Effects of Social Context on the Transition of Technologies Created through the U.S. Department of Defense Small Business Innovation Research Program

Youngbok Ryu, Ph.D.
Northeastern University
y.ryu@northeastern.edu
• Brief Introduction
• Social Context on the SBIR Tech Transition
• Q&A
Biography

Youngbok Ryu

- Currently faculty at Northeastern University
- Previously faculty at New Mexico Tech
- Assistant policy researcher at RAND Corporation
- Christine Mirzayan Science and Technology Policy Fellow at the National Academies of Sciences, Engineering, and Medicine
- Some other positions in South Korea
Research Interests

- **Areas of interest** – Innovation/Entrepreneurial Ecosystem, Clean Energy Innovation, and Transportation Decarbonization
- **Methodological interests** – Data Envelopment Analysis, Hierarchical Linear Modeling, and Social Network Analysis
Major Goals of SBIR Program
- Stimulate technological innovation
- Use small business to meet federal R&D needs
- Foster and encourage participation by minorities and disadvantaged persons in technological innovation
- Increase private-sector commercialization innovations derived from federal R&D

Source: SBIR Program Policy Directive

SBIR BUDGETS BY AGENCY, 2013

NIH: 44%
DOE: 31%
NSF: 14%
NASA: 12%
All Others: 10%
Army: 8%
Navy: 8%
Air Force: 3%
Other DOD Components: 7%

$2B

Technology Transition
Transition between the government and small businesses is emerging:

- Technological advantage is moving to industry from the government
- Open innovation system adopted by large businesses needs small suppliers that can provide alternative technology solutions to DOD
- Opportunities for small businesses to play as a prime contractor are increasing

Nonetheless, small businesses are facing substantial challenges, stemming from internal and external sources, in the process of technology transition:

- Limited assets and resources; Vulnerable to external shocks
- More likely to be impacted by region-, industry-, and network-related factors, e.g., regional investment in human capital, industrial growth rate, and relationship with government and market
Emphasis on technology commercialization and entrepreneurship:
- Presidential Memorandum on “Accelerating Technology Transfer and Commercialization of Federal Research in Support of High Growth Business”
- Presidential initiative on “Startup America” – encouraging high-growth entrepreneurship

Lack of appropriate metrics and databases:
- Metrics (e.g., sales, patents, ROI, and jobs) suggested by SBIR/STTR Interagency Policy Committee (SSIPC) have not been fully tested yet
- Database concept suggested by SSIPC is still underway

Aforementioned metrics (possibly, with more alternative metrics) need to be applied with real data and alternative databases, such as SAM and FPDS-NG databases, need to be utilized.
Gap in Existing Literature

- **Most assessments (particularly, NRC reports) have:**
  - Focused on the program itself or management or private commercialization
  - Used self-reporting data: e.g., (expected) sales
  - Employed qualitative approach: case study (success story), survey- or interview-based

Technology Transition? Quality of Data? Quantitative Approach?

- **Many studies of innovation entrepreneurship have:**
  - Focused on microscopic factors: entrepreneur- or firm-level
  - Ignored the nested structure of data: e.g., clustering of SBIR awardees
  - Viewed the SBIR as a signal for following private funding: e.g., venture capital
  - Lacked integrative approach: e.g., region- or network-focused

Understand the effects of context on the DoD SBIR technology transition

- The study explores the effect of spatial (region), industry (technology), and social (network) factors on technology transition of DoD SBIR awardees. (https://doi.org/10.7249/RGSD405)

- Background includes:
  - Role of context in explaining entrepreneurial actions and outcomes: “[I]nstead of controlling for contextual variables as is common today, context becomes part of the story being told.” (Zahra et al., 2014, p. 494)
  - Contexts underlying entrepreneurial innovation: temporal; spatial; organizational; institutional/policy; social; and industry/technology (Autio et al., 2014)

Networks play as a channel for information (knowledge absorption) and money (government funding)
How do network-related factors influence the success of DOD SBIR technology transition?

- Technological position (relational embeddedness): technology distance, specialization, and variety
- Network position (structural embeddedness): centrality and core/periphery of SBIR funding network
SBIR awardees technologically position themselves in relation to DoD and prime contractors.

