustering /Sub-Group Analysis
- Node Centrality Correlation Analysis



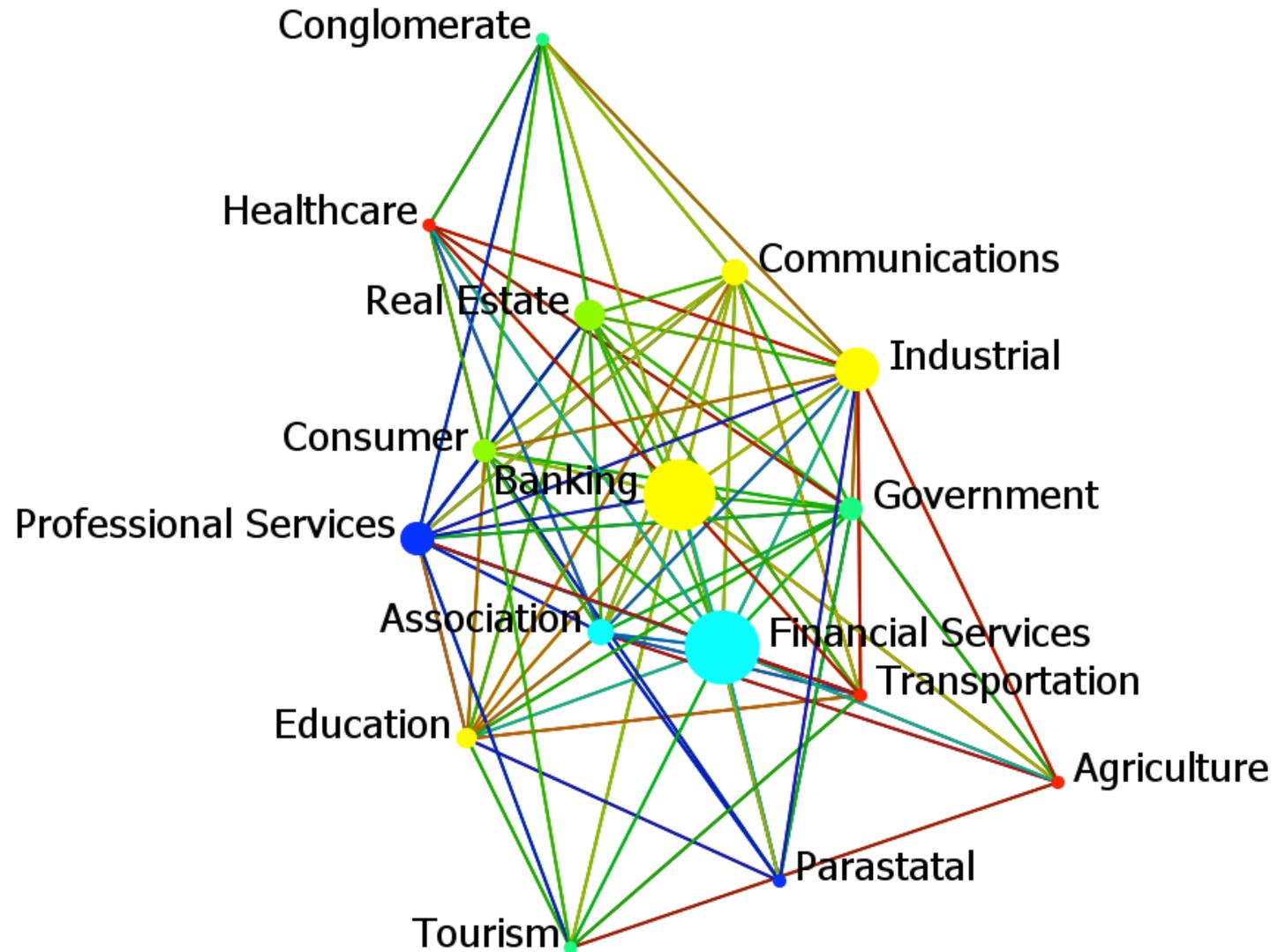
