Proposed Research Question

The Network Science Center, as part of an ongoing research project classifying complex networks, has initiated a pilot project developing entrepreneurial network topologies. A topology refers to the shape of a network, or the network’s layout. Network topologies reveal how actors, organizations, positions, or roles in the network are connected and highlight which nodes serve as central hubs and power brokers. Armed with the knowledge that a topology imparts, a policymaker will be able to understand and influence that network with knowledge of the “driver nodes;” the nodes in the network that have the greatest probability of affecting a desired outcome. We envision that this methodology can facilitate development of a playbook for evaluating and understanding many types of complex networks.

The Network Science Center at West Point has been involved in ongoing research exploring the network topologies of Capital Markets in Frontier Capital Markets. Frontier Markets are essentially a subset of Emerging Markets with lower market capitalization and liquidity. This term was coined in 1992 by the International Finance Corporation. Our team’s research has involved extensive data collection including numerous interviews with financial leaders and innovators in these emerging economies.

During the course of this data collection and the subsequent analysis, the research team has identified additional topics that we believe are ripe for analysis. We believe that addressing these research topics is vital to understanding and devising potential innovations in economic development.

Our initial visits to these Frontier Markets focused on larger firms, financial institutions, and macro-economic issues. During the course of these visits, especially in Africa, our teams observed a culture of vibrant entrepreneurship as we met with owners and founders of Small and Medium Enterprises (SMEs). Because of the impact of our discussions with these entrepreneurs, we have decided to explore the importance of these SMEs and their potential impact of economic development, at large, and their potential contribution to the development of these frontier capital markets.

Study Proposal

The team proposes that we expand on the current pilot study by developing network topologies of the environment in which entrepreneurs operate in these frontier markets. The initial data set will capture the entrepreneurial environment in Addis Ababa, Ethiopia. The data collection process involves an innovative 6-question survey.

Upon completion of the data collection, the team will construct a social capital topology of the network, and then quantitatively differentiate these networks utilizing network analysis techniques resulting in several proposed network classifications.
Data Collection Methodology

The team has developed a 6 question survey (Appendix 1) that gathers some basic demographic data yet keeps the interview subject’s identify anonymous. The survey asks questions in regards to positions or roles in the local network. In summary, the survey will analyze 6 different focus areas in the network under analysis:

- Business Registration
- Start-Up Capital
- Equipment
- Legal Issues
- Infrastructure
- Human Resources

Analysis

After the data is collected, we are able to develop a network model based on matrix algebra principles. For instance, a sample raw data set based on 10 interviews will look like this table:

<table>
<thead>
<tr>
<th></th>
<th>Register</th>
<th>Capital</th>
<th>Equipment</th>
<th>Legal</th>
<th>Infrastructure</th>
<th>Human Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>1</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>11</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>F</td>
<td>9</td>
<td>3</td>
<td>11</td>
<td>1</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>G</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>I</td>
<td>7</td>
<td>2</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>J</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

In this particular table, the rows are the interview subjects’ responses to each of the 10 questions. The numbers in each cell represent the response. For instance, “10” in the upper left cell indicates that the respondent indicated that they would approach a “Commercial Bank” to address a “Business Registration” issues.

Based on this raw data, we can now create a matrix that “counts” the number of times a respondent selects a particular “position or role” in response to a survey question.
This matrix enables us to map the positions or roles' influence in the entrepreneur network in relationship to the respondents:

![Entrepreneur Network Diagram]

Mathematically, we can now manipulate this data in order to illustrate the connection of the positions or roles through the respondents.
Based on this network model, we can now determine the nodes (in this case, the positions or roles) that are the most influential in this network. The values incorporate the link weightings, are normalized from 0 to 1, and allow us to accurately compare and contrast the nodes.

