Composition of Scientific Teams and Publication Productivity

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Purpose

This study examines scientific teams at the National High Magnetic Field Laboratory (NHMFL) to determine how the diversity of science teams effects overall team productivity as measured by peer reviewed journal publication.

Why scientific teams?

- The production of scientific knowledge has evolved from a process of inquiry largely based on the activities of individual scientists to one grounded in the collaborative efforts of research teams.
- Recent studies show that impacts of scientific teams are higher than that of individual scientist. Multi-authored publications are now cited more frequently than single-authored publications.

Why the NHMFL?

- The NHMFL is the world's largest and most highly powered magnet laboratory.
- The NHMFL hosts over 900 scientists per year .
- The Lab is multi-disciplinary, with scientists working on research from a variety of areas in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, and materials science.

ABOVE: Scientists working on a magnet

Research Hypotheses

H1: Increased diversity in institutional affiliations is associated with a decrease in team research productivity.

H2: Increased diversity in the scientific disciplines represented in the team is associated with increased productivity.

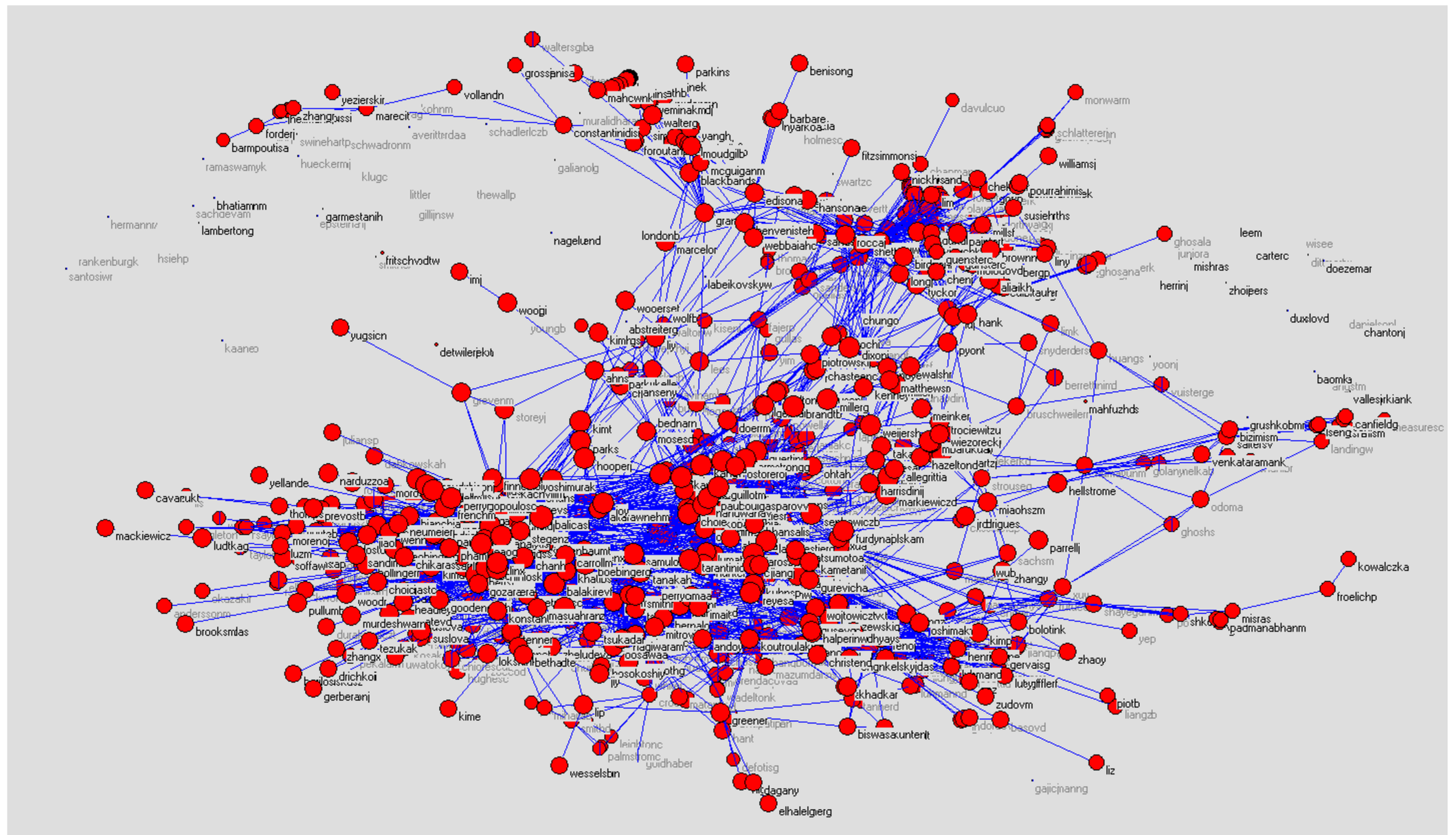
H3: Increase in gender diversity has no or an insignificant effect on team productivity in scientific teams.

