Carnegie Mellon University

H. JOHN HEINZ III COLLEGE
School of Public Policy and Management
and Information Systems Management

DISSERTATION

By

Sharique Hasan

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Organizational Theory and Management

Title: Social Networks, Stratification and Careers in Organizations

Accepted by the
Dissertation Committee:

David M. Krackhardt	3/4/10 Date
Daniel B. Neill	3/4/10 Date
Denise M. Rousseau	4 March 2010 Date
Shelby Stewman	3/4/10 Date

Approved by the
Dean

Ramayya Krishnan	3/4/10 Date

SOCIAL NETWORKS, STRATIFICATION AND CAREERS IN ORGANIZATIONS

A dissertation submitted to the

H. JOHN HEINZ III COLLEGE

CARNEGIE MELLON UNIVERSITY

In partial fulfillment for the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ORGANIZATIONAL THEORY AND MANAGEMENT

by

SHARIQUE HASAN

Dissertation committee:

David M. Krackhardt (Chair)
Daniel B. Neill
Denise M. Rousseau
Shelby Stewman

March 4, 2010

Few tragedies can be more extensive than the stunting of life, few injustices deeper than the denial of an opportunity to strive or even to hope, by a limit imposed from without, but falsely identified as lying within.

Stephen Jay Gould

ACKNOWLEDGEMENTS

I would like to thank my dissertation chair David Krackhardt for being the ideal role model for a scholar, advisor, and teacher. He has always kept his door open and been most generous in providing all the resources a student ever needs. I hope someday I can be that kind of mentor. Professor Shelby Stewman has been one of the most inspiring mentors in my entire academic career. From the first course I took with him ("Population Policy") to the many late night discussions we've had over these six years, it is because of him that I have learned the value of "picking up the rock and looking underneath it." Professor Denise Rousseau has been a kind and wonderful mentor over the last few years. Meetings with her always left me with new insights and a feeling of excitement about research, teaching, and life. Daniel Neill has been a wonderful advisor. I am always in awe about how difficult problems seem so clear after talking to him.

I would also like to thank Professor Rema Padman who was my chair and Prof. George Duncan who was my advisor during my first two research papers at Heinz. I am tremendously grateful for their support and mentorship during my first two years in the PhD program. The PhD experience has been made all that much better because of my friends and peers at CMU. Surendra has provided me with motivation, courage, and support to pursue work that I felt really mattered. Keith, almost since the beginning, has provided me with opportunities to succeed here at Heinz. From getting me involved in TAing important classes to providing opportunities to participate on research projects. I am truly indebted. There are so many others that have been such wonderful friends, peers, and colleagues. I probably can't name all of them, but I would like to thank Anuj, Chris, Gaurav, Gretchen, Ju-Sung, Ponnurangam, Sam, Nachi, Vikram, and Yaa.

Finally, and most importantly, I would like to thank my mom and Alifia.

CONTENTS

SOCIAL NETWORKS, STRATIFICATION AND CAREERS IN ORGANIZATIONS

Abstract

This dissertation examines the nature, antecedents, and consequences of the stratification of individuals within intra-organizational social networks. In order to examine these phenomena I use two research strategies: (1) empirical analysis of real organizational data and (2) the development and analysis of an equilibrium model of social network formation. In the three studies that constitute the second, third and fourth chapters of this dissertation, I analyze the nature, antecedents and consequences of informal social networks using data from a professional services firm. The first of these chapters is primarily descriptive in nature. I provide an empirical analysis of differences in the social network structures of men and women at the firm. The second develops a structural theory of socialization and network formation and empirically tests hypothesis derived from this theory using both cross-sectional and longitudinal data about how inequalities in the networks of existing professionals are reproduced in the networks of new entrants. The third chapter examines the differential effect of brokerage in weak tie, strong tie, and Simmelian tie networks within the firm on prospective turnover. In the final chapter of this dissertation, I examine, by developing and analyzing an equilibrium model of network formation, how different network formation behaviors can alter status distributions and result in inequalities when social arenas consist of multiple groups with differing network formation behaviors. This dissertation contributes to the literature on social networks and stratification in three primary ways. First, by using longitudinal data I overcome limitations of purely cross-sectional studies by understanding how gender differences in social networks initially emerge in evolving social networks. Second, I propose and test a broader structural theory of the determinants of group-level differences in social networks. Finally, I theoretically examine using a formal model of network formation, the process whereby differing tie formation behaviors, both within and between groups, can result in differing stratification patterns and decoupling of exogenous quality from social capital.

INTRODUCTION TO THE DISSERTATION

This dissertation examines the nature, antecedents, and consequences of the stratification of individuals within intra-organizational social networks. In order to examine these phenomena I use two research strategies: (1) empirical analysis of real organizational data and (2) the development and analysis of an equilibrium model of social network formation. In the three studies that constitute the second, third and fourth chapters of this dissertation I analyze the nature, antecedents and consequences of informal social networks using data from a mid-sized professional services firm located in the United States.

In chapter two of this dissertation, I empirically examine gender differences in the social networks of professionals at the firm using a combined longitudinal and cross-sectional study design. Several aspects of personal network structure including network size, prestige and homophily are examined in both the instrumental and expressive networks of existing professionals and the emerging networks of incoming analysts. Results indicate that men and women's network structures differ in several important ways. Although no major differences were found in instrumental networks, males break status boundaries in friendships more often and have higher prestige in the friendship networks. Several consistencies between the network structures of existing professionals and emerging networks of incoming analysts exist. These results provide directions for further theoretical and empirical research on gender differences in networks and organizational stratification.

In chapter three, I build on the results of chapter two and attempt to address the tension between structuralist and dispositional perspectives on the disadvantaged position of women in intra-organizational social networks. I employ a broader conceptualization of the structuralist perspective currently used in the analysis of gender differences in networks and hypothesize that

employees entering organizations model their networks after those of similar others, thereby reproducing existing inequalities. I also assert that deviation from one's expected prestige affects satisfaction with personal networks. A negative and U-shaped association between deviation and satisfaction is hypothesized. The validity of these hypotheses is examined using cross-sectional and longitudinal sociometric data from a mid-sized professional services firm. The empirical analysis provides support for the hypothesis that inequalities that are consequent of the network choices of existing employees are reproduced in new entrants' networks. Results also suggest that the satisfaction of high and low deviants, that are most at odds with expected prestige or that adhere to their expected prestige respectively, is least affected. Conversely, moderate deviants are most dissatisfied as a consequence of the inconsistency between their actual and expected prestige. The findings have implications for the study of social network formation and add insight to the growing body of research on the interaction networks of women and other minorities in organizations.

In chapter four, I study the role of network structure on the tendency to exit the firm in the subsequent year. Consistent with existing theory, it is hypothesized that greater brokerage, or tendency to bridge disconnected sub-networks, reduces the probability of turnover. However, this chapter posits a more nuanced view of brokerage. I argue that the ties across which brokerage occur, matters as well. Drawing from Simmelian tie theory, I hypothesize that a sub-class of brokering relations (Simmelian brokerage) in which the focal actor brokers relations between two or more disconnected cliques, is positively associated with turnover. I argue that Simmelian brokers are most constrained and thus more likely to leave since they belong to two or more disconnected cliques, and must contend with potentially conflicting norms and expectations, which reduces their independence; and thus hinders their ability to use the novel

information they get from being a broker. Using data from this mid-sized professional services firm, I find empirical support for the two main hypotheses. Implications for theory and future research on the relationship between personal networks and turnover in organizational settings are discussed.

In chapter five, I analyze the effect of tie formation behaviors on stratification within social networks. Using an equilibrium model of network formation, I explore how an individual's tendency to put differential emphasis on four factors in their tie formation decisions: actor quality, reciprocity, transitivity, and social influence affects stratification in the larger network. I examine the resulting stratification in the social networks under two scenarios. First, I examine the relationship between exogenous quality and several measures of network centrality under varying regimes of tie formation behaviors that are homogeneous across all actors in a social arena. Second, I examine inter-group inequality when members of the social arena hail from two groups, each with different emphasis on the tie formation behaviors. Results indicate that a significant disjunction between quality and centrality exists when individuals place greater emphasis on reciprocity, creating groups with distinctly high and low centrality. Similarly, I find inter-group differences when the arena consists of two groups with differing behaviors. The group that places greater emphasis on reciprocity has significantly lower types of certain centrality than the other group. Furthermore, I find that social cues, both local transitivity and global social influence increases one's centrality in the social network by allowing connections between actors whose quality difference and potential asymmetry is overcome by social influence, thereby increasing personal network size. Finally, I present a brief discussion of the implications of this analysis for studying inequality in social networks and directions for further research and exploration.

CHAPTER 2:

A LONGITUDINAL ANALYSIS OF GENDER DIFFERENCES IN NETWORKS

Abstract

In this chapter, I empirically examine gender differences in the social networks of professionals at the firm using a combined longitudinal and cross-sectional study design. Several aspects of personal network structure including network size, prestige and homophily are examined in both the instrumental and expressive networks of existing professionals and the emerging networks of incoming analysts. Results indicate that men and women's network structures differ in several important ways. Although no major differences were found in instrumental networks, males break status boundaries in friendships more often and have higher prestige in the friendship networks. Several consistencies between the network structures of existing professionals and emerging networks of incoming analysts exist. These results provide directions for further theoretical and empirical research on gender differences in networks and organizational stratification.

INTRODUCTION

An extensive literature exists in the social sciences examining the occupational and income stratification of workers by gender (Macpherson and Hirsch 1995; Reskin 1993). In addition to studies of aggregate economy-wide stratification, an increasing interest in understanding gender-stratification within organizations. Organizational theorists contend that the status achieved by an individual is a consequence of the position attained in an organization (Baron 1984; Brinton 1988; Pfeffer 1977; Stinchcombe 1965) . The process of status attainment within organizations first begins with getting a job. McPherson and Smith-Lovin (1982) argue that although men and women have the same number of voluntary organizational memberships; women are members of smaller organizations located at the periphery of economic institutions (McPherson and Smith-Lovin 1982). This, they argue, contributes to women having fewer contacts than men, and consequently fewer weak ties, reducing economic mobility (Granovetter 1973). Although this may be true in some respects, the increased enrollment of women in institutions of higher education may reduce the differences in weak ties (Moore 1990). A recent study of a midsized high-technology firm, in fact, found no gender differences in the ability to get a job once age and education were accounted for (Petersen, Saporta and Seidel 2000).

Looking within the organization, we also observe the stratification by gender of individuals based on positions, salaries and access to other resources within the firm. An analysis of women's careers in the federal government over a quarter century found that women's ability to break the glass ceiling improved if they changed internal labor markets (Yamagata et al.

1997). The literature examining the marginalization or exclusion of women from important organizational networks has also been growing in recent years (Brass 1985a; Burkhardt and Brass 1990; Ibarra 1992; Ibarra 1993; Kanter 1977). A network analytic study of women's networks in an advertising firm found that women occupy less central positions than men in both the instrumental and expressive networks of the organization (Ibarra 1992). Rank, department, and other individual characteristics have primarily explained these differences. On the other hand, the study also found that men were able to better capitalize on their individual and positional characteristics.

Analysis of gender differences in social networks

Formal studies of gender differences in network structures and access to network resources have allowed us to look beyond individual perceptions of exclusion (Ibarra 1992). To date, most studies examining gender or sex-differences in social networks have looked at these networks at one point in time (Burkhardt and Brass 1990). As a result of this limitation in study design, important questions remain. Are women's structures different from the time they enter the organization or do they differentiate over time? What are the causes of these differences? There is a paucity of literature or even data on networks as they emerge, both in organizations and in other settings, preventing researchers from better understanding what differences exist, and why how, and when they emerge.

This chapter uses unique longitudinal and cross-sectional data on three interaction networks of existing professionals and incoming analysts at a mid-sized professional services firm in the United States, to empirically investigate gender differences in network size, homophily and network centrality. The remainder of this chapter is organized in the following

manner. The first section describes several important features of personal networks including, their size, composition, and distributions of status within the larger social network. The second section describes the data, methodology and empirical measures that quantify the theoretical components discussed in section one. In the third section, the results of the empirical analysis examining gender differences are presented and described. Network size, homophily, and centrality and prestige, are examined for both the cross-sectional and longitudinal samples. Finally, we present a discussion of the results, focusing on both the structures where stratification is observed as well as encouraging situations where it is not.

FEATURES OF PERSONAL NETWORKS

Network size

In directed networks, two basic measures of network size are *out-degree* and *in-degree.* Out-degree measures the raw number of ties a focal individual sends out to others in social arena. In some ways, it measures that individual's level of extroversion. *In-degree* on the other hand can be thought of as the popularity of a focal individual corresponding to the raw number of nominations they receive from others (Wasserman and Faust 1994). There is an important literature on differences between males and females, particularly adolescents, with respect to their relationships and social networks. It is observed that females tend to have smaller social networks than males (Benenson 1990; McPherson, Smith-Lovin and Cook 2001). Furthermore, males tended to value attributes related to status, corresponding to large networks, whereas females value attributes related to maintaining a few close friends (Benenson 1990; Benenson and Christakos 2003; Benenson, Morganstein and Roy 1998). It is argued that these preferential

differences result in large functional coalitions for men and intimate secure relationships for women (Cheng and Chan 1999; Vigil 2007).

If these are the predominant social behaviors of males and females in adolescence and early adulthood, these attitudes should carry over to other relationships, particularly expressive ones, in organizations.

Homophily

Researchers have posited several antecedents to gender differences in networks for women; for a review see (Ibarra 1992). Homophily, or the tendency to associate with those similar to oneself, is argued to be one important factor in explaining these differences. Homophily is however predicated on a variety of factors and can be broadly broken down into two types: induced and choice homophily (McPherson and Smith-Lovin 1987). Furthermore, homophily need not be based on *gender* alone; individual characteristics such as values, educational attainment, formal status, and age may be other attributes on which homophily functions. In this paper we examine three types of homophily: (1) *spatial* homophily, which is propensity to associate more with those who are located at the same office, (2) *status* homophily, which is the propensity to associate more with those who occupy the same formal status in the organization (e.g. Analyst to Analyst), and (3) *gender* homophily which indicates a tie is between individuals of the same sex.

Induced Homophily

Induced homophily posits that our interpersonal relations are limited by the demographic composition of the population available to us. Consequently, if an individual's department is primarily composed of women, relationships that individual has will primarily be with women.

Similarly, it is argued that *geographic propinquity* has a significant effect on the relationships we form (Back, Schmukle and Egloff 2008; Latane et al. 1995). As a result, we are more likely to form relationships with those who are closer to us and with whom we have significantly more opportunity to interact.

Choice Homophily

In addition to the constraints that demographic composition and geographic location put on our ability to form relationships, individual choice also plays a role. A wide and historic literature suggests that interpersonal attraction is based on attributes both sociodemographic and behavioral. Ibarra (1992) found that when it comes to instrumental (e.g. advice) and expressive relationships (e.g. friendships), women tended to exhibit more gender homophily with their expressive relationships and less so with their instrumental ones. On the other hand, males tended to exhibit gender homophily for both.

In this study, we examine two types of choice homophily: (1) *gender* homophily and (2) *status* homophily. In accordance with Ibarra (1992), in a professional organization such as this, we expect women to exhibit *gender* homophily differentially in their instrumental and expressive ties – with more gender homophily in their expressive ties. We also expect that men will have more *gender* homophily in their instrumental and expressive ties than will women.

Status Homophily

In this organization, there are three major titles for professionals that indicate formal *status*. At the bottom of the status hierarchy are the "*analysts*" who are junior members of the organization. The second, middle-level category is "*mid-level laterals*" who are professionals brought into the

firm laterally, with the expectation of becoming partner. The third, and generally the highest, category of professionals in this professional services firm are the "*partners*" who normally share in the profits of the organization.

On a day-to-day basis, we do not expect that men and women should differ significantly with respect to *status* homophily in their instrumental relationships, particularly for task related advice seeking. The absence of significant differences in *status* homophily is necessary if men and women occupy similar roles in the organization and are part of similar projects and activities. However, as the relationships become more expressive we expect that men will tend to show less status homophily. That is, we expect men to break formal status boundaries more often when it comes to friendships in the organization. The intuition behind this hypothesis is two-fold. First, in order for women to gain higher status contacts they may have to work harder to signal their legitimacy by having preexisting friendships with those who already have higher status (Burt 1992; Ibarra 1992). The second reason may be that women define friendship as being more intimate and therefore may have a higher tendency to withhold nominations to higher status others as friends because of potential inequity in the dyadic relationship (Benenson 1990; Benenson and Christakos 2003; Benenson, Morganstein and Roy 1998). Thus, we propose the following hypothesis:

Hypothesis 1: *Controlling for availability and individual characteristics, men will have a higher tendency to break formal status boundaries in their expressive relationships.*

Centrality and its Correlates

The concept of network centrality is fundamental to social network analysis. Formally, *centrality* is a set of mathematical measures on a network, where vertices on that graph are individuals or entities, and the edges are relationships amongst those entities (e.g. advice, friendship, and exchange). Abundant research in anthropology, sociology, and social psychology suggests that those who hold more central positions in the network tend to have more power (Bonacich 1987a; Bonacich and Lloyd 2001). Several measures of network centrality exist, each providing a different intuition of how the individual having or not having such centrality is either empowered or constrained by their position. For this study, we use *Eigenvector centrality* as our centrality measure. It is premised on the intuition that one's centrality or prestige is a function of the centrality of its contacts. The methods section of the paper defines and discusses the specific nature of this centrality measure.

Ibarra (1992) found that after controlling for individual and positional factors, there were no differences in men and women's centrality in either the instrumental or expressive networks within the firm she studied. The setting in our study is in some ways unlike the setting in the Ibarra (1992) study. Although there are more male partners than female partners, there is near equity in human capital and the gender distribution is approximately balanced at the analyst level. Consequently, we expect that the nature of work in the professional services firm we studied and the expectation that there is no systematic bias in assignment of less desirable tasks to one group or the other, necessitates men and women having equally central positions in the instrumental networks of this firm.

Expressive relationships, particularly friendships, are a different matter. One's ability to accomplish short-term work related tasks dictates interaction with a wide array of people across

the organization. The nature of work therefore inhibits systematic marginalization of groups purely based on gender alone. On the other hand, the completion of short-term tasks is not directly linked to friendship. Friendship is a relationship where people form ties because of want, not because of need. In this situation we would expect that due to men and women's greater tendency for gender homophily in friendship relations and the expectation that men are more likely to break status boundaries in their friendship relations, result will be lower centrality for women in the friendship network at this firm. Thus we propose the following hypothesis:

Hypothesis 2: *Controlling for individual characteristics, men will be more central in the friendship networks than women.*

Stability of Network Structures

Longitudinal network data gives us the ability to analyze patterns in network structure over time. Two longitudinal network studies, namely Newcomb (1961) and Sampson (1968) have shaped our understanding of how networks emerge. Several re-analyses of Newcomb's data have found that the networks tend to stabilize rapidly, perhaps as early as the third week (Doreian et al. 1999). Test-retest studies of social networks have also found considerable stability over time, particularly in developed countries and over short periods. (Bignami-Van Assche 2005). However, not all groups are the same and dynamics and stability may vary. Nevertheless, we believe that because individuals in this cohort are spatially distributed across different offices and have ample opportunity to participate in networks outside of work – the within cohort network will stabilize quickly.

METHODS

To examine the phenomenon of gender disparities in the networks of male and female professionals we studied a mid-sized professional services firm with offices spread across several cities in the United States. Our sample consisted of two major groups: (1) existing professionals in the firm and (2) incoming analysts. The incoming analysts participated in a longitudinal study consisting of a sociometric survey every week for twelve consecutive weeks. The existing professionals participated in a sociometric survey during the eleventh week of the study. Our implicit assumption is here is that the network structures of the existing attorneys, have for the most part, stabilized.

Participants: Incoming Analysts

The first group was a cohort of seventeen incoming analysts (IA). The IA consisted of 6 males and 11 females spread across 6 offices with 12 (70%) of the IA located in just two geographically proximate offices. The IAs participated by completing a sociometric survey each of the twelve weeks, beginning with their first day at the firm. For this group, we achieved a 100% response rate for each of the 12 weeks.

Participants: Existing Professionals

Table 2.1 Distribution of respondents by hierarchical rank

	Analyst	Laterals	Partner	Other	Total
Gender	(1)	(2)	(3)	(4)	(5)
Females	42	11	22	7	82
Males	54	20	78	13	165
Total	96	31	100	20	247

The second group was the existing set of client-facing professionals (EP) spread across the geographic offices of this firm. These professionals consisted of (1) analysts, (2) laterals, (3) partners and small set of high-level employees with different titles we aggregated into a category called (4) other. Two-hundred and forty seven (247) professionals completed the entire survey (response rate = 54%). We did not find any significant difference between the respondents and non-respondents with respect to formal title ($\chi^2 = .199$), gender ($\chi^2 = .538$), ethnicity ($\chi^2 = .728$), or geographic location ($\chi^2 = .404$).

Table 2.1 describes the hierarchical distribution of the 82 women and 165 men in the final sample. The proportion of men and women is approximately balanced for analysts (p = .261), but with significantly more men at the level of partner (p = .000). Overall, the hierarchical distribution by gender in our sample reflects both the composition of the entire firm as well as industry wide statistics (Catalyst, 2008).

Measures

The longitudinal study of incoming analysts extended over twelve consecutive weeks beginning with their first day at work. At the beginning of each week, the IA were asked to complete a sociometric survey asking them about five types of relationships they had with (1) other incoming analysts and (2) existing professionals at the firm. The cross-sectional component of the study was conducted on week 11 by sending a link to an online sociometric survey asking respondents about the same five relationships, in addition to a network generator question which asked individuals to subset the firm population to those individual whom the respondent had some knowledge of.

Network questions

The sociometric questionnaire for the incoming analysts asked about five types of relationships separately for both the IA population and the EP population. For the IA population the respondent was provided a checklist with the names of all other incoming analysts and was asked to check the box next to the names of people:

- (Q1) "who you would approach for help or advice on work related issues",
- (Q2) "who might typically come to you for help or advice on work related issues",
- (Q3) who you go to "about more than just how to do your work well. For example, you may be interested in 'how things work' around here, or how to optimize your chances for a successful career here",
- (Q4) "who might typically come to you for help or advice along these [non-task related] dimensions" and finally
- (Q5) "who you think of as friends here at [firm]."

For the EP population, IA respondents were provided a directory of all professionals at the firm with a unique code next to each name. For each of the five sociometric questions, respondents wrote the code numbers corresponding to the individual names that fit the description. In order to limit measurement error, respondents were allowed to nominate as few or as many individuals as they wanted (Holland and Leinhardt 1973).

For the online sociometric survey administered to the existing professionals, each respondent initially checked the names of all those people who they knew well or at least knew of at the firm. After sub-setting to only the individuals that the respondent at least knew of, they answered the same sociometric questions pertaining to the five types of relationships they had with all other professionals in the firm, including the incoming analysts.

Responses to these five questions were used to generate three networks of mutually agreed upon relationships consisting of (1) task-related advice seeking $\boldsymbol{TR}$, (2) non task-related advice seeking $\boldsymbol{NR}$ and (3) friendships $\boldsymbol{FR}$. The relationships range from the instrumental (task-related advice) to the expressive (friendships). In general, we constructed the networks as follows:

- $\boldsymbol{TR = Q1 \cdot Q2^T}$ the element $\boldsymbol{TR_{ij} = 1}$ if and only if person *i* says they ask task-related advice from *j* and *j* says that *i* comes to them for advice (note this not mutual advice seeking, it is agreement in the direction of advice seeking)
- $\boldsymbol{NR = Q3 \cdot Q4^T}$ the element $\boldsymbol{NR_{ij} = 1}$ if and only if person *i* says they ask non-task related advice from *j* and *j* says that *i* comes to them for advice (again, note this not mutual advice seeking, it is agreement in the direction of advice seeking)
- $\boldsymbol{FR = Q5 \cdot Q5^T}$ the element $\boldsymbol{FR_{ij} = 1}$ if and only if person *i* says they are friends with *j* and *j* also says that *i* is their friend (friendship here is defined as mutual).

The cross-sectional survey of the existing professionals produces three networks (1) task-related advice, (2) non-task related advice, and (3) friendship. The longitudinal study of the incoming analysts produces 12 networks (one per week) for each of the three types specifying their relationships with the other incoming analysts. As for their relationships to the existing professionals, because we did not have corresponding longitudinal data for the EP population, we analyzed only the IA's nominations of the EP's and not the mutual agreement on the nature of the relationship.

Individual Characteristics

In addition to the sociometric data, human resources at the firm provided information on each person's (1) gender, (2) formal title, (3) geographic location, and (4) ethnicity. We constructed an additional two variables to provide controls for the regression analyses: (5) CoIA, which counts the number of incoming analysts co-located with the responding IA and (6) OSize, which counts the number of EAs co-located in the same office with the responding IA.

Homophily Measures

Homophily is the tendency for individuals to associate with others who are similar to them. In this paper, we examine three types of homophily: (1) formal *status* homophily, (2) *gender* homophily and (3) *spatial* homophily. We define *status* homophily as the tendency for the focal individual to associate more with those who occupy the same formal position in the organization as themselves. For instance, a partner seeking advice from another partner would be defined as a exhibiting homophily in their advice relationship. *Gender* homophily is the tendency for a focal individual to associate with those of the same gender (e.g. a female asking advice from another female). We define *spatial* homophily as the tendency for a focal individual to associate with those who are located in the same geographic office. To parameterize homophily we use a modified version of the E-I or External-Internal index that adjusts the measure for the distribution of the underlying population for each group (Krackhardt and Stern 1988). The formula for the adjusted E-I index is:

$$Adj\ E-I = \frac{\frac{E}{p_E} - \frac{I}{p_I}}{\frac{E}{p_E} + \frac{I}{p_I}}$$

where E is defined as the number of external ties an individual has, p_E is defined as the proportion of potential ties in the firm that are in external groups for the focal individual, I is the number of internal ties the individual has, and p_I is proportion of potential ties in the firm that are in the internal group for the focal individual. A score of -1 indicates that the individual has all internal ties, 0 if the ties are balanced, and 1 if all ties are to individuals in external groups, adjusting for availability.

Centrality

Network centrality for this study was operationalized as eigenvector centrality. The eigenvector centrality measure is based on the premise that an individual's centrality is determined by the centrality of its neighbors (Jackson 2008). Thus, in turn, a neighbor's centrality is determined by the centrality of its own neighbors. An elegant solution to this self-referential problem is proposed by (Bonacich 1987a). Here $C^e(N)$ is the eigenvector centrality for the network *N*. For our analysis, we rescaled the eigenvector centrality scores so that they sum to 100, with higher values indicating more centrality, where g_{ij} is whether i is connected to j, some scale factor λ and the centrality of the alter j to whom i is connected C_j^e.

$$\lambda C_i^e(N) = \sum_j g_{ij} \lambda C_j^e(N)$$

Eigenvector centrality scores were calculated for each of the three matrices for the EP population and for each weekly network for the within IA networks. A second reason for the choice of *Eigenvector* centrality as our measure of prestige is that it is robust to issues of network sampling (Costenbader and Valente 2003).

Although the task and non-task relationships were not symmetrized, we attempted to control for arbitrary nominations by specifying a directed relationship that was mutually agreed

upon (Krackhardt 1992). We did however symmetrize friendship to take into account strong mutual friendships and to reduce measurement error.

RESULTS

Descriptive statistics and correlations for the homophily and centrality variables for the cross-sectional EP survey are presented in Table 2.2. In this organization, we find that there is significant correlation between centrality variables for the three networks. However, we do not find significant correlation between the homophily indices and the network centrality measures. The only exception is inverse relationship between status homophily in the task network and the friendship network. Examining the means, we see that there seems to be slight or no tendency for status homophily in the friendship and non-task related advice networks. There is a slight positive mean for the status homophily variable for the task-related advice network, suggesting a tendency to break status boundaries for such advice. Overall, there is a tendency towards gender homophily for all network types and a very strong tendency for spatial homophily. Interpretation of the means for the centrality scores is difficult because of rescaling. However, we do see greater variance for the non-task related advice network than we do for task-related or friendship relationships. An interesting negative correlation exists between the tendency to break status boundaries in task advice seeking and the centrality in the friendship network, though we do not have a theoretical interpretation about why this may be the case.

The remainder of this section is organized into three parts. Part one examines the hypotheses as they relate to the network of existing professionals. This analysis gives us a broad context into which the incoming analysts are forming their own ties. In part two, we examine the network of relationships that the incoming analysts form amongst each other during the first twelve weeks of their careers at the firm. Finally, in part three we briefly explore the

relationships that the incoming analysts begin forming with the existing professionals in the organization. For each part, we examine three network factors: (a) network size, (b) homophily and (c) centrality. For parts two and three, we examine the dynamics of these phenomena over the first twelve weeks of the analysts' careers and nature of stability in their networks.