The following table illustrates the results of a mathematical analysis which determines the nodes that are most “central” in this network:

<table>
<thead>
<tr>
<th>Node</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Govt Program</td>
<td>1.0000</td>
</tr>
<tr>
<td>Social</td>
<td>0.9355</td>
</tr>
<tr>
<td>Bank</td>
<td>0.8387</td>
</tr>
<tr>
<td>Professional</td>
<td>0.8065</td>
</tr>
<tr>
<td>Self</td>
<td>0.7742</td>
</tr>
<tr>
<td>Govt</td>
<td>0.7419</td>
</tr>
<tr>
<td>NGO</td>
<td>0.7419</td>
</tr>
<tr>
<td>Incubator</td>
<td>0.7097</td>
</tr>
<tr>
<td>Family</td>
<td>0.6452</td>
</tr>
<tr>
<td>Military</td>
<td>0.5806</td>
</tr>
<tr>
<td>Religious</td>
<td>0.4839</td>
</tr>
<tr>
<td>VC/Angel</td>
<td>0.3226</td>
</tr>
</tbody>
</table>
So, for example, the “Government Program” position or role is 4 times (4x) more central than the “VC/Angel” role.

Mathematically, we can also manipulate this data in order to illustrate the connection of the respondents through the positions or roles.

Based on this network model, we can now determine the nodes (in this case, the respondents) that are the most influential in this network. Once again, the values incorporate the link weightings, are normalized from 0 to 1, and allow us to accurately compare and contrast the nodes.
Conclusion

To summarize, this particular near-term effort is primarily focused on validating our methodology. Once we successfully develop initial “real-world” data sets, we can then initiate our quantitative analysis. Our main goal is to develop the mathematical techniques required to determine if the network topologies are different and if so, what exactly, from a quantitative standpoint, makes them different? As stated earlier, the respondents will remain anonymous and we will readily share our results with any interested parties.

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APPENDIX 1: Survey
Demographic Data:
1. Age
2. Sex
3. Marital Status
4. Annual Revenue
5. Sector
6. Political Party Affiliation
7. Education Level
8. Name of University/College

1. If you would need assistance with legal registration of your business, who would you most likely approach in order to address this issue?
   - Myself
   - Government Representative
   - Government Business Development Program
   - Private Incubator
   - Non-Governmental Organization
   - Venture Capitalist or Angel Investor
   - Family Member
   - Religious Leader
   - Someone in Social Network
   - Commercial Bank
   - White Collar Professional
   - Military Leader

2. If you would need assistance with start-up capital of your business, who would you most likely approach in order to address this issue?
   - Myself
   - Government Representative
   - Government Business Development Program
   - Private Incubator
   - Non-Governmental Organization
   - Venture Capitalist or Angel Investor
   - Family Member
   - Religious Leader
   - Someone in Social Network
   - Commercial Bank
   - White Collar Professional
   - Military Leader
3. If you would need assistance **acquiring equipment** for your business, who would you most likely approach in order to address this issue?

- Myself
- Government Representative
- Government Business Development Program
- Private Incubator
- Non-Governmental Organization
- Venture Capitalist or Angel Investor
- Family Member
- Religious Leader
- Someone in Social Network
- Commercial Bank
- White Collar Professional
- Military Leader

4. If you would need assistance with **legal issues or intellectual property rights** for your business, who would you most likely approach in order to address this issue?

- Myself
- Government Representative
- Government Business Development Program
- Private Incubator
- Non-Governmental Organization
- Venture Capitalist or Angel Investor
- Family Member
- Religious Leader
- Someone in Social Network
- Commercial Bank
- White Collar Professional
- Military Leader

5. If you would need assistance with **required infrastructure** for your business, who would you most likely approach in order to address this issue?

- Myself
- Government Representative
- Government Business Development Program
- Private Incubator
- Non-Governmental Organization
- Venture Capitalist or Angel Investor
- Family Member
- Religious Leader
- Someone in Social Network
- Commercial Bank
6. If you would need assistance with **hiring additional employees** for your business, who would you most likely approach in order to address this issue?

- Myself
- Government Representative
- Government Business Development Program
- Private Incubator
- Non-Governmental Organization
- Venture Capitalist or Angel Investor
- Family Member
- Religious Leader
- Someone in Social Network
- Commercial Bank
- White Collar Professional
- Military Leader