1-1-2012

Is It a Small World after all: An Examination of Scientific Collaborations in Public Administration

James Earl Orr

Is it a small world after all: an examination of scientific collaborations in public administration

By

James Earl Orr Jr

A Dissertation
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Doctorate of Philosophy
in Public Policy & Administration
in the Department of Political Science and Public Administration

Mississippi State, Mississippi

December 2012

Is it a small world after all: an examination of scientific collaborations in public administration

By

James Earl Orr Jr

Approved:

Gerald A. Emison
Associate Professor of Political Science and Public Administration
(Chair of Dissertation)

Stephen D. Shaffer
Professor of Political Science and Public Administration
(Committee Member)

William M. Wiseman
Professor of Political Science and Public Administration
(Committee Member)

P. Edward French
Associate Professor and Graduate Coordinator of Political Science and Public Administration
(Committee Member)

R. Gregory Dunaway
Professor and Interim Dean
College of Arts &Sciences

Name: James Earl Orr Jr

Date of Degree: December 15, 2012

Institution: Mississippi State University

Major Field: Public Policy & Administration

Major Professor: Gerald A. Emison

Title of Study: Is it a small world after all: an examination of scientific collaborations in public administration

Pages in Study: 155

Candidate for Degree of Doctorate of Philosophy

Peer reviewed journal articles are one way in which scholars communicate with each other and the public. Such publications create networks of collaboration. This study uses social network analysis techniques and theory to examine the network of collaborations that occur in public administration. Social network analysis is a perspective that takes into account the structure of relationships that can exist among individuals, organizations or other entities (Wellman, 2008). The small world theory is the specific theoretical framework that guides this study. The small world theory is based on the notion that despite a population being very large, individuals in that population are still connected with each other within a few steps.

The author constructs a scientific network of research collaborations by assigning a relationship to two actors who have co-published an article together in the *Public Administration Review, American Review of Public Administration,* or *The Review of Public Personnel Administration* during the time periods of January 2003- December 2011. The results of this analysis reveal that the public administration network consists primarily of faculty members. The network also exhibits a high degree of clustering and

several cliques. On average, individuals in the network are only slightly farther apart from each other than what would be expected in a small world network.

This research contributes to public administration by introducing scientific networks of collaboration to public administration. The field has not ignored who publishes in its journals, but it has not used network analysis techniques to examine such publications. This study demonstrates how network analysis techniques and methodology can be used to examine a large network. Finally, this research contributes to the small world theory by applying it to scientific networks in public administration.

DEDICATION

This dissertation is dedicated to those who served as an inspiration, encouragement, and advisor to me throughout my life. First and foremost, this dissertation is dedicated to my Lord and Savior, Jesus Christ. I understand that you paid the ultimate price for me and that you are responsible for my existence. Thus, I dedicate this document and my life to you. To my mother, Susie Orr, thank you for praying for me throughout my life and my graduate career. I have always felt a special strength because I knew that you were praying for me. I also appreciate you for reminding me that Jesus would give me the knowledge and strength to complete this dissertation. To my father, James Earl Orr, Sr., I would like to thank you for teaching me that I would need Jesus and an education in order to be successful. I appreciate you for attending basketball tournaments with me and for driving several hours just to bring me something that I needed. Your support and wisdom enabled me to focus on completing this dissertation and maintaining a relationship with Christ. To my sister, Karita Orr, thank you for reviewing my dissertation and encouraging me to work hard. To my sister, Felicia Orr, thank you for proof reading my papers throughout my collegiate career. I also admire the work that you do in order to encourage others to obtain an education. To my brother, Jason Orr, thank you for demonstrating a drive for excellence and a commitment to making a difference in the world. I am grateful for having a strong and supportive family.

ACKNOWLEDGEMENTS

I would like to first express my appreciation to my dissertation committee members. I truly appreciate you for taking time out of your schedules to assist me throughout this process. I am especially grateful to you for providing me with timely and candid feedback throughout the process. Dr. Emison, I would like to thank you for serving as my chairperson and advisor for the past five years. I appreciate you for supporting me and providing me with career advice. You are indeed a model advisor, and Mississippi State University is fortunate to have you on its faculty. Dr. Edward French, thank you for serving as a member of my committee. I am honored that I was given the opportunity to work with you. I appreciate the honest advice that you have provided me with throughout this process. I am also grateful to you for the conversations that we have had over the years about what it means to be a true scholar. Dr. Shaffer, thank you for your critical evaluation of my dissertation. I appreciate you for challenging me to strive for perfection. Dr. Wiseman, I am grateful to you for taking time out of the demanding schedule that you have as an administrator and scholar to assist me throughout this process.

