Gender & Collaboration

Lorenzo Ductor (Middlesex University London)
Sanjeev Goyal (University of Cambridge)
Anja Prummer (Queen Mary University)
Introduction

- Explore gender differences in research output and co-authorship patterns in economics.
- Provide a systematic overview of gender disparities in economics over a 40 year period covering all existing journals.
- Similar patterns emerge in sociology.
Findings

1. Fraction of women increased significantly from 1970 to 2011

2. Gender disparities in research output persists for various output measures
   - Research output as defined in Ductor, Goyal, van der Leij (2014)
   - Number of Papers
   - Citations

3. Gender differences in collaboration patterns remain stable:
   - Men have more co-authors than women
   - Women repeatedly work with the same co-authors
   - Women have tighter networks than men: clustering coefficient is larger for women

4. Homophily, a preference to collaborate with own gender, present
OUTLINE

1. Economics
   1.1 Gender Differences in Research Output
   1.2 Gender Differences in Co-Authorship Networks
   1.3 Homophily
   1.4 Gender Differences in Co-Authors’ Characteristics
   1.5 Robustness: Heterogeneity, Top Journals, Institutions

2. Sociology
Data Description

- Publications by economists over 42 years, 1970-2011.
- Data from EconLit database, a bibliography of journals in economics compiled by the editors of the Journal of Economic Literature.
- Panel data start for each individual with first publication, lasts until last observed publication (or 2011).
- US Social Security Administration records to determine the gender from first names
  - identify an author's gender if author's first name is associated with single gender in social security records at least 95% of the time
  - if this fails, google authors
  → identify gender of 80% of economists in sample
Research Output

- average number of research papers per author is small
- long lags in publications

→ 5 year window

Robustness Check: 3- and 10-year windows

Research Output:
Number of publications during the period $t - 4$ to $t$, weighted by journal quality and discounted by the number of co-authors
<table>
<thead>
<tr>
<th>Year</th>
<th>Fraction of women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>0.05</td>
</tr>
<tr>
<td>1980</td>
<td>0.1</td>
</tr>
<tr>
<td>1990</td>
<td>0.15</td>
</tr>
<tr>
<td>2000</td>
<td>0.2</td>
</tr>
<tr>
<td>2010</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Graph showing the increase in the fraction of women in economics from 1970 to 2010.
Average Research Output Across Years
## Research Output Across Time

<table>
<thead>
<tr>
<th>Year/Gender:</th>
<th>(1) Women</th>
<th>(2) Men</th>
<th>(3) % Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-1975</td>
<td>15.25</td>
<td>28.57</td>
<td>87%</td>
</tr>
<tr>
<td>1976-1980</td>
<td>8.69</td>
<td>18.94</td>
<td>118%</td>
</tr>
<tr>
<td>1981-1985</td>
<td>6.98</td>
<td>13.24</td>
<td>90%</td>
</tr>
<tr>
<td>1986-1990</td>
<td>7.35</td>
<td>11.20</td>
<td>52%</td>
</tr>
<tr>
<td>1996-2000</td>
<td>5.27</td>
<td>8.21</td>
<td>56%</td>
</tr>
<tr>
<td>2001-2005</td>
<td>4.54</td>
<td>7.63</td>
<td>68%</td>
</tr>
<tr>
<td>2006-2010</td>
<td>6.20</td>
<td>9.55</td>
<td>54%</td>
</tr>
<tr>
<td>1970-2011</td>
<td>5.82</td>
<td>10.72</td>
<td>84%</td>
</tr>
</tbody>
</table>
Gender Differences in Output Model

\[ q_{it} = \alpha + \rho F_i + C_{it}\omega + \sum_{l=1}^{L} \beta_l JEL_{lit} + \mu_t + \varepsilon_{it} \]

- \( F_i \): female dummy
- \( C_{it} \): career time dummies for differences in experience
- \( JEL_{lit} \): field dummies for differences in specialization
- Standard errors clustered by author

Alternative Specifications: Random Effects, Correlated Random Effects
## Gender Differences in Output

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Output</th>
<th>(2) Output</th>
<th>(3) # Papers</th>
<th>(4) ( \frac{Output}{#\text{Papers}} )</th>
<th>(5) ( \frac{Citations}{#\text{Papers}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-3.654***</td>
<td>-2.049***</td>
<td>-0.480***</td>
<td>-0.225***</td>
<td>-0.577***</td>
</tr>
<tr>
<td></td>
<td>(0.249)</td>
<td>(0.229)</td>
<td>(0.028)</td>
<td>(0.048)</td>
<td>(0.161)</td>
</tr>
<tr>
<td>Obs.</td>
<td>240,897</td>
<td>240,897</td>
<td>240,897</td>
<td>240,897</td>
<td>240,897</td>
</tr>
<tr>
<td>Career FE</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>JEL FE</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
Gender Differences in Research Output

- Academic publishing changed: dramatic increase in number of journals, articles

- Significant increase in the number and share of women

- Gender differences in output remain large, independent of measure used (research output, # papers, citations)
1. Economics
   1.1 Gender Differences in Research Output
   1.2 **Gender Differences in Co-Authorship Networks**
   1.3 Homophily
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2. Sociology
Co-Authorship Network

- Authors as nodes
- Collaborations as links
- Networks defined over a 5-year period

**Degree:** number of co-authors in period \( t - 4 \) to \( t \)

**Clustering:**
Share of co-authors that are themselves collaborators

**Strength of Tie:**
Number of papers co-authored with same co-authors, normalized by total number of papers within a five year period
Network Structure & Research Output: Previous Work

Lindenlaub and Prummer 2014:
- Higher centrality is associated with higher performance in uncertain environments, such as research
- Tighter networks lead to lower performance in these environments