Table 2.2 Descriptive statistics and correlations of network variables used in analysis

Variables	Mean	StDev	(2)	(3)	(4)	(5)	(6)
1. Status - Friend	-0.097	0.794	0.556**	0.553**	-0.175	-0.102	-0.112
2. Status - Task	0.146	0.673		0.642**	-0.072	0.088	-0.004
3. Status - Non-Task	-0.004	0.922			-0.06	0.07	-0.05
4. Gender - Friend	-0.321	0.71				0.477**	0.593**
5. Gender - Task	-0.213	0.659					0.622**
6. Gender - Non-Task	-0.261	0.84					
7. Spatial - Friend	-0.593	0.675					
8. Spatial - Task	-0.341	0.713					
9. Spatial - Non-Task	-0.626	0.723					
10. Centrality - Task	0.405	0.604					
11. Centrality - Non-Task	0.405	2.107					
12. Centrality - Friend	0.405	0.698					

Variables	(7)	(8)	(9)	(10)	(11)	(12)
1. Status - Friend	-0.033	0.132	0.054	-0.019	-0.093	-0.03
2. Status - Task	-0.046	0.011	-0.072	-0.128	-0.101	-0.169*
3. Status - Non-Task	-0.001	0.013	-0.1	-0.144	-0.067	-0.11
4. Gender - Friend	-0.029	0.042	0.031	-0.069	-0.097	-0.065
5. Gender - Task	-0.047	-0.026	-0.076	-0.095	-0.126	-0.119
6. Gender - Non-Task	-0.008	0.138	0.002	-0.134	-0.104	-0.118
7. Spatial - Friend		0.664**	0.606**	0.094	0.077	-0.002
8. Spatial - Task			0.579**	0.108	0.079	-0.012
9. Spatial - Non-Task				0.065	0.198	-0.031
10. Centrality - Task					0.407**	0.511**
11. Centrality - Non-Task						0.321**
12. Centrality - Friend						

* p <.05, **p <.01, *** p <.001

The Existing Organizational Network

Network Size

Table 2.3 Analysis of Out-Degree for Existing Professionals

	Task Advice (Seeking)	Task Advice (Giving)	Non-Task Adv. (Seeking)	Non-task Adv. (Giving)	Friendship
Independent Variable	(1)	(2)	(3)	(4)	(5)
Intercept	13.53*	1.837	3.663*	2.871	1.482
	(8.202)	(5.069)	(1.790)	(2.469)	(3.471)
Male	-5.106	1.519	0.042	0.817	1.640
	(3.010)	(1.860)	(0.657)	(0.906)	(1.273)
R^2	0.299	0.251	0.085	0.120	0.191
Adjusted R^2	0.227	0.173	-0.009	0.0286	0.108
F-Statistic	4.140	3.243	0.905	1.315	2.292

Notes: Control variables for the ethnicity of the individual, location, and formal status, were included.
* p <.05, **p <.01, *** p <.001

Two basic measures of network size and centrality are *out-degree* and *in-degree*. Out-degree indicates to some extent the level of extroversion of a focal individual, whereas in-degree represents an individual's popularity. We estimated OLS regressions with out-degree and in-degree as dependent variables for each of the sociometric questions. After holding ethnicity, location, and formal position constant, we find that although men have a higher out-degree than women (except for seeking advice – Q1), these coefficients are not statistically significant. Men and women tend to nominate approximately similar number of people they seek advice from, seek advice from them, and they consider friends. Table 2.3 presents the regression results for the out-degree analyses.

As for in-degree (Table 2.4), we find that approximately the same number of people nominate men and women for task advice seeking (Q1), task advice giving (Q2), non-task advice seeking (Q3) and friendship. However, one inconsistency we find is a negative and statistically significant coefficient on non-task advice giving for the gender variable (p = 0). This may

suggest that others perceive women as asking for more advice about "how things really work around here." Table 2.4 presents the regression results for the in-degree analyses.

Table 2.4 Analysis of In-Degree for Existing Professionals

	Task Advice (Seeking)	Task Advice (Giving)	Non-Task Adv. (Seeking)	Non-Task Adv. (Giving)	Friendship
Independent Variable	(1)	(2)	(3)	(4)	(5)
Intercept	4.423	3.772	1.246	4.291***	5.904
	(4.882)	(2.394)	(2.340)	(0.882)	(1.692)
Male	-0.101	-0.308	0.655	-1.274***	-0.867
	(1.791)	(0.878)	(0.858)	(0.324)	(0.621)
R^2	0.530	0.464	0.207	0.309	0.404
Adjusted R^2	0.482	0.409	0.114	0.238	0.342
F-Statistic	10.95	8.384	2.215	4.336	6.567

Notes: Control variables for the ethnicity of the individual, location, and status, were included.
* p <.05, **p <.01, *** p <.001

Homophily

The results for homophily analysis, presented in Table 2.5, suggest an intricate story. Men and women tend to have similar levels of status homophily for task and non-task advice seeking, the coefficient on male, although positive, is not significant. The sign of the intercept suggests that for task related advice, status boundaries are generally not important. On the other hand, for non-task related advice both males and females tend to be inward looking. Our hypothesis that men will show less status homophily than women in expressive relationship, is supported. As an additional check, we looked at status homophily in the unsymmetrized friendship network and found similar results. Though the coefficient on male is smaller (.199 vs .309) and less significant (p-value = .027 vs. .003) men are still more likely to nominate individuals as friends across formal status boundaries.

Table 2.5 Homophily for Existing Professionals

	Status Homophily			Gender Homophily			Spatial Homophily		
	Task	non Task	Friend	Task	non Task	Friend	Task	non Task	Friend
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0.590	-0.575	-0.400	0.327	0.405	-0.420	-0.954***	-1.111***	-1.283***
	(0.226)	(0.350)	(0.303)	(0.194)	(0.326)	(0.272)	(0.253)	(0.316)	(0.272)
Male	0.042	0.174	0.309**	-0.961***	-1.005***	-0.466***	-0.021	0.080	0.0199
	(0.078)	(0.124)	(0.105)	(0.068)	(0.116)	(0.094)	(0.088)	(0.112)	(0.094)
R^2	0.4295	0.4913	0.405	0.5648	0.4686	0.3988	0.3676	0.3269	0.3364
Adjusted R^2	0.3637	0.4083	0.326	0.5146	0.3819	0.3182	0.2946	0.2171	0.2474
F-Statistic	6.525	5.921	5.08	11.25	5.406	4.947	5.038	2.978	3.78

Notes: Control variables for the ethnicity of the individual, location, and status, and out-degree were included.
* p <.05, **p <.01, *** p <.001

Thus, analysis suggests that men are significantly more likely to break status boundaries for reciprocated friendships than are women. This result corroborates the observation made by the American Bar Foundation study that men are more likely to participate in informal gatherings (e.g. lunch or breakfast) with partners than are women. The results for gender homophily also suggest that there is more gender homophily in men's relationships in both expressive and instrumental networks. The results for gender homophily are for the most part consistent with those obtained in Ibarra (1992). With respect to spatial-homophily we do not find any difference between men and women's tendency to seek advice from or be friends with those in other geographic locations.

Centrality

Existing research on the centrality of women in organizational networks have found that although women do occupy less central positions, this difference in centrality is mediated mostly by individual characteristics. However, in these studies women often occupied lower status jobs and were at lower ranks (Ibarra, 1992). Since our study focused on only the population of

professionals in the firm, major status differences in education and occupational prestige were not factors that significantly differentiated men from women. Therefore, we expect that in the two instrumental networks, men and women will be on par after controlling for individual characteristics. However, we expect that women will be less central than men in the friendship network as per Hypothesis 2. The regression analyses, presented in Table 2.6, provide evidence for this hypothesis. We find that although women and men have equal centrality when it comes to the task and non-task advice networks, men are significantly more central in the organizational friendship network than are women.

Table 2.6 Centrality for Existing Professionals

	Task Advice	Non-task Advice	Friendship
Independent Variable	(1)	(2)	(3)
Intercept	-0.223	-0.542	0.146
	(0.201)	(0.831)	(0.22617)
Male	0.089	0.405	0.168*
	(0.0734)	(0.305)	(0.083)
R^2	0.3463	0.0780	0.378
Adjusted R^2	0.2788	0.01711	0.314
F-Statistic	5.135	0.82	5.893

Notes: Control variables for the ethnicity of the individual, location, and formal status, were included.
* p <.05, **p <.01, *** p <.001

The reasons for this apparent marginalization in the strong friendship network may be the result of several factors. Clearly, the significant gender homophily shown by both men and women plays a role. To test whether the marginalization of women was the result of men's unwillingness to nominate women as friends or women's lower reciprocity of incoming friendship nominations, we first tested whether women were marginalized when we looked at the unsymmetrized matrices. When the definition of a friendship tie did not require dyadic symmetry, our regression results suggest that men and women are on par in the friendship network (coefficient on male = -.031, p-value = .47). This result suggests that there is a significant lack of reciprocity in the network. To examine whether it was men or women who

exhibited greater reciprocity of incoming friendship nominations we regressed the proportion of incoming friendship nominations that were reciprocated by an individual on the full set of their individual characteristics. Consistent with the "broad coalition" view of men's friendship choices and "intimate and secure" view of women's we find that men on average reciprocate 10% more of their incoming friendship ties than do women (coefficient on male =.096, p-value = .028). If symmetric friendships are in fact qualitatively different from asymmetric friendships, as we expect them to be, then women's lower reciprocity may be a contributing factor for their lower average centrality in the friendship network of this firm.

The analysis in part one examines these phenomena from one perspective. The existing social networks at the organization provide a context and culture for the incoming analysts as they form their own networks amongst each other and with existing members of the organization.

Cohort Network of Incoming Analysts

We began our analysis of the emerging networks of the incoming analysts by looking at the correlations across the different network types and network stability over time. We find that correlations across networks and across time are high and significant, particularly after the second and third week. These results are generally consistent with existing literature on network evolution (Dorien et al., 1999). We also believe that these networks are even more likely to stabilize quickly because of the geographic dispersion of the analysts across several offices and the ability to socialize with others outside of work.

Network Size

With respect to out-degree, we find that the incoming male analysts consistently nominate more individuals in their cohort as those to whom they go to for both task, non-task related advice, and

whom they consider friends. The relevant coefficient is positive and significant for all weeks for each of the three network types. This result is consistent with research on the larger social networks expected for men, but differs from the result we observe for the entire organization. The explanation for this difference is not so straightforward. Perhaps one rationalization is that when entering the organization, men cast a wider net. As time progresses, they know which relationships are reciprocated or not, and as a result pull back accordingly.

However, for in-degree the story is consistent with the results we obtained for the existing professionals. Women and men in the incoming cohort seem to be on par with each other with respect to the number of nominations they receive from others in their cohort. There are a few sporadic weeks where women are receiving fewer nominations than men for non-task advice and friendship, though without any clear pattern, per se, but is possibly suggestive of a potential difference on the expressive networks.

Homophily

For the cohort specific network of the incoming analysts, we examined two types of homophily: (1) *spatial* homophily and (2) *gender* homophily. We find that the male incoming analysts tend to have consistently lower levels of spatial homophily on average than the women for all three types of networks. This result is contrary to the results obtained for the analysis of the existing professionals at the firm where both men and women exhibited significant spatial homophily. The coefficients for the male variable are significant for all types of networks but particularly strong for the friendship networks. Although our sample size limits conclusive interpretation, the results, presented in Table 2.7, provide some evidence for the claim that men tend towards larger coalitions.

Table 2.7 Spatial homophily analysis coefficients on male indicator variable for all weeks

	Task	Non-Task	Friendship
Week of Survey	(1)	(2)	(3)
1	0.637 (0.249)*	0.827 (0.246)**	0.929 (0.221) ***
2	1.040 (0.232)***	0.717 (0.259)*	0.766 (0.243)**
3	0.712 (0.242)*	0.783 (0.257)**	0.561 (0.231)*
4	0.976 (0.202)***	0.756 (0.244)**	0.716 (0.223)**
5	0.730 (0.244)**	0.747 (0.218)**	0.712 (0.223)**
6	0.724 (0.270)*	0.606 (0.249)*	0.537 (0.244)*
7	0.706 (0.268)*	0.765 (0.240)**	0.917 (0.197) ***
8	0.681 (0.249)*	0.742 (0.254)*	0.966 (0.211) ***
9	0.673 (0.269)*	0.770 (0.216)**	0.847 (0.208)**
10	0.702 (0.282)*	0.845 (0.244)**	0.823 (0.206)**
11	0.653 (0.299)*	0.827 (0.229)**	0.975 (0.199) ***
12	0.823 (0.268)**	0.933 (0.231)**	0.942 (0.197)***

Note: Controls for number of new analysts co-located with each individual are included for all regressions.
* p <.05, **p <.01, *** p <.001

The regression analyses for *gender* homophily, presented in Table 2.8, for the incoming analysts suggest that both men and women nominate those of a different gender at equal levels for the task advice and non-task advice. However, for the friendship relationships, the result is different from the results for the task and non-task advice networks but generally consistent with existing literature that both men and women will show significant *gender* homophily in their expressive relationships with the mean intercept for the twelve weeks in the friendship network as -.845 and a mean p-value of .012.

Table 2.8 Gender homophily analysis coefficients on male indicator variable for all weeks

	Task	Non-Task	Friendship
Week of Survey	(1)	(2)	(3)
1	0.284 (0.203)	0.392 (0.218)	0.295 (0.159)*
2	0.081 (0.194)	0.131 (0.220)	0.235 (0.175)
3	0.358 (0.278)	0.282 (0.251)	0.169 (0.180)
4	0.347 (0.223)	0.477 (0.231)	0.332 (0.192)
5	0.096 (0.224)	0.064 (0.236)	0.252 (0.214)
6	0.435 (0.255)	0.471 (0.222)	0.697 (0.264)*
7	0.384 (0.252)	0.284 (0.221)	0.155 (0.185)
8	0.412 (0.256)	0.165 (0.229)	0.197 (0.206)
9	0.358 (0.272)	0.106 (0.190)	0.091 (0.203)
10	0.326 (0.225)	0.202 (0.222)	0.062 (0.211)
11	0.196 (0.256)	0.143 (0.233)	-0.02 (0.237)
12	0.221 (0.169)	0.232 (0.181)	0.059 (0.277)

Note: Controls for number of new analysts co-located with each individual are included for all regressions.
* p <.05, **p <.01, *** p <.001

Centrality

Because of the nature of the work that individuals do at this firm, we expected that men and women would be equally central in the instrumental networks of this organization. The analysis of the existing professionals and the networks of the incoming analysts over the first twelve weeks provide consistent results suggesting no significant difference between the two groups. There are, however, a few sporadic weeks where men are more central than women in the task and non-task networks but they do not follow any clear pattern.

For expressive networks, in particular friendship, we hypothesized that men would be more central. We find that although there are some sporadic weeks in the first half of the study were men have significantly higher centrality than women, the size and significance increases dramatically in the latter half. At approximately the 7th week, men become the dominant group in the cohort friendship network. This result is consistent with the results obtained for the existing professionals and may suggest that even within the first several weeks at the organization, men

take on a dominant position in the friendship network consisting of individuals from their cohort. Furthermore, consistent with the results for the larger firm, we find that if we look at women's centrality in the unsymmetrized friendship network we find no significant difference in the last 6 weeks in the centrality of men and women in this cohort (mean coefficient = 1.83, mean p-value = .233). Also consistent with the larger network results, men in this cohort have a higher tendency to reciprocate their incoming friendship nominations for the same period (mean coefficient on male = .357, mean p-value = .012). The lower level of reciprocity to incoming friendship ties for women do indicate it may be one factor in their lower average centrality in the strong symmetric friendship network. Table 2.9 provides the regression results of the centrality analyses for the incoming analysts.

Table 2.9 Centrality analysis coefficients on male indicator variable for all weeks

	Task	Non-Task	Friendship
Week of Survey	(1)	(2)	(3)
1	3.684 (4.640)	8.352 (3.858)*	4.024 (2.158)
2	4.927 (1.704)*	1.528 (2.275)	2.355 (1.685)
3	2.207 (1.540)	1.859 (1.638)	2.508 (1.375)
4	2.552 (1.942)	1.526 (2.583)	1.745 (1.889)
5	4.198 (1.597)*	2.235 (1.848)	2.345 (1.205)
6	2.186 (1.845)	1.453 (2.594)	1.080 (2.701)
7	2.767 (1.721)	2.039 (1.761)	4.839 (0.960)***
8	2.404 (1.842)	3.161 (1.574)	4.408 (1.304)**
9	2.114 (1.785)	3.716 (1.556)*	2.601 (1.533)
10	2.898 (1.573)*	2.600 (1.598)	3.733 (0.963)**
11	4.228 (1.809)*	3.242 (2.553)	5.462 (1.265)***
12	2.832 (1.927)	2.130 (1.992)	5.279 (1.181)***

Note: Controls for number of new analysts co-located with each individual are included for all regressions.
* p <.05, **p <.01, *** p <.001

Incoming Analysts Integration into the Existing Organizational Network

The previous two sections looked at the networks of the existing professionals at the firm and the cohort specific networks of the incoming analysts. A second set of emerging network ties also form, bridging these two groups. Incoming analysts, as they progress through their careers at the firm are also forming ties with the existing professionals.

Network size

Results in Table 2.10 suggest that there is no significant difference between males and females in the number of outgoing ties they had with respect to task and non-task related advice, controlling for their home office. However, for almost every week after the first, men tended to nominate more people on average as "friends" among the existing professionals than women (these results were significant at the $p < .1$ for weeks 2-4, 6-11 and significant at $p < .05$ for week 12).

Table 2.10 Summary of gender homophily male coefficients for out-degree

	Mean (Min, Max)	P-value (Min, Max)
Network Type	(1)	(2)
Task Advice	4.863 (-2.186, 6.950)	0.2876 (0.1921, 0.5506)
Non-Task Advice	4.863 (-2.186, 6.950)	0.2876 (0.1921, 0.5506)
Friendship	9.000 (1.150, 11.293)	0.098 (0.047, 0.408)

Note: Controls for The number of new analysts co-located with each individual were included for each regression.

Homophily

After controlling for location, we did not find any significant difference between the incoming male and female analysts with respect to *status*, *gender* or *spatial* homophily in for any of the three types of relationships. Although we are limited by sample size and thus the absence of robust controls, this analysis does suggest that at least for the friendship relations with existing

members of the firm, men's relations do possibly point in the direction of more gender homophily than women's, although our results are not statistically significant.

Centrality

The results for the apparent lack of difference in men and women's choices with respect to status homophily suggest that the individuals in the incoming cohort of analysts go to individuals of approximately equal average *formal status* for all network types. On the other hand, although two individuals may hold the title of "partner" or "mid-level laterals", they may differ significantly in the informal power they hold. Our assumption is that the nature of work prevents significant disparities in instrumental networks. Thus, we do not expect to see significant differences between males and females in the average informal power, parameterized as the eigenvector centrality of the recipient of their nomination. This analysis is presented in Table 2.11.

Table 2.11 Centrality analysis coefficients on male indicator variable for all weeks

	Task	Non-Task	Friendship
Week of Survey	(1)	(2)	(3)
1	-0.19 (0.222)	0.130 (0.235)	0.297 (0.486)
2	0.240 (0.194)	0.118 (0.220)	0.051 (0.182)
3	0.051 (0.182)	-0.13 (0.171)	0.412 (0.334)
4	0.214 (0.174)	0.124 (0.189)	0.299 (0.276)
5	0.242 (0.159)	0.056 (0.162)	0.320 (0.252)
6	0.147 (0.168)	0.154 (0.154)	0.499 (0.223)*
7	0.191 (0.155)	0.172 (0.147)	0.522 (0.223)*
8	0.087 (0.162)	0.073 (0.137)	0.312 (0.231)
9	0.112 (0.150)	0.146 (0.139)	0.412 (0.208)$^{+}$
10	0.118 (0.141)	0.055 (0.126)	0.403 (0.227)$^{+}$
11	0.074 (0.139)	0.110 (0.128)	0.323 (0.204)
12	0.141 (0.146)	0.107 (0.134)	0.272 (0.215)

Note: Controls for number of new analysts co-located with each individual are included for all regressions.
$^{+}$ p <.1, * p <.05, **p <.01, *** p <.001

Consistent with the results in part one and two, we do not find any evidence suggesting that women and men differ significantly in their tendency to nominate those with higher centrality in the advice networks. However, there is some evidence that for expressive relationships, men tend to nominate individuals of higher *informal status* than do women. Although the results are not significant for all weeks, the coefficients are positive each week and are statistically significant for weeks 6, 7 and 9. These results do again potentially point, though not by any means conclusively, in the direction of what we observed for the network of existing analysts and the incoming analyst cohort network. Namely, men and women tend to have equal access to instrumental networks, but women are more likely to be at the margins of the firm's expressive network.

DISCUSSION

The results of the empirical analysis provide evidence for several of our major hypotheses regarding differences in the networks of male and female professionals at the firm we studied. There are also several points of strong consistency in our cross-sectional and longitudinal results. Taken as a whole, men and women seem to be on par in the instrumental networks, but differ in prominence in the strong friendship networks. In agreement with the results of Ibarra (1992) we find that women's lower centrality is not, at least on the surface, unequivocally a result of exclusion.

Network size

For the network of existing professionals, we did not find any significant difference in the average out-degree and in-degree for males and female. On the other hand, we observed a

significant difference in the incoming cohort with males having significantly larger out-degree, but not in-degree. This apparent inconsistency is partially rationalized by the fact that network formation is inherently a dynamic process. Putting the two stories of the incoming analysts and the existing employees together, an argument can be made that although males and females initially entering an organization differ in their out-degree, as time progresses and the focal individual realizes whether their nominations have been reciprocated or not, they strategically pull back nominations given to those who have not provided cues of their reciprocity.

As for in-degree, the near equality we observe in the total number of nominations for males and females for both groups suggests that there does not seem to be significant explicit marginalization of women in this respect.

Homophily

Our cross-sectional results for the homophily analysis are broadly consistent with Ibarra (1992). Men tend to show significantly more homophily than women in both their instrumental and expressive networks, whereas women tend to show more homophily in their expressive ties as compared to their instrumental ties. The longitudinal results tell a slightly, but not entirely, different story. With respect to the instrumental networks formed amongst them, both male and female incoming analysts show the same low levels of gender homophily. However, for gender homophily in the expressive networks, though we do not observe a significant difference between the two, we do see a statistically significant and consistent tendency for gender homophily for both groups - a result that is consistent with the cross-sectional analysis. There does not seem to be a significant difference in gender homophily in the nominations that the incoming analysts send out to the existing professionals. However, for the outgoing friendship

ties, the average coefficient on Male was more negative than for the task and non-task related advice networks.

With respect to spatial homophily there does not seem to be any apparent difference between males and females in the cross-sectional analysis. Both groups tend to be significantly inward looking for both instrumental and expressive ties. The results for the longitudinal analysis however finds that men are more outward looking when it comes to spatial constraints. This result however may again be the result of the "wider net" phenomenon suggesting that men may send out more outgoing nominations initially but may pull back as time progresses.

For the existing professionals we find that *status* homophily plays a differentiated role for males and females in the three types of networks we looked at. There was no significant difference in formal status homophily for the two groups with respect to the two instrumental networks. However, we did observe that men exhibited significantly less status homophily than women when it came to mutual friendships. This result suggests that men are or perceive themselves to be better connected across status boundaries than do women. To some extent, it corroborates the observation by the American Bar Foundation that male analysts tend to participate in more informal gatherings with partners than women. For the incoming cohort, there did not seem to be a significant difference between males and females with respect to the tendency to break formal status boundaries.

Centrality

For centrality, we observe the strongest concordance between the cross-sectional and two longitudinal analyses. For all three analyses, males and females did not differ significantly in their average centrality in the instrumental networks (task and non-task related advice), nor did

the new incoming analysts differ in the average centrality of those they said they went to for advice. These results are in accord with the nature of work in a professional organization where tasks of equivalent importance are distributed equally to both genders.

In contrast, men were significantly more central in the friendship networks, both within the network of existing professionals and incoming cohorts, respectively. There is also some evidence, though not as robust as for the other phenomena observed, that suggests men in the incoming cohort tend to nominate those with higher "informal power" among the existing professionals than do women. This is in contrast to the status homophily result that found no gender differences for incoming analysts with respect to their out-going ties to existing professionals for any network. The higher centrality of males in the friendship networks can partially be accounted for their by higher rate of reciprocation of their incoming nominations. This tendency gives them larger networks, particularly for friendship, and consequently an increase in centrality that comes from the greater propensity to connect with people of higher formal and informal status.

Implications for Future Research

This study contributes to the understanding of gender differences in organizational networks in several respects. Methodologically, we are able to overcome some of the limitations of cross-sectional analyses by using a combined cross-sectional and longitudinal study design. We find that several types of gender differences in networks are consistent across both existing and incoming professionals. Our results also indicate that gender differences in incoming professionals' friendship network emerge rather rapidly, perhaps as quickly as their second month in the organization. In this paper we also extended the concept of homophily to spatial

and status homophily, finding significant differences in male professionals' propensities to break formal status boundaries in their friendships within the organization. In agreement with the literature on gender differences in networks and relationships, we find that men do tend towards larger networks and reciprocate their incoming ties more often as compared to women. This difference in perception of relationships does explain some of the gender differences observed in the average centrality of men and women in the organizational friendship network.

The results raise a plethora of interesting questions, both micro and macro. Qualitatively, it is unclear what the difference is between men and women's strong and weak ties in the organization. Future research needs to examine whether the strong and reciprocated ties of men in organizations contain different content than women's and whether these ties produce differential results in organizational and individual outcomes such as commitment, turnover, promotion, and productivity. Another set of questions related to mentoring arise in light of the evidence suggesting that gender differences in expressive networks arise rather quickly. If these expressive networks are conduits for information critical to the careers of employees, how can mentor-mentee relationships be designed to bridge some of these disparities?

A third set of questions also arise from our analysis concerning the impact of organizational demography on the nature of instrumental and expressive relationships formed in professional organizations. For instance, are networks formed in female-only organizations significantly different from those formed by females in male dominated or demographically balanced firms? Furthermore, if differences exist, how do they affect organizational design and outcomes?

Limitations

Although we attempted to overcome the limitation of a purely cross-sectional study design by including a longitudinal component, there is no real substitute for a truly longitudinal study. Ideally, we would be able to track the careers and networks of individuals in an organization over a period of years or decades. Given this limitation, we were still able to find some striking consistencies in the networks of existing professionals and the emerging networks of incoming analysts. Even the inconsistencies provide some insight for the lower turnover rates for men, for instance their initially higher tendency break spatial boundaries in advice and friendship networks.

The second limitation of this study is the absence of a complete response rate for the cross-sectional survey. Despite the fact that we received a response rate of 54%, we did not find significant differences in the observable characteristics of respondents and non-respondents. Additionally, our sample of incoming analysts was also limited in two ways. First, the sample size of 17, although comparable to the canonical Sampson (1968) and Newcomb (1961) studies, is relatively small. A second limitation is the varied geographic distribution of these 17 individuals. This limitation however will be difficult to overcome in real organizational studies. Our firm is relatively large in comparison to most firms of this type and the 17 individuals constitute the entire population of incoming analysts. We expect that future studies that examine this phenomenon may face similar sample size issues in their longitudinal study population. Nevertheless, we are reassured in some ways by the concordance of our results for the cross-sectional and longitudinal populations.

Finally, as with any study of a single firm, our results may not necessarily extend beyond its walls. Nevertheless, our firm is in many ways representative of other mid-sized professional

services firms in the United States with respect to demographic composition and hierarchical distribution (Catalyst, 2008). The broader results of our analysis are also in agreement with existing literature in social psychology, organizational research, and industry wide statistics.

This paper posits that, at least in professional organizations where there is near equity in the human capital of males and females, gender differences in firm-wide instrumental networks do not seem to exist. However, the gender differences observed in the expressive networks are the result of several inter-related phenomena that include men and women's differential rates of reciprocity, tendency to break formal status boundaries in expressive relationships, and for incoming employees, differences in the number of outgoing ties to other members of the organization. The broader consequences of these gender differences in network size and network structure, particularly expressive networks, may provide a more solid foundation for understanding some of the network antecedents of the persistent organizational and occupational gender stratification despite equivalent human capital.

CHAPTER 3:

STRUCTURE, SOCIALIZATION AND DURABLE INEQUALITY IN SOCIAL NETWORKS

Abstract

This chapter builds on the results of chapter two and attempts to address the tension between structuralist and dispositional perspectives on the disadvantaged position of women in intra-organizational social networks. I employ a broader conceptualization of the structuralist perspective currently used in the literature on gender differences in social networks and hypothesize that employees entering organizations model their networks after those of similar others, thereby reproducing existing inequalities. I also assert that deviating from one's expected prestige affects satisfaction with personal networks. A negative and U-shaped association between deviation and satisfaction is hypothesized. The validity of these hypotheses is examined using cross-sectional and longitudinal sociometric data from a mid-sized professional services firm. The empirical analysis provides support for the hypothesis that inequalities that are consequent of the network choices of existing employees are reproduced in new entrants' networks. Results also suggest that the satisfaction of high and low deviants, that are most at odds with expected prestige or adhere to their expected prestige respectively, is least affected. Conversely, moderate deviants are most dissatisfied as a consequence of the inconsistency between their actual and expected prestige. The findings have implications for the study of social network formation and add insight to the growing body of research on the interaction networks of women and other minorities in organizations.

INTRODUCTION

That social networks are important in the explanation of many important organizational and individual phenomena is now well established. Work satisfaction, power, promotion, compensation, and organizational level outcomes such as turnover have all been shown, in some measure, have network antecedents (Burt 1992; Krackhardt 1990; Krackhardt and Porter 1985; Podolny and Baron 1997; Roberts and O'Reilly 1979). Research also reveals that women are often systematically disadvantaged with respect to their social networks and may lack legitimacy that allows them to capitalize on their networks (Brass 1985a; Burt 1998; Ibarra 1992; Ibarra 1993; Ibarra 1997). They occupy, on average, less central positions in important interaction networks than men, achieve lower network returns to education and tenure, and may lack legitimacy that allows them to capitalize on their networks (Burt 1998; Ibarra 1992). However, a debate over whether women are disadvantaged in organizational social networks because of situational constraints or as a consequence of disposition persists (Ely and Padavic 2007).

The dispositional or individualist perspective on women's disadvantage posits that there are fundamental differences in how men and women form and value certain types of relationships. An important literature on network differences between male and female adolescents has found support for this orientation. The research finds that females tend to have smaller social networks than males (Benenson 1990; McPherson, Smith-Lovin and Cook 2001). Moreover, males tend to value attributes related to status, corresponding to large networks, whereas females value attributes related to maintaining a few friends (Benenson 1990; Benenson and Christakos 2003; Benenson, Morganstein and Roy 1998). These preferential differences

result in large functional coalitions for men and intimate secure relationships for women (Cheng and Chan 1999; Vigil 2007). With this perspective, it can then be argued that the predominant social behaviors of males and females in adolescence and early adulthood should carry over to other relationships, particularly expressive ones– resulting in the observed sex differences in organizational networks.

A competing perspective focuses on the structural features of the organization in which networks are formed. A growing body of empirical research suggests that the networks of women and other minorities are constrained by a variety of situational or structural factors (Brass 1985b; Friedman and Krackhardt 1997; Ibarra 1992; Ibarra 1997). It has been demonstrated that an individual's formal position in the organization is correlated with increased centrality in the informal network. Since men often constitute the majority of upper-level managers or have longer tenure in the organization, we would then expect to see sex-differences in centrality. This is similarly true of other structural constraints such as organizational demography (e.g. distributions of individuals and groups across the organization) or departmental affiliation as well.