I would also like to thank Andrea Michelle Perkins for reviewing multiple drafts of this document and for having countless discussions with me about my dissertation. Your assistance provided me with invaluable insight and encouragement.

TABLE OF CONTENTS

DEDICATION ii

ACKNOWLEDGEMENTS iii

LIST OF TABLES vii

LIST OF FIGURES ix

CHAPTER

I. INTRODUCTION 1

Journal Publications 1
Selection of Journals to Review 2
Problem Statement 3
Solution to the Problem 5
Significance of Study 6
Research Questions 8
Organization of Dissertation 8

II. LITERATURE REVIEW 10

Social Network Analysis 12
Networks in Public Administration 15
Defining Networks in Public Administration 18
A New Type of Network 23
Summary 25
Small World Theory 26
Quantification of the Small World Theory 30
Small World Theory in Management 33
Scientific Networks of Collaborations 35
Co-authorship Using Conference Papers 53
Public Administration Co-Publication Articles 54
Summary 57

III. THEORITICAL FRAMEWORK 59

Small World Theory 59
Most Central Authors in Field 61

Status of Theoretical Frame for Research Collaborations in Public Administration 63
Insight that Research Provides 64
Conclusion 65

IV. METHODOLOGY 66

Research Questions and Expectations 67
Data Collection 69
Authors and Co-Authors of Articles 71
Institution of Employment 71
Occupation 71
Discipline of Employment 72
Gender of Authors 73
Organization of Data as Collected 73
Analyzing Data and Terminology 73
Validity, Accuracy and Reliability of Data 74
Construction of Network 76
Construction of Network of Collaborations in Public Administration 78
Graphical Representation of Network 79
Make-up of the Network 81
Overall Connectivity of Network 81
Description of the Network's Make-up 82
Testing the Small World Theory 83
Giant Component 83
Clustering Coefficient 84
Average Path Length 85
Random Graph 86
Cliques of Networks 87
Cliques in the Network 89
Most Central Authors in Public Administration Network 89
Degree Centrality 89
Closeness Centrality 90
Betweeness Centrality 91
Correlating the Three Measures of Centrality 92
Public Administration Network Compared to Other Academic Disciplines 92
Conclusion 93

V. RESULTS 94

Introduction 94
Make-up of the Network 94
Overall Connectivity of Network 96
Descriptive of the Network's Make-up 97

Testing the Small World Theory....100
Average Number of Links Compared to Actors....100
Giant Component....101
Average Path Length....104
Clustering Coefficient....105
Random Graph....105
Cliques of Network....107
Homogeneity of Cliques and Publications....107
Most Central Authors in Public Administration....116
Degree Centrality....116
Betweeness Centrality....117
Closeness Centrality....118
Discussion of Overall Results....119
Public Administration Network Compared to other Academic Disciplines....121
Conclusion....122

VI. CONCLUSION....123

Problem Statement/Significance of Study....124
Results and Discussion....124
Make-up of Network....126
Small World Theory....128
Network Cliques....130
Recommendations....130
Further Studies....132
Conclusion....133

REFERENCES....135

APPENDIX

A. NETWORK COMPOENTS....142

LIST OF TABLES

1	Example of a One Mode Network	78
2	Example of a Two Mode Network	79
3	Publication Preferences	87
4	Most Publications in Network	95
5	Gender of Authors	96
6	Network Density	96
7	Publications	97
8	Authors Per Article	98
9	Profession	99
10	Academic Rank	100
11	Number of Components and Actors Per Component	102
12	Connectivity of the Giant Component	102
13	Small World Measures	107
14	Publications by Practitioners	109
15	Student Publications	110
16	Women's Publications	111
17	Publications by Public Administration Scholars	112
18	Network Cliques	114
19	Authors with Top 39 Centrality Scores	119
20	Correlation Matrix	120