H4: Diversity in team seniority is positively related with team research productivity.

H5: Teams in more central network positions are likely to be more productive.

Methodology

Data: 1,415 experiments conducted at the NHMFL between 2005 and 2008; 1,514 distinct names
2,128 publications resulting from experiments
Sample: 89 teams of size 3
Methods: network analysis, correlation analysis, and quantile regression analysis



ABOVE: Experiment team member co-occurrence graph; 1,514 nodes; the node sizes reflect member closeness centrality scores.

Findings

The results from quantile regression supported **H2** but did not support **H1**, **H3**, **H4**, and **H5** (see table below).

The level of team cohesion as measured by the number of experiments in which the same team members participated was positively related to productivity.

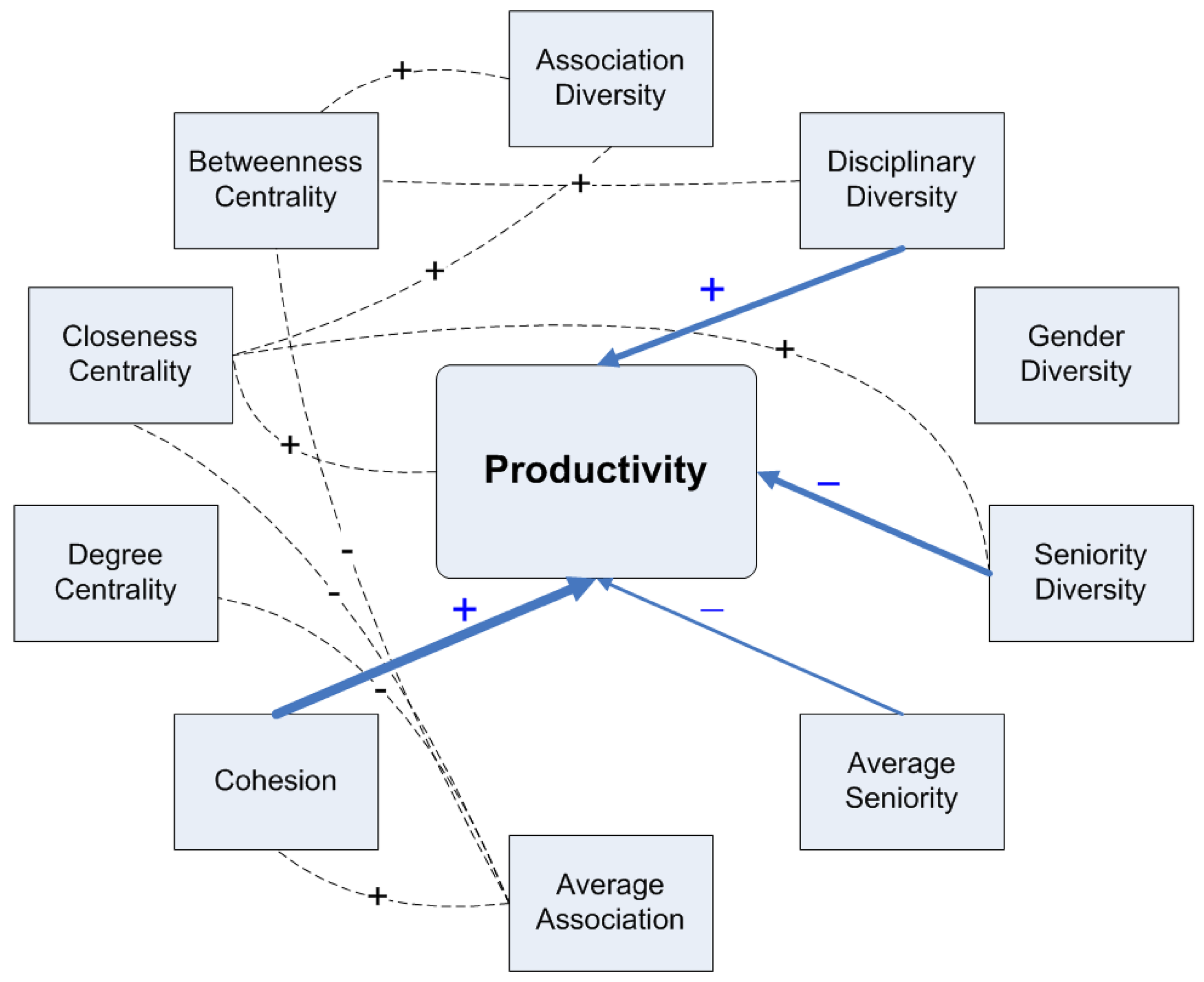
Disciplinary diversity was positively related to productivity. However, diversity in regards to seniority was negatively related to productivity.