On one hand, sex-differences in networks can be explained as a mere consequence of these structural constraints. On the other, questions about direction of causality emerge. *Are the structural differences (e.g. longer tenure and higher formal positions of males) the consequence of the weaker network positions of women, or are they the cause?* It is difficult to say conclusively. Much of the research on sex-differences in organizational networks has thus far been informed by cross-sectional analysis – assuming a network structure in equilibrium. Empirical studies on sex-differences begin primarily with aggregate individual level network constructs such as centrality or homophily as variables needing to be explained. Variables such

as individuals' formal position, department, and a variety of other variables are used as measures of the structural constraints under which people form their networks and thus acquire some centrality or exhibit some degree of homophily. The variance not explained by these structural variables is then attributed to random error or dispositional factors such as fundamental differences or extra-organizational socialization.

The feminist critique of the sex-difference research in organizations argues that the socializing role of the organization is often absent from the theorizing of these differences, particularly in research taking the dispositional perspective (Ely and Padavic 2007). Taking note of this perspective, we present a theoretical framework for examining the broader structural constraints on the sex-differences we observe in intra-organizational networks. A variety of concurrent processes in the organization may shape the network into the form that is observed in many of the cross-sectional studies. We argue that the role of structure should be extended to other forces germane to the organization such as the selection of entrants into organizational ranks, socialization of entrants within the organization, and exits of non-conforming individuals (Carroll and Harrison 1998; Fernandez and Sosa 2005; Harrison and Carroll 2006; Krackhardt and Porter 1985; Petersen, Saporta and Seidel 2000; Van Maanen and Schein 1977). In our analysis however, we focus primarily on the socialization of individuals within the organization and devise an empirical strategy with competing models in order to test our hypotheses.

The remainder of the paper is organized into four sections. The first section presents a theoretical framework for more carefully examining the dynamics and persistence of sex-differences in organizational networks. We begin by analyzing the choices that we expect people to make with respect to their dyadic relationships and then examine how these choices in aggregate result in the observed sex-differences documented in the literature. The second section

describes our data and analytical framework. In the third section, we present the results of our empirical analysis. Finally, we conclude with a discussion of our main results and directions for future research.

THEORETICAL FRAMEWORK

A variety of processes occurring simultaneously within and outside the organization affect how intra-organizational networks are formed. We delineate four processes germane to the organization, depicted in Figure 3.1, that we believe should be incorporated into a broader conceptualization of the structural constraints on networks: (a) entries, (b) formal, physical and distributional structures, (c) socialization, and (d) exits.

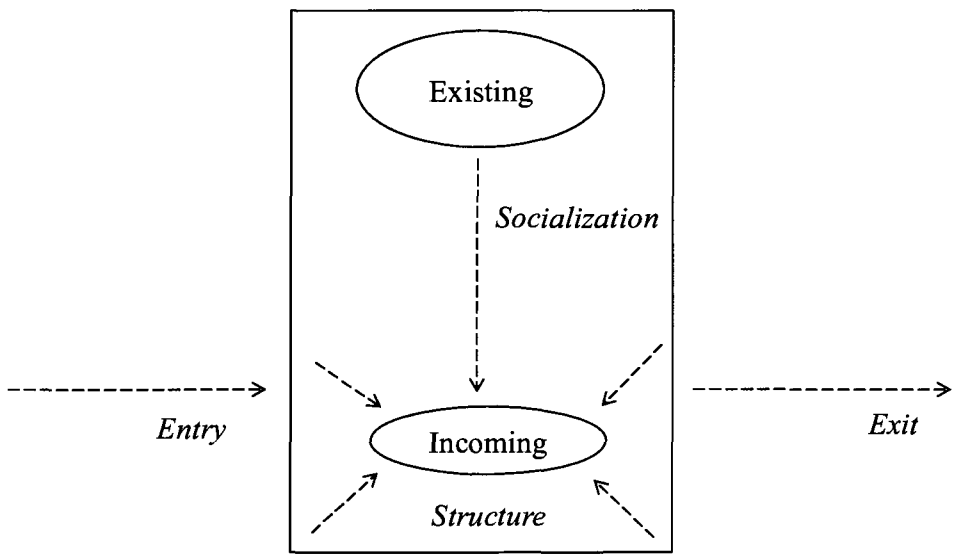


Figure 3.1: Persistence of Network Inequalities through Entry, Structure, Socialization and Exit

Entry provides one of the most potent mechanisms of shaping intra-organizational networks (Castilla 2005; Fernandez and Sosa 2005). Aspiring job candidates seeking employment provide information about their qualifications as well as their "fit" with organizational culture (O'Reilly

Iii, Chatman and Caldwell 1991). From a field of candidates, the organization chooses those whom it considers to have the necessary qualifications and fit. At one level, the selection of candidates determines demography; shaping the distributions of sex, ethnicity and race, educational qualifications, or age (Stewman 1988). At another level, the entry process tends to select individuals who represent the appropriate norms for membership in the organization. Homogeneity of entrants is therefore partly a consequence of a process resembling the Candidate-Audience Interface (Zuckerman 1999). The audience, consisting of existing employees responsible for selection of new entrants, defines appropriate categories for acceptable employees. As a result, successful entrants are those who conform to those categories.

Once entrants have been selected, several other processes begin to take hold. Structural features of the organization, such as distributions and authority relations, are factors that have been examined extensively with respect to their effect on the formation of intra-organizational networks. These factors as they have been conventionally parameterized in the empirical networks literature focus primarily on characteristics of the organization. These characteristics include formal authority relations (e.g. the organizational chart), organizational demography, physical layouts and distance, tenure, and departmental affiliations. Several studies have found that these factors explain much of the sex-differences in aggregate level measures of personal networks such as degree of homophily or centrality (Ibarra 1993). However, there are three related limitations to the current structuralist approach. First, one assumption is that factors such as one's location in the formal hierarchy or tenure are antecedents to differences in network structure. However, researchers have acknowledged that a reverse causality issue may be at play here (Ibarra 1992). The second is that factors such as sex or ethnic homophily not explained by the structural variables may be a consequence of fundamental differences in preferences, pre-

organizational socialization or explained as random error (Ely and Padavic 2007). However, it may be the case that the observed sex-differences that remain are induced by the organization itself in ways that cannot be adequately explained by the traditional structural variables. Furthermore, although enough people may behave in way that generates the statistical significance of a variable, it is not the case that those who do not, are doing so "randomly" or without consequence. Adherence to structure, as well as deviation from it, have important implications for both individuals and organizations.

A third limitation is a consequence of methodology. Regression analysis on cross sectional data often leads primarily to directional interpretation of the impact of variables on phenomenon of interest (e.g. "organizational tenure has a positive and significant affect on centrality") (Abbott 1988). Though in general this may be correct, it tends to detract from the relative importance of a variable of interest as compared to other variables in this organization or this specific variable in other organizations. For example, organization A may place significant emphasis on the norms concerning cross-status relations while organization B may do so to a lesser degree. Regression analysis may find that the direction and statistical significance may be the same for this variable in two organizations. Nevertheless, cross-status relations may be qualitatively quite different across the two settings and out-of-sample predictions based solely on the direction of the relationship between a variable and the network structure may be turn out to be inaccurate.

The literature on organizational socialization provides an alternative framing of the effect of structure and norms on new entrant behavior. Van Maanen and Schein articulate the role of socialization with respect to relationships in organizations as consisting of "... models for social etiquette and demeanor, certain customs and rituals suggestive of how members are to relate to

colleagues, subordinates, superiors, and outsiders" (Van Maanen and Schein 1977). This definition puts emphasis on the role of implicit organizational norms and the effect of these norms on entrants to *that* organization (Barley 1986). Reframing the structural and dispositional variables in existing analyses in this manner allows for reinterpretation of coefficient magnitudes, emphasizing their uniqueness to an organization. These coefficients can now be interpreted as organization specific weights for the importance of certain variables for predicting a phenomenon of interest. Furthermore, the process of socialization implies learning, and is thus embedded in time. If, through the process of socialization and a desire to minimize uncertainty, new entrants learn how things are done in their new setting and emulate the behaviors of similar others in the organization, their own networks should come to resemble those of the existing employees (Cialdini et al. 1999; Festinger 1954; Lawrence 2006; Rao, Greve and Davis 2001). That is, the networks of entrants converge to the organization-specific weights as those entrants spend more time within the firm.

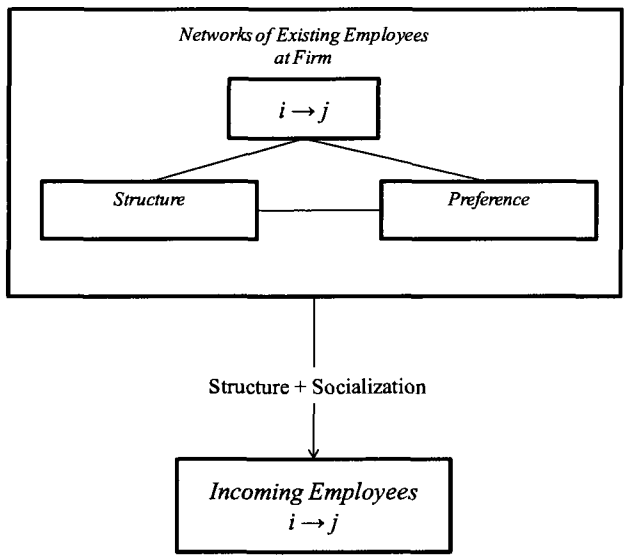


Figure 3.2: The role of Structure and Socialization in Emerging Networks

Figure 3.2 depicts the process by which norms about dyadic relationships in an organization are transferred to incoming employees. The observed dyadic choices and behaviors of existing employees and their perceived antecedents constitute the schemas by which the new entrants form their own relationships. These behaviors in aggregate, result in prominence or lack thereof for each individual in the newly formed network of entrants. If entrants model their network behavior after existing employees, then we would expect inequalities that are consequent of the dyadic choices of existing employees to be reproduced in the networks of entrants.

Hypothesis 1: *New entrants' actual centrality in the informal social network will, over time, converge to the* ***expected prestige****. That is, converge to the centrality expected of them if they and the other new entrants were to model their networks based on the observed dyadic choices and behaviors of existing employees.*

Although structure and socialization are powerful forces, the existence of non-conformity and the fact that it may result in penalties should not be surprising (Hsu and Hannan 2005; Phillips and Zuckerman 2001; Zuckerman 1999). In the study of network inequality, this aspect of structure is rarely studied. An individual's deviation from their expected prestige should influence not only how others perceive them but also how they perceive themselves and their networks. These perceptions, in time, should affect how entrants behave. Deviation from expectations can be of two types: negative and positive. Those who have negative deviation are performing worse than expected for someone of their type (e.g. same gender, ethnicity and formal position) and should feel less satisfied with their relationships as they compare themselves to similar others (Faunce 1989). Those who deviate positively, having higher

centrality than expected, may have legitimacy problems whereby they are unable to capitalize on their networks in the same way as those with similar centrality, but more legitimacy (Burt 1998). This again should induce less satisfaction with their relationships. However, the relationship between deviation from expectations and satisfaction need not be monotonic. A class of individuals, termed "high deviants" who stray far from expectations may be thought to deviate because they are oblivious or dismissive of norms. For them, we expect that deviation should have less impact on their relationship satisfaction than those who deviate moderately. In general, we expect the following hypothesis to hold.

Hypothesis 2: *Deviation from "expected prestige" will have a negative and U-shaped relationship with satisfaction with one's relationships in the organization.*

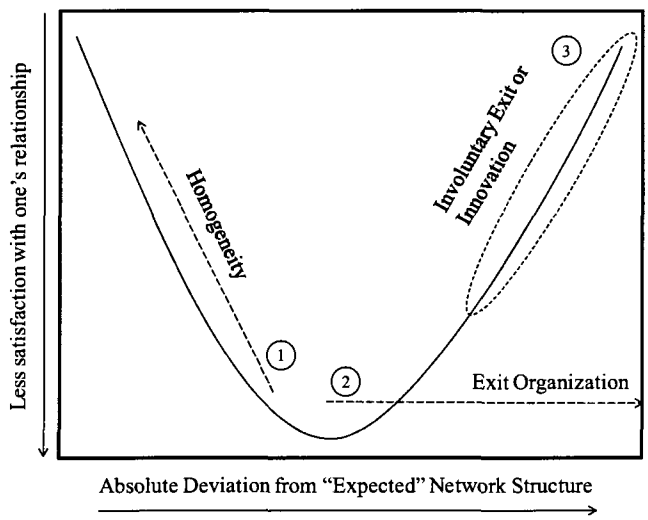


Figure 3.3: Network Centrality Deviance and Relationship Satisfaction

The anticipated effect of deviation on one's satisfaction with one's relationships at work, and its expected behavioral consequences, are depicted in Figure 3.3. At the bottom of the U-shaped

curve are the moderate-deviants. The satisfaction of these individuals is dampened the most because of the discrepancy between their expected and actual networks. We expect this group to have the greatest impetus for change. One mode of change is a shift towards conformity. In order to improve their satisfaction, these individuals begin to match expectations - reducing their deviation and improving their satisfaction. The second potential mode of change is an exit from the organization resulting from dissatisfaction (Hom and Kinicki 2001). Both modes in aggregate imply the same consequence for the organization: persistence of existing structures and inequalities. High deviants, who most likely constitute a very small subset of individuals, face two alternatives. The first is a forced exit from the organization for not complying with norms. The second and potentially more interesting is the prospect for innovation in expected prestige that such an individual might bring forth (Phillips and Zuckerman 2001).

In summary, we expect inequalities in social networks to persist because of two processes. The first is through forces consequent of the organizational structure and through socialization, broadly defined. New entrants, in order to reduce anxiety and uncertainty, model their networks after similar others in the organization, thereby reproducing inequalities (DiMaggio and Powell 1983; Festinger 1954). The second is through a process of conformity and selective exit resulting from a need to minimize dissatisfaction. Third, high deviants whose satisfaction is not significantly affected have the potential to become catalysts for change within the organization.

THEORETICAL SCOPE

A variety of informal social networks exist simultaneously within organizations (Ibarra 1993). These range from the instrumental, such as task-related advice, to expressive ones such as

friendship. We expect the hypotheses described in the previous section to hold in networks with two properties. The first is that relations should have relative stability. Ties in the networks should persist over long periods and regular shifts in task assignment should not result in major shifts in network structure. The second property is that relations should not be completely restricted by formal authority relations, and that individuals should have significant agency in choosing these relations. Networks that are strongly coupled with tasks that may change over time and networks that are restricted by formal authority relations minimize or eliminate individual agency and do not fall within the theoretical scope of this paper. We expect relations such as trust, social support and friendship to fall within our scope. Others such as task-related advice may not be as stable or give enough leeway to individuals in making network choices – and therefore an ability to model their behaviors after those of existing professionals.

DATA

To validate our hypotheses we used cross-sectional and longitudinal data from a large professional services firm located in the United States. Data consist of sociometric and demographic information on each individual in our study. Two populations of employees at the firm were delineated: new entrants consisting of a cohort of seventeen incoming analysts (IA) and a sample of 247 existing client-facing employees (EE) at all levels. The IA consisted of six males and 11 females spread across six offices with 77% of the IA located in three geographically proximate offices. The IAs participated by completing a sociometric survey for twelve consecutive weeks, beginning with their first day at the firm. For this group, we achieved a 100% response rate for each of the 12 weeks.

The existing professionals (EP) were spread across the geographic offices of this firm. These employees consisted of *analysts*, *laterals*, *partners* and a small set of high-level employees with different titles that we aggregated into a category called *other*. Two-hundred and forty seven (247) employees completed the entire survey (response rate = 54%). We did not find any significant difference between the respondents and non-respondents with respect to formal title ($p = .199$), sex ($p = .538$), ethnicity ($p = .728$), geographic location ($p = .404$), incoming friendship nominations ($p = .363$), or task advice nominations ($p = .900$). Table 1 describes the hierarchical distribution of the 82 women and 165 men in the final sample. The proportion of men and women is approximately balanced for analysts ($p = .261$), but with significantly more men at the level of partner ($p \leq .0001$). Overall, the hierarchical distribution, as presented in Table 3.1, by sex in our sample reflects both the composition of the entire firm as well as industry wide statistics.

Table 3.1 Distribution of respondents by hierarchical rank

	Analyst	Lateral	Partner	Other	Total
Gender	(1)	(2)	(3)	(4)	(5)
Females	42	11	22	7	82
Males	54	20	78	13	165
Total	96	31	100	20	247

Sociometric Questions

The longitudinal study of incoming analysts extended over twelve consecutive weeks, beginning with their first day at work. At the start of each week, all members of the IA cohort were asked to complete a sociometric survey asking them about two types of relationships they had with other members of their cohort. The cross-sectional component of the study was conducted on weeks 11 and 12 in order to allow respondents to fit the survey into their schedule. In addition to a network

generator question that subset the firm population to acquaintances all employees at the firm, respondents were sent a link to an online sociometric survey asking about the same relationships.

The sociometric questionnaire for the incoming analysts asked about two types of relationships they had with others in their cohort. Each respondent was provided a checklist with the names of all other incoming analysts and was asked to check the box next to the names of people:

- **Task-related advice:** "who you would approach for help or advice on work related issues",
- **Friendship:** "who you think of as friends here at [firm]."

For the online sociometric survey administered to the existing employees, each respondent initially checked the names of all those people who they knew well or at least knew of at the firm. After sub-setting to only the individuals that the respondent at least knew of, they answered the same sociometric questions pertaining to the two types of relationships they had with all other employees in the firm.

The cross-sectional survey of the existing employees, administered on weeks 11 and 12 produced two networks: task-related advice and friendship. The longitudinal study of the incoming analysts produces 12 networks for each of the two types denoting their relationships with the other incoming analysts.

Demographic Characteristics and Relationship Satisfaction

In addition to the sociometric data, human resources at the firm provided information on each person's sex, formal title, geographic location, and ethnicity. A question on the survey also provided us with information about the tenure in years for each of the existing employees who

responded to the survey. A 5-item scale about the incoming analysts' satisfaction with their work relationships was also included in the survey. Cronbach's alpha for this measure was *0.92*.

ANALYTIC FRAMEWORK

Given the nature of our first and second hypotheses, we will need to make out-of-sample predictions about the expected networks and related centrality for each of the entrants. In order to do so, we need to specify ex ante models about how we expect the network to form. In this section, we propose three competing models: physical distance or propinquity, sex homophily, and a logistic regression model of socialization.

Steps 1 and 2 consist of specifying models we use to make out-of-sample predictions about the networks of the new entrants and then using these models to predict the structure of the networks. Three models are constructed. The first two models provide counterfactuals to the socialization hypothesis and are based on directional theories about the role of two factors that have been shown to be important in the formation of social networks: propinquity (physical distance) and sex homophily. We formalize the propinquity based prediction as (Back, Schmukle and Egloff 2008; Nahemow and Lawton 1975). In a sense, this is our estimate of the probability that a tie between i and j exists.

$$\{f_{ij}^{pd}\}^{*} = \frac{1}{(1 + pd_{ij})^{2}}$$

Thus, the tie between i and j is proportional to the square of one plus the physical distance, here measured in miles, between them. The second model uses sex homophily as the basis for tie formation. It is specified as (McPherson, Smith-Lovin and Cook 2001):

$$\{f_{ij}^{gh}\}^* = \begin{cases} 1 & \text{iff } Sex_i = Sex_j \\ 0 & Otherwise \end{cases}$$

This model states that we predict a tie to exist if and only if the individuals are of the same sex and not to exist otherwise.

In addition to the robustness of these two directional theories in many settings, they comprise two of the most important variables on which individuals in our cohort vary. The cohort members do not vary in their formal status (all are analysts), tenure (have all just entered the organization), education (all have professional degrees from comparable universities), age, or ethnicity (except for two individuals, all are non-Hispanic white).

The third model uses a logistic regression estimated with the dependent variable as the probability that a tie from $i \rightarrow j$ exists, with predictors including variables for structural features, disposition, the existence of other network ties, and interaction terms. The estimated equation takes the form $p(i \rightarrow j) = \frac{\exp(z)}{\exp(z)+1}$ and $z = \alpha + \beta^c \boldsymbol{S}^c + \gamma^c \boldsymbol{D}^c + \delta^c \boldsymbol{N}^c + \zeta^c \boldsymbol{T}^c$.

where β^c, γ^c, δ^c, and ζ^c are the estimated coefficients for the variables of interest from the cross-sectional data and $\boldsymbol{S}^c$, $\boldsymbol{D}^c$, $\boldsymbol{N}^c$, and $\boldsymbol{T}^c$ are sets of vectors for each of the dyadic predictors from the cross-sectional sample; to be described in the next section. The coefficients produced by this estimation procedure β^c, γ^c, δ^c, and ζ^c and variables of interest from the longitudinal data are used to make predictions about the probability of existence of a tie from $i \rightarrow j$. Thus, we make predictions about the structure of the network from the logistic regression estimated with the cross-section and substitute the relevant variables from the longitudinal sample to make our prediction, with the equation taking the form:

$$\{f_{ij}^{l}\}^{*} = \exp(\alpha + \beta^{c}\boldsymbol{S}^{l} + \gamma^{c}\boldsymbol{D}^{l} + \delta^{c}\boldsymbol{N}^{l} + \zeta^{c}\boldsymbol{T}^{l})/(1 + \exp\alpha + \beta^{c}\boldsymbol{S}^{l} + \gamma^{c}\boldsymbol{D}^{l} + \delta^{c}\boldsymbol{N}^{l} + \zeta^{c}\boldsymbol{T}^{l})$$

Step 3 compares the accuracy of each of the model predictions about an individual's centrality (expected prestige) in the network and their actual centrality. Network centrality is operationalized as eigenvector centrality or aggregate prestige. The eigenvector centrality measure is based on the premise that an individual's centrality is determined by the centrality of its neighbors (Jackson 2008). Thus, in turn, a neighbor's centrality is determined by the centrality of its own neighbors.

There are two additional reasons for using eigenvector centrality as our measure of centrality. First, it has been the common measure for quantifying centrality in several important studies of network inequalities (Friedman and Krackhardt 1997; Ibarra 1992). The second is eigenvector centrality's relative robustness to network sampling (Costenbader and Valente 2003). To compare the quality of our predictions from each of these three models, we used the mean squared error (MSE) as our measure of fit, with $centrality_{i,t}$ being an individual i's actual centrality at time t and $centrality_{i,m}^{*}$ being predicted centrality from model m (Friedman, Hastie and Tibshirani 2001). This method penalizes larger errors more than smaller ones. The resulting output of this comparison is $MSE_{m,t}$, the mean squared error for each model m for time period t, with lower $MSE_{m,t}$ meaning better predictive power. If the logistic regression model estimated using the cross-sectional data out-performs the other two, this would provide support for hypothesis 1.

$$MSE_{m,t} = \frac{1}{n}\sum_{i=1}^{n}\left(centrality_{i,t} - centrality_{i,m}^{*}\right)^{2}$$

Finally in step 4 we examine the relationship that deviation D_i, measured as the difference between actual and predicted centrality, an individual i has from their expected prestige has on their satisfaction with their work relationships in order to test hypothesis 2.

In summary, step 1 consists of the estimation of the models we will use to make out-of-sample predictions about the networks of new entrants to this firm. Correlation among the matrices used in estimating these models is presented in Table 3.2. In step 2 we make predictions about the network and consequently about the centrality of males and females in the incoming cohort. Step 3 compares the predicted centrality from the physical distance, sex homophily, and logistic regression models using MSE as our measure of fit. Finally, in step 4 we evaluate how deviation from the expected prestige in the organization affects satisfaction with one's relationships.

VARIABLES IN THE ANALYSIS

This section describes the relevant variables included in the analytical framework.

Dependent variable. – The dependent variable in the dyadic choice logistic regression model is the friendship network at the firm. Respondents were asked to check the names of individuals whom the considered friends at the firm. A "1" indicates that the individual responding selected individual j as a friend and "0" if they did not. We did not delineate a specific definition of friendship, giving respondents the opportunity to make such discretions themselves.

Structural variables. – A variety of structural factors may influence how networks are formed. We include three variables, *office size* and *proportion female* to account for office level effects that may influence the density of ties. *Physical distance* measures the distance between i and j offices in miles. A robust finding is that the probability that any two individuals are

connected decreases with the physical distance between them. In addition to these office level and physical variables, we also included two variables related to an individual's tenure in the organization. The first variable is the individual i's actual tenure in the organization measured in years and the second is the difference in tenure between i and j. The first tenure variable is meant to take into account the fact that the greater number of years an individual spends in the organization, the larger the network they would be expected to have. The second takes into account how tenure differences between pairs of people may affect how one relates to the other. The final set of traditional structural variables consist of the nature of the hierarchical relationship between i and j. Four distinct relations are encoded into four variables taking into account whether i and j are analysts or partners. For instance, the variable $Associate \rightarrow Partner$ is "1" if and only if i is an analyst and j is a partner. This variable is coded as "0" otherwise.

For prediction purposes many of these variables are matrices with all elements equal to either "0" or "1." Since, all entrants are analysts and have the same tenure, tenure variables are set to "0." Furthermore, all hierarchical variables except the "Analyst to Analyst" variable, which is set to "1," are set to "0."

Dispositional variables. – In addition to the structural factors that may explain the friendship network, we also include what would traditionally be considered dispositional variables. Three variables encode whether i and j are respectively, Female and Male, Female and Female, or Male and Female, with "1" indicating yes and "0" otherwise.

Other networks. – Because over time, other relations may induce friendship we have also included the *Task Advice Network* as an explanatory variable. Furthermore, since reciprocity is a

strong balancing factor, a variable called *reciprocity* which is the transpose of the friendship matrix is also included. These variables are important in teasing out a more accurate measurement of the structural and dispositional variables included in the regression. However, in order to produce our equilibrium predictions about the network we exclude these variables from our set of predictors, setting the elements in these matrices to "0."

Interaction terms. – Three interactions between the dispositional variables and the task-advice network were included to test whether males and females differed in their tendencies to have multiplex ties (simultaneous ties of differing types such as friendship and advice between two actors) with same sex and opposite sex others. As with the *other network* variables, these coefficients are excluded from the actual prediction of in order to exclude the use of network variables in the prediction of the equilibrium structures.

Centrality. – In step 3, we compare the actual and expected prestige of the individuals in our incoming cohort. The centrality is computed as scaled eigenvector centrality, scores sum to unity.

Step 4 takes our prediction of an entrant's centrality if they chose their networks in the same fashion as similar individuals, and examines how deviation from this expected prestige would affect satisfaction with their work relationships.

Dependent variable. – Satisfaction at work has is shown to be important in predicting a variety of individual and organizational factors. In this study we focus on a construct called "Work relationship satisfaction." This construct consisted of five questions. Respondents were asked to indicate their degree of agreement with the following statements on a 5-point Lickert scale. The Cronbach's alpha for this measure was *0.92*.

- *The relationships I have at the firm fulfill my professional needs.*
- *I feel adequately connected to others at the firm.*
- *I am satisfied with the relationships I have at work.*
- *My professional relationships at work are as strong as they need to be.*
- *The interactions I have with others in my firm are satisfactory.*

Deviance. – The key variable of interest here is what we call deviance, it is the absolute difference between the predicted and actual centrality of the individual. In order to test our hypothesis that there is a negative and U-shaped relationship between deviation from expected prestige and satisfaction with one's relationships, we also include the square of the *deviance* term in our regression to test the non-linear hypothesis.

Control variables. – In the analysis for Step 4 we also include in our model one's *actual centrality*, their *sex* and the *number of individuals in their cohort who are co-located* with them.

ANALYSIS

Step 1.- The dyadic choices of the existing employees at this firm are estimated using a logistic regression model. Four models are estimated. The first model includes only the structural variables, the second only dispositional, the third other networks, and finally a full model is estimated with all terms and interactions. Because of the dyadic nature of the data and the potential for structural autocorrelation, a non-parametric test of significance called the Quadratic Assignment Procedure (QAP) is used for inference on the coefficients (Dekker, Krackhardt and Snijders 2007). The test provides unbiased significance tests on dyadic data even in the presence of structural autocorrelation and skewness. Table 3.3 presents the results for all four models. We avoid causal interpretations for this analysis, thus all relationships are assumed only to be correlations.

Table 3.2: Correlation table for cross-sectional analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable							
1. # People in Office							
2. Prop. Female	0.095						
3. Geographic Distance	0.006	0.037					
4. Tenure Similarity	0.022	-0.006	0.000				
5. Tenure	0.032	-0.008	-0.010	0.709			
6. Both Analyst	-0.044	-0.028	-0.018	0.000	-0.210		
7. Both Partner	0.026	-0.019	-0.020	0.000	0.196	-0.185	
8. Analyst / Partner	-0.045	-0.029	-0.017	-0.289	-0.217	-0.182	-0.191
9. Partner / Analyst	0.025	-0.019	-0.017	0.289	0.192	-0.182	-0.191
10. Female / Male	-0.037	0.001	-0.005	-0.131	-0.124	0.026	-0.052
11. Female / Female	-0.024	0.001	-0.010	0.000	-0.081	0.107	-0.089
12. Male / Female	0.018	0.000	-0.005	0.131	0.062	0.026	-0.052
13. Reciprocity	-0.002	-0.006	-0.049	-0.019	0.047	0.011	0.096
14. Advice	0.001	-0.019	-0.066	0.014	0.150	-0.059	0.189
15. Friendship	-0.010	-0.035	-0.049	0.019	0.075	0.011	0.096

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
9. Partner / Analyst	-0.188						
10. Female / Male	0.123	-0.103					
11. Female / Female	-0.018	-0.018	-0.188				
12. Male / Female	-0.103	0.123	-0.286	-0.188			
13. Reciprocity	-0.028	-0.047	-0.002	0.008	-0.037		
14. Advice	-0.034	-0.052	0.003	0.012	-0.032	0.330	
15. Friendship	-0.047	-0.028	-0.037	0.008	-0.002	0.414	0.399

Model 1 includes only the traditional structural variables. We see that the four variables in order of increasing importance in their association with the *absence of a tie* are the physical distance between the individuals in the dyad, the proportion of females co-located with i, whether the tie is from an analyst to partner, from a partner to an analyst, and the difference between i and j's tenure. Interestingly, partners are more likely to nominate an analyst as a friend as compared to the opposite. In addition, we find that the proportion female in an office is significant. This may be a consequence of the multi-colinearity with the office size variable, which turned out not to be a significant predictor. As the number of individuals in an office

increases at this firm, we also find that the proportion of females increase as well. Structural variables positively associated with the presence of a tie in order of decreasing importance are whether the two individuals are partners, analysts, and *i*'s tenure in the organization.