21 Most Central Authors 121
22 Network Comparison 122
23 Expectations 125

LIST OF FIGURES

1 Undirected Graph 80

2 Directed Graph 81

3 Public Administration Network 103

4 Giant Component of Network 104

5 Authors Connecting Sub-Groups 116

CHAPTER I

INTRODUCTION

Journal Publications

Journal publications are an important part of academic life in public administration. The rankings of graduate programs and productivity of faculty members are often measured in part by peer reviewed journal publications (Meier & Morgan, 1982). Douglas (1996) recommends that students who are evaluating graduate programs consider the productivity of faculty members and graduate students in regards to journal publications (Douglas 1996). Journal publications are particularly important to scholars seeking to develop their careers. Forrester and Watson (1994) note that peer-reviewed journals serve as gate-keepers for the field of public administration (Forrester & Watson, 1994).

Individuals who seek to work in academia understand that obtaining tenure is critical for job security. When considering tenure, most institutions are interested in a faculty member's track record and potential in the areas of teaching, research and service. In many instances, if one cannot demonstrate that they have engaged in these activities, they will not obtain tenure. While teaching and service are important at major research institutions, faculty members who do not demonstrate the ability to publish consistently will often not obtain tenure regardless of the amount of teaching and service that they perform. Thus, research is a critical aspect of obtaining job security in an institution of

higher learning. Rodgers &Rodgers (1999) note that junior faculty members who do not publish tend to be forced to move to different institutions or they do not survive in academia (Rodgers & Rodgers, 1999).

Peer reviewed journal publications are also important as it allows scholars to contribute to the body of knowledge that exists in a field of study. Scholarly publications allow scholars to communicate with each other as well as the public. Scholars seek to publish research in journals so that other scholars, practitioners and students can learn from their work. Publishing in a peer-reviewed journal is important, as it signifies that one's research has met the criteria of being considered scholarly work that is worthy of dissemination to the public.

Given the critical nature of research and the dissemination of knowledge, it is also important to understand who is publishing and the structure of their relationships. Individuals producing scholarly work transmit knowledge to society. In the field of public administration, these individuals often identify trends, problems, and solutions for the field.

Selection of Journals to Review

The purpose of my research is to advance the body of knowledge regarding scientific networks in public administration. When identifying journals to review for this analysis, I sought journals that other scholars have conducted studies on who publishes in those journals, but did not do so through the lenses of scientific networks and network analysis. The literature review did not reveal any studies that used network analysis to examine scientific collaboration networks in public administration. This is important as it allows me to demonstrate how much more information and advancement in theory can

be gleaned from a network approach. Thus, I chose to examine journals associated with the American Society of Public Administration (ASPA). Journals associated with ASPA have been studied by Handley et. al (2005), but the authors did not utilize the theoretical lenses that I use. Specifically, I examine the *Public Administration Review, American Review of Public Administration,* and *The Review of Public Personnel Administration*. I chose to review the *Public Administration Review* and the *American Review of Public Administration* because these two journals examine the entire public administration field. They are not journals that only examine a specific sub-field of the discipline. These journals also encourage the work of both practitioners and scholars. In addition, the *Public Administration Review* consistently ranks as the top journal in the field of public administration (Douglas 1996, Forrester & Watson, 1994, Giles & Wright, 1975; Garand & Giles, 2003). I chose to include the *Review of Public Personnel Administration* because it allows me to review a subfield of the discipline through a journal that is regarded as the premier journal in that sub-discipline (West, 2010). Further, West (2010) conducted a review of the scholarly work that can be found in the *Review of Public Personnel Administration*. This allows me to utilize my research to demonstrate how I advance the theory and knowledge that he highlighted in his study. I also am able to capture a diversity of perspectives and scholarly work for this analysis with the three journals that I have chosen to review.

Problem Statement

Networks have major implications on the development and implementation of public administration. Toonen (1998) argues that considering networks in public administration broadens the scope of focus in public administration. For example,

Toonen (1998) writes, "It automatically broadens the relevant locus to the social, political and economic structures which are always involved in the business of government" (Toonen, 1998, p. 250). The proper study of networks can also reveal potential inequities that may exist in public organizations. Meier and O'Toole's (2004) study of public organizations revealed that individual actors in organizations could act in such a way that would lead the organization to make decisions that primarily benefited the most "advantaged clientele" (Meier & O'Toole, 2004). Further, Cresswell et.al (2009) argue that it is critical for the culture of networks among various public organizations to embrace the importance of sharing information and collaborating with each other. Cresswell et.al. (2009) further argue that considering networks outside of one's immediate organization is more favorable than simply communicating with only those in the organization's immediate network (Cresswell et.al., 2009).