Teams with mixed institutional associations were more central to the overall network compared to teams with homogeneous affiliations.

BELOW: Quantile regression results (* $p<0.05$, ** $p<0.005$)

	Complete Model		Reduced Model	
	0.5 quantile	0.75 quantile	0.5 quantile	0.75 quantile
Variable	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**
Association diversity	0.27(0.66)	-0.34(0.96)	-0.01(0.22)	0.35(1)
Disciplinary diversity	0.61(0.67)	0.52(1.04)	***0.86(0.22)*****	1.25(1.12)
Gender diversity	-0.38(0.69)	-0.3(1.03)	-0.31(0.23)	-1.29(1.11)
Seniority diversity	-1.14(1.12)	-1.48(1.43)	***-1.58(0.35)*****	***-4.84(1.75)****
Average seniority	-0.36(0.49)	-0.29(0.67)	-0.24(0.16)	-1.45(0.77)
Betweenness centrality	6.12(49.03)	81.41(79.11)	-3.75(17.18)	-57.11(81.97)
Closeness centrality	6.83(51.49)	-57.48(85.86)	30.76(17.48)	135.28(83.84)
Degree centrality	0.19(6.77)	8.42(12.14)	-4.06(2.17)	-3.63(13.27)
Cohesion	***0.37(0.11)*****	***0.73(0.16)*****		
Pseudo R2	0.11	0.30	0.05	0.16

Overall, the study indicates that high productivity in teams is associated with high disciplinary diversity and low seniority diversity of team membership. Finally, an increase in the share of senior members renders a negative effect on productivity.



ABOVE: Summary view of the model.

Limitations

Data was obtained from internal documents such as annual reports and publication logs. Collecting additional types of data through observations, interviews or surveys of team members and key institutional stakeholders may provide additional information regarding the factors that impact the productivity of scientific teams.

Future research may find it helpful to control for team longevity since the longevity of teams may influence the development of work norms and relationships, which in turn may impact their productivity levels.

Conclusions

This study provides evidence to governmental funding agencies, administrators in research laboratories, and the broader science and research policy community regarding the benefits of interdisciplinarity, moderate levels of seniority, and network centrality for the effectiveness of scientific teams.

The designers of groupware and collaboration support systems could use the demographic and structural variables of the model and the relationships among those variables in determining desired components and services of a system.

Future Research

- An analysis of the relationship between team composition and the *quality* of publications measured by some metric.
- Investigate *dynamics* of scientific teams, the *structure* and *types* of member relationships, and *motivations* for joining the team.

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