Table 3.3 Dyadic choice models for friendship network for cross section

	Structure	Preference	Other Network	Full Model
Independent variables	(1)	(2)	(3)	(4)
Structure				
Office size	-0.001			-0.001
Proportion Female	-1.646***			-2.192***
Normalized Distance$_{ij}$	-3.235***			-1.707***
Tenure$_i$-Tenure$_j$	-0.027***			0.001
Tenure$_i$	0.067***			0.007
Analyst→Analyst	0.609***			0.607***
Partner→Partner	0.789***			0.151*
Analyst→Partner	-0.668***			-0.748***
Partner→Analyst	-0.305***			-0.066
Disposition to opposite sex				
Female→Male		-0.657***		-0.920***
Female→Female		-0.045		-0.046
Male→Female		-0.180***		0.205$^+$
Network Variables				
Reciprocity (Friendship$_{ji}$)			2.346***	2.378***
Task Advice$_{ij}$			3.053***	3.073***
Task Interactions				
Task Advice$_{ij}$*(F→M)				0.165
Task Advice$_{ij}$*(F→F)				-0.124
Task Advice$_{ij}$*(M→F)				-0.102
Constant	-3.479***	-3.260***	-4.851***	-4.070***
BIC	16024.26	16979.93	10783.74	10528.75

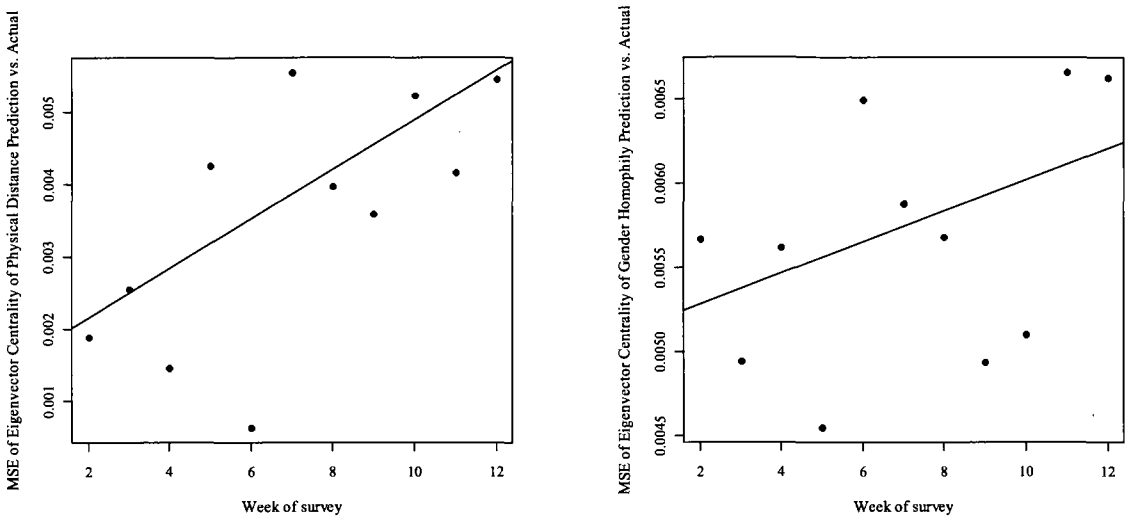
$^+p < .1$, $^*p < .05$, $^{**}p < .01$. All tests are two-tailed.
Note: Significance tests computed using Quadratic Assignment Procedure with reps =1000

Model 2 includes only the dispositional variables. In order of importance, we see that (a) ties from females to males are less likely to exist as compared to ones (b) from males to females.

With Model 3, which includes other network variables, we see that both reciprocity and having a "task-advice" relation are both strongly correlated with the existence of a friendship nomination from i to j.

Finally, Model 4, the full model which includes all variables, is the one we will use for predictive purposes. We find that four variables are most strongly associated with the absence of a tie from $i \rightarrow j$. These, in order of decreasing importance are: (a) the proportion of females in i's office, (b) the physical distance between i and j, (c) if i is a female and j is male, (d) and if i is an analyst and j is a partner. Conversely, the factors most strongly associated with presence of a tie are: (a) whether there also exists a task-advice relationship from $i \rightarrow j$, (b) reciprocity – that is a tie from $j \rightarrow i$, (c) whether both are analysts, (d) whether i is male and j is female, and (e) finally whether both are partners. We find that variables related to tenure are no longer significant. This relationship loses significance as a consequence of including the "other networks" variables. Furthermore, males and females, as they relate to those with whom they have advice relations does not seem to be significantly different.

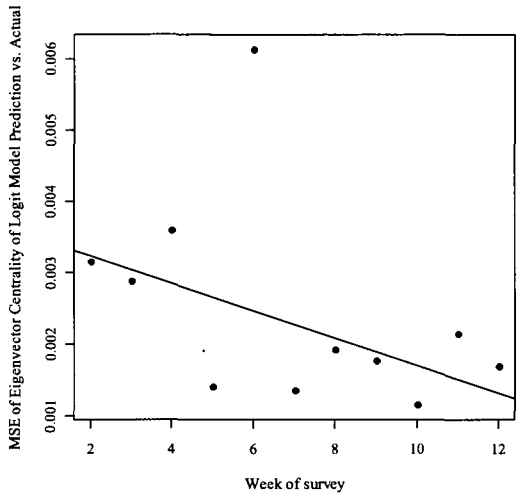
Step 2. – In the second step of the analysis we use the models of tie formation based on physical distance, sex homophily as well as Model 4 from the logistic regression analysis to make out-of-sample predictions about the intra-cohort centrality of the incoming analysts. Dyadic predictions are first made and then converted into scaled eigenvector centrality scores for each individual i. Figure 3.4 depicts plots of the prediction accuracy, as measured by MSE, for the first two models. We see that both have upward trends, though the one for sex homophily is not as steep. These suggest decreasing predictive quality over time.

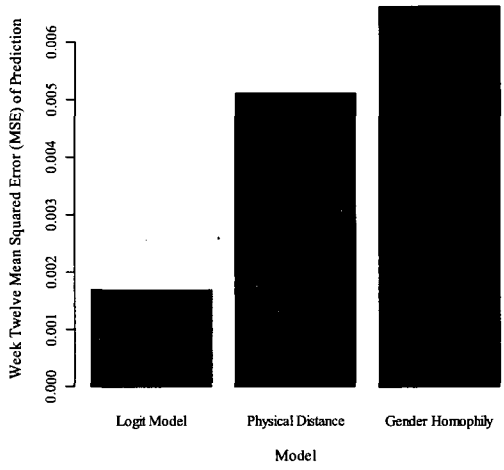


(4a) **(4b)**

Figure 3.4: MSE of Prediction for Physical Distance and Sex Homophily models

The distance model starts with a mean squared error of .002 and ends up with an error of .005, a 150% increase. The upward trend and its comparison to sex homophily, observed here suggests that simple propinquity is initially a robust phenomenon and may remain so, relatively speaking, over time. However, as time proceeds, other factors may begin to shape the network as well. The logit model, which takes into account a variety of structural and dispositional factors, performs 86% worse than the physical distance model in predicting centrality in the beginning, though at the $p < .1$ level. However, we see a significant trend toward better predictive capability over time. We find that at the 12^{th} week of the survey, the logit model performs significantly better than the *Physical Distance* model (two-tailed $p < .05$) with a mean reduction in MSE of .003, a 69% improvement over the distance model. This result provides some evidence for our first hypothesis that the networks of incoming analysts will come to resemble those of the existing employees at the firm. Figure 3.5a presents plots of the MSE for the logit model and Figure 3.5b presents the week 12 comparisons for all three models.





(5a) **(5b)**

Figure 3.5a: MSE of the Survey for the Logit Model over time
Figure 3.5b: Comparison of the MSE for Logit, Distance and Homophily models

Figure 3.6 provides a histogram of the mean actual and model predicted centralities for males and females entrants on week 12. In reality, males in this cohort have eigenvector centrality scores that are on average 190% larger than females ($p < .01$). A similar finding, however with less difference, is shown with the predictions made using the logit model, where we see that females have 65% less centrality than their male counterparts, and that this difference is significant at $p < .01$. On the other hand, no such difference is found with the physical distance model, and a completely opposite prediction is made with the sex homophily model – with females being the dominant group.

The predictions made using the logit model attempt to answer the question: *if entrants were to choose their networks in the same way as similar others in the existing organization, would the inequality implicit in their choices reproduce themselves in the networks of the entrants?* The analysis seems to provide evidence for this argument.

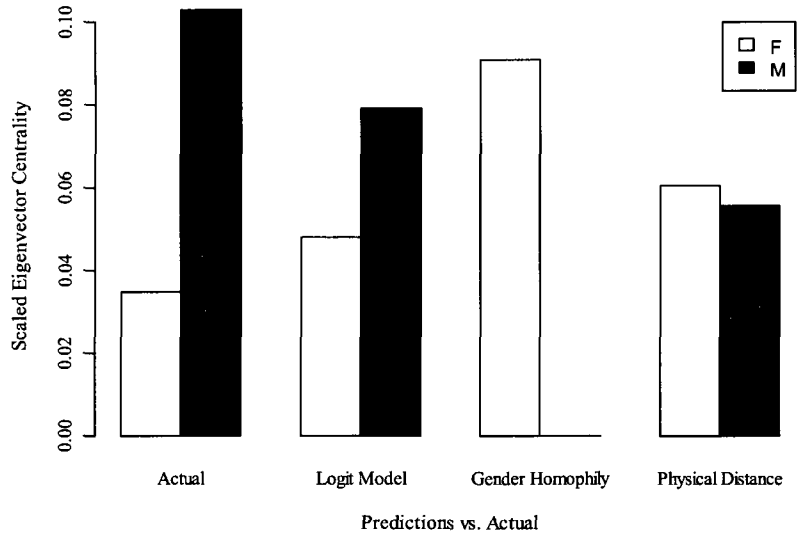


Figure 3.6: Male vs. Female Centrality for Week Twelve, Actual vs. Model Predicted

Step 4.- In the final stage of the analysis, we examine whether deviation from expected prestige (e.g. centrality implicit in the choice of similar others) affects how one feels about their relationships at the firm. A chi-squared test for outliers identified two observations with significantly high values, one for the satisfaction variable ($\chi^2 = 5.02, p < .05$) and another for the deviance variable ($\chi^2 = 12.55, p < .001$). Since our longitudinal sample size was comparatively small, these two observations would have significant influence on our results. In order to take into account the effect of these two outliers on our results, we estimated three models for testing Hypothesis 2. The first model included all observations, including the outliers, and found no significance for any of the covariates. The second model addressed the outlier problem by removing them from the analysis.

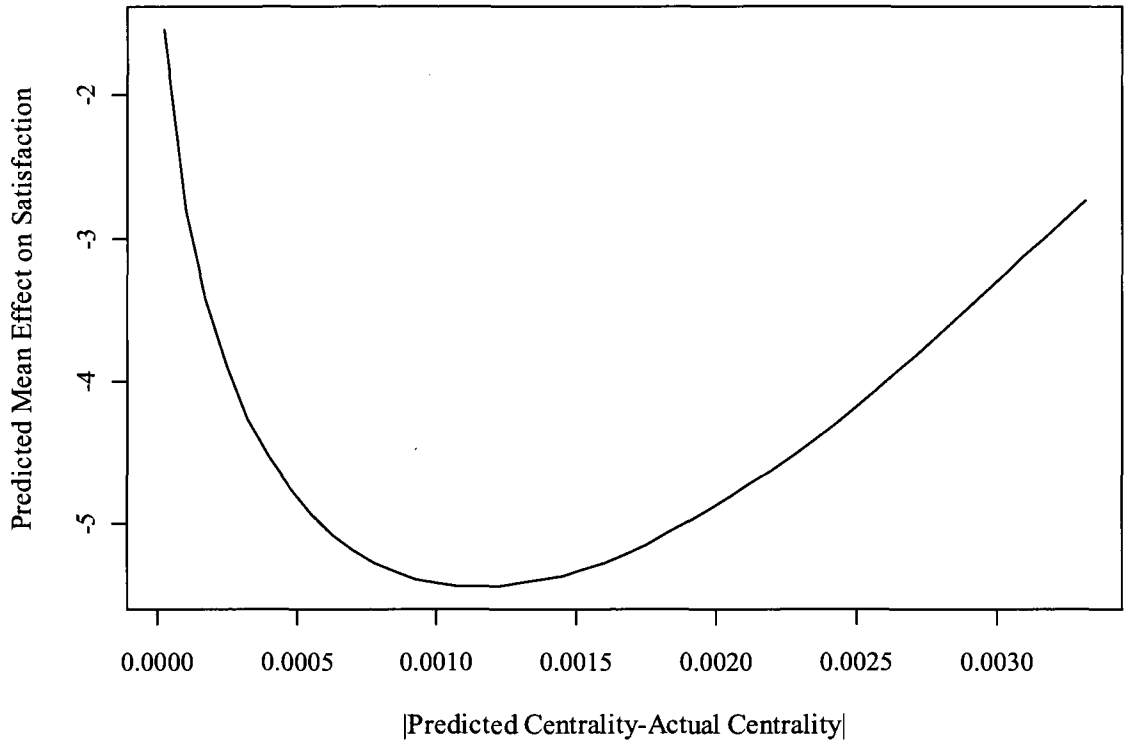


Figure 3.7: Predicted Mean Effect on Satisfaction vs. Absolute Deviance

Here we find, as hypothesized, a significant U-shaped relationship, depicted in Figure 3.6, between the deviation of the predicted centrality from the actual centrality on week 12. A similar relationship, though with less significance on the *absolute deviation* term was found with the iteratively re-weighted robust regression. Furthermore, as would be expected, we find in models 2 and 3 a significant and positive relationship between one's actual centrality on week 12 and satisfaction with one's relationships. Table 3.5 presents the results from these three estimations.

Table 3.5 Estimates of relationship satisfaction at week twelve

	OLS Estimates	Outliers Removed	Robust regression
Variables	(1)	(2)	(3)
Actual centrality	67.621	95.440**	95.639**
on Week 12	(40.719)	(24.456)	(28.704)
Absolute Deviation	-772.196	4828.313*	4838.991+
	(1167.80)	(1891.73)	(2614.08)
(Absolute Deviation)^2	49.155	-349.249*	-351.113*
	(117.38)	(127.52)	(156.96)
Sex	-1.116	-3.836	-3.847
	(3.257)	(1.899)	(2.204)
Co-located New Employees	-0.441	-0.384	-0.388
	(0.484)	(0.304)	(0.343)
Constant	17.082**	24.933***	25.025***
	(5.250)	(3.662)	(3.534)
Adjusted R^2	0.0508	0.7414	
F-Statistic	1.17	4.75	4.07
N	17	15	17

$^+p < .1$, $^*p < .05$, $^{**}p < .01$. All tests are two-tailed.
Note: Robust standard errors are reported for models (1) and (2).

The control variables in this analysis are not significant, suggesting that centrality and deviance from one's expected prestige are variables most strongly correlated with satisfaction. Although not conclusive, this analysis does suggest that individuals may in some ways be affected by how much they deviate from what is considered "prestige" or roles appropriate for a person of their type. Thus, deviation from as well as adherence to structure in the organization are both phenomena that should be of interest in understanding network differences. Several other regressions were estimated that include actual deviation (e.g. including both positive and negative deviation). When only the deviation (actual – predicted) variable was added to the regression with the outliers removed, it was not a significant predictor of satisfaction with one's relationships ($p = .344$). The other variables retained their qualitative significance, with actual centrality, absolute deviation and the square of absolute deviation all having significance values at ($p < .05$).

Possible Spuriousness.- Although we employed competing models of network formation, as opposed to a "random" null, there are still concerns that should be addressed. The first is that the logit model had significantly more variables than the two competing models – and thus may have an unfair advantage in prediction. However, because our tests were out-of-sample, the more complex logit model was at higher risk for overfitting the data and thus making significantly worse out-of-sample predictions (Wasserman 2004). To ensure that our results were not just the consequence of the number of variables, we compared the logit model to a generalized linear model with all the same variables, but coefficients drawn from a normal distribution with mean "0" and unit standard deviation. Running this simulation 10,000 times, we found that only 2.9% of the runs of this improper linear model had a MSE less than our cross-sectional logit model (Dawes 1979). The logit model estimated from the cross-sectional data performed significantly better at the $p < .05$ level. We also note that the physical distance model, although seemingly naïve, made significantly better initial predictions. Thus, the distance model has predictive validity in this context and can be justified as a competing model.

Aside from methodological concerns, there may be concern over whether it is actually the case that entrants reproduce existing inequalities because of socialization, or whether other factors are at play. On one hand, a selection argument can be made. The existing employees can be said to select those entrants who best fit the culture of the organization, and thus, replication of inequalities is a direct consequence of this. Though this argument has clear merit, our evidence suggests conformity occurs over time with an observed reduction in mean squared error, implying a process of learning.

CONCLUSION AND DISCUSSION

In this paper, we extend the literature on sex-differences in social networks and network formation on two fronts. First, we argue for a broader conceptualization of structure than has currently been employed in the literature on sex-differences in networks structures. In the framework presented, the traditional "structural" variables as well as variables that are often considered to be "dispositional" constitute the schemas that organizational entrants use to build their own networks. Our out of sample predictions using competing ex ante models of network formation provide empirical support for this hypothesis. Second, we argue that that "structure" has two sides: adherence and deviation, and these should also have implications. We find support for the hypothesis that moderate deviance affects satisfaction with one's relationships the most, with low and high deviance being less associated with dissatisfaction – a negative U-shaped relationship. Methodologically, we are able to overcome some of the limitations of cross-sectional analyses by using a combined cross-sectional and longitudinal study design that allows us to observe the networks of entrants as they form in the early months of their careers.

Although we attempted to overcome the limitation of a purely cross-sectional study by including a longitudinal component, there is no real substitute for a truly longitudinal study. Ideally, we would be able to track the careers and networks of individuals in an organization over a period of years or decades. This would have allowed us to empirically test other facets of our framework. Given this limitation, we were still able to find that in such a short time, entrants have for the most part reproduced the inequalities implicit in the choices of existing organizational members. Even the inconsistencies, in the form of deviance, provide some insight on the role of structure on satisfaction.

The second limitation of this study is the absence of a complete response rate for the cross-sectional survey. Despite the fact that we received a response rate of 54%, we did not find significant differences in the observable characteristics of respondents and non-respondents. Additionally, our sample of incoming analysts was limited in two ways. First, the sample size of 17, although comparable to the canonical Sampson (1968) and Newcomb (1961) studies, is relatively small (Newcomb 1961; Sampson 1968). A second limitation is the varied geographic distribution of these 17 individuals. This limitation however will be difficult to overcome in real organizational studies. Our firm is relatively large in comparison to most firms in this industry and the 17 individuals constitute the entire population of incoming analysts. We expect that future studies that examine this phenomenon may face similar sample size issues in their longitudinal study population. Nevertheless, we are reassured in some ways by the concordance of our results for the cross-sectional and longitudinal populations.

This paper provides a general framework that begins to address the tension between structuralist and dispositional perspectives on the disadvantaged position of women in intra-organizational social networks. By jointly employing the structuralist perspective and arguing that employees entering organizations form networks by modeling their behavior after similar others, we show that existing inequalities are reproduced. We also demonstrate that both adherence to and deviation from expected prestige are important phenomena – and should be studied in combination.

The analysis presented in this paper has implications for the study of social network formation and adds insight to the growing body of research on the interaction networks of women and minorities in organizations. The broader consequences of these durable inequalities

may provide a better understanding of the persistent organizational and occupational sex stratification despite equivalent human capital.

CHAPTER 4:

WEAK, STRONG AND SIMMELIAN BROKERAGE AND THE NETWORK DETERMINANTS OF TURNOVER

Abstract

In this chapter, I study the role of network structure on the tendency to exit the firm in the subsequent year. Consistent with existing theory, it is hypothesized that greater brokerage or tendency to bridge disconnected sub-networks reduces the probability of turnover. However, this chapter posits a more nuanced view of brokerage. I argue that the ties across which brokerage occur, matters as well. Drawing from Simmelian tie theory, I hypothesize that a sub-class of brokering relations (Simmelian brokerage) in which the focal actor brokers relations between two or more disconnected cliques, is positively associated with turnover. I argue that Simmelian brokers are most constrained and thus more likely to leave since they belong to two or more disconnected cliques, and must contend with potentially conflicting norms and expectations, which reduces their independence; and thus hinders their ability to use the novel information they get from being a broker. Using data from this mid-sized professional services firm, I find empirical support for the two main hypotheses. Implications for theory and future research on the relationship between personal networks and turnover in organizational settings are discussed.

INTRODUCTION

Every year, a substantial number of people leave their jobs, sometimes voluntarily and other times not. These exits can be classified into those occurring because of retirement, death, downsizing, involuntary dismissal as well as voluntary transition to another firm due to availability of better opportunities elsewhere. As a consequence of the sheer volume of exits and their implications for individuals, organizations, and the economy as a whole, the study of turnover has been an important endeavor for many social scientists (Cotton and Tuttle 1986; Griffeth, Hom and Gaertner 2000; Hom and Kinicki 2001; Mitchell et al. 2001; Tett and Meyer 1993). Research on employee turnover has examined a variety of contributing factors, both micro and macro. Factors such as perceptions about employment, the overall unemployment rate, and the presence of a union have all been shown to be important macro correlates. Other features germane to the organization and the employees' relation to it, such as pay, satisfaction and organizational commitment, also tend to correlate with whether people stay or leave (Mitchell et al. 2001). At the individual level, a variety of personal correlates such as age, tenure, gender, and education have shown to matter as well (Cotton and Tuttle 1986).

In addition to these individual, firm, and economy-wide variables, there is also research that suggests that informal social networks also affect turnover. Although few studies examine this phenomenon specifically, there is evidence suggesting that turnover does not occur randomly, but has network antecedents (Krackhardt and Porter 1985; Krackhardt and Porter 1986). On the other hand, there is a rich literature that examines the complementary phenomenon of promotion. Studies in this stream suggest that focal actors who were high in measures of betweenness and closeness or had networks rich in structural holes were more likely

to be promoted in subsequent years (Brass 1984; Burt 1992). Furthermore, individual mobility was enhanced by having large as well as sparse informal networks (Podolny and Baron 1997). The firms studied all had standard promotion processes where individuals are allowed to stay in their current position if promotion is not granted, with no specific date by which a promotion needs to occur. For instance, the study populations of several of these analyses included employees at a government bureaucracy (Brass 1984), a high-technology firm (Burt 1992; Podolny and Baron 1997), and a newspaper publishing company (Brass 1985a).

Conversely, another class of firms systematically dismisses junior employees if promotion is not granted by a certain date (Waldman 1990). Firms in this category include law, accounting, and consulting firms as well as academic departments. For instance, in an academic department if a junior professor is not granted indefinite tenure he/she might be given one year to look for another position before the employment contract is terminated. Unlike employees working for firms with traditional ladders, those working for firms with the up-or-out (UOO) processes face significantly more uncertain circumstances. If they are not promoted, it is likely that they will have to leave the firm. For the organization, the decision to promote or dismiss a junior employee is not without its perils either (O'Flaherty and Siow 1995). Firms face the problem of false positives and negatives. They may, on one hand, promote an employee who may not produce adequately in the future or dismiss an otherwise qualified and capable employee. Thus, understanding the factors that contribute to an individual's chances of exiting a firm is an important issue for not only the individual, but also the firm. Furthermore, as several empirical studies have demonstrated the importance of social networks for promotion decisions in firms with traditional processes, we hypothesize that social networks should matter in exit outcomes as well.

In this paper, we examine the relationship between features of an individual's social network and the probability that they exit the firm in the subsequent year. Specifically, we focus on the role of brokerage (Gould and Fernandez 1989), or the degree to which an actor connects otherwise disconnected individuals, in facilitating "survival" at the firm. Analogous to previous research on the importance of network structure, particularly brokerage or bridging ties, we also argue that those individuals with more opportunities for brokerage and thus access to more intra-firm knowledge and resources will be less likely to exit the firm. On the other hand, we argue for a more nuanced view of the role of network effects on turnover. We propose a decomposition of brokerage into three categories: weak, strong, and Simmelian. Weak ties exist when at least one individual in a pair indicates a tie, strong ties exist when both individuals indicate a tie, and finally a Simmelian tie is one where strong ties between actors are embedded in a clique (Krackhardt 1998; Krackhardt 1999; Krackhardt and Kilduff 2002). That is to say, a Simmelian dyad consists of two actors who are strongly connected to each other and are strongly connected to the same third party or parties.

Simmelian tie theory argues that strong and Simmelian ties are qualitatively different, and thus brokerage in these two circumstances should have different implications (Krackhardt 1999; Tortoriello and Krackhardt In press). The theory argues that "solely dyadic ties may provide comfort, support, and information" and these ties give people "power to act independently." However, once a tie is embedded in a triad, the individual now has to abide by the rules and norms of the group in order to remain a member (Krackhardt 1999). Thus, those who play brokering roles in Simmelian networks are more constrained than if brokerage was not Simmelian. We postulate that this type of brokerage should have negative implications for that individual.

Consistent with the "ties that torture" hypothesis of Simmelian tie theory, we show that a person's probability of exit decreases with their degree of brokerage in the strong friendship network but increases with their brokerage in the Simmelian network. That is to say, while brokering increases the chance of staying, brokering across cliques actually reduces it. By introducing the decomposition of brokerage into weak, strong, and Simmelian brokerage, and showing that not all brokering is equal in predicting turnover, we make an important contribution to the literature on intra-organizational social networks, mobility, and turnover.

In the remainder of this paper, we present and empirically validate our theory and hypotheses using data on the networks and exits of 241 client-facing employees at a professional services firm in the United States. We begin with a brief discussion of the literature on turnover, networks and mobility, Simmelian tie theory and then subsequently present our hypotheses. Next, we describe our study population, methodology and our empirical results. Finally, we conclude with a discussion of our results and implications for further research.

THEORY

A variety of factors contribute to both voluntary and involuntary job exits (Cotton and Tuttle 1986; Griffeth, Hom and Gaertner 2000). Meta-analysis of the turnover literature shows that demographic factors such as gender, age and marital status often determines job turnover (Cotton and Tuttle 1986). Women, for instance, have a higher rate of turnover than men; though this does not seem to hold in more recent studies (Griffeth, Hom and Gaertner 2000). Other personal characteristics such as age and marital status tend to be negatively correlated with turnover – signifying that older as well as married workers are more likely to stay, than leave. In addition to demographic variables, one's tenure in the organization is also shown to be negatively associated

with leaving (Griffeth, Hom and Gaertner 2000). The longer an individual has been working at an organization, the less likely they are to leave in subsequent years (Griffeth, Hom and Gaertner 2000). Aside from these personal characteristics, work-related factors such as satisfaction, repetitiveness of tasks, and role clarity also significantly predict turnover. For instance, satisfaction with one's job is strongly correlated with the absence of turnover (Tett and Meyer 1993). Research suggests that satisfaction with not only the work itself, but also with co-workers, promotions, and pay are all negatively associated with exits (Cotton and Tuttle 1986; Griffeth, Hom and Gaertner 2000; Hom and Kinicki 2001). Simply put, people who are satisfied are more likely to stay in their jobs.

In addition to the traditional research on the determinants of turnover, there is also some work suggesting that one's social networks are also important. In a study of employees at a fast food restaurant, Krackhardt (1986) finds that turnover did not occur randomly but occurred because of role similarities in the communication networks within the organization. In another study, Krackhardt (1985) finds that turnover affects the attitudes of friends who stay, with stayers becoming more satisfied and committed. Aside from these early studies, there has been little additional work on the relationship between intra-organizational social networks and turnover.

There is, however, a rich literature that examines the role of social networks in facilitating the complementary phenomenon of intra-organizational mobility, namely promotion. For instance, Brass (1984) finds that those individuals who were central in the informal social networks at a newspaper publishing company were more likely to be promoted in the three years following the original data collection. Network centrality, particularly access (closeness centrality) and control (betweenness centrality) were significant predictors of promotion (Brass 1984). That is, those individuals who had short paths to others (closeness) in the firm and those

who played brokering roles (betweenness) were more likely to be promoted into the supervisory ranks. In his influential research on social networks and competition, Burt (1992) examines the role of social networks on the promotion outcomes of managers. Similar to the concept of betweenness, structural holes theory describes the tendency to bridge otherwise disconnected components of the network, but in an efficient manner, without the encumbrance of redundant ties that provide no additional benefit (Burt 1992). He finds for those White males with structural holes in their personal networks, promotions came faster than their peers did. Other studies have shown similar relationships between informal networks and promotion. Podolny and Baron (1997), for instance, find that having a large as well as sparse informal network provides the actor with valued information and resources, and thus increases promotion chances. Another study also finds similar results, with structural holes significantly predicting promotions over one's career (Seibert, Kraimer and Liden 2001).

We believe that the consistent nature of these findings suggests that brokerage – or bridging unlinked groups - should also have an effect on turnover, particularly in situations where the promotion process resembles an "up-or-out" system. Systems such as these are often found in accounting, law, academia, and professional services consulting. Employees are usually hired at the lowest level of the firm, either directly from college or from graduate school, and are then subsequently promoted up through the ranks. Promotion continues until the employee reaches the most senior positions in the career ladder: full professor in an academic department or partner in an accounting firm. On the other hand, if promotion does not occur by a specified date, the employee under normal circumstances must leave the company and find a new job. Thus, exit (or turnover), in this context is particularly telling. Promotions are scarce and individuals at the same level in the career ladder must compete with each other in order to keep

their jobs. If networks, and particularly brokerage in networks, are important in promotion decisions in firms with traditional promotion systems, they should be as important in predicting exits in up-or-out systems as well.

However, we believe that brokerage should have similar effects regardless of whether turnover is voluntary or involuntary. Brokerage in intraorganizational social networks represents firm-specific social capital. The information and resources that are a consequence of the network position of the individual, although potentially useful outside of the organization, are most useful within it. These benefits in many cases include organization-specific gossip, career guidance or mentorship, as well as the independence *within* the organization to apply this information to individual and group productivity and career advancement. Thus, brokerage should be beneficial for reducing the likelihood of involuntary turnover because it should increase productivity (Mehra, Kilduff and Brass 2001) – and thus reduce likelihood of termination because the employee produces value for the firm. On the other hand, brokerage should also reduce the likelihood of voluntary turnover because it increases the chances of internal advancement and pay (Brass 1984; Burt 1992; Podolny and Baron 1997) – factors that have been shown to reduce voluntary turnover (Cotton and Tuttle 1986; Mitchell et al. 2001).