Tanzania Functions Network



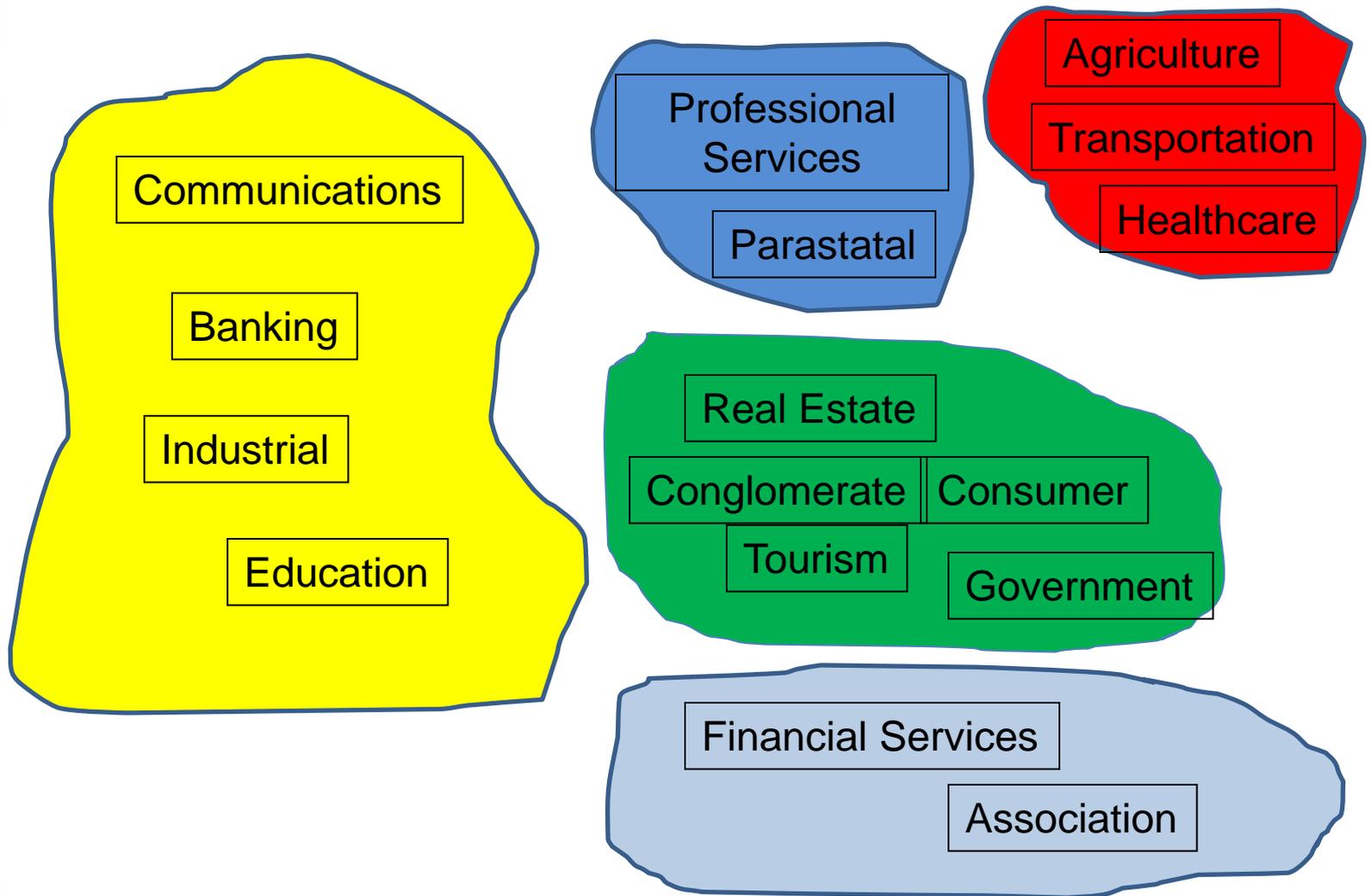
Initial Grouping (Tanzania)