G01S: radar and sonar; G06F: digital data processing; H01L: semiconductors
SBIR awardees position themselves in the SBIR funding network with centrality and core/periphery structure.
Extending Gilsing et al.’s (2008) approach:

- Absorptive Capacity: \( AC = a_o - a_1 \cdot TD - a_2 \cdot NC + a_3 \cdot TV \)
- Novelty Value: \( NV = b_o + b_1 \cdot TD + b_2 \cdot NC - b_3 \cdot TV \)
- Innovation Performance: \( IP = AC \cdot NV = a_o \cdot b_o + (a_o \cdot b_1 - b_o \cdot a_1) \cdot TD \\
+ (a_o \cdot b_2 - b_o \cdot a_2) \cdot NC + (a_3 \cdot b_o - b_3 \cdot a_o) \cdot TV - a_1 \cdot b_1 \cdot TD^2 - a_2 \cdot b_2 \cdot \\
NC^2 - a_3 \cdot b_3 \cdot TV^2 - (a_1 \cdot b_2 + a_2 \cdot b_1) \cdot TD \cdot NC + (a_1 \cdot b_3 + a_3 \cdot b_1) \cdot TD \\
\cdot TV + (a_3 \cdot b_2 + a_2 \cdot b_3) \cdot TV \cdot NC \)

where \( TD \) = technological distance, \( NC \) = network centrality, and \( TV \) = technological variety

Variables

- \( C \) = firm demographics (e.g., age, ownership)
- \( N \) = network characteristics
  - Technology position (e.g., technological distance, specialization, and variety)
  - Network position (e.g., centrality and core/periphery)
Data

Data: 2,889 DoD SBIR phase II funding awardees during the 2001 to 2010 period

- **Dependent variables**: $TS = \text{Indicators for the success of technology transition}$
  - Federal procurement contracts (FPC) \(\rightarrow\) measure for the effectiveness of the SBIR program;
  - Return on investment (ROI): $ROI = (FPC - \text{SBIR awards})/\text{SBIR awards}$ \(\rightarrow\) measure for the efficiency;
  - Jobs created (JOB) \(\rightarrow\) measure for the economic performance; and
  - Patents filed (PAT) \(\rightarrow\) measure for the technological performance.
## Analysis Results

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Statistically Significant Independent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Controls</td>
</tr>
<tr>
<td>FPC</td>
<td>(+) ASA(_{ln}); AGE; TPA; HTC</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ROI</td>
<td>(+) AGE; TPA; HTC</td>
</tr>
<tr>
<td></td>
<td>(-) ASA(_{ln})</td>
</tr>
<tr>
<td>JOB</td>
<td>(+) ASA(_{ln}); AGE; MFG</td>
</tr>
<tr>
<td></td>
<td>(-) OWN; HUB</td>
</tr>
<tr>
<td>PAT (Negative Binomial)</td>
<td>(+) AGE; MFG; TPA; HTC</td>
</tr>
<tr>
<td></td>
<td>(-) OWN</td>
</tr>
</tbody>
</table>

ASA = amount of SBIR awards  
AGE = age of a firm  
TPA = timing of patent applications  
HTC = hi-tech or not  
MFG = manufacturing or not  
OWN = owned by woman/minority or not  

SEC = eigenvector centrality  
SEQ = core or periphery  
TDP = technology distance relative to prime contractors  
TDD = technology distance relative to DOD  
TVP = technology variety relative to prime contractors  
TVD = technology variety relative to DOD  
TSP = technology specialization
Relationship between FPC and TDP by HTC:
*Inverted U-shape curve*

Relationship between PAT and TVP by LST:
*U-shape curve*

\[ FPC = \text{federal procurement contracts}; \ PAT = \text{number of patent applications}; \ TDP = \text{technological distance relative to prime contractors}; \ TVP = \text{technological variety relative to prime contractors}; \ HTC = \text{dummy for hi-tech industries}; \ \text{and} \ LST = \text{dummy for leading states} \]
Conclusion

- Small firms’ larger SBIR awards, higher age, more cutting-edge technology or high-tech focus are more likely to lead to success in technology transition;

- Small firms’ higher technological distance (in particular, relative to prime contractors) and more central network position are more likely to facilitate technology transition. To some extent, they are expected to lead to success, but excessive centrality and technological distance may stifle that success;

- Small firms’ ownership by women or minorities, and their technological specializations, are expected to lower their patent output whereas technological diversification (in particular, relative to the DOD) is expected to raise the patent output; and

- Small firms’ technological distance (in particular, relative to the DoD) is expected to increase their patent output to a certain degree, but undue distance may decrease the patent output.
Thank you!