But what type of networks and what kind of brokerage should predict turnover? Informal intraorganizational networks come in a variety of flavors, but they can generally be broken down into two types: *expressive* and *instrumental* (Ibarra 1992; Ibarra 1993; Podolny and Baron 1997). Expressive networks consist of relations such as friendship or trust, and provide individuals with social support, organizational gossip and other information that may be strategically useful (Podolny and Baron 1997). Instrumental networks on the other hand, consist of relationships that often are consequent of job interdependencies and may consist of such relations as seeking task-

related advice ("how do I do this part of my job?") from a colleague, superior or subordinate. These ties often do not contain the richness of sensitive information or emotional content that expressive ties do. Thus, we expect that in an organization with a competitive up-or-out promotion system, information and resources that may provide an individual with an edge in promotion should come from their expressive network and not their instrumental network.

The nature of the transmitted content varies not only across networks, but also across ties with differing strengths (Krackhardt 1992). Weak ties in organizations are those that exist if at least one person acknowledges a tie. For instance, if an individual i indicates that j is a friend, then we assume a tie to exist. Thus, the network structure consists of the underlying undirected graph. Although weak ties often do provide individuals with new information, they are not as "available" and do not have the "motivation to be of assistance" as do strong mutual ties where both individuals indicate that the other is a friend. As Krackhardt (1992) articulates in his discussion of Granovetter (1982), strong ties are "much more likely to be useful to the individual when that individual is an insecure position" (Granovetter 1982; Krackhardt 1992). Potentially losing your job is often as insecure a position an employee will face within an organization. Thus, we argue that the benefits of brokerage in this context should be more pronounced in the strong tie friendship network, than in the weak tie network. Brokerage in the strong tie network should provide not only new information from disparate sources, but also the assistance and availability that are consequent of the strong ties. Thus, we hypothesize:

Hypothesis 1: *Greater brokerage in the strong tie friendship network is negatively associated with leaving the firm in the subsequent year.*

However, we argue that the relationship between brokerage and turnover is not so straightforward. Structural holes theory argues that the effect of brokerage is dampened by redundancy in ties (Burt 1992). According to the theory, dampening occurs when an individual no longer has unique access to information (ego's alters are themselves connected) or is applying effort in maintaining ties that do not provide new information (ties to two individuals from the same clique). Consequently, Burt incorporates this dampening effect into his measure of brokerage called *constraint*. The measure has two basic components: (a) the benefit derived from unique contacts and (b) the penalty incurred for redundancy. If structural holes theory provides the correct measure of brokerage in this situation, then the constraint measure should be positively associated with the probability of exiting the firm even in the place of statistical controls. Consequently, those individuals whose networks have more structural holes should be more likely to stay.

However, Simmelian tie theory offers a different conceptualization of brokerage and constraint. Figure 1, adapted from Krackhardt (1999) depicts the ways in which Simmelian tie theory differs from Structural holes theory (Krackhardt 1999). Figure 4.1a, where ego is connected to four actors who themselves are not connected to each other, is considered by both theories to be the least constraining situation. Ego has information from four unique sources and all communication flows through her. Figure 1b is where the two theories begin to differ. Structural holes theory argues that this is most constrained scenario for Ego. Her contacts do not provide much new information since most of them already share information with each other.

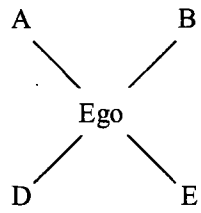
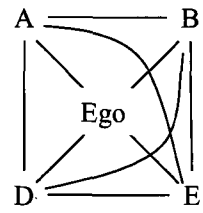
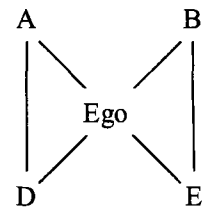
Figures of Brokerage	 (a)	 (b)	 (c)
Structural Hole Theory	Least Constrained	Most Constrained	Somewhat Constrained, But also empowered as bridge between 2 Cliques
Simmelian Tie Theory	Least Constrained	Somewhat Constrained, but only by 1 Clique	Most Constrained, must satisfy 2 Cliques

Figure 4.1: Constraint in Simmelian tie theory vs. Structural holes theory

* Adapted from Krackhardt (1999)

Simmelian tie theory on the other hand, argues that constraint comes not only from the number or from redundancy of ties, but also the degree to which these ties are embedded in strongly connected cliques or triads. The triad, it is argued, is qualitatively different from the dyad. Whereas dyadic ties provide "comfort, support, and information" and the ability to act independently – ties embedded in triads do not (Krackhardt 1998; Krackhardt 1999). Substantively, it is argued that ties embedded in triads are different. Groups develop norms and rules that each member must follow, or face the threat of rejection. Thus, ties embedded in triads are constraining because individuals must conform to the norms and expectations of the group. The Simmelian interpretation of Figure 4.1b is that ego is constrained, but only somewhat, since she has to abide by the norms of one clique.

Finally, the Structural holes interpretation of Figure 4.1c is one where ego is somewhat constrained, but also empowered since she bridges two otherwise disconnected cliques and has access to non-redundant information. The Simmelian interpretation is fundamentally different. It

argues that of the three networks presented, Ego is most constrained in this scenario. She is a member of two cliques, each with different and potentially conflicting norms and expectations about attitudes and behavior. Her action is severely restricted. In pleasing one clique, she may make the other dissatisfied. Consequently, the more brokerage one has across cliques (Simmelian brokerage), the more restrictions there should be on one's actions. As a result, the main benefits of increased brokerage on mobility, namely new information and the independence and freedom to use it, are severely diminished when that brokerage occurs across cliques. For this reason, we depart from Structural holes theory by analytically separating the positive effects of brokerage from the negative when it occurs across cliques. Thus, we hypothesize that:

Hypothesis 2: *Greater brokerage across cliques (Simmelian brokerage) is positively associated with leaving the firm in the subsequent year.*

Until now, we have mostly framed our discussion of Simmelian brokerage vis-à-vis involuntary turnover in up-or-out scenarios since it is most analogous to the lack of promotion in traditional scenarios. However, we argue that hypothesis 1 & 2 still hold if turnover is voluntary. As discussed earlier, greater brokerage increases one's access to and ability to use network resources for their benefit within the firm. Thus, they should be expected to stay since they are achieving relative success within the firm and should therefore be at lower risk for leaving or being dismissed. Similarly, we expect that when the individual decides to leave on their own accord, greater Simmelian brokerage may have placed individuals in situations where the conflicting norms of multiple cliques severely constrained their behavior to such an extent that the tension could only be resolved through an exit.

In the next section, we describe our study population and the variables used in the analysis of our hypotheses. In the fourth section we present the results of our empirical analysis and then finally conclude with a discussion of the implications of our work.

METHOD

Study Population

In order to test our hypotheses we used data on the networks and turnover of client-facing professional employees (hereafter refered to as *employees*) at a professional services firm. The firm has multiple offices spread across several adjacent US states, with 40% of the employees located at the firm's headquarters. Human resources at the firm provided names of all relevant employees in each of the offices at the firm. An email with a link to an online survey was sent to each of these employees. A response rate of 51% was achieved, resulting in a total of 241 complete surveys. Our final sample consisted of 38.9% analysts, 40.4% partners, 12.6% of "senior non-partner lateral hires", and 8.1% other senior level employees with administrative roles we categorized as "other." Furthermore, 33.2% of our sample was female. No significant differences were found between the respondents and non-respondents with respect to formal title ($p = .199$), sex ($p = .538$), ethnicity ($p = .728$), geographic location ($p = .404$), incoming friendship nominations ($p = .363$), or task advice nominations ($p = .900$).

In the year after the survey was administered, 27 individuals, or 11% of these employees were no longer employed by the firm. Males and females had approximately equivalent rates of exit at 11.5% and 9.8%, respectively. Of those who left 52% were analysts and 41% were partners. The mean tenure of analysts who exited was 2.49 vs. 3.89 for stayers ($p < .05$) and for partners the mean tenure of those who exited was 4.6 vs. 11.27 for those who stayed ($p < .001$).

The large and significant difference in tenure of the exiting and staying partners may be the consequence of new policies that were developed in order to ensure flexibility in dismissal if performance was lacking. The policies include stipulations whereby laterally hired partners were initially in a probationary period lasting several years before they could be considered "full" or "equity partners." The lower average tenure for exiting partners suggests that these individuals were mostly lateral hires from other firms. However, because data did not provide the reason for the exit, we are unable to determine whether the turnover was voluntary. Therefore, no separate analysis was conducted to determine differential effects of networks by exit type. Nevertheless, we believe the benefits and constraints of brokerage should hold, on average, regardless of the exit type.

Instrument

The online questionnaire completed by respondents consisted of sociometric (network) questions and questions about tenure and satisfaction with opportunities for success and appreciation at the firm. Human resources also provided data on gender, formal position, and office location. The sociometric questions completed by respondents began with a roster of all relevant employees at the firm. Respondents were asked to check the names of employees whom they knew well or at least knew of at the firm. After sub-setting to only the individuals that the respondent at least knew of, they answered questions about their task-related advice network and their friendship network. Individuals were asked to check boxes next to the names of people:

- **Task-related advice:** "who you would approach for help or advice on work related issues",
- **Friendship:** "who you think of as friends here at [firm]."

The satisfaction questions were administered using a 5-point Likert scale (from "strongly disagree" to "strongly agree"). The first set of questions was related to whether respondents felt they had enough information available about promotion and *success* at the firm. Alpha reliability for this measure is .88.

- The promotion process at my firm is easy to understand.
- I get very useful information about my firm's promotion process.
- I have a very good idea of what it takes to succeed here.
- I know most things I need to know in order to succeed at this firm.
- I have adequate access to the information I need to succeed here.

Satisfaction with the *appreciation* one receives from the firm was assessed using the following items. Alpha for this measure was .90.

- The firm shows an appropriate level of appreciation for my work.
- My importance to the firm seems will understood.
- The firm realizes the full value of my contributions.
- My presence at this firm is highly valued.
- I receive the right amount of acknowledgment for the work I do here.

Control variables

Control variables were constructed in the following manner. In order to take into account sex-differences in turnover, an indicator variable for whether the respondent was *male* was included. Formal position at the firm was indicated with dummy variables for *senior lateral non-partner*, *other* and *partner*. The omitted category was *analyst*. Another indicator variable specifying

whether the respondent was working at the *headquarters* was also included. *Tenure* in years, as well as the sum of each of the items for the two satisfaction scales were included as *success* and *appreciated.* Consistent with extant theory, we expect *tenure, male*, *partner*, *success* and *appreciated* to be negatively associated with turnover. These variables are included in all models.

Network variables – degree centrality

Indegree and *outdegree* for both the task-related advice and the friendship network were included in models 2-7. Indegree and outdegree for the advice network indicate the number of people who say they come to Ego for advice and the number of people Ego says they go to for advice. Indegree in the advice network suggests that many people consider Ego a source for information about how to complete tasks or how to get their job done. It, in some ways, is a measure of the level of task-related knowledge that a person at the firm is thought to have by his/her colleagues. Similarly, indegree and outdegree in the friendship network indicate the extent to which Ego is considered a friend by their colleagues (popularity) and the extent to which Ego considers their colleagues as friends (gregariousness). All degree variables are highly correlated. Indegree in friendship and advice have significantly high correlation of .759.

Structural Holes

The variable used to measure the degree of *structural holes* in Ego's network is one minus *constraint* (Burt 1992). Constraint is calculated as $c_i = \sum_{j \neq i}(p_{ij} + \sum_{k \neq i, k \neq j} p_{ik} p_{ij})^2$ where p_{ij} is the amount of effort that an actor i directs towards their relationship with j, where $p_{ij} = \frac{z_{ij}}{\sum_j z_{ij}}$ and z_{ij} is the amount of effort i puts into a relationship with j or in dichotomous networks,

whether an $i \rightarrow j$ tie exists. If i and j are not connected, then p_{ij} is zero. It can be seen that when individuals add redundant ties, constraint increases. As a consequence, the independence, novel information, and resources of ego are also theorized to decrease. The structural holes variable, as expected, is significantly correlated with the other network measures.

Weak, Strong and Simmelian Brokerage

To test our primary hypotheses we construct three brokerage measures using the graph level betweenness measure and the friendship network, represented by the matrix $\boldsymbol{F}$, at the firm (Freeman 1977; Freeman, Borgatti and White 1991). We begin by formally defining the three structures representing the weak, strong and Simmelian networks (Dekker 2006; Krackhardt 1998; Krackhardt and Kilduff 2002).

- The weak friendship network $\boldsymbol{F^w}$ is defined where $F^{w}_{ij,ji} = 1$ if $F_{ij} = 1 \cup F_{ji} = 1$. That is, if at least one individual in a dyad indicate a tie, a tie exists.
- The strong friendship network $F^s$is defined where $F^{s}_{ij,ji} = 1$ if $F_{ij} = 1 \cap F_{ji} = 1$. That is, a tie only exists if both individuals in dyad are in agreement about their friendship.
- The Simmelian friendship network F^m where $F^{m}_{ij,ji} = 1$ if $F_{ij} = 1 \cap F_{ji} = 1$ and $\exists\ k$ such that $F_{ik} = 1 \cap F_{ki} = 1$ and $F_{jk} = 1 \cap F_{kj} = 1$. That is, a Simmelian tie is said to exist only if i and j have a strong tie embedded in a clique. These actors (i, j) therefore have strong ties to some third alter k.

The betweenness centrality measure is calculated on each of the networks to yield, *weak*, *strong* and *Simmelian brokerage* scores for each of the employees at the firm. Betweenness is calculated as $B_i = \sum \frac{\sigma_{jk}(i)}{\sigma_{jk}}$, where σ_{jk} is the number of shortest paths from j to k and $\sigma_{jk}(i)$ are the number

of shortest paths from j through k that pass through individual i. The individual i has high betweenness if she acts as a bridge more often than others between all other actors j and k in the network. Correlations among all independent variables are presented in Table 4.1.

Table 4.1 Correlation among variables in analysis

	Mean	Sd	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables											
1. Turnover	0.11	0.31									
2. Tenure	7.32	7.36	-0.19*								
3. Male	0.67	0.47	0.01	0.17*							
4. Success	15.30	4.15	-0.11	0.16*	0.24*						
5. Appreciation	15.01	4.32	-0.14*	0.04	0.23*	0.74*					
6. Senior Lateral non-partner	0.13	0.34	-0.09	0.13	-0.02	-0.06	-0.10				
7. Other	0.08	0.28	-0.06	-0.10	-0.01	0.00	0.09	-0.12			
8. Partner	0.41	0.49	0.01	0.37*	0.18*	0.13*	-0.09	-0.32*	-0.25*		
9. Headquarters	0.40	0.49	-0.17*	0.23*	-0.03	0.06	0.02	0.07	-0.06	0.05	
10. Structural Holes	0.77	0.19	-0.26*	0.35*	0.02	0.19*	0.05	-0.04	-0.14*	0.31*	0.41*
11. Indegree Friend	7.76	5.37	-0.23*	0.39*	-0.03	0.23*	0.09	-0.12	-0.08	0.32*	0.53*
12. Outdegree Friend	7.95	9.44	-0.15*	0.34*	0.12	0.12	0.10	-0.03	-0.10	0.27*	0.26*
13. Indegree Advice	24.03	17.41	-0.22*	0.55*	0.08	0.26*	0.08	-0.04	-0.06	0.54*	0.46*
14. Outdegree Advice	24.56	23.90	-0.17*	0.47*	-0.04	0.21*	0.04	-0.02	-0.15*	0.37*	0.33*
15. Weak Betweenness Friendship / 1000	0.46	0.96	-0.11	0.28*	0.07	0.14*	0.10	-0.04	-0.06	0.27*	0.00
16. Strong Betweenness Friendship/ 1000	0.58	1.12	-0.16*	0.19*	0.12	0.10	0.09	-0.10	-0.01	0.23*	0.09
17. Simmelian Betwn. Friendship/ 1000	0.05	0.15	-0.06	0.28*	0.05	0.15*	0.14*	0.00	-0.10	0.14*	0.34*
18. Weak Betweenness Advice / 1000	0.26	0.45	-0.11	0.38*	0.01	0.21*	0.02	-0.03	-0.02	0.32*	0.14*
19. Strong Betweenness Advice / 1000	0.39	0.77	-0.11	0.37*	0.05	0.23*	0.07	-0.08	-0.10	0.38*	0.05
20. Simmelian Betweenness Advice/ 1000	0.27	0.59	-0.10	0.37*	0.06	0.22*	0.09	-0.09	-0.09	0.35*	0.07

Variables	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
11. Indegree Friend	0.61*									
12. Outdegree Friend	0.45*	0.40*								
13. Indegree Advice	0.56*	0.76*	0.40*							
14. Outdegree Advice	0.42*	0.57*	0.41*	0.61*						
15. Weak Betw. Friendship/ 1000	0.31*	0.30*	0.79*	0.34*	0.30*					
16. Strong Betw. Friendship / 1000	0.30*	0.48*	0.62*	0.35*	0.37*	0.55*				
17. Simmelian Betw. Friendship / 1000	0.26*	0.58*	0.53*	0.39*	0.38*	0.31*	0.48*			
18. Weak Betw. Advice / 1000	0.30*	0.48*	0.23*	0.69*	0.72*	0.28*	0.29*	0.27*		
19. Strong Betw. Advice / 1000	0.26*	0.45*	0.26*	0.57*	0.70*	0.36*	0.34*	0.25*	0.78*	
20. Simmelian Betw. Advice / 1000	0.25*	0.44*	0.26*	0.57*	0.70*	0.31*	0.36*	0.29*	0.73*	0.93*

Note: $p < .05$

RESULTS

Logistic regression was used to evaluate the validity of our hypotheses. We modeled the probability of exit in the subsequent year as a function of the independent variables. In total, seven models are presented. All models include the following controls: *tenure* (in years), whether the respondent was a *male*, *senior lateral*, *other*, *partner*, located at the firm's *headquarters*, and the two satisfaction measures – *appreciation* and *success*. Models 1 and 2 evaluate the effect of structural holes on the probability of exit. Models 3-6 successively add the relevant network variables to examine whether hypothesis 1 & 2 have empirical support. Finally, model 7 examines whether the brokerage effect on tenure holds for other network types, namely an instrumental network such as task-related advice.

In Table 4.2, we present the logistic regression models that test our main hypotheses. We used a quasi-binomial link function for the logistic regression because of overdispersion in our data. However, results remained qualitatively the same with the logistic regression and a binomial link function. All models use robust standard errors for hypothesis tests on the coefficients (White 1982).

Model 1 finds that the *structural holes* variable, after controlling for several characteristics, is significant ($p < .05$) and negative. This suggests that those with more structural holes in their networks are significantly less likely to leave. The control variables that are significant in this regression, as predicted by theory are tenure ($p < .05$), and whether people are satisfied with their appreciation at work ($p < .1$).

Table 4.2 Logistic Regression model of probability of exiting the firm in subsequent year

	Structural Holes and Turnover		Brokerage in Friendship Network				Brokerage in Advice Network
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	-0.655	1.121	1.302	1.253	1.802	1.581	1.655
	(1.133)	(1.311)	(1.094)	(1.085)	(1.141)	(1.359)	(1.332)
Tenure	-0.173***	-0.135**	-0.138**	-0.189***	-0.178***	-0.176***	-0.134**
	(0.059)	(0.061)	(0.063)	(0.068)	(0.065)	(0.065)	(0.065)
Male	0.201	0.020	-0.028	-0.038	0.079	0.079	0.009
	(0.504)	(0.546)	(0.542)	(0.562)	(0.577)	(0.577)	(0.549)
Success	0.058	0.084	0.090	0.083	0.079	0.080	0.099
	(0.076)	(0.074)	(0.074)	(0.077)	(0.083)	(0.083)	(0.079)
Appreciated	-0.154*	-0.168**	-0.167**	-0.175**	-0.199**	-0.199**	-0.179**
	(0.084)	(0.085)	(0.082)	(0.083)	(0.090)	(0.090)	(0.091)
Senior Lateral non-partner	-1.682	-1.300	-1.199	-1.355	-1.521	-1.537	-1.318
	(1.309)	(1.229)	(1.224)	(1.329)	(1.372)	(1.369)	(1.260)
Other	-1.135	-0.974	-0.934	-0.820	-0.686	-0.705	-0.982
	(1.251)	(1.167)	(1.110)	(1.102)	(1.136)	(1.164)	(1.160)
Partner	0.446	1.393*	1.465*	1.378*	1.390	1.407	1.449
	(0.580)	(0.738)	(0.780)	(0.837)	(0.901)	(0.897)	(0.774)
Headquarters	-0.599	1.121	0.197	-0.330	-0.511	-0.505	0.360
	(0.627)	(0.657)	(0.654)	(0.822)	(0.961)	(0.971)	(0.688)
Structural holes	-2.705**	-0.546				-0.374	-0.487
	(1.052)	(1.288)				(1.249)	(1.284)
Friendship Indegree		-0.123	-0.131	-0.063	-0.127	-0.114	-0.132
		(0.096)	(0.097)	(0.097)	(0.109)	(0.115)	(0.100)
Friendship Outdegree		-0.043	-0.008	0.125	0.084	0.090	-0.042
		(0.052)	(0.070)	(0.080)	(0.076)	(0.079)	(0.054)
Task advice Indegree		-0.069	-0.072	-0.061	-0.065	-0.065	-0.071
		(0.046)	(0.046)	(0.043)	(0.041)	(0.041)	(0.054)
Task advice Outdegree		0.004	0.002	0.005	0.014	0.014	0.004
		(0.026)	(0.028)	(0.026)	(0.024)	(0.024)	(0.032)
Weak Betweenness /1000			-0.586	-0.691	-0.212	-0.210	0.317
			(0.737)	(1.229)	(1.216)	(1.207)	(2.474)
Strong Betweenness /1000				-3.774***	-5.225**	-5.255**	-1.175
				(1.324)	(2.147)	(2.153)	(1.283)
Simmelian Betweenness /1000					12.986***	12.832***	1.266
					(4.276)	(4.315)	(1.034)
Null deviance	164.88 df = 240		-	-	-	-	-
Residual deviance	131.05 df = 231	123.19 df = 227	122.70 df = 227	114.06 df = 226	107.80 df = 225	107.75 df = 224	122.36 df = 225

*Note: * p < .1, ** p < .05, *** p < .01.*

Robust standard errors are in parenthesis and all tests are two-tailed.

However, when aggregate network variables for indegree and outdegree for the advice and friendship network are included in Model 2, we find that the effect of structural holes disappears. This result suggests that after controlling for the number of incoming and outgoing ties for an individual, the degree to which they broker ties, as specified by structural holes theory, does not significantly predict turnover.

Model 3 includes the controls, degree centrality in the two networks, and a variable for weak brokerage. As expected, weak brokerage does not significantly predict turnover. We do however find a stronger negative relationship between turnover and feeling *appreciated* as well as marginally significant ($p < .1$) positive effect of being a *partner.* We believe that the *partner* variable is marginally significant because of the exit of partners with lower tenure that we observe in our data.

Model 4 includes the same variables as Model 3 but with an additional variable for strong brokerage. This model specifically tests hypothesis 1. We find that this variable is negative and significant ($p < .05$) as hypothesized. This result suggests that greater brokerage in the strong tie friendship network is negatively associated with leaving the firm in the subsequent year. Thus, it is not just that one gets information from diverse and disconnected contacts across the organization that matters. Rather, it is also the strength of the relationship that indicates greater usefulness and motivation to help, that is associated with lower chances of exit.

Model 5 tests for the main effect of *Simmelian brokerage* on turnover. As hypothesized, we find a positive and significant ($p < .01$) relationship between the greater tendency to serve as a Simmelian broker and turnover. That is to say, being a Simmelian broker increases one's chances of leaving the firm in the subsequent year. The direction of the coefficient for the *strong brokerage* variable remains the same, but we find that the significance of the variable decreases

slightly, but is still significant at p = .014. Thus, both our main hypotheses are supported. Brokerage across strong ties decreases turnover, whereas brokerage across Simmelian ties actually increases it.

Models 6 and 7 are included as robustness checks. In Model 6, we include the *structural holes* variable along with all variables in Model 5. Our results do not change and the structural holes variable is not significant. In Model 7, we replace the friendship network brokerage measures used in Model 5 and replace them with the analogues for the advice network[1]. Again, we find that these variables are not significantly associated with the probability of exit.

DISCUSSION

Social networks have been shown to explain many important organizational and individual phenomena. As research has found over the past several decades, informal networks are important for getting crucial information, advice, and support in the workplace. These networks are also important for getting ahead. Although there has not been much research into the network antecedents of turnover aside from some early studies (Krackhardt and Porter 1985; Krackhardt and Porter 1986) – the literature on networks and promotion are telling . A consistent finding is that large as well as sparse networks are crucial for getting important information and improving one's promotion chances (Podolny and Baron 1997). It is particularly those individuals in the firm's informal organizational network who play the role of broker, that benefit the most (Brass 1984; Burt 1992). Likewise, we argue that networks, and brokerage in particular, should be predictive of turnover as well and particularly predictive in high-stakes up-or-out career ladders.

[1] We estimated several other specifications including models with dummy variables for all locations, and ethnicity. The direction and significance for the variables of interest remained qualitatively the same. However, the inclusion of the 20 additional location and ethnicity dummies reduces our significance on the strong brokerage variable to .06 and .03 for the Simmelian brokerage variable. We also find similar results when structural holes is calculated using the advice network instead of the friendship network.

Departing from existing literature on the brokerage/mobility relationship, we use Simmelian tie theory to argue for a more nuanced view of the relationship between brokerage and turnover. Although brokers who are connected to disparate sources have more information than their peers, they must possess the freedom and independence to use it (Krackhardt 1999). By providing a decomposition of the brokerage measure into weak, strong, and Simmelian brokerage we empirically demonstrate that while brokerage across strong ties is negatively associated with turnover in an up-or-out scenario, Simmelian brokerage actually increases one's likelihood of leaving the firm.

Our results contribute to the literature on social networks and mobility as well as the literature on turnover (Griffeth, Hom and Gaertner 2000; Podolny and Baron 1997). Current research has focused primarily on the benefits of brokerage on careers and mobility (Burt 1992). Firstly, we demonstrate that brokerage also matters for turnover as well. Secondly, we demonstrate using Simmelian tie theory that the benefits of brokerage should be viewed through the prism of constraints that result from membership in multiple triads. Dyads and triads (cliques) are qualitatively different. Triads impose norms, culture, and expectations. Membership in multiple disconnected cliques means that individuals have to not only adhere to the norms and expectations of one group, but multiple, disconnected groups. This puts them in constrained situations where their freedom and independence is restricted to such an extent that information and resources resulting from their bridging roles is diminished. Thirdly, we extend the literature on turnover in organizations by showing that a social network perspective can be a powerful tool in understanding a phenomenon that is important for not only individuals, but organizations and society as well.

One limitation of our study is that we are unable to distinguish between voluntary or involuntary turnover. Although we argue that the theory should hold regardless of turnover type, we concede that a better understanding of the networks and turnover relationship can only be gained when we are able to make this distinction. This limitation in our study, however, leaves open rich opportunities for future study into this important and understudied relationship. A second limitation of our study is that we were unable to achieve a complete sample. However, statistical analysis revealed no significant differences between our sample and the non-respondents on both demographic and network characteristics (indegree for friendship and advice). Finally, as with any study using data from a single firm, our results may be limited only to this firm. However, our results in many ways are in agreement with existing theory and evidence. Furthermore, our firm is in many ways, representative of firms in this industry in terms of its hierarchical distribution, sex distribution, and recruitment pool.

This paper builds on existing work in sociology and management on the relationship between social networks and individual mobility. In accordance with exiting theory and empirical evidence, we do find evidence that "brokerage" decreases the tendency of an individual to leave the firm. On the other hand, the type of brokerage matters as well. We find that "Simmelian brokers," who bridge across cliques, are actually at greater risk of leaving than those whose bridges are not across cliques – in agreement with Simmel's triadic model. We expect that future research will help further clarify the relationship between social networks and turnover.

CHAPTER 5:

MORE EQUAL THAN OTHERS: THE EFFECT OF TIE FORMATION BEHAVIORS ON STRATIFICATION IN SOCIAL NETWORKS

Abstract

In this chapter, I analyze the effect of tie formation behaviors on stratification within social networks. Using an equilibrium model of network formation, I explore how an individual's tendency to differentially value four factors in their tie formation decisions (actor quality, reciprocity, transitivity, and social influence) affects stratification in the larger network. I examine the resulting stratification in the social networks under two scenarios. First, I examine the relationship between exogenous quality and several measures of network centrality under varying regimes of tie formation behaviors that are homogeneous across all actors in a social arena. Second, I examine inter-group inequality when members of the social arena hail from two groups, each with different emphasis on the tie formation behaviors. Results indicate that a significant disjunction between quality and centrality exists when individuals place greater emphasis on reciprocity, creating groups with distinctly high and low centrality. Similarly, I find inter-group differences when the arena consists of two groups with differing tie formation behaviors. The group that places greater emphasis on reciprocity has significantly lower types of certain centrality than the other group. Furthermore, I find that social cues, both local transitivity and global social influence increases one's centrality in the social network by allowing connections between actors whose quality difference and potential asymmetry is overcome by social influence, thereby increasing personal network size. Finally, I present a brief discussion of the implications of this analysis for studying inequality in social networks and directions for further research and exploration.

INTRODUCTION

How cleavages in social structure arise and how individuals in societies become stratified is an important and enduring problem in social science (Cancian 1976; Ganzeboom, Treiman and Ultee 1991; Kao and Thompson 2003). The division of individuals or groups into different strata traces its origins back to the earliest parts of human history and modern social science has produced a massive literature on why stratification in human society exists (Ganzeboom, Treiman and Ultee 1991). Both economists and sociologists have theories that attempt to explain the problem of stratification. The economists have human capital theory and the sociologists have status attainment theory (Becker 1962; Haller and Portes 1973; Lin 1999; Lin, Vaughn and Ensel 1980). Both approaches look at the status that individuals attain in society as a function of their individual qualities, such as personal resources and characteristics such as intelligence. The classical theory argues that the stratification within society is primarily a consequence of these differences in individual factors and resources.

In recent decades, the traditional approaches to human capital theory and status attainment research has received criticism from those who argue that "structural and relational" concerns are often absent from existing models and theories (Breiger 1995). Seminal research on social networks and status attainment, namely *social resources theory,* has provided compelling evidence that suggests access to and mobilization of resources embedded in social networks enhances an individual's attainment of status (Burt 1992; Granovetter 1973; Lin 1999). That is, those with more advantaged positions within the relational structure of society are able to better attain status and increase their chances of upward mobility.