Ductor et al 2014:
- Degree associated with higher output
- Strength of Ties related to lower output
- Clustering correlated with lower output

→ Gender Differences in Network Patterns?
Degree and Gender Across Time

→ gender gap in number of distinct co-authors increasing
Clustering Across Time

→ women have persistently tighter networks than men
Strength Across Time

→ women collaborate more often with the same co-authors
## Gender Differences in Networks

<table>
<thead>
<tr>
<th></th>
<th>Degree</th>
<th>Strength</th>
<th>Clustering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.407***</td>
<td>0.165***</td>
<td>0.066***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.011)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Degree</td>
<td></td>
<td></td>
<td>-0.238***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td>Past output$_{t-5}$</td>
<td>0.007***</td>
<td>-0.156***</td>
<td>-0.053***</td>
</tr>
<tr>
<td></td>
<td>(0.0004)</td>
<td>(0.006)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Observations</td>
<td>394,113</td>
<td>316,145</td>
<td>226,078</td>
</tr>
<tr>
<td>Number of authors</td>
<td>56,949</td>
<td>48,936</td>
<td>38,757</td>
</tr>
<tr>
<td>Career FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>JEL FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

**Note:** *** p<0.01, ** p<0.05, * p<0.1
Summary: Gender & Network Characteristics

- Women work with fewer distinct co-authors than men: lower degree
- Women have tighter networks: higher clustering coefficient
- Women work repeatedly with the same co-authors: higher strength of ties

→ BUT: share of single-authored papers is similar for men and women
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2. Sociology
Do economists display homophily? Preference for collaborating with same gender?

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Share</td>
<td>72.72%</td>
<td>27.28%</td>
</tr>
<tr>
<td>Men’s Collaborators</td>
<td>81.01%</td>
<td>18.99%</td>
</tr>
<tr>
<td>Women’s Collaborators</td>
<td>67.28%</td>
<td>32.72%</td>
</tr>
<tr>
<td>Inbreeding Homophily</td>
<td>0.3039</td>
<td>0.0748</td>
</tr>
</tbody>
</table>

→ Inbreeding Homophily:

- Share of same type connections, relative to the share of same type in the population
- Inbreeding homophily for women if share of female collaborators is higher than the share of women among economists, otherwise inbreeding heterophily
Does an increase in the share of women change collaboration patterns?

Predictions of Currarini, Jackson and Pin (2009)

1. larger group forms more connections: higher degree

2. as the share of women increases, differences in degree decrease
Homophily: Variation in Cohorts

- In 1974: women have .14 fewer co-authors than men
- Difference in the number of co-authors has been increasing
Homophily: Variation across Fields

- Variation in gender shares using the first two digits of the JEL codes to define 124 different fields
- Pooling all the years and detrending degree


## Outline

1. **Economics**
   1.1 Gender Differences in Research Output
   1.2 Gender Differences in Co-Authorship Networks
   1.3 Homophily
   1.4 **Gender Differences in Co-Authors’ Characteristics**
   1.5 Robustness: Heterogeneity, Top Journals, Institutions

2. **Sociology**
Differences in Experience

Women’s co-authors are more senior than men’s.

![Graph showing differences in average coauthors' experience between males and females. The graph indicates that female co-authors have more senior experience on average across career time.](image-url)
OUTLINE

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2. Sociology
**Robustness**

- **Top Authors:** gender differences in networks persist for most productive women

- **Career Time:** gender differences in networks stable across career time

- **Top journals:** 4* REF journals, results also emerge in this sample

- **Institutions:** controlling for institutions does not change results
  - Institution with lower Repec ranking have higher share of women
  - Women not less likely to move institutions conditional on past output
  - Women more likely to co-author with those from the same institution

- **Network disparities greater among active economists** (those who publish at least one paper per year)
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2. Sociology
Economics and Sociology

- Despite increase of share of women, gender gap in output persists
- Gender differences in collaboration patterns
  - Women tend to have fewer distinct co-authors, are more likely to collaborate with the same co-authors repeatedly, and tend to have overlapping co-authorship patterns
  - Share of co-authored papers for men and women is same
  - Women tend to collaborate with more senior co-authors
- Economists display homophily, sociologists do not
HOMOPHILY ACROSS TIME SOCIOLOGY

Inbreeding Homophily

Year
Male 95% CI
Female 95% CI

Inbreeding Homophily

Year
Male 95% CI
Female 95% CI
What explains these patterns?

Risk taking due to

- Different beliefs, perceptions and payoff structures
- Family constraints as background risk
- Preferences
Differences in Risk Taking Predicts

1. Men have a higher output and variance:
   - Men’s research output on average 50% higher than women’s
   - Women’s variance in output 50% lower than men’s
   → Prediction consistent with data

2. Women have more senior co-authors
   - More senior co-authors are safer choice as both gender attitudes and ability established
   - More senior co-authors may help overcome adversities in environment
   → Prediction consistent with data
Differences in Risk Taking Predicts Collaboration Networks

1. Women choose to work with same co-authors repeatedly:
   - Choice between new co-author or old co-author
   - Old co-authors is less risky as already well known
   → Lower risk taking leads to higher strength of ties

2. Women choose to work with collaborator’s co-authors
   - Women can rely on collaborators to introduce them
   - Common collaborators can vouch for a new co-authors
   → Lower risk taking leads to higher clustering coefficient

3. Women have fewer distinct co-authors
   - Selecting new authors with little knowledge about attitudes and ability less a risky undertaking
   → Lower risk taking leads to lower degree
CONCLUSION

- Share of women in economics has increased significantly
- Output gap between men and women remains pronounced
- Distinct collaboration networks of men and women
- Homophily present
- Women’s co-author more senior, female co-authors less productive
- Patterns carry over to sociology, with exception of homophily
- Potential explanation: risk taking