Despite the importance of considering networks that is highlighted in the public administration literature, the field has a long way to go. Much of the research in public administration that has discussed network analysis has done so from a standpoint in which networks are only used to describe an element, but no true network analysis has occurred- the term is being used as a metaphor (Isett et.al, 2011). Freeman (1984) made a similar critique regarding the status of the network literature in other disciplines (anthropology, sociology, economics) (Freeman, 1984). Since that time those disciplines have experienced studies that have examined large networks through the appropriate theoretical and methodological lenses. Public Administration scholars have made a call to the discipline that it is important to start thinking "seriously" about networks (O'Toole,

1997). This involves exploring true networks as well as systematically using network analysis techniques and structures to actually test a study in public administration.

A second problem is that the discipline has not studied scientific networks in public administration using network analysis. As I note in the literature review of this research, the studies that have examined who publishes in the discipline have been conducted with very little theoretical framework. The proper methodological technique and framework must be used when studying the scientific network in order to enhance the body of knowledge in the field regarding this area.

Solution to the Problem

This research presents a solution to both of the problems outlined above. This research answers O'Toole's (1997) call in which he urged the field of public administration to begin paying closer attention to networks in the study and practice of public administration. His research focused on networks from a metaphorical standpoint, but since then scholars have called for the utilization of network analysis in more applied aspects. This research utilizes network analysis techniques to analyze a network that the discipline has not ignored, yet not adequately addressed. This network is that of scientific collaborations. In this study, I utilize the small world theory as a theoretical framework for evaluating the structure of scientific collaborations in public administration. This theory is based on the notion that most individuals, even in very large social networks, are connected to each other within a few people. I will utilize specific network analysis techniques to examine research collaborations in public administration using the small world theory. My study provides a theoretical foundation

for studying large networks in public administration. This study also demonstrates how networks can be analyzed and evaluated through the lenses of network analysis.

Significance of Study

This research advances the theory of public administration in four areas. The first area is that it contributes to the field of public administration from a network methodological perspective. O'Toole (2010) argued that the study of public administration could not occur without the consideration of networks (O'Toole, 2010). Scholars in the field have discussed networks, but many do so without using the appropriate network terminology and techniques. In this study, I present methods and techniques that can be used to study networks in public administration. This study demonstrates how network analysis theory and techniques can be used to systematically examine a network in public administration. While my study examines one network, the theories and statistical techniques that I utilize can be replicated and applied to a variety of different types of networks (Wasserman & Faust, 2005). This will assist in enhancing the field's ability to evaluate networks using the appropriate theories, terminology and methodological approaches.

The second way in which this study advances the development of theory in public administration is that I introduce the concept of scientific networks to the field of public administration. Scientific networks have not been examined in public administration. Given the important role that scholarly publications play in the development of theory, it is important to understand the network of individuals who publish. This research contributes to public administration by providing insight into scientific collaborations in the discipline's scholarly works. This approach is important as it will assist in identify

the influential scholars in the discipline. One's first inclination may be that the researcher who publishes the most articles, those whose work is cited the most, or even editors of a journal are the most influential scholars in theory development in the discipline. An examination using network analysis and the small world theory may reveal that the influential scholars in the discipline are those who connect various aspects of the network together. For example, Barbasi (2002) argued that networks exhibit scale free properties (Barbasi, 2002). This indicates that in the network there are a few key individuals who hold the network together. The network falls apart when they are removed. If the network indeed consists of scholars who connect various segments of the network together, this allows for the transmission of ideas and theories across research areas of focus. Further, it has been noted that there is a need for graduate students and practitioners to publish more in the discipline (Pitts & Edwards 2005; Handely & Watson 2005). This study will reveal how connected these individuals are to other scholars in the field.

This study also has implications for strategies that researchers may use to be influential in the network. Topham (2011) argues that the development of a network allows individuals to see where they are in the network in relations to where they would like to be in the network. This may assist individuals in a network in developing a plan to improve their position in the network. This current research will assist scholars in identifying where they are in the network and where they would like to be in the network. For example, for a scholar seeking to penetrate the network, it would make much more sense for them to publish with someone who is deeply embedded in the network as

oppose to publishing with another scholar who has published multiple times but is relatively disconnected from the network as a whole.