In addition to the analysis of stratification and status attainment on a societal level, there has been an increasing interest in the study of the organization as an intermediary between the individuals and subsequent stratification. With respect to the role of the organization, Pfeffer (1977) argues, "in some measure, earnings and social status are derived from the positions persons occupy in formal organizations" (Pfeffer 1977). Clearly, individual human capital plays a role in the status attainment within organizations as well. However, research has shown that other factors such as differences in social capital also affect attainment within organizations. A growing body of literature argues that the informal social networks and social resources of individuals play a role in determining whether a person is hired and promoted, as well as their level of compensation (Burt 1992; Fernandez and Sosa 2005; Petersen, Saporta and Seidel 2000).

Aside from the literature on social networks and individual organizational outcomes, there have been several important studies examining network structures of individuals from different groups within organizations. The literature in this area suggests individuals from minority or previously excluded groups, such as women, Asians, and African Americans, have lower network returns from their human capital and less social capital (Friedman and Krackhardt 1997; Ibarra 1992; James 2000). Although this literature sheds light on the nature of the different structures observed for women and minorities, there are many open questions about why, how, and when these structures differentiate. Existing research suggests that some reasons for the differential structures are homophily, job segregation, and for men and women, differences in the how they perceive and value different factors in their relationship formation decisions (Benenson 1990; Ibarra 1992; McPherson, Smith-Lovin and Cook 2001).

This paper takes a step back from the link between social capital and mobility and asks how differences in social capital arise and are amplified by regimes which encourage or

discourage certain relational norms. Specifically, we investigate the effect of tie formation behaviors on stratification in social networks. Using an equilibrium model of network formation, we can explore how an individual's tendency to differentially value four factors in their tie formation decisions (actor quality, reciprocity, transitivity, and social influence) affects stratification in the social network. We examine the resulting stratification in the social networks under two scenarios. First, we examine the relationship between exogenous quality and several measures of network centrality under varying regimes of tie formation behaviors that are homogeneous across all actors in this social arena. Second, we examine inter-group inequality when members of the social arena hail from two groups, each with different emphasis on the tie formation behaviors.

Results indicate that that a significant disjunction between quality and centrality exists when individuals place greater emphasis on reciprocity, creating groups with distinctly high and low centrality. Similarly, we find inter-group differences when the arena consists of two groups with differing behaviors. The group that places greater emphasis on reciprocity has significantly lower types of certain centrality than the other group. Furthermore, we find that social cues, both local (transitivity) and global (social influence) increase one's centrality in the social network by increasing personal network size. These factors allow connections between actors whose penalties from quality differences and dyadic asymmetry are overcome by social influence, thereby increasing personal network size.

The remainder of this paper is organized into five sections. In the theory section, we present a brief overview of the empirical and theoretical literature on tie and network formation. These form the basis of the tie formation behaviors and are the antecedents determining larger network structures. The primary emphasis here is to provide a sound theoretical basis for the

construction of the utility functions used by actors in the network formation model. Next, we provide a formal definition of the model. The basic setup of the directed network formation game and a formal parameterization of the four factors discussed in the theory section are presented. Next, we provide a description of the simulation procedure used to arrive at our results. The third and fourth sections present the results of the analysis. In the third section, we examine how the distribution of social capital measures within an arena, where all actors' behaviors are homogenous, becomes decoupled from their exogenous quality. In the fourth section, we examine inter-group social capital differences when the arena consists of two groups, α and β, each with differing weight on the network formation behaviors. Finally, we conclude with a discussion of the results and their implications for future research into the origins of variation in social capital among individuals in organizations and societies.

THEORY

The literature on social networks and interpersonal attraction outlines a variety of factors that have been shown to contribute to the formation of social ties. These include factors such as homophily, the quality and competence of potential actors, the effect of third parties, as well as social influence. In this section, we briefly outline some of the literature, both in sociology as well as psychology on the importance of these factors for the formation of interpersonal ties in social networks.

Homophily

In the sociological literature on affiliation and the formation of social networks, the concept of homophily is one that has fared quite well with respect to the broad consensus of empirical

support that it has received. Homophily is the tendency of individuals to be tied to others who are similar to them on some dimension. This similarity can be based on both easily observable characteristics such as age, sex, or race as well as ones that are sometimes more difficult to observe such as values or intelligence. Homophily that is observed in networks can arise primarily out of two mechanisms. That is, homophily can be induced either by availability or by distribution of the types of individuals as well as choice and preference. Induced homophily posits that our interpersonal relations are limited by the demographic distribution of the population of potential actors that are available to us. Consequently, if an individual's department is primarily composed of individuals of a certain type (males), then ties will primarily with individuals of that type (other males). Similarly, the research also demonstrates that geographic propinquity has a significant effect on the relationships we form (Back, Schmukle and Egloff 2008; Latane et al. 1995). Individuals tend to form relationships with those who are closer to us and with whom we have significantly more opportunity to interact.

In addition to the constraints that demographic composition and geographic location put on our ability to form relationships, individual choice also plays a role. A wide and historic literature suggests that interpersonal attraction is based on attributes both socio-demographic and behavioral. People tend to form relationships with those who are similar to them on some or several dimensions. In addition to the restrictions that demographic distributions place on the potential pool of alters to whom an actor can link, individuals tend to prefer forming relationships with those who are similar to them in ethnicity and race, age, religion, education occupation, as well as gender (McPherson, Smith-Lovin and Cook 2001). Research also finds that social ties created between dissimilar actors tend to have a higher likelihood of being

dissolved than those between more similar individuals (McPherson, Smith-Lovin and Cook 2001).

Quality, Competence and Efficiency

In addition to the interpersonal attraction that is induced by demography and preference for individuals who are similar on some dimension, there is also a body of research that suggests that alter quality – again on a variety of dimensions – significantly predicts other actors' attraction to them as potential contacts or partners. Measures of quality can include aspects of physical appearance that are deemed of high quality such as skin color or race, height, physique and dress or cognitive measures such as intelligence or competence. The preference for individuals who are deemed physically attractive has been seen in among nursery school age children, adolescents and young adults, as well as adults well into their mid-sixties. Physically attractive individuals are seen as "more responsible for good deeds, and less responsible for bad ones." (Huston and Levinger 1978)

There is also research that suggests that task competence is an important factor in interpersonal attraction (Hamm, Baum and Nikels 1975) and group member selection (Hinds et al. 2000). People have been shown to select others as work group members who they expect to contribute to the group's goal or task. For instance, Hinds et al. (2000) find that people strongly rely on "on indicators of competence when choosing future group members," particularly indicators that "provide information about competence on specific areas of expertise necessary for successful completion of the task" (Hinds et al. 2000).

Reciprocity

The norm of reciprocity is one of the most powerful forces observed in human behavior (Gould 2002; Gouldner 1960). Particularly in dyadic relationships, individuals prefer their status conferring gestures of respect, esteem, love or friendship to be reciprocated. This is particularly true when the potential alter is of similar quality. For example, an elementary school student may on their first day of school extend a hand of friendship to one of her classmates. However, if that classmate does not, over time, reciprocate that friendship by inviting the first person over to play at their home or demonstrate that she considers the first person a friend, then the first person may over time withdraw the show of deference or friendship.

Though reciprocity and symmetry are important for the stability of ties, a significant amount of asymmetry can often be observed in real world social networks. One explanation for the persistence of asymmetry, even in affective ties such as friendship, may be the consequence of the "basking-in-reflected-glory" phenomenon where individual actors may perceive benefits accruing from other's knowledge of their connection to a high quality actor (Cialdini et al. 1976; Hinds et al. 2000). This asymmetry can be sustained if the pain of extending an unreciprocated tie is less than the benefit one gets from the quality of their contact. Similarly, receiving deference from others without having to reciprocate should benefit actors as well. Movie stars, famous professors, and politicians enjoy receiving deference from others and do not, in most cases, directly get disutility from failing to reciprocate these gestures (Gould 2002).

Thus, asymmetry is particularly painful when the penalty for having one's ties not reciprocated is greater than the quality of the tie originally extend. Similarly, a scenario where asymmetric ties can be sustained can occur when actors receive more benefit from the their unreciprocated gestures than from the penalties from asymmetry.

Transitivity

The discussion so far has focused primarily on the dyadic and individual components of interpersonal attraction and tie formation. However, it is clear that third parties, particularly our direct ties, influence our choices along a variety of dimensions (Cartwright and Harary 1956; Heider 1958; Simmel 1950; Tortoriello and Krackhardt In press). These include our choices about what music to listen to, what clothes to wear, as well as our choice of other friends. The ideas of balance and transitivity in psychological and sociological theory provide an important framing of how these third parities influence our choices. Formally, transitivity argues that if an actor i chooses another actor k as a tie ($i \rightarrow k$) and $k \rightarrow j$ then, it will increase the incentive for an $i \rightarrow j$ tie to be created (Wasserman and Faust 1994). Research has found that these types of transitive ties are common in real world social networks. It can be argued that transitivity considerations enter the calculations of tie formation decision when actors receive greater benefit by connecting to an otherwise less desirable alter, when connection to that alter is socially acceptable among direct contacts.

Social Influence

Often times our attitudes and behaviors are shaped by individuals to whom we are not directly tied, but are members of our arena. The idea of "social influence" in networks arises when there are situations where uncertainty about appropriate actions or behaviors exists. In such situations, we look to others our social sphere and imitate their behavior in order to comply with actions that are considered appropriate (Cialdini 1993). In a social situation, when others consider an

alter to be popular; actors who are given a choice as to whether they should direct deference or attention to this alter may imitate the behaviors of others. An example relating to scientific contribution given in Gould (2002) describes this phenomenon: "In deciding which authors are central, researchers invariably consider names their peers have cited in print or mentioned in conversation; but these peers have done the same thing in deciding whom to mention"(Gould 2002). This, he argues is a self-reproducing process, whereby one's judgments – informed by the judgment of others – once again becomes part of the collective social evaluation that others depend on for their own evaluation. This leads to an avalanche of ties to already central actors.

Centrality and Social Capital

As actors in an arena form ties with each other, complex social networks begin to emerge. Actors' positions within these networks, often termed their centrality or social capital, have been shown to predict many important phenomena related to attainment, mobility, and power (Burt 1992; Burt 2000; Podolny 1993). The structure of individuals' personal networks can be interpreted with respect to how much power they have, their influence over others, and their access to information as well as their ability to spread information or other content across network ties. Several measures of centrality and social capital exist, each with different implications for outcomes of economic and sociological interest. Measures such as out-degree and in-degree quantify the size of an individual's personal network and often indicate the degree to which an individual is gregarious or popular, respectively. For instance, Sparrowe et al. (2001) found that greater in-degree in the advice network was related to supervisors' rating of an employee's performance (Sparrowe et al. 2001). Other, more complex measures such as Eigenvector centrality are often used as more sophisticated measures of status and prestige. In

his study of market competition, Podolny (1993) finds that actors who are higher status or prestige have an advantage with respect to producing a product of a given quality (Podolny 1993).

Other measures of centrality and social capital in networks are based on the idea of "brokerage" or the tendency to link otherwise disconnected individuals in the network (Burt 1992). Two measures of brokerage, betweenness and constraint, are often found to correlate with measures of success such as promotion, compensation as well as the generation of good ideas. A somewhat related measure, closeness, the degree to which an actor can quickly reach other parts of the network, has also been found to correlate with power, faster promotions, and in the epidemiological realm, disease spread (Burt 1992; Freeman 1977; White and Borgatti 1994).

As these measures of centrality and social capital are predictive of important economic and social phenomena, we explore the important problem of understanding how differences in centrality arise as a consequence variation in tie formation behaviors. In the next section we present the formulation of the tie formation model that incorporates many of the factors presented in this section, the simulation procedure used to arrive at the equilibrium networks, and formal definition of the measures of centrality and social capital we have discussed.

MODEL FORMULATION

Basic Setup

Before we examine the relationship between the tie formation behaviors mentioned in the prior section and their relation to differences in social capital, let us begin by first providing a formal definition of the directed network formation model used in this paper. The notation here is adapted from (Bala and Goyal 2000). In a given social arena let there be N actors with i and j

being members of this arena. Each of the actors is numbered such that $i = 1 \ldots n$ and $j = 1 \ldots n$. All actors in the arena $i \in N$ have a strategy which consists of a vector $g_i = (g_{i1}, \ldots, g_{ij}, \ldots, g_{in})$ where $g_{ij} \in \{0,1\}$. Since actors have two options, to create ties or not, the number of possible strategies that a given actor has is $|\mathcal{G}_i| = 2^{n-1}$, and the set of strategies of all actors is $\mathcal{G} = \mathcal{G}_1 \times \ldots \times \mathcal{G}_n$.

In this arena, actors make choices about whether to create a tie with each of the other actors $j \in N_{-i}$. If an actor i chooses to create a tie with another actor j, such that $g_{ij} = 1$, a directed link between i and j is created and a relationship of the specific type is said to exist between the directed pair such that one can state that "i considers j a friend" or "i seeks advice from j." Conversely, if $g_{ij} = 0$, it is said that a relationship of the specified type (e.g. friendship or advice) does not exist between the pair ij. Furthermore, since symmetry is not assumed, $g_{ij} = 1$ does not imply $g_{ji} = 1$. So, although i may consider j a friend, j may not necessarily feel the same way.

By choosing to create a tie or not for each of the actors $j \in N_{-i}$, actors $i \in N$ receive some utility u_i from their connections to others in the social arena. Thus, $u_i(g)$ is the utility that actor i gets from a directed network of the form g after he/she has chosen a strategy such that $g = g_{-i} \cup g_i$, where g_{-i} is the empty vector where i chooses not to link with any other actor j, and g_i is the chosen strategy for actor i. For a given network g a strategy g_i is said to be a *best response* for an actor i to creating no ties g_i if the following holds:

$$u_i(g_{-i} \cup g_i) \geq u_i(g_{-i} \cup g_i'), \ \forall \ g_i' \in \mathcal{G}_i$$

A network consisting of all best responses of actors i is said to be sustainable if agents are playing their Nash equilibrium strategies.

Utility Function and Parameters

Thus far, we have focused primarily on the formal specification of the major components of the model without specifying the form actors' utility functions take. Since our intention is to understand how group level differences in aggregate network structures emerge if actors in a social arena behave in a certain manner – we need to specify the form of this utility function. As mentioned earlier, the empirical networks literature has accumulated a body of evidence suggesting a variety of factors that are important for network formation. The factors we incorporate into our model include alter quality, reciprocity, transitivity, and social influence. Furthermore, the formulation of the utility function to follow allows for two types of individuals $t = \{\alpha, \beta\}$ who may differ with respect to the importance they give to the following factors:

1. being connected to individuals who exhibit high quality,
2. symmetry in their dyadic choices (reciprocity),
3. sensitivity to a third party's ties with the alter in considering j as a tie (transitivity),
4. susceptibility to social influence in an evaluation of an alter j (Gould Social Influence)

The subsections to follow provide the parameterizations of the four factors mentioned earlier. We draw on the model of network formation presented in Gould (2002) as our basis, with some modifications with respect to normalization of model parameter values and the introduction of a transitivity component to the utility function that takes into account third party effects (Gould 2002).

Quality

In our model, we follow the example of Lynn, Podolny and Tao (2009) by assigning exogenous quality Q_j to an individual that is drawn from a normal distribution with mean of μ =0 and standard deviation of $\sigma = 1$ (Lynn, Podolny and Tao 2009). The draws are normalized such that the Q_j used in the model are re-assigned a value of: $q_j = \left(Q_j / \left|\max Q_1 \ldots Q_J, \forall\, Q_j \in J\right|\right) \times n$. That is, the q_j are now approximately normally distributed with a minimum value of $-n$ and maximum value of n. This is so that a person can have exogenous quality that can be at most or at least the quality of the number of people in the arena. An interpretation of this could indicate that connecting to one person with $q_j = 5$ may provide just as much benefit as connecting to five individuals, each with $q_j = 1$. The component of the utility function that incorporates an individual's assessment of another's quality is thus:

$$\omega_1 \left(\frac{\sum_j g_{ij} q_j}{(n-1)n} \right)$$

That is to say, the maximum utility derived from the exogenous quality of ego's alters is the sum of the quality of those to whom they are directly connected to, normalized so that the maximum absolute value is unity – the term $(n-1)n$ normalizes this component to this effect. The parameter $\omega_1$is a weight parameter on an actor's preference for quality considerations, with greater values of ω_1 indicating greater consideration of exogenous quality considerations, and vice versa, with the constraint that $\omega \geq 0$.

Reciprocity

The model incorporates the reciprocity constraint as $g_{ij}(g_{ji} - g_{ij})$. This constraint is a slight alteration from the formulation proposed by Gould (2002) and also used by Lynn et al (2009). With this constraint, the actor can experience three types of effects on their utility function. The first occurs when an actor i's tie to an alter is perfectly reciprocated such that $g_{ij} = g_{ji}$, so that

the term $g_{ij}(g_{ij} - g_{ji}) = 0$. That is to say that when there is reciprocity, the actors get utility from each other that is proportional to their quality since the reciprocity terms drops out. The other two scenarios occur when there is a mismatch between the tie formation decision of i and that of j. If i, the actor making a decision decides to extend a tie to j, but j does not reciprocate, then the actor i will experience a disutility from the unreciprocated gesture. On the other hand, if the actor i does not extend a tie, but receives one from j then the actor gets no additional utility, but does not suffer a penalty as well. Gould argues for these two outcomes by stating that:

"It is painful to pay attention to another person if the favor is not repaid. By the same token, it is particularly pleasant to receive attention when it is not solicited[.]...If it is unpleasant to offer more approval to someone than he or she gives back, it is reasonable to suppose that it is also enjoyable to receive more approval from a given person than one has offered" (Gould 2002). Because our actors can only make "0" or "1" ties, explicit benefit from ties that one does not have to reciprocate are not built into the utility function, but actors still experience no penalties for not having to reciprocate. Thus, it is still relatively worse to have your gestures not reciprocated than not reciprocating others' gestures. For all actors in an arena, we incorporate the following component into the utility function to capture the reciprocity effect on the tie formation decisions:

$$\omega_2 \left(\frac{\sum_j g_{ij}(g_{ji} - g_{ij})}{(n-1)} \right)$$

Similar to the quality component, we normalize the term such that the maximum absolute value is unity, and it is weighted by ω_2 which indicates the emphasis than an actor places on reciprocity in his or her relationships. The greater the value of ω_2, then, the more painful are unreciprocated gestures.

Transitivity

The first two components of the utility function were primarily individual (variation in quality) and dyadic (concern for dyadic reciprocity). The following two components model the social aspects of tie formation decisions. As mentioned in the theory section, actors often look to others to determine whether behavior or attitudes are appropriate. The transitivity components of the utility function models the effect of third parties on tie formation decisions. Traditionally, transitivity is modeled as $g_{ik}g_{kj}$. That is to say, the benefit i gets from connecting to j is derived from whether the other individuals k to whom i is connected to are also connected to j (Wasserman and Faust 1994). Thus, if i is connected to several actors k and they are also connected to other actors j for whom i would like to make a tie formation decision, then this social influence will steer i toward making these connections with j. On the other hand, if the actors k to whom i is connected are not connected to the j in question, then, i receives no additional increase in their utility from creating that tie. The practical implication of the transitivity constraint is that it allows for cohesion in social networks to occur when dyadic considerations do not necessarily provide actors with enough incentives to create ties, either because of quality considerations or distaste for lack of reciprocity.

For all potential alters in the social arena, the additional term in the utility function that incorporates the transitivity components looks like:

$$\omega_3 \left(\frac{\sum_{i \neq j \neq k} g_{ij}(g_{ik}g_{kj})}{(n-2)(n-1)} \right)$$

Again, the term is summed over all potential actors k and j, and is normalized such that the maximum absolute value of the term is unity, and the weight parameter ω_3 is allowed to vary so that differential emphasis can be placed on considerations of transitivity.

Gould (2002) Social Influence

The final component of the utility function also incorporates social influence, but of a less general, and more broader type than that modeled by transitivity. This component is taken from Gould (2002)'s model of social influence, and is parameterized as the sum of all the nominations to an alter j from all other actors k in the arena, irrespective of whether i is linked to k, so that the benefit is proportional to $\sum_k g_{kj}$ (Gould 2002). Thus, as compared to the transitivity component, which can be considered *local social influence*, the Gould Social Influence component can be considered *global social influence*. The intuition behind this constraint is that actors, in order to minimize cognitive load and uncertainty, look to the attitudes and behaviors of others and adjust their own attitudes and behaviors accordingly. Examples of this type of behavior is often seen with respect to citation patterns, quality of music, and other judgments where actors look beyond quality and dyadic considerations or the judgments of our direct contacts to much broader socially acceptable attitudes, behaviors, and norms.

This element again is incorporate into our utility function as:

$$\omega_4 \left(\frac{\sum_{i \neq j \neq k} g_{ij}(g_{kj})}{(n-2)(n-1)} \right)$$

This term is also summed over all actors and divided by a constant so that the maximum value is unity. The term ω_4 is the weight on that parameter by the actor whose utility function we are modeling. Here, actors i get increased utility from connecting to an alter j when many others in the social arena, regardless of whether i is directly connected to them or not are also directing positive attachments to them. This, is in many ways a parameter modeling the Matthew effect where we observe that the "rich get richer" and the "poor get poorer." Here, even slight differences in exogenous quality can increase the direction of status conferring gestures of actors

towards alters j, which creates a cascade of gestures towards those alters as a result of social influence.

The Combined Utility Function

In sum, the utility that an actor i gets from a network configuration g is the following:

$$u_i(g) = \omega_1\left(\frac{\sum_j g_{ij}q_j}{(n-1)n}\right) + \omega_2\left(\frac{\sum_j g_{ij}(g_{ij}-g_{ji})}{(n-1)}\right) + \omega_3\left(\frac{\sum_{i\neq j\neq k} g_{ij}(g_{ik}g_{kj})}{(n-2)(n-1)}\right) + \omega_4\left(\frac{\sum_{i\neq j\neq k} g_{ij}(g_{kj})}{(n-2)(n-1)}\right)$$

If weights $\omega_1 \ldots \omega_4$ are allowed only to range from $0 \ldots 1$, then the maximum value of the utility function is 4, and the weights can be interpreted as the proportional emphasis given to these factors by the actors forming ties within the arena. In the next subsection, we describe the simulation procedure used to arrive at the Nash equilibrium for this network formation game. As with Gould (2002) and Lynn et al. (2009)'s model, we assume either that variation in Q_j is sufficiently low, or that in most cases sufficiently large values on the reciprocity constraint and sufficiently small values on the social influence constraints exist in order to sustain an interior equilbrium (Gould 2002).

Simulation

A simulation method is used to find sustainable networks for each game. Using the best response dynamic for directed networks, we use a modified version of the simulation solution technique presented in (Buechel and Buskens 2008; Buskens and van de Rijt 2008).

1. Start with some random network with a fixed density (e.g. $p = .35$ so that each tie is present independently with a probability p)

2. Pick a pair of actors $\{i, j\}$ where $i \neq j$ at random with every pair having equal probability of selection.
3. If a tie ij does not exist, form the tie ij if i strictly improves their utility by the formation of the link. If ij exists, then delete the tie if i strictly improves their utility by the deletion of the link
4. Go back to step 2 with the new network g resulting from the prior iteration until the network stabilizes. That is if no individual wants to either form or delete a tie.

Figure 5.1: Simulation procedure for arriving at an equilibrium network

The simulation procedure, presented in Figure 5.1, for arriving at the equilibrium, let us call it $\boldsymbol{E}$, produces a network g^* which consists of all the best response tie formation decisions of all actors in the arena. This resulting equilibrium network is then evaluated to examine the social capital of all actors. In the next subsection, we present the ten measures of network centrality and social capital that will be used to understand the effect of tie formation behaviors on stratification in social networks. Since we do not expect the equilibrium for the simulation to be unique, we will average centrality measures over multiple simulations in our analysis of stratification in the centrality measures.

Measures of Centrality and Social Capital

In this paper, we evaluate the effect of tie formation behaviors on distribution of three broad categories of centrality and social capital measures that are often used in the empirical networks literature. The categories include measures that are primarily associated with an actor's network *size*, their *status and prestige*, and graph level measures that quantify actors' ability *to access and broker* information across the network. Presented below is a brief overview of these measures and their interpretation.

Network Size

Two primary measures exist for quantifying network size (Wasserman and Faust 1994). These are in-degree and out-degree. Out-degree measures the number of nominations an actor gives to the alters in his or her social arena. It is often interpreted as a measure of one's gregariousness, the degree to which they nominate others as acquaintances, friends, or advice givers. Those with smaller out-degree are considered less gregarious than those with greater out-degree. It is measured by summing up the number of alters j that i nominates.

The second measure, in-degree, is often used as a measure of an actor's popularity in a social arena. It is the count of the number of nominations that an actor i receives from all other actors j in their arena. The greater the in-degree of an actor, the greater their popularity. Greater in-degree often signifies that this individual is a local leader of sorts.

Status and Prestige

Although in-degree provides a measure of status and prestige, it ignores the importance or prestige of those to whom one is connected. Other measures of prestige based on Eigenvector centrality allows one to iteratively re-weight the degree measure such that the prestige of an individual is proportional to the prestige of their contacts, and so on. This obviously is a recursive problem, and a solution to this is presented by (Bonacich and Lloyd 2001; Bonacich 1987b). The analysis presented in this paper measures prestige based on the Eigenvector centrality measure using two variants of the original g^* networks. This includes centrality on the original directed network g^* and on the strong tie network g_s^* where a tie between two actors ij only exists of $ij = 1 \cap ji = 1$. That is, a tie only exists when both actors acknowledge the tie, and no tie otherwise. Those with greater values on the Eigenvector centrality based prestige measures are individuals who are connected to many others who themselves are connected to many others. This measure has often been used as a more sophisticated measure of status in the

empirical networks literature. For instance, Podoly uses Eigenvector centrality to measure status among firms and Gulati and Gargiulo (1999) use it as a measure of position among venture capitalist firms.

Access and Brokerage

The final set of measures attempt to capture, to varying degrees, an actor's ability to quickly access novel information from different parts of the network. To measure the potential for brokerage in one's network, or the degree to which and individual is connected to otherwise disconnected individuals, we use both the betweenness measure (Freeman 1977; White and Borgatti 1994) and the constraint measure (Burt 1992). More formally, the betweenness measure calculates the extent to which shortest paths between two actors j and k pass more often through a focal actor i, relative to other actors in the network. Thus the betweenness measure is $B_i = \sum \frac{\sigma_{jk}(i)}{\sigma_{jk}}$, where $\sigma_{jk}(i)$ is the number of shortest paths between j and k that pass through i and σ_{jk} as the number of total shortest paths between j and k. Thus, the greater the betweenness score for an actor, the more often he or she plays the critical role of controlling passage of information across various parts of the network. We calculate betweenness on four variants of the equilibrium network g^*. These variants include:

1. The original directed network g^*
2. The weak tie network g_w^* where a tie ij exists if $ij = 1 \cup ji = 1$
3. The strong tie network g_s^* where a tie ij exists if $ij = 1 \cap ji = 1$
4. The Simmelian tie network g_m^* where a tie ij exists if $(ij = 1 \cap ji = 1) \cap \exists k\ (ik = 1 \cap jk = 1 \cap ki = 1 \cap kj = 1)$

Interpretations of the betweenness scores for each actor i under the conditions presented above vary according to the quality and strength of information that flows through links of certain types – with weak ties allowing for the flow of the least sensitive information and Simmelian ties, perhaps the most.

Another measure of brokerage often used in the literature is the constraint measure (Burt 2002). The constraint measure is formulated as $C_i = \sum_i (p_{ij} + \sum_{ik} p_{ik} p_{kj})^2$, where $p_{ij} = \frac{g_{ij}}{\sum_k g_{ik}}$ (Burt 1992). It measures the extent to which to which an actor is connected to many actors who themselves are not connected to others. As compared to the betweenness centrality measure, the constraint measure places greater emphasis on the penalty for closure within groups – that is the constraint coming from the redundancy in ties among ego's alters. The constraint measure is calculated on the directed graph g^* to arrive at scores for each of the actors in the arena. With respect to interpretation, greater constraint is worse for an actor with respect to social capital. It decreases their access to novel information and their ability to use it in meaningful ways.

The last measure, closeness centrality, quantifies the extent to which an actor in the network has more shortest paths to other alters in the network relative to the other actors. Practically, closeness centrality measures how quickly an actor can reach other actors in the network. This can be important in terms of information or disease spread – with those actors having high closeness being able to convey information to different parts the network faster than others, or with respect to disease spread, the actor is the most dangerous since they may spread diseases much faster across the population. Closeness centrality is often measured as $Cl_i = \frac{1}{n-1} \sum_{j \neq i} l(ij)$, where $l(ij)$ is the number of links in the shortest path between i and j and those with more shorter paths between other actors have higher closeness.

RESULTS

In this section, we present the results of our analysis. The section is broken up into two sub-parts. The first part examines the relationship between exogenous actor quality and the distribution of network centrality scores under varying regimes of tie formation behaviors when actors are homogeneous. The second sub-section explores stratification in social capital when the social arena consists of two groups, α and β, each with different weights on three components of the utility function – that is: reciprocity, transitivity, and social influence. For each subsection, we first present a description of the simulation procedure followed by a discussion of the results.

The Relationship between Quality and Centrality when Actors have Homogeneous Behaviors

The question this section attempts to answer is: *how does the relationship between quality and centrality vary as a function of tie formation behaviors when all actors are behaving the same way?* We attempt to answer this question using the simulation procedure presented above to arrive at equilibrium networks under varying regimes of actor emphasis on reciprocity, transitivity and social influence – and examine the resulting relationship between exogenous quality q_j and actor in-degree (a simple measure of status) $indegree_i = \sum_j g_{ij}$. In-degree is used as a measure of status for this simulation to allow for comparability with other studies looking at tie formation behaviors and status distributions (e.g. Gould (2002) and Lynn et al. (2009)). The simulation for this section begins with a random draw from $N(0,1)$ which is normalized according to the procedure mentioned in the methods section. This quality vector is kept constant for all simulations. That is, all calculations for the equilibrium networks use the same underlying quality vector so that the resulting distributions of in-degree can be compared across simulation runs. Next, the weights $\omega_1 \ldots \omega_4$ are set for the four factors in the utility

function. Third, a random graph g with density set to . 35 is generated and then with these inputs the procedure $\boldsymbol{E}$ is run until convergence. For each configuration of weights, a plot is generated with exogeneous quality on the x-axis and the model derived in-degree on the y-axis. Figure 5.2 outlines this process.

