Gender and the Social Structure of Collaboration

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Focal Issues

- Broadly: Public Science, Private Science
- Science as an institution exists in the face of great gender inequality
- Intersection of gender and commercial science relatively unaddressed.

Academic Commercial "Pipeline" - Professional structure in academia and industry

- Patenting → Licensing → Industry Consulting → Firm Founding → Involvement with a Company
Distribution of Scientific Clusters
Main Component, Boston Inventors
1976-2002

Color Legend
Reds: University (21%)
All other colors: Biotech (38%)
Light Grey: Public Research Organization (26%)
Black: Cross-sector (16%)
Distribution of Male and Female Scientists
Main Component, Boston Inventors
1976-2002

Node Color
Blue: Male (69%)
Magenta: Female (18%)
Yellow: Unknown (13%)

Percent Gender:
Biotechnology: 21%
Academia: 16%
PRO: 18%
The social structure of academia and industry

### Academic Science
- **Largest Academic Component (all years)**
  - Male (Blue) = 73%
  - Female (Magenta) = 14%
  - Unknown (Yellow) = 12%
  - Overall Centralization (0-1 range): .28

### Industrial Science
- **Largest Industry Component (all years)**
  - Male (Blue) = 66%
  - Female (Magenta) = 25%
  - Unknown (Yellow) = 8%
  - Overall Centralization (0-1 range): 0.07
These same networks inverted hierarchically:

**Academic Science**
- Degree Distribution
- Largest Academic Component
  - Bottom Level (avg.): 5.25
  - Subsequent Levels (std. dev): 6.93
  - Overall Centralization (0-1 range): .28

**Industrial Science**
- Degree Distribution
- Largest Industry Component
  - Bottom Level (avg): 6.45
  - Subsequent Levels (std. dev): 5.31
  - Overall Centralization (0-1 range): 0.07
The Importance of Networks and Network Structure

- Those situated in particularly central or strategic positions accrue benefits from these positions, be they for promotion, tangible outcomes, likelihood of retention, etc.

- Positioning in surrounding social structure influences the extent of output and performance. At the level of:
  - Scientists
  - Science Organizations
  - Science and Technology Regions
Collaboration Network Mechanics

Network Analysis Can Reveal:
• Differences among individual positions
• Overarching structure of collaboration

Examples of Network Structure

High Centralization: 1
Low Centralization: 0

Male: Blue
Female: Magenta
Unknown: Yellow
Networks and Gender

- Situation of underrepresented groups may complicate taken for granted network relationships – status, legitimacy, and marginality influence the flow of information and resources.

- Both structural and status mechanisms are speculated to play a role in defining where women are located in work and productivity networks.

- The need for “borrowed social capital” may be a need for women in workplaces where issues of status and legitimacy are prevalent (Burt).
Gender, Networks, and Work Setting

- The necessary connections needed to establish successful innovative outputs may vary for women by location in academia or industry.

- In industry (specifically in horizontally organized firms) collective work environments may result in women assuming more central collaborative locations than in academic settings.

- Those with decreased access or exposure to potential collaborators may benefit more from dense ties than sparse ones.
  - Academic women may see more innovative return from network positions that foster close ties than those high in brokerage opportunities.
  - DBF women (and men) may see return from brokerage opportunities.
Data

I construct patenting collaboration networks of life science inventors in the Boston region.

- Total N = 215,639, Total(Boston) = 6,988
- Scientific Affiliations:
  - 5% Dedicated biotechnology firms (DBF)
  - 12% University
  - 5% Public research organizations (PRO)
  - 67% Pharmaceutical firms
  - 4% Other biotechnology firms
  - 7% Multiple firm-type inventors
- 21% Female
Measures and Methodology

Individual Fixed Effects Models, 1980-2000 (inventor-years)

**Dependent Variable:**
- Patenting involvement (0/1, Logit)
- Patenting productivity (Count, NBCM)

**Independent Variables:**
- Degree centrality, normalized
- Brokerage (0/1)

**Control Variables:**
- Betweenness centrality, normalized
- Main component membership (yearly)
- Current patenting activity
## Directions of Network Effects on Increasing Centrality Measures

<table>
<thead>
<tr>
<th>Centrality Measure</th>
<th>Involvement in Patenting or Number of Patents</th>
</tr>
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<tbody>
<tr>
<td><strong>Independent Variables</strong></td>
<td>Academic Men</td>
</tr>
<tr>
<td>Degree Centrality</td>
<td>+</td>
</tr>
<tr>
<td>Brokerage Role (at least one instance)</td>
<td>+</td>
</tr>
<tr>
<td>Betweenness Centrality (normalized)</td>
<td>+</td>
</tr>
<tr>
<td>Main Component</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Signs indicate statistically significant coefficients (p<.05). Models control for previous patent activity and individual fixed effects.

Blank cells indicate neither a positive or negative effect of the measure on patenting.

* Coefficient not significant in models predicting involvement in patenting.
Implications and Conclusion

• Patenting as a non-required activity in the academy may also be influencing women’s involvement in patenting.

• Lack of influence for various network measures may suggest that other types of ties and linkages may be more salient for women.

• The models suggest that organizational form mediates the effects of centrality for women.

• Underrepresented groups may be more constrained in conditions of hierarchy versus more horizontal arrangements.