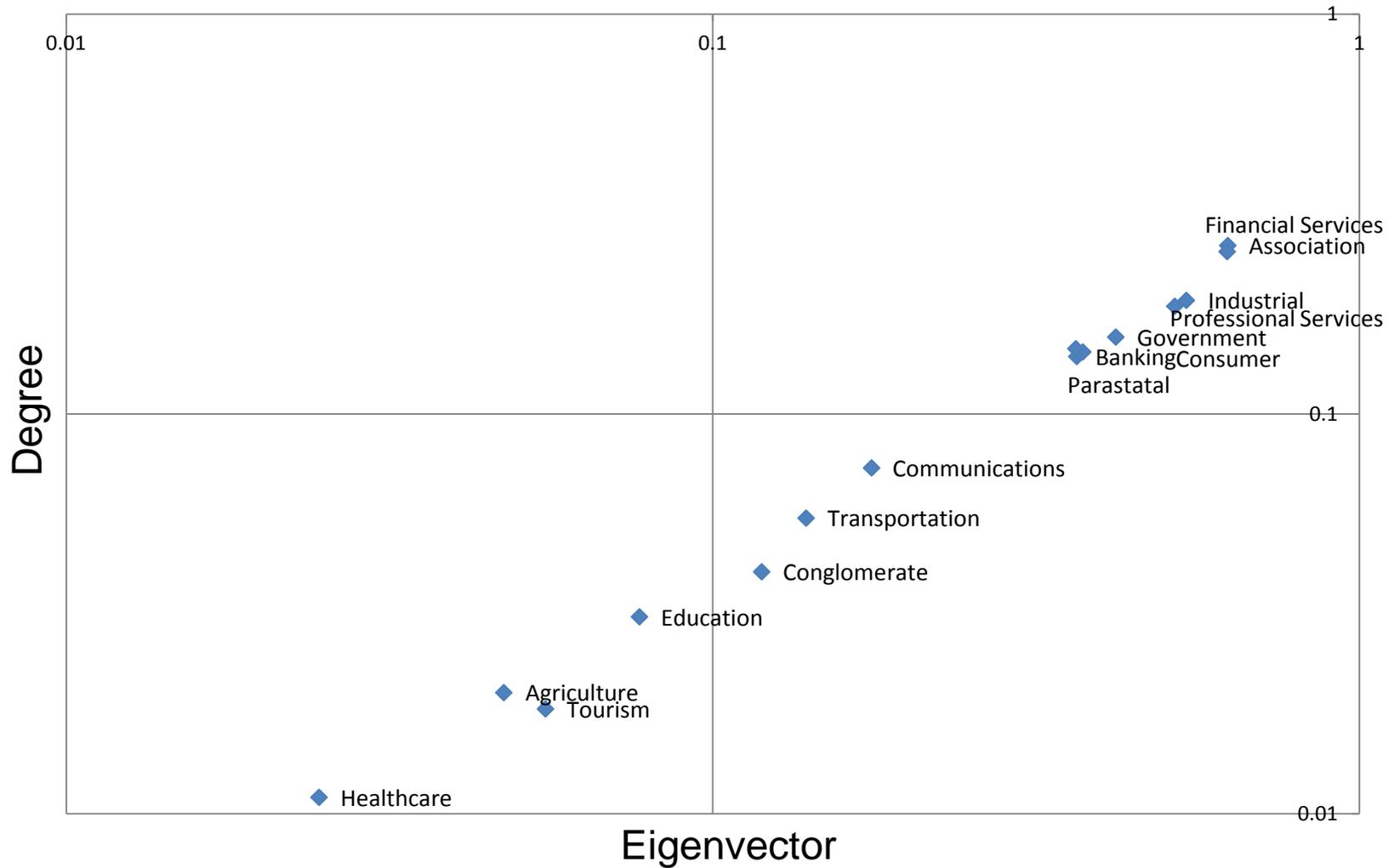
Czech Republic



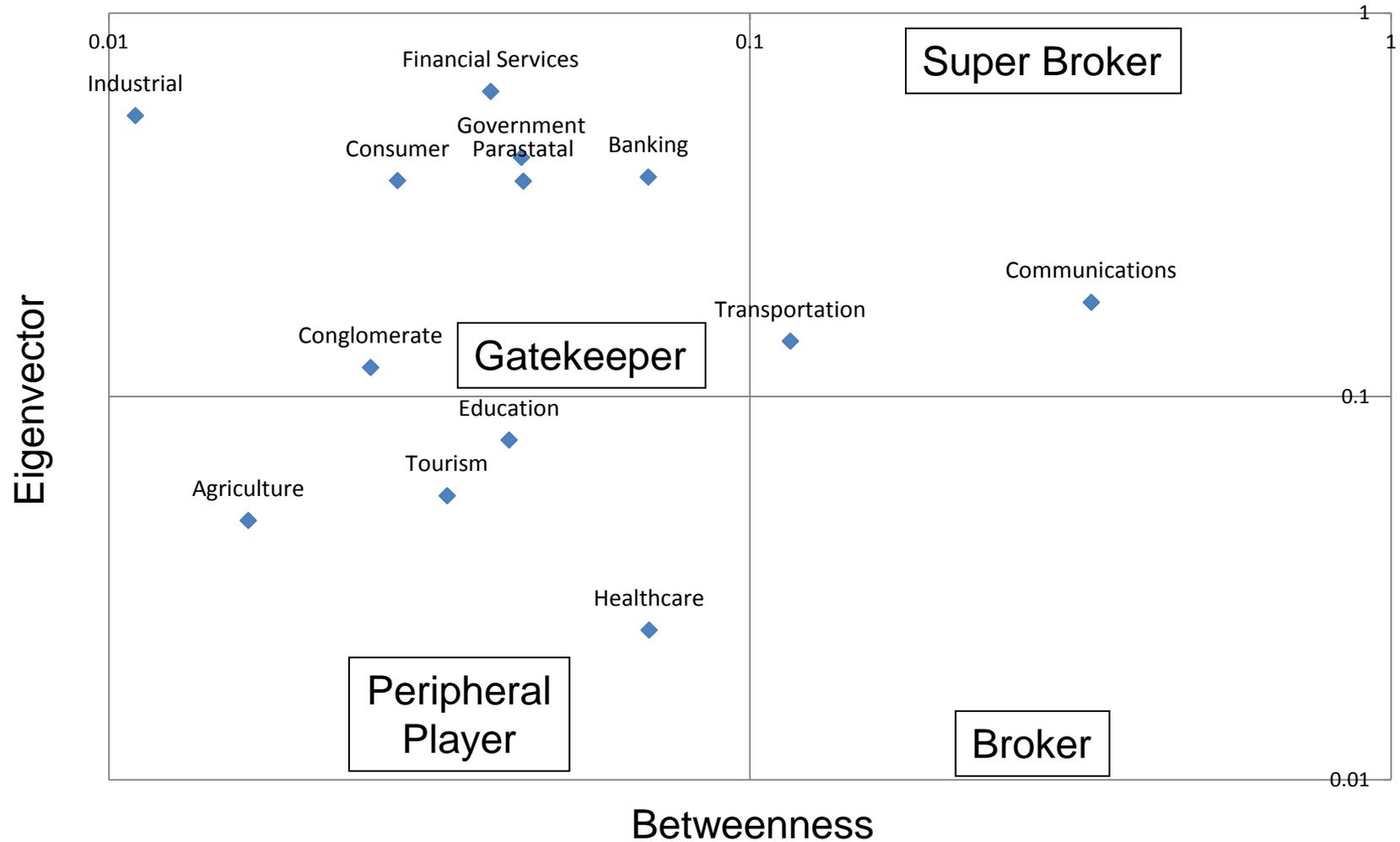
Initial Grouping (Czech Republic)