1. Generate quality vector consist of Q_j and normalize
2. Set weights $\omega_1 \ldots \omega_4$
3. Generate random network g with density = .35
4. Run simulation procedure to arrive at the equilibrium $\boldsymbol{E}$
5. Repeat starting at step 2 for all configurations of weights $\omega_1 \ldots \omega_4$

Figure 5.2: Simulation procedure for quality vs. centrality analysis

Figures 5.3 to 5.6 present the results from this simulation experiment. In Figure 5.3, we plot the original quality vector (on the range -1 to 1) on the x-axis and the in-degree from an example seed random graph on the y-axis. As in all graphs presented in this section, higher values on each axis are better and lower values are worse. A linear trend means that the quality and status are perfectly correlated. Here, we can see, as expected, that there is no relationhip between exogenous quality and in-degree.

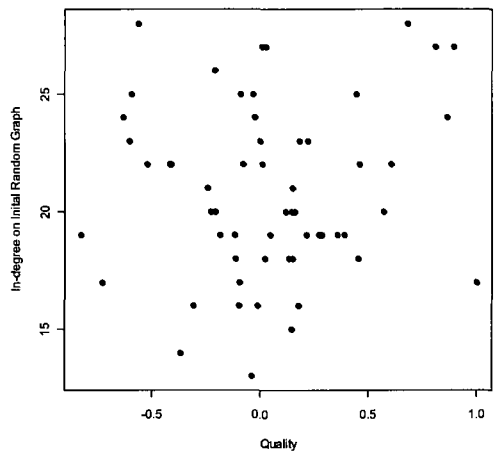
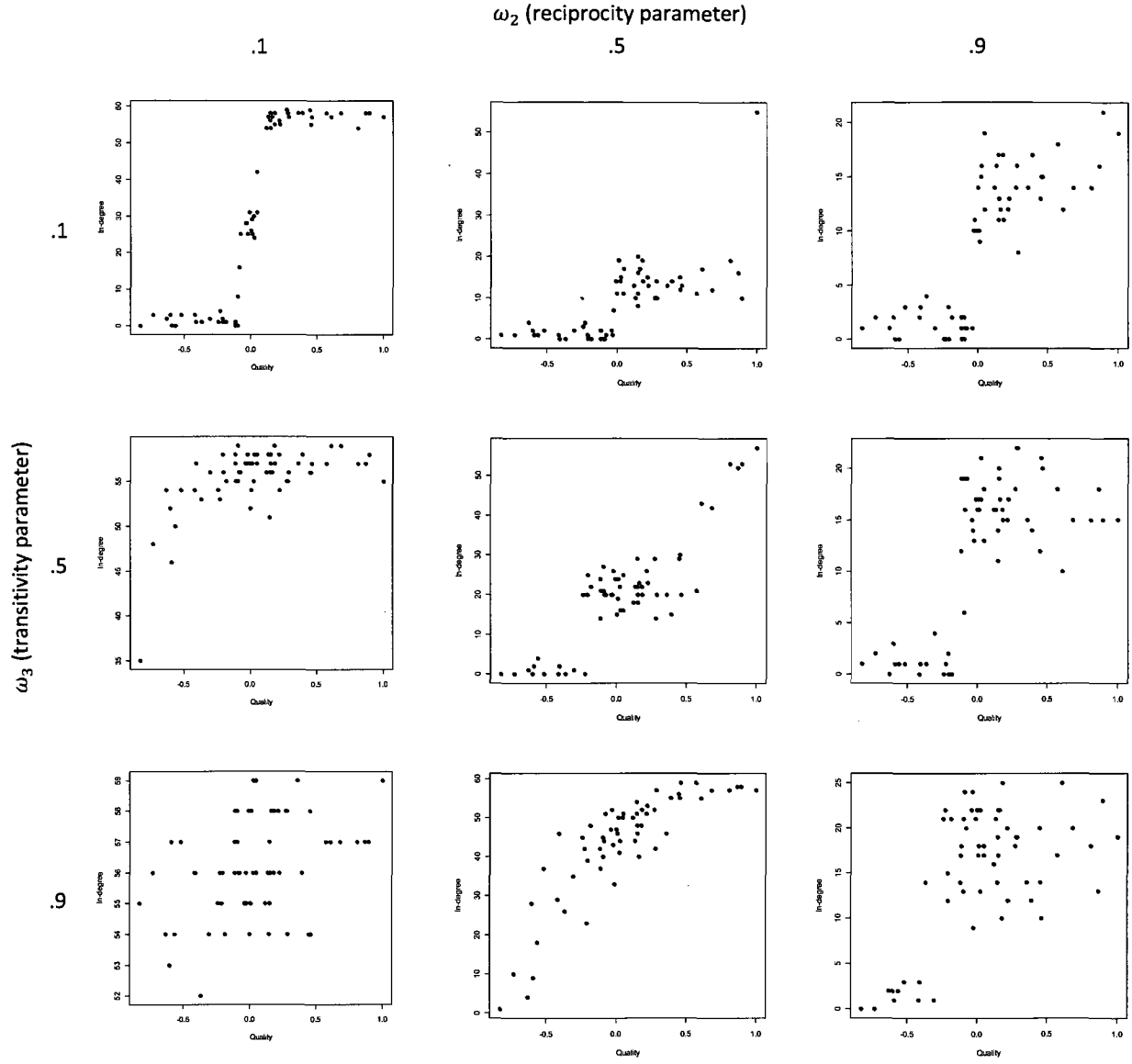


Figure 5.3: Plot of quality vs. in-degree in a example seed random graph

Figure 5.4 presents the analysis of the relationship between exogenous quality and in-degree under the regime where the Gould parameter is eliminated ($\omega_4 = 0$), but the reciprocity and transitivity parameter are varied uniformly for all actors under three different scenarios. The rows represent the variation in the reciprocity parameter under the three scenarios and the columns represent the variation in the transitivity parameter. The graphs are the plots of the relationship between Q_i and $indegree_i$.

Here we find that there are many ways by which quality and status can become decoupled under varying scenarios that emphasize certain levels of reciprocity and transitivity. In these graphs, it is important to note not only the nature of the relationship between status and quality, but also the range of the y-axes which tells us about how much variation there is between the status of all actors. More specifically, in the discussion to follow we focus on four aspects of these graphs: (1) range of in-degree, (2) number of clusters or "class cleavages", and (3) shape of the relationship between quality and status, and (4) variation in status within levels of quality.



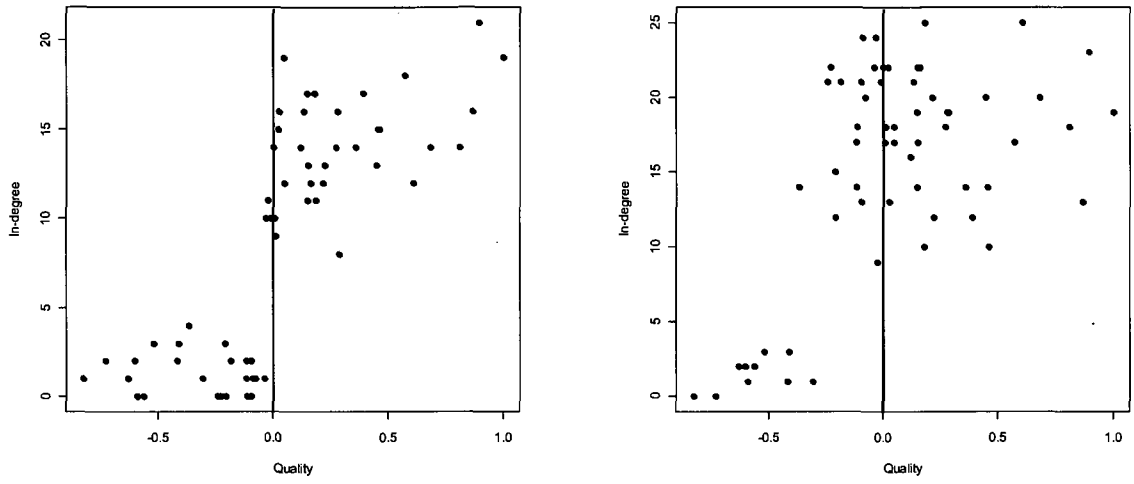
1. All Q_j variables are drawn randomly from a Normal distribution with mean = 0 and sd = 1. The same quality vector is used for all conditions. Initial attachments are random.
2. Networks with nodes = 60 generated until convergence for each condition.

Figure 5.4: Plot of quality vs. in-degree for varying reciprocity and transitivity parameters

Two general features of Figure 5.4 can be seen without much effort. First, we notice that moderate levels of reciprocity, particularly when not counter balanced with transitivity, tends to increase the range in the in-degree distribution whereas increased transitivity tends to create a

countering force that increases the in-degree of those individuals with lower quality and reduces the range of the degree distribution. For instance, we see when ($\omega_2 = .1, \omega_3 = .1$) the range of in-degree goes from 0 to 59, but if we hold reciprocity constant at .1 and increase transitivity to .9, the in-degree range compresses to 52 to 59. Furthermore, when high transitivity ($\omega_3 = .9$) is complemented with moderate levels of sensitivity to reciprocity (eg. $\omega_2 = .5$) we have a re-expansion of the range of the degree distribution, but also a more continuous transition of in-degree for individuals with low to high q_j. We also note that high reciprocity reduces the range of the degree distribution by reducing the in-degree of even high-quality individuals.

The second feature that is important to note is that increased reliance on reciprocity creates large and distinct cleavages in the status distributions – with the cleavage points being primarily at $q = 0$. This is a consequence of individuals distaste for not having their status conferring gestures reciprocated and valuing situations where incoming status conferring ties don't have to be reciprocated. How this could result in status cleavages can be seen when we have two individuals i and j. Let us assume that i gets some positive benefit from j, q_j, but j does not reciprocate the gesture such that $g_{ji} = 0$, this is sustainable if the benefit i gets from j, q_j, is greater than the disutility resulting from the lack of reciprocity, so a $g_{ij} = 1$ tie can be formed without the need for a $g_{ji} = 1$ tie. Similarly if i provides negative utility based on their quality q_i, but $g_{ij} = 1$, then j will continue to not create the tie with i – maintaining the asymmetry in the relationship because j gets negative utility from connecting to i based on their quality and no penalties from not reciprocating the status conferring gesture coming from i to j. This, will result in the high quality actor getting a greater number of nominations from both high and low quality actors, and low quality actors only getting nominations from other low quality actors. This, it is postulated, will result in the cleavages we observe at the $q = 0$ line.



$\omega_2 = .9, \omega_3 = .1$ $\omega_2 = .9, \omega_3 = .9$

Figure 5.5: Quality vs. in-degree for reciprocity and transitivity at (high,low) and (high,high)

Another important distinction to note can be seen in the transition from a regime where there is high reciprocity sensitivity and low transitivity sensitivity ($\omega_2 = .9, \omega_3 = .1$) to one that is high on both reciprocity and transitivity ($\omega_2 = .9, \omega_3 = .9$). We note, in Figure 5.5, that the cleavage is not as clearly defined around the $q = 0$ point in the (high, high) regime as it is in the (high, low) regime. Furthermore, the degree distribution is wider in the (high, high) scenario as well. The intuition for why this is the case is straightforward. As there are three components to the utility function when the Gould parameter drops out, so the utility function takes the form $u_i = quality + reciprocity + transitivity$. Even if the quality of the actor is negative and the reciprocity parameter is 0, a directed tie from i to j could potentially be created if $transitivity > quality + reciprocity$. That is, if enough of your direct contacts are connected to an alter, then there may be enough utility gained from connecting to the alter (as a result of local social influence) that would allow the actor to overcome hesitations about quality or

reciprocity. Furthermore, the greater weight one gives to this social consideration, it would overcome some aspects of the stratification we observe.

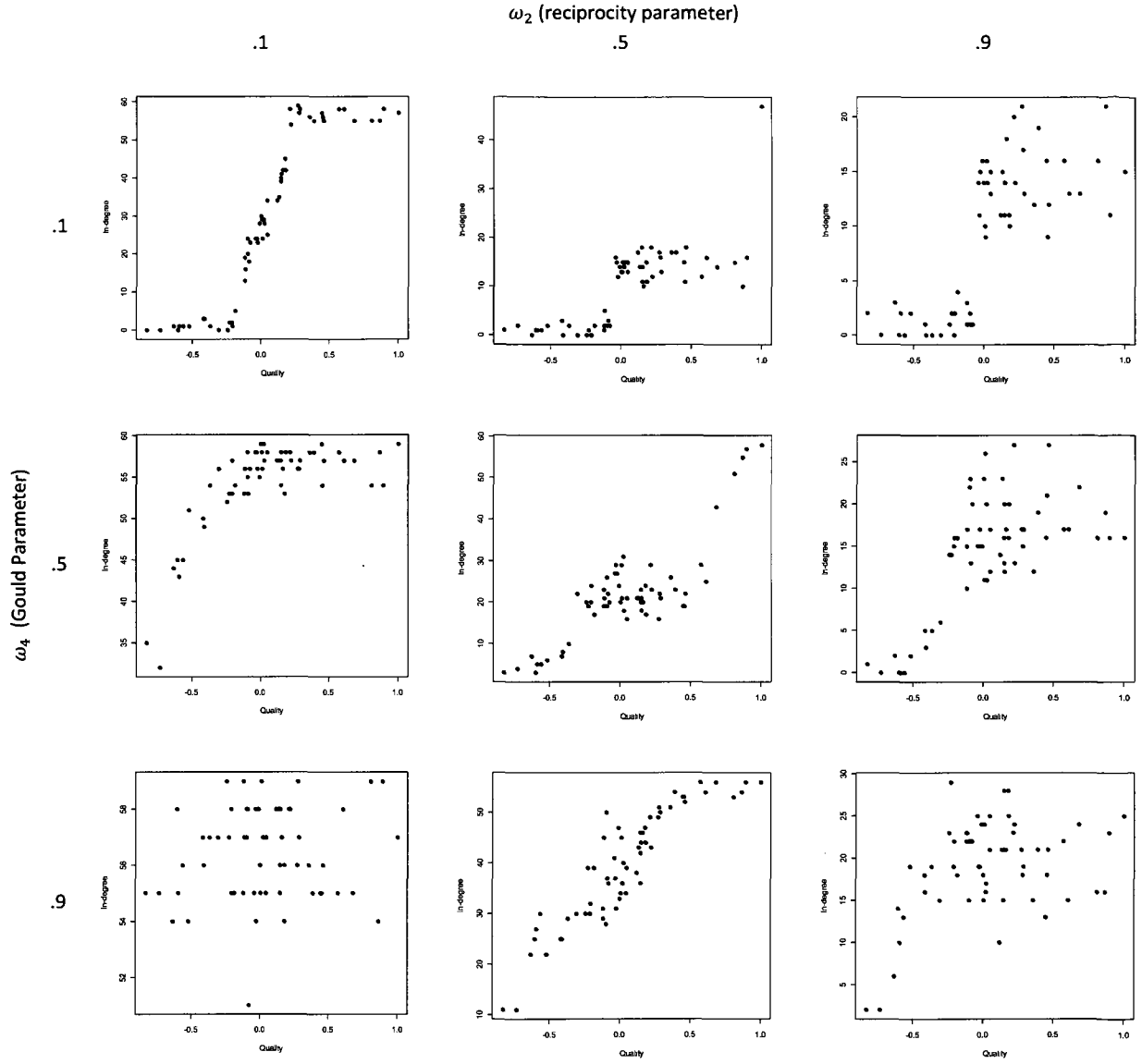
One of the most interesting graphs appears when reciprocity and transitivity considerations fall into the (low, low) scenario. We note that here, the range of in-degree goes from its theoretical minimum of 0 (having no incoming nominations) to its theoretical maximum, 59. Furthermore, we see a very steep shift in-degree as a function of quality as soon as the $q = 0$ mark appears, with some residual individuals on the margins of the $q = 0$ mark, having moderate levels of in-degree. This occurs since quality considerations are high and there is enough (though not a lot) of emphasis on reciprocity to create this cleavage. Therefore, high quality actors will connect to all high quality actors (they get a lot of benefit and lack of reciprocity is painful, so they reciprocate each others gestures). Furthermore, low quality actors will connect to all high quality actors without much consideration for reciprocity (because high quality actors are valuable and there is little penalty for lack of reciprocity). This creates a scenario where the high quality actors have ties from the high quality actors plus the low quality actors, and the low quality actors have none.

With moderate levels of reciprocity and high transitivity (moderate, high) we see another interesting pattern emerge. Although the range is essentially the same as the (low, low) scenario, the discontinuity is much less severe. This occurs because reciprocity is balanced out by transitivity. Although the variation around each point on the quality distribution is larger, individuals are more tolerant of slight differences in quality if their contacts extend status conferring ties to alters they would not have connected to otherwise.

Finally, an important feature of the stratification in these networks can be seen at all transitivity levels, when reciprocity considerations are high. There are clear cleavages between

"low quality" and "high quality" individuals with respect to the distribution of in-degree. This, as mentioned earlier is a consequence of low "quality" individuals willing to provide un-reciprocated ties to high "quality" individuals and high "quality" individuals being less likely to extend ties low "quality" individuals. The third party effects tend to minimize the cleavage, and allow for a more "inclusive" high status group with a higher number of individuals and greater variation with this group as a consequence of these dynamics.

In Figure 5.6, when we put no weight on transitivity considerations and low, moderate or high weight, on the social influence considerations as modeled by Gould ω_4, we see that the pattern of results is qualitatively the same with one slight difference: the distributions of status are more continuous. This occurs because there is more information about the alters in consideration than was available in the scenarios where transitivity was allowed to vary. In this case, an actor uses information from all actors in the social sphere rather than just her friends. Thus, although amplification of quality, either good or bad, does occur in this scenario, it is less likely to allow the cleavages created by the consideration of reciprocity to be as distinct as when only local social proof was used as a factor in the utility function.



2. All Q_j variables are drawn randomly from a Normal distribution with mean = 0 and sd = 1. The same quality vector is used for all conditions. Initial attachments are random.
3. Networks with nodes = 60 generated until convergence for each condition.

Figure 5.6: Plot of quality vs. in-degree for varying reciprocity and social influence parameters

Building on the results of this section, in the next section we explore intergroup inequality in centrality and social capital when the social arena consists of two groups, α and β, who have differing behaviors for tie formation.

Intergroup inequality

In this section, we attempt to answer the question: *If different groups within a social arena had differing tie formation behaviors, how would this affect their centrality and social capital?* To answer this question we build on the simulation procedure in the previous section to look at inter-group inequality in social networks.

We begin by breaking up our population of actors in the arena into two equally sized groups, $n_\alpha = 30$ and $n_\beta = 30$. Individuals in the arena are allowed to have the weight parameters on quality, reciprocity, transitivity, and social influence $\omega_1 \ldots \omega_4$ vary as a function of their group membership such that members of group α have weight parameters $w_1^\alpha \ldots w_4^\alpha$ and similarly for members of group β. Next we generate a quality vector for the entire population such that regardless of group membership, the quality value Q_j for an actor are drawn iid from the same normal distribution with $\mu = 0$ and $\sigma = 1$. These are normalized according to the procedure described in the methods section above. Next, we generate a random graph as our seed for the entire network with density set to .35. After these parameters have been set, then the procedure for arriving at the equilibrium $\boldsymbol{E}$ is executed. When the procedure has finished, means for the centrality and social capital measures described previously are extracted and saved for each group. This procedure is executed 100 times for each weight configuration. At the end of the procedure, we examine whether there were meaningful differences across groups for the measures. An outline of the simulation procedure is described in Figure 5.7.

1. Set weights $\omega_1 \ldots \omega_4$ for groups α and β
2. Generate quality vector consist of Q_j and normalize
3. Generate random network g with density = .35
4. Run simulation procedure to arrive at the equilibrium $\boldsymbol{E}$
5. Extract centrality measure means for each group
6. Repeat starting at step 2, $k = 100$ times
7. Compare means for groups

Figure 5.7: Simulation procedure for analyzing cross-group differences in social capital

Table 1 presents the results of this simulation. As expected, when the weights for the two groups are the same, there is no significant difference between the centrality measures across groups. However, even with slight shifts in emphasis on reciprocity, $\omega_2^{\alpha} = .3$ vs. $\omega_2^{\beta} = .1$ we begin to see quite dramatic difference between the centrality measures. For instance, the increased emphasis on reciprocity reduces mean in-degree by 35% and prestige as measured by eigenvector centrality by over 25%. Similar penalties can be seen for the other measures, such as betweenness and closeness. Constraint also follows a similar pattern. As opposed to the other measures, where greater values are better, as constraint increases, one's social capital decreases. Consistent with the other results, we again find that the group with higher concern for reciprocity has greater constraint, and thus lower social capital, than the group that places less emphasis on reciprocity.

Both the transitivity and Gould parameters, when even only slightly greater for the α group than the β group, tend to increase several measures of their social capital because of increased out-degree. Greater emphasis on these two parameters increases one's out-degree as one is more likely to create outgoing ties even when quality or reciprocity considerations might, in isolation, warrant the withholding of ties.

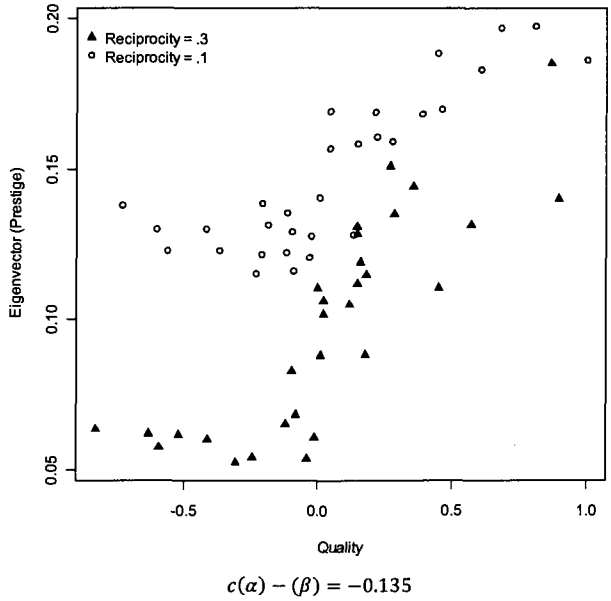
Table 5.1 Comparison of mean social capital measures for groups α and β

	Same values		Reciprocity		Transitivity		Gould (2002) Social Influence	
Group	α	β	α	β	α	β	α	β
Parameters								
$\omega_1 =$	.5	.5	.5	.5	.5	.5	.5	.5
$\omega_2 =$	.1	.1	.3	.1	.3	.3	.3	.3
$\omega_3 =$	0	0	0	0	.3	.1	0	0
$\omega_4 =$	0	0	0	0	0	0	.3	.1
Network Measures								
Out-degree	21.776 (3.234)	21.748 (2.957)	13.602 (2.053)	20.96** (3.018)	17.526** (3.592)	15.068 (2.374)	19.101** (3.17)	15.998 (2.665)
In-degree	22.047 (4.113)	21.477 (3.627)	16.899 (2.99)	17.663 (3.268)	16.315 (3.866)	16.279 (2.774)	17.787 (3.277)	17.312 (3.098)
Eigenvector (Prestige)	0.590 (0.061)	0.585 (0.054)	0.434 (0.052)	0.581** (0.062)	0.489* (0.071)	0.452 (0.05)	0.494** (0.063)	0.449 (0.059)
Eigenvector (strong)	0.430 (0.07)	0.424 (0.064)	0.359 (0.063)	0.417** (0.073)	0.427+ (0.066)	0.401 (0.055)	0.452** (0.071)	0.404 (0.058)
Betweenness (directed)	41.754 (7.303)	40.675 (8.371)	45.052 (7.826)	52.483** (8.852)	51.439** (7.21)	44.487 (9.557)	51.249** (7.363)	37.017 (9.743)
Betweenness (weak)	26.850 (5.175)	26.317 (6.971)	30.279 (6.023)	37.167** (5.924)	36.796 (6.965)	37.377 (8.953)	37.39 (8.413)	35.754 (8.285)
Betweenness (strong)	59.592 (12.202)	59.078 (12.728)	58.209 (16.411)	66.007* (12.407)	68.043** (10.673)	54.165 (13.037)	67.852** (8.968)	39.68 (11.853)
Betweenness (Simmelian)	28.129 (9.113)	27.295 (7.51)	20.641 (7.66)	31.686** (9.396	41.971** 10.483)	28.609 (7.249)	53.944** (12.175)	26.241 (7.014)
Constraint	0.094 (0.008)	0.094 (0.007)	0.112** (0.008)	0.096 (0.006)	0.107 (0.008)	0.11+ (0.007)	0.105 (0.008)	0.109+ (0.009)
Closeness	0.713 (0.039)	0.709 (0.034)	0.624 (0.022)	0.670** (0.029)	0.628 (0.037)	0.620 (0.026)	0.631 (0.027)	0.622 (0.027)
Graph Measures								
Density	0.369 (0.052)		0.293 (0.041)		0.276 (0.049)		0.297 (0.048)	
Clustering	0.632 (0.047)		0.52 (0.053)		0.431 (0.074)		0.432 (0.058)	

1. All Q_j variables are drawn randomly from a Normal distribution with mean = 0 and sd = 1 and normalized.
2. Networks with nodes = 60 generated until convergence and 100 iterations of the process are run for each condition.
3. +p < .05 , * p<..01, **p < .001, Standard deviations are in parenthesis and all tests are two-tailed.

We find that this increase in out-degree that is a consequence of the increase in the transitivity and Gould parameters increases an actor's prestige, strong eigenvector centrality, and three measures of betweenness (directed, strong and Simmelian). Furthermore, in concordance with these results, constraint also decreases – though at this level, the statistical significance of the decrease is not as large as those for the other measures.

The results in Table 5.1 do indicate that differences in tie formation behaviors across groups affects measures of social capital, with increased concern for reciprocity decreasing certain measures of social capital, and increased emphasis on transitivity and social influence increases certain measures. However, a question arises: are the differences in social capital that we observe across these two groups a result of a shift in intercept, slope, or both with respect to the relationship between quality and social capital, or are there other non-linear effects occurring?



$c(\alpha) - (\beta) = -0.135$

Figure 5.8: Quality vs. Eigenvector (Prestige) for groups α and β under different regimes

Figure 5.8 depicts the relationship between Quality vs. Eigenvector (Prestige) centrality when there are two groups with all else equal except that the reciprocity parameter for one group is set to .3 and for the other group is set to .1. We see that the group with lower emphasis on reciprocity has higher centrality than the other group, even with the same quality. A shift upward occurs in a pattern that shifts the intercept upwards, but the shape of the relationship remains relatively the same – an S-shaped curve with a steep increase at the $q = 0$ mark.

Thus far, when looking at inter-group inequality, we have focused primarily on differences between the two groups at only one level of difference in the relevant parameters. It is also important to examine differences across a wide range of parameter values, with one parameter for a group varied while all others are held constant. Figure 5.9 presents the results of this analysis where one parameter (e.g. reciprocity, transitivity, and Gould) are varied only for group α and all other parameters are equal and fixed for both groups. The x-axis is variation in the range of the parameter values for the relevant parameters as indicated by the legend, while the y-axis plots the difference in the centrality measure, in this case out-degree, for the two groups. Table 5.2 presents the setup of the simulation procedure and the values for the other fixed parameters when reciprocity, transitivity, and Gould (2002) parameters are allowed to vary. For example, when we examine the effect of varying reciprocity for group α, we hold quality (ω_1) for both groups constant at .5, and set reciprocity for the other group at .1, and the transitivity and Gould parameter at 0 for both groups.

Table 5.2 Fixed values of other parameters when reciprocity, transitivity, and Gould vary.

	Quality	Reciprocity	Transitivity	Gould
Varied Parameter	(1)	(2)	(3)	(4)
Reciprocity(ω_2^α)	$\omega_1^\alpha, \omega_1^\beta$ =.5	$\omega_2^\beta = .1$	$\omega_3^\alpha, \omega_3^\beta$ =0	$\omega_4^\alpha, \omega_4^\beta$ =0
Transitivity (ω_3^α)	$\omega_1^\alpha, \omega_1^\beta$ =.5	$\omega_2^\alpha, \omega_2^\beta$ =.2	$\omega_3^\beta = .1$	$\omega_4^\alpha, \omega_4^\beta$ =0
Gould (2002) (ω_4^α)	$\omega_1^\alpha, \omega_1^\beta$ =.5	$\omega_2^\alpha, \omega_2^\beta$ =.2	$\omega_3^\alpha, \omega_3^\beta$ =0	$\omega_4^\beta = .1$

Figure 5.9 plots the intergroup difference in out-degree when the three parameters are allowed to vary. As we can see, when reciprocity is at .9, the α group nominates about ten fewer individuals than the β group. Furthermore, out-degree is greater by 10 when there are high levels (.9) of transitivity or social influence in the group. However, we do not see a significantly large difference between transitivity and Gould Social Influence as their parameters vary while the others are held constant. This suggests that at this level of emphasis on quality and reciprocity, these two factors have similar counteracting effects that tend to increase the size of one's network with respect to the out-going ties.