Finally, this study contributes to the overall theory development of scientific networks and the small world theory. The small world theory is important for public administration, as it provides insight into how connected the discipline and research concepts are to the field. This study uses social network analysis and the small world theory to evaluate a discipline that has not examined scientific networks through these lenses. This will add to the development of a theoretical perspective on the structure of scientific networks. This research contributes to the small world theory by building upon the theory to provide insight into whether or not the small world theory can be generalized to public administration scientific collaboration networks.

Research Questions

This research explored scientific collaborations in public administration that occurs in the *Public Administration Review, American Review of Public Administration,* and *The Review of Public Personnel Administration*. Using the small world theory, this research seeks to provide insight into the social network that exists in scientific collaborations that can be found by examining co-authorships in public administration. This research seeks to provide insight into the structure of the public administration network by using network analysis.

Organization of Dissertation

This research tests the small world theory to examine scientific collaborations in *Public Administration Review, American Review of Public Administration,* and *The*

Review of Public Personnel Administration. This study will be divided into six chapters. Chapter two reviews the literature on networks in public administration, the small world theory, and studies that utilize network analysis to examine scientific collaborations through co-authorship. Chapter three of this study discusses the theoretical framework that guides my research. In this chapter, I also list the overarching questions that I examine as well as the various expectations that I tested. Chapter four presents the methods section of this research. In this chapter, I discuss how I collected and analyzed the data. I also discuss the network terminology that will be used throughout my analysis. Chapter five discusses the statistical results from this analysis. The final chapter, chapter six, discusses recommendations for future studies, how network analysis can inform scholarship and practice in public administration, and limitations of this current research.

CHAPTER II

LITERATURE REVIEW

The purpose of this review is to identify through the literature how this research adds to the development of theory in public administration. I have identified three streams of research that is important to this analysis. I will first mention each stream and then conclude with how these streams of the literature coupled together advance the development of theory in public administration. It is critical that I make this distinction, as my goal is to advance the state of knowledge and theory development in public administration. I bring together the literature on social networks, networks in public administration, the small world theory, and scientific networks to advance theory.

The first stream of literature that is appropriate to discuss is social network analysis. Social network analysis is not simply a set of techniques used to conduct a study, it is rather a perspective that takes into account the structure of relationships that can exist among individuals, organizations or other entities (Wellman, 2008). Wasserman and Faust (2005) write, "The fundamental difference between a social network explanation and a non-network explanation of a process is the inclusion of concepts and information on relationships among units in a study" (Wasserman and Faust, p. 6, 2005). Wasserman and Faust (2005) go on to specifically define a social network as a group of individuals and the "relation or relations defined on them" (Wasserman & Faust, p. 20, 2005). The word relation refers to the relationships or ties

that connect the individuals in the network. In this literature review, the discussion of social network analysis contributes to the overall development of theory in public administration by first clearly identifying the underlying perspective of this research. Secondly, the discussion of social network analysis couples very well with the second stream of research that I have identified concerning networks in public administration. The discussion of networks in public administration is important to the development of theory in that I identify how networks are used and studied in public administration. The third stream of literature that I discus in this review is the small world theory. The small theory provides the theoretical framework for this study. This strand of research is based on the notion that individuals are connected to each other through very few connections despite the large world that we live in. The final stream of research that I review is that of scientific networks through co-publications.

The streams of social network literature, networks in public administration literature, the small world theory, and scientific networks together demonstrate how I advance the theory in public administration. As will be indicated in my review of the literature, other studies have examined who publishes in public administration journals. While these studies are interesting, they lack a theoretical framework for studying a network. Further, as I will illustrate throughout the literature review, the discipline in public administration has lacked the appropriate methodological framework for studying networks. The current study contributes to the literature in this area by using specific network terminology and theory to examine a large network in public administration. Further, I identify where my research falls in regards to the current status of network research in public administration. In addition, I analyze a new network in public

administration that the discipline has not analyzed, scientific networks. After reading my review of the literature and this research, the discipline will have a better understanding of the connectivity or lack of thereof that exist in public administration scientific networks. The techniques that I utilize will demonstrate how a large network can easily be analyzed using specific network concepts. Thus, in the review below I first seek to demonstrate an overview of the stream of research that I have identified. I then proceed in discussing the gap in the literature as it relates to public administration that I fill.