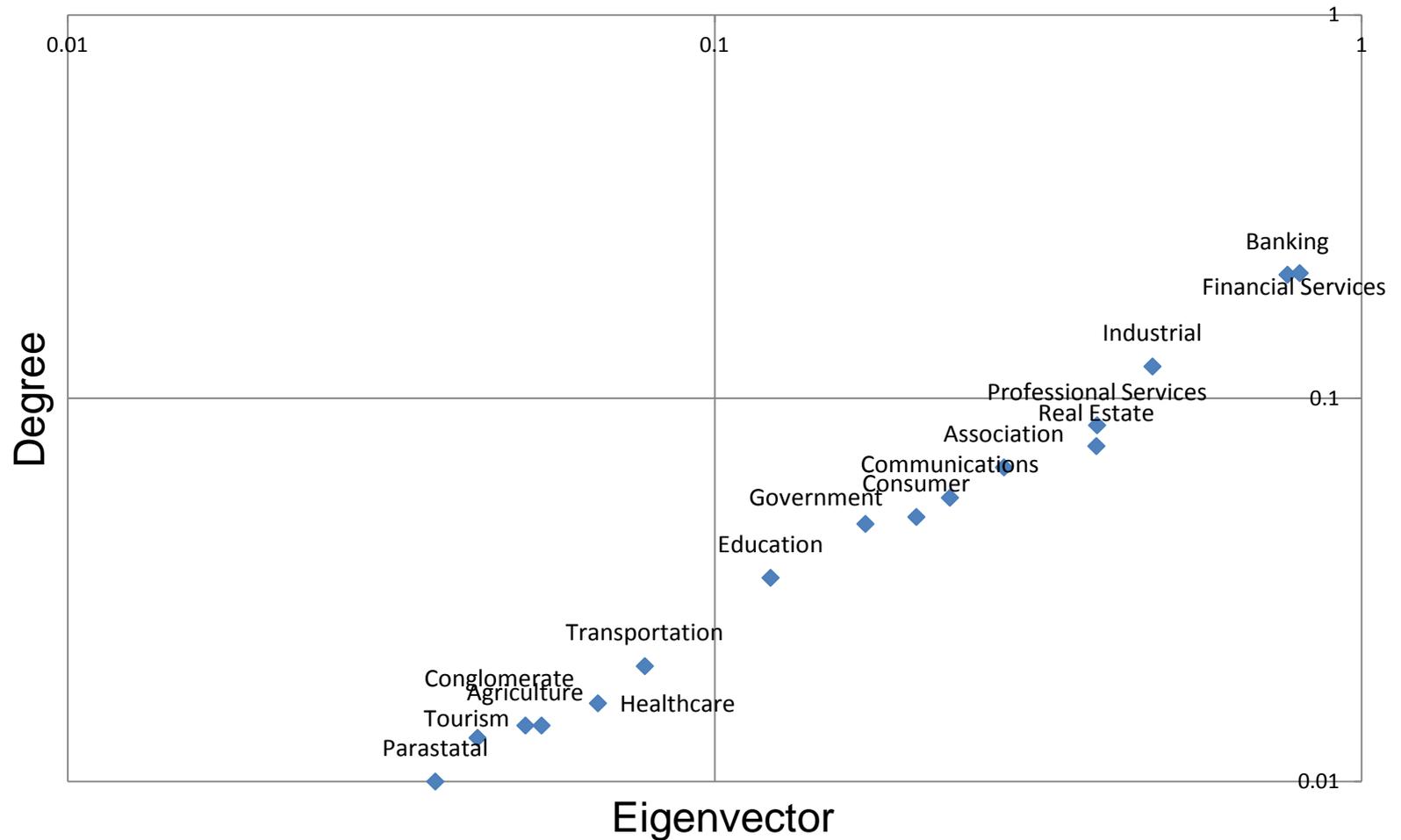
Centrality Measure Correlation (Tanzania)



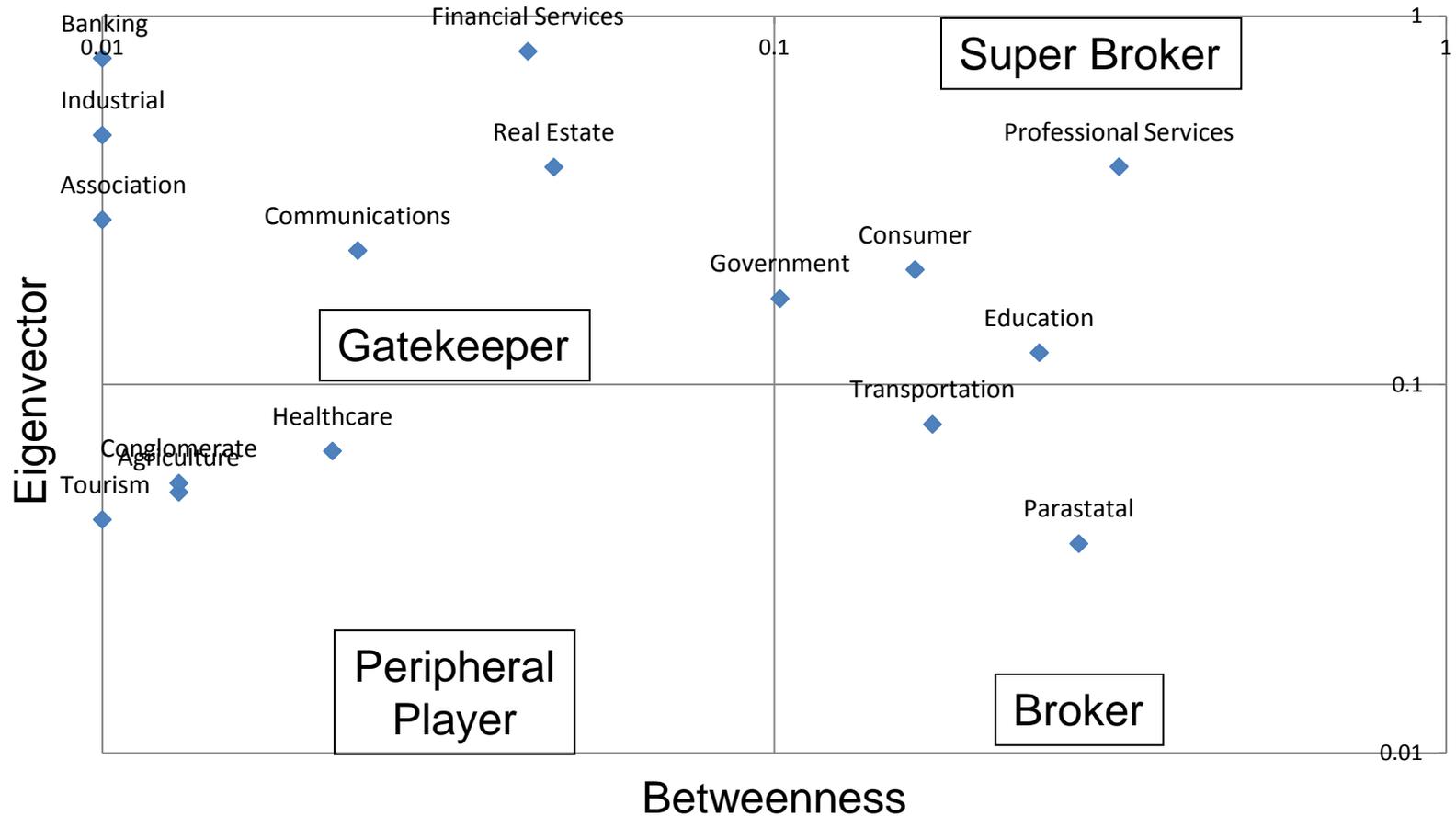
Centrality Measure Correlation (Tanzania)



Centrality Measure Correlation (Czech Republic)



Centrality Measure Correlation (Czech Republic)



Thanks to...

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