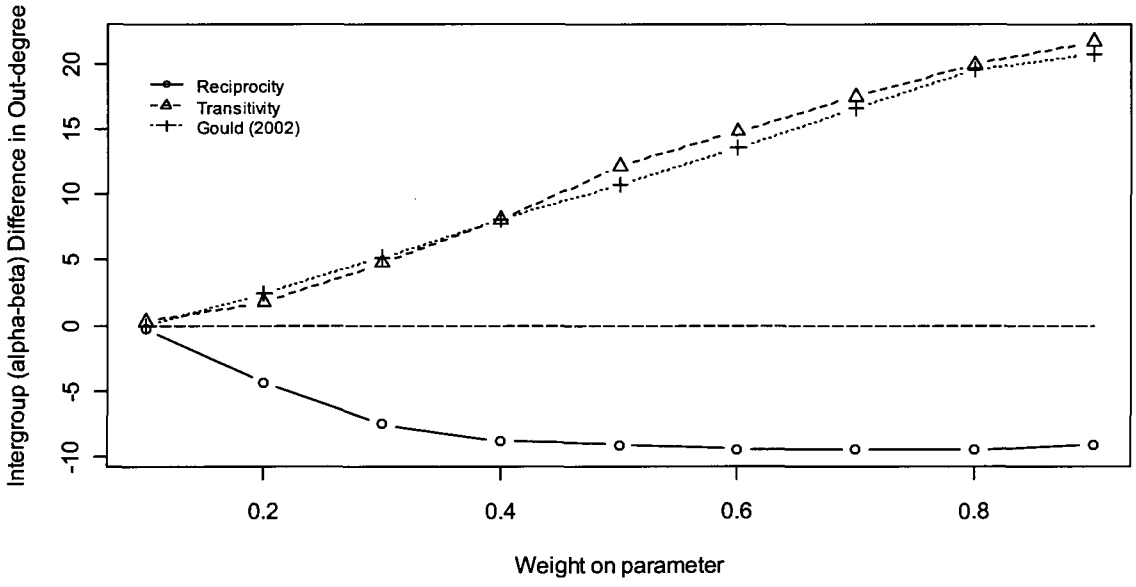


Figure 5.9: Comparison of α vs. β differences in out-degree as parameters vary from 0.1 to 0.9

Figures 5.10 which plots betweenness on the directed graph and 5.11 which plots 1-Constraint (e.g. structural holes) allow us to see differences between the transitivity and Gould parameters as they vary. In Figure 5.10, we observe that with the betweenness measure, the Gould parameter is more beneficial. It allows the actor to reach across the network using the heuristic of social influence to create ties with actors are globally popular, but far away on the network. The

transitivity parameter's effects work in the same direction, but the impact is less pronounced in increasing betweenness because the social influence is primarily local and the extent of spanning ties across the network is not as much as with global social influence.

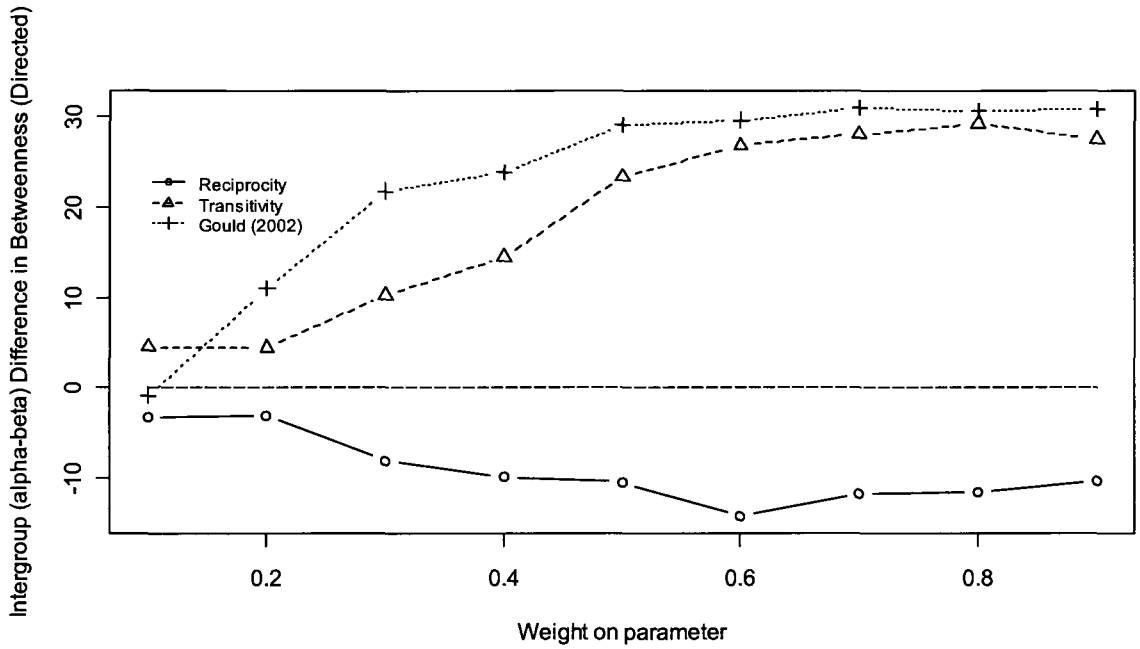


Figure 5.10: Comparison of α vs. β differences in Betweenness as parameters vary

1-Constraint, or "structural holes" another measure of brokerage in social network is plotted in Figure 5.11 as the sensitivity to the relevant parameters is varied. Here we see some differences between this measure and the betweenness measure. First we notice that the emphasis on reciprocity is significantly more detrimental to the α group in 1-Constraint scenario with a severely more pronounced drop off relative to the gains experienced with emphasis on the transitivity and social influence parameters. Furthermore, we see that unlike the betweenness measure, the 1-Constraint measure is benefited more by transitivity than Gould, though the difference is not as pronounced as it is with the betweenness measure. This occurs because the

constraint measure is penalized severely when others are connected to your alters. This occurs more often when global social influence tends to increase the amount of connections your alters get from other actors in all parts of the network.

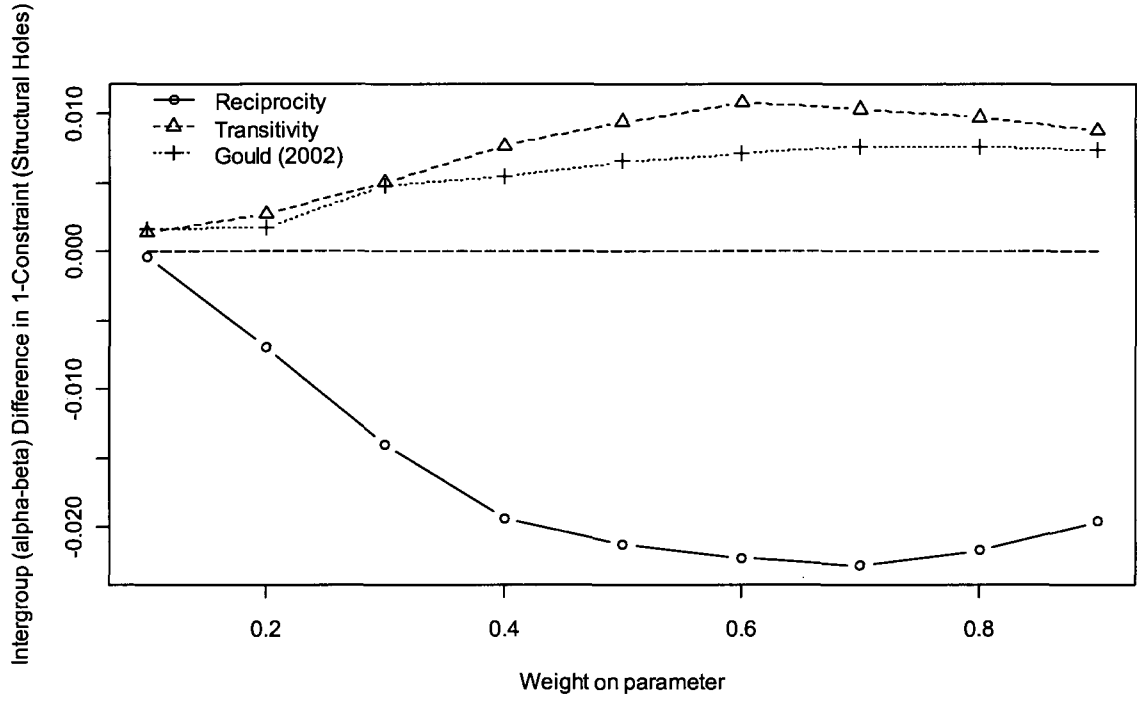


Figure 5.11: Comparison of α vs. β differences in 1-Constraint as parameters vary

Summary of Results

Overall, we see several major patterns with respect to stratification within the social network as the tie formation behaviors of actors within the network are allowed to vary, both homogeneously and across groups with differential emphasis on the four behaviors.

1. When actors are homogeneous with respect to their tie formation behaviors, increasing the emphasis on reciprocity increases cleavages in the status distribution even when there are no pronounced cleavages in the quality distribution.

2. Low sensitivity to reciprocity combined with low levels of social influence increase the range of the status distribution.
3. Increased social influence without the countervailing force of reciprocity reduces the range in the status distribution by increasing the overall status of all actors.
4. Both local (transitivity) and global social influence (Gould Social Influence) reduce actors' reliance on considerations of reciprocity and quality, thereby reducing the magnitude of cleavages.
5. Global social influence as opposed to local social influence creates more continuous status distributions.
6. With respect to inter-group differences in centrality and social capital, the emphasis on reciprocity significantly decreases one's social capital by restricting out-degree, thereby reducing prestige, brokerage and access.
7. Both local and global social influence allow actors to overcome utility penalties arising from asymmetry and quality by encouraging connections to actors to whom they would not otherwise be connected.

CONCLUSION

In this chapter, we explored the relationship between the behaviors that individuals use to form dyadic ties and their resulting social capital. We find that different tie formation behaviors can alter the status distribution significantly. Under some regimes, status distributions are more continuous, while in others, distinct and large cleavages emerge. Emphasis on reciprocity tends to limit people's social worlds and thereby reduces their social capital. Social influence, both local and global, have the potential to reduce the impact of negative individual and dyadic

calculations, and allow for the creation of bridging ties across the network, thereby decreasing cleavages as well as variation in the social capital distributions.

The model presented in this paper extends, in several important ways, sociological models of network formation (Gould 2002; Lynn, Podolny and Tao 2009). First, we add to the utility function of the actors a term for transitivity. As the sociological literature on networks and the network structures of small groups place special emphasis on triadic closure, it is an important and oft ignored component in network formation models (Holland and Leinhardt 1970; Holland and Leinhardt 1976; Holland and Leinhardt 1978; Louch 2000). Individuals regularly take cues from their friends on whom to befriend (Coleman, Menzel and Katz 1959; Shibutani 1955). Second, we examine not just the resulting rank in the status distribution as measured by in-degree of the actors, but rather examine the distributions of a wide array of social capital measures shown to be important for attainment and upward mobility. We also go beyond correlations to look at more telling graphical distributions of the social capital measures as a function of quality. Although, we are unable to provide analytic results for these relationships, we benefit by observing distinct and sociologically meaningful patterns of stratification existing within the networks, often lurking behind simple correlations. These patterns include markedly non-linear relationships, cleavages, and even important ranges of continuity. Third, we examine differences in social capital that arise when actors hail from different groups, each with differing models about the appropriate norms of network tie formation. When actors are behaving differently, even when that difference is small, it affects their social capital. Actors who place greater emphasis on reciprocity have reduced network size, prestige, and brokerage. Conversely, when actors take social cues, either global or local, it increases several measures of their social capital.

Though the results of this chapter do provide several new insights about stratification in social networks, there are still many pathways for extending this research. One limitation and area for potential extension, germane to not only this chapter, but also other work that builds on the Gould (2002) model is the arbitrary treatment of the underlying distribution of actor quality. Several avenues for making this distribution more realistic come to mind. A simple extension would be to use alternative distributions that are perhaps non-symmetric or otherwise skewed. The beta distribution may be a viable candidate in this respect. With other distributions, we may be more accurately able to model income distributions or citation distributions – consequential measures of underlying quality. Moreover, although the concept of homophily was discussed in some detail, it was not meaningfully parameterized in our model. In future models, actor quality can be perhaps be made dyadic, with the q_{ij} being a function of actor similarity on meaningful measures such as sex, age, geographic location, and education. Third, although Gould (2002) and Lynn et al. (2009) do allow for negative ties, network ties in this paper were restricted to being either "0" or "1." This choice was made in order to allow for calculation of the traditional social capital measures. Future work can and should look at extensions where ties can be negative. Research has shown that negative ties, though present, are not as prevalent within social networks as are positive ties (Labianca and Brass 2006; Labianca, Brass and Gray 1998). The empirical evidence on the density and distribution of negative ties within social networks can help guide more realistic integration of this phenomenon of into the models of network formation. Furthermore, generalizing to networks with negative ties will allow for more interesting network structures and status distributions, particularly because of the third-party dynamics. Not only will connecting to a "friend of a friend" improve utility, connecting to an

"enemy of a friend" will penalize the connection to an alter that is deemed by one's contacts to be undesirable.

The model presented here demonstrates that quality and social capital become decoupled even without the introduction of uncertainty in dyadic or social evaluations of quality. Resulting social capital distributions vary dramatically when players' tie formation behaviors are altered. Implications of these results exist for the study of stratification patterns across societies, between different groups within societies, and across organizations with different cultures and potentially different relational norms and distribution of quality.

REFERENCES

Abbott, A. 1988. "Transcending general linear reality." *Sociological Theory*:169-186.

Back, M. D., S. C. Schmukle, and B. Egloff. 2008. "Becoming Friends by Chance." *Psychological Science* 19:439-440.

Bala, V., and S. Goyal. 2000. "A noncooperative model of network formation." *Econometrica* 68:1181-1229.

Barley, S. R. 1986. "Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments." *Administrative science quarterly*:78-108.

Baron, J. N. 1984. "Organizational Perspectives on Stratification." *Annual Reviews in Sociology* 10:37-69.

Becker, G. S. 1962. "Investment in human capital: a theoretical analysis." *The Journal of Political Economy* 70:9.

Benenson, J. F. 1990. "Gender Differences in Social Networks." *The Journal of Early Adolescence* 10:472.

Benenson, J. F., and A. Christakos. 2003. "The Greater Fragility of Females' Versus Males' Closest Same-Sex Friendships." *Child Development* 74:1123-1129.

Benenson, J. F., T. Morganstein, and R. Roy. 1998. "Sex differences in children's investment in peers." *Human Nature* 9:369-390.

Bignami-Van Assche, S. 2005. "Network stability in longitudinal data: A case study from rural Malawi." *Social Networks* 27:231-247.

Bonacich, P. 1987a. "Power and Centrality: A Family of Measures." *AJS* 92:1170-82.

Bonacich, P, and P Lloyd. 2001. "Eigenvector-like measures of centrality for asymmetric relations." *Social Networks* 23:191-201.

Bonacich, P. 1987b. "Power and centrality: A family of measures." *The American Journal of Sociology* 92:1170-1182.

Brass, D. J. 1984. "Being in the Right Place - a Structural-Analysis of Individual Influence in an Organization." *Administrative Science Quarterly* 29:518-539.

—. 1985a. "Men's and women's networks: A study of interaction patterns and influence in an organization." *Academy of Management Journal* 28:327-343.

Brass, F. J. 1985b. "Mens and Womens Networks - a Study of Interaction Patterns and Influence in an Organization." *Academy of Management Journal* 28:327-343.

Breiger, R. L. 1995. "Social Structure and the Phenomenology of Attainment." *Annual Reviews in Sociology* 21:115-136.

Brinton, M. C. 1988. "The Social-Institutional Bases of Gender Stratification: Japan as an Illustrative Case." *American Journal of Sociology* 94:300.

Buechel, B., and V. Buskens. 2008. "The dynamics of closeness and betweenness." *Economics*.

Burkhardt, M. E., and D. J. Brass. 1990. "Changing Patterns or Patterns of Change: The Effects of a Change in Technology on Social Network Structure and Power." *Administrative Science Quarterly* 35.

Burt, R. S. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.

—. 1998. "The gender of social capital." *Rationality and Society* 10:5-46.

—. 2000. "The network structure of social capital." *Research in Organizational Behavior, Vol 22, 2000* 22:345-423.

Buskens, V., and A. van de Rijt. 2008. "Dynamics of Networks if Everyone Strives for Structural Holes." *American Journal of Sociology* 114:371-407.

Cancian, F. 1976. "Social stratification." *Annual Review of Anthropology* 5:227-248.

Carroll, G. R., and J. R. Harrison. 1998. "Organizational demography and culture: Insights from a formal model and simulation." *Administrative Science Quarterly* 43:637-640.

Cartwright, D., and F. Harary. 1956. "Structural balance: A generalization of Heider's theory." *Psychological Review* 63:277-293.

Castilla, E. J. 2005. "Social Networks and Employee Performance in a Call Center." *American Journal of Sociology* 110:1243-1283.

Cheng, ST, and AC Chan. 1999. "Sex, competitiveness, and intimacy in same-sex friendship in Hong Kong adolescents." *Psychol Rep* 84:45-8.

Cialdini, R. B. 1993. *Influence: The psychology of persuasion*: Collins.

Cialdini, R. B., R. J. Borden, A. Thorne, M. R. Walker, S. Freeman, and L. R. Sloan. 1976. "Basking in reflected glory: Three (football) field studies." *Journal of Personality and Social Psychology* 34:366-375.

Cialdini, R. B., W. Wosinska, D. W. Barrett, J. Butner, and M. Gornik-Durose. 1999. "Compliance with a request in two cultures: The differential influence of social proof and commitment/consistency on collectivists and individualists." *Personality and Social Psychology Bulletin* 25:1242.

Coleman, J., H. Menzel, and E. Katz. 1959. "Social processes in physicians' adoption of a new drug." *Journal of chronic diseases* 9:1.

Costenbader, E, and TW Valente. 2003. "The stability of centrality measures when networks are sampled." *Social Networks* 25:283-307.

Cotton, J. L., and J. M. Tuttle. 1986. "Employee turnover: A meta-analysis and review with implications for research." *Academy of Management Review*:55-70.

Dawes, R. M. 1979. "The robust beauty of improper linear models in decision making." *American Psychologist* 34:571–582.

Dekker, D. 2006. "Measures of Simmelian Tie Strength, Simmelian Brokerage, and, the Simmelianly Brokered." *Journal of Social Structure* 7:1-22.

Dekker, D., D. Krackhardt, and T. A. B. Snijders. 2007. "Sensitivity of MRQAP tests to collinearity and autocorrelation conditions." *Psychometrika* 72:563-581.

DiMaggio, P. J., and W. W. Powell. 1983. "The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields." *American sociological review*:147-160.

Doreian, P., R. Kapuscinki, D. Krackhardt, and J. Szczypula. 1999. "A brief history of balance through time." *Evolution of Social Networks*:129–48.

Ely, R., and I. Padavic. 2007. "A feminist analysis of organizational research on sex differences." *Academy of Management Review* 32:1121.

Faunce, W. A. 1989. "Occupational status-assignment systems: The effect of status on self esteem." *American Journal of Sociology*:378-400.

Fernandez, R. M., and M. L. Sosa. 2005. "Gendering the Job: Networks and Recruitment at a Call Center." *American Journal of Sociology* 111:859-904.

Festinger, L. 1954. "A theory of social comparison processes." *Human relations* 7:117-140.

Freeman, L. C. 1977. "A set of measures of centrality based on betweenness." *Sociometry* 40:35-41.

Freeman, L. C., S. P. Borgatti, and D. R. White. 1991. "Centrality in Valued Graphs - a Measure of Betweenness Based on Network Flow." *Social Networks* 13:141-154.

Friedman, J., T. Hastie, and R. Tibshirani. 2001. "The elements of statistical learning." Springer Series in Statistics.

Friedman, R. A., and D. Krackhardt. 1997. "Social capital and career mobility: A structural theory of lower returns to education for Asian employees." *The Journal of Applied Behavioral Science* 33:316.

Ganzeboom, H. B. G., D. J. Treiman, and W. C. Ultee. 1991. "Comparative intergenerational stratification research: Three generations and beyond." *Annual Review of Sociology* 17:277-302.

Gould, R. V. 2002. "The origins of status hierarchies: A formal theory and empirical test." *American Journal of Sociology* 107:1143-1178.

Gould, R. V., and R. M. Fernandez. 1989. "Structures of mediation: A formal approach to brokerage in transaction networks." *Sociological Methodology*:89-126.

Gouldner, A. W. 1960. "The norm of reciprocity: A preliminary statement." *American sociological review* 25:161-178.

Granovetter, M. 1982. "Who Gets Ahead - the Determinants of Economic Success in America - Jencks,C." *Theory and Society* 11:257-262.

Granovetter, M. S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78:1360.

Griffeth, R. W., P. W. Hom, and S. Gaertner. 2000. "A meta-analysis of antecedents and correlates of employee turnover: Update, moderator tests, and research implications for the next millennium." *Journal of Management* 26:463.

Haller, A. O., and A. Portes. 1973. "Status attainment processes." *Sociology of Education* 46:51-91.

Hamm, N. H., M. R. Baum, and K. W. Nikels. 1975. "Effects of race and exposure on judgments of interpersonal favorability." *Journal of Experimental Social Psychology* 11:14-24.

Harrison, J. R., and G. R. Carroll. 2006. *Culture and demography in organizations*: Princeton Univ Press.

Heider, F. 1958. *The psychology of interpersonal relations*: Wiley New York.

Hinds, P. J., K. M. Carley, D. Krackhardt, and D. Wholey. 2000. "Choosing work group members: Balancing similarity, competence, and familiarity." *Organizational Behavior and Human Decision Processes* 81:226-251.

Holland, P. W., and S. Leinhardt. 1970. "A method for detecting structure in sociometric data." *The American Journal of Sociology* 76:492-513.

—. 1976. "Local structure in social networks." *Sociological methodology* 7:1-45.

—. 1978. "An omnibus test for social structure using triads." *Sociological Methods & Research* 7:227.

Holland, PW, and S Leinhardt. 1973. "The structural implications of measurement error in sociometry." *Journal of Mathematical Sociology* 3:1973.

Hom, P. W., and A. J. Kinicki. 2001. "Toward a greater understanding of how dissatisfaction drives employee turnover." *Academy of Management Journal*:975-987.

Hsu, G., and M. T. Hannan. 2005. "Identities, genres, and organizational forms." *Organization Science* 16:474.

Ibarra, H. 1992. "Homophily and Differential Returns - Sex-Differences in Network Structure and Access in an Advertising Firm." *Administrative Science Quarterly* 37:422-447.

—. 1993. "Personal Networks of Women and Minorities in Management - a Conceptual-Framework." *Academy of Management Review* 18:56-87.

—. 1997. "Paving an alternative route: Gender differences in managerial networks." *Social Psychology Quarterly* 60:91-102.

Jackson, M. O. 2008. "Social and economic networks."

James, E. H. 2000. "Race-Related Differences in Promotions and Support: Underlying Effects of Human and Social Capital." *Organization Science* 11:493-508.

Kanter, R. M. 1977. "Some Effects of Proportions on Group Life: Skewed Sex Ratios and Responses to Token Women." *American Journal of Sociology* 82:965.

Kao, G., and J. S. Thompson. 2003. "Racial and Ethnic Stratification in Educational Achievement." *Annual Review of Sociology* 29:417-442.

Krackhardt, D, and RN Stern. 1988. "Informal networks and organizational crises: An experimental simulation." *Social Psychology Quarterly* 51:123-140.

Krackhardt, D. 1990. "Assessing the Political Landscape - Structure, Cognition, and Power in Organizations." *Administrative Science Quarterly* 35:342-369.

—. 1992. "The strength of strong ties: The importance of philos in organizations." *Networks and Organizations: Structure, Form, and Action*:216-239.

—. 1998. "Simmelian ties: Super strong and sticky." *Power and influence in organizations*:21-38.

—. 1999. "The ties that torture: Simmelian tie analysis in organizations." *Research in the Sociology of Organizations* 16:183-210.

Krackhardt, D., and M. Kilduff. 2002. "Structure, culture and Simmelian ties in entrepreneurial firms." *Social networks* 24:279-290.

Krackhardt, D., and L. W. Porter. 1985. "When Friends Leave - a Structural-Analysis of the Relationship between Turnover and Stayers Attitudes." *Administrative Science Quarterly* 30:242-261.

—. 1986. "The Snowball Effect - Turnover Embedded in Communication-Networks." *Journal of Applied Psychology* 71:50-55.

Labianca, G., and D. J. Brass. 2006. "Exploring the social ledger: Negative relationships and negative asymmetry in social networks in organizations." *Academy of Management Review* 31:596-614.

Labianca, G., D. J. Brass, and B. Gray. 1998. "Social networks and perceptions of intergroup conflict: The role of negative relationships and third parties." *Academy of Management Journal* 41:55-67.

Latane, B., J. H. Liu, A. Nowak, M. Bonevento, and L. Zheng. 1995. "Distance Matters: Physical Space and Social Impact." *Personality and Social Psychology Bulletin* 21:795.

Lawrence, B. S. 2006. "Organizational reference groups: A missing perspective on social context." *Organization Science* 17:80.

Lin, N. 1999. "Social networks and status attainment." *Annual review of sociology* 25:467-487.

Lin, N., J. C. Vaughn, and W. M. Ensel. 1980. "Social resources and occupational status attainment." *Soc. F.* 59:1163.

Louch, H. 2000. "Personal network integration: transitivity and homophily in strong-tie relations." *Social networks* 22:45-64.

Lynn, F.B., J. M. Podolny, and L. Tao. 2009. "A Sociological (De)Construction of the Relationship between Status and Quality." *American Journal of Sociology* 115.

Macpherson, DA, and BT Hirsch. 1995. "Wages and Gender Composition: Why do Women's Jobs Pay Less?" *Journal of Labor Economics* 13:426.

McPherson, J. M., and L. Smith-Lovin. 1987. "Homophily in voluntary organizations: Status distance and the composition of face-to-face groups." *American Sociological Review* 52:370-379.

McPherson, JM, and L Smith-Lovin. 1982. "Women and Weak Ties: Differences by Sex in the Size of Voluntary Organizations." *American Journal of Sociology* 87:883.

McPherson, M., L. Smith-Lovin, and J. M. Cook. 2001. "Birds of a feather: Homophily in social networks." *Annual Review of Sociology* 27:415-444.

Mehra, A., M. Kilduff, and D. J. Brass. 2001. "The social networks of high and low self-monitors: Implications for workplace performance (vol 46, pg 121, 2001)." *Administrative Science Quarterly* 46:376-376.

Mitchell, T. R., B. C. Holtom, T. W. Lee, C. J. Sablynski, and M. Erez. 2001. "Why people stay: Using job embeddedness to predict voluntary turnover." *Academy of management journal*:1102-1121.

Moore, G. 1990. "Structural determinants of men's and women's personal networks." *American Sociological Review* 55:726-735.

Nahemow, L., and M. P. Lawton. 1975. "Similarity and propinquity in friendship formation." *Journal of Personality and Social Psychology* 32:205-213.

Newcomb, T. M. 1961. "The acquaintance process." *New York: Holt, Rinehart, & Winston.*

O'Flaherty, B., and A. Siow. 1995. "Up-or-out rules in the market for lawyers." *Journal of Labor Economics*:709-735.

O'Reilly Iii, C. A., J. Chatman, and D. F. Caldwell. 1991. "People and organizational culture: A profile comparison approach to assessing person-organization fit." *Academy of management Journal*:487-516.

Petersen, T., I. Saporta, and M. D. L. Seidel. 2000. "Offering a Job: Meritocracy and Social Networks." *American Journal of Sociology* 106:763-816.

Pfeffer, J. 1977. "Toward an Examination of Stratification in Organizations." *Administrative Science Quarterly* 22:553-67.

Phillips, D. J., and E. W. Zuckerman. 2001. "Middle-Status Conformity: Theoretical Restatement and Empirical Demonstration in Two Markets 1." *American Journal of Sociology* 107:379-429.

Podolny, J. M. 1993. "A status-based model of market competition." *American Journal of Sociology* 98:829.

Podolny, J. M., and J. N. Baron. 1997. "Resources and relationships: Social networks and mobility in the workplace." *American Sociological Review* 62:673-693.

Rao, H., H. R. Greve, and G. F. Davis. 2001. "Fool's gold: Social proof in the initiation and abandonment of coverage by Wall Street analysts." *Administrative Science Quarterly*:502-526.

Reskin, B. 1993. "Sex Segregation in the Workplace." *Annual Reviews in Sociology* 19:241-270.

Roberts, K. H., and C. A. O'Reilly. 1979. "Some correlations of communication roles in organizations." *Academy of Management Journal*:42-57.

Sampson, S. F. 1968. "A Novitiate in a Period of Change: An Experimental and Case Study of Social Relationships." Cornell University.

Seibert, S. E., M. L. Kraimer, and R. C. Liden. 2001. "A social capital theory of career success." *The Academy of Management Journal* 44:219-237.

Shibutani, T. 1955. "Reference groups as perspectives." *The American Journal of Sociology* 60:562-569.

Simmel, G. 1950. "The triad." *The Sociology of Georg Simmel*:145-169.

Snijders, T, and M Van Duijn. 1997. "Simulation for Statistical Inference in Dynamic Network Models." *LECTURE NOTES IN ECONOMICS AND MATHEMATICAL SYSTEMS*:493-512.

Sparrowe, R. T., R. C. Liden, S. J. Wayne, and M. L. Kraimer. 2001. "Social networks and the performance of individuals and groups." *The Academy of Management Journal* 44:316-325.

Stewman, S. 1988. "Organizational demography." *Annual Review of Sociology* 14:173-202.

Stinchcombe, A. L. 1965. *Stratification and organization*: Cambridge University Press.

Tett, R. P., and J. P. Meyer. 1993. "Job satisfaction, organizational commitment, turnover intention, and turnover: Path analyses based on meta-analytic findings." *Personnel Pyschology* 46:259-293.

Tortoriello, M, and D Krackhardt. In press. "Activating Cross-Boundary Knowledge: The Role of Simmelian Ties in the Generation of Innovations." *Academy of Management Journal.*

Van Maanen, J. E., and E. H. Schein. 1977. "Toward a theory of organizational socialization."

Vigil, J. M. 2007. "Asymmetries in the Friendship Preferences and Social Styles of Men and Women." *Human Nature* 18:143-161.

Waldman, M. 1990. "Up-or-out contracts: A signaling perspective." *Journal of Labor Economics*:230-250.

Wasserman, L. 2004. *All of statistics: a concise course in statistical inference*: Springer.

Wasserman, S, and K Faust. 1994. *Social Network Analysis: Methods and Applications*: Cambridge University Press.

White, D. R., and S. P. Borgatti. 1994. "Betweeness Centrality Measures for Directed-Graphs." *Social Networks* 16:335-346.

White, H. 1982. "Maximum likelihood estimation of misspecified models." *Econometrica: Journal of the Econometric Society*:1-25.

Yamagata, H., K. S. Yeh, S. Stewman, and H. Dodge. 1997. "Sex Segregation and Glass Ceilings: A Comparative Statics Model of Women's Career Opportunities in the Federal Government over a Quarter Century 1." *American Journal of Sociology* 103:566-632.

Zuckerman, E. 1999. "The categorical imperative: Securities analysts and the illegitimacy discount." *AJS* 104:1398-1438.