This chapter is organized into three sections. In the first section, I provide a brief overview of social network analysis from a sociological perspective. I then proceed to demonstrate a call for the usage of networks in public administration as well as provide insight into how the word is used in our discipline. Finally, I demonstrate in the literature a need for a new type of network to be examined as well as highlight how the current research adds to the state of knowledge in public administration.

Social Network Analysis

When I define social network analysis, I do so from a perspective that is espoused by Wasserman and Faust (2005). Social network analysis (SNA) from this perspective is an analytical technique and perspective that allows a researcher to study the structure of relationships. In this section, I introduce the concept of social network analysis that undergirds this research. This approach is taken from a sociological view of network analysis. This section contributes to the state of knowledge on networks in public administration in that it provides insight into the foundations of networks as well as the underlying assumptions of the approach. In this section of the review of the literature, I first discuss the theoretical foundations of network analysis. I then proceed to discuss the

potential analytical approaches that can be used in network studies. I then conclude this section by foreshadowing how I intend to use the approach in the current study.

Freeman (1984) argues that the thought and concept of looking at networks has its roots in a variety of academic disciplines, as it is a very interdisciplinary approach. The actual terminology and formalization of the analytical techniques associated with network analysis has its foundations in sociology, mathematics, and social psychology (Wasserman & Faust 2005). SNA has become a popular tool in examining the relationships that exist in a variety of fields and disciplines. In the book, Social Network Analysis: Methods and Applications by Stanley Wasserman and Katherine Faust, the authors write, "Much of this interest can be attributed to the appealing focus of social network analysis on relationships among social entities, and on the patterns and implications of these relationships" (Wasserman & Faust, 2005, p.3). SNA is much different from other forms of analyses in that it does not focus on the individual, but rather focuses on the structure of relationships. When discussing the assumptions of SNA, Wasserman and Faust (2005) write,

a) "Actors and their actions are viewed as interdependent rather than independent, autonomous units" (Wasserman & Faust, 2005, p. 4)

b)" Relational ties (linkages) between actors are channels for transfer or "flow" of resources (either material or nonmaterial)" (Wasserman & Faust, 2005, p. 4)

c) "Network models focusing on individuals view the network structural environment as providing opportunities for or constraints on individual action" (Wasserman & Faust, 2005, p. 4)

d) “Network models conceptualize structure (social, economic, political, and so forth) as lasting patterns of relations among actors” (Wasserman & Faust, 2005, p. 4).

SNA offers both quantitative and qualitative approaches that provide insight into relationships. Freeman (1984) notes that social network analysis provides specific formal wording and techniques that can be used to examine social relationships. In addition, it provides theoretical perspectives that can provide useful techniques for the examination of relationships and the flow of knowledge that exists in those relationships. This is important as Freeman (1984) argues that “The study of social networks is nothing if not mathematical” (Freeman, 1984, p. 126). Leinhardt (1977) notes that the precise definitions that social network analysis offers is important, as he argues that building theories with explanatory power is impossible to do if one can only utilize metaphors to discuss relationships. Kadushin (2002) highlights this when writing, “A network structure can be described in the same terms whether it is a structure of friendship between people or a structure of trading relations between nations” (Kadushin, 2002, p. 77). Network analysis provides techniques and theories that allow one to examine the structure of relationships, regardless of the direction of those relationships (Berry et al., 2004). Network analysis serves as an analytical technique that acknowledges the importance of relationships and the structure of those relationships. The technique can assist practitioners and scholars in focusing on the external aspects of organizations and the public sector (Bogason & Tooner, 1998). O’Toole (2010) notes, “The use of tools such as social network analysis, furthermore, provides an array of conceptual instruments and network characteristics that can aid in empirical analysis” (O’Toole, 2010, p.9).

The discussion of the theoretical underpinnings of SNA is what makes the approach a vital area of study. Much of SNA theory has a strong mathematical foundation and it has been empirically tested (Wasserman & Faust, 2005). In the current study, I test one theory that has origins in social network analysis by looking at the small world theory and concept. There are indeed a host of other theories and techniques that can be utilized from social network analysis that would provide insight into public administration. Further, Slancik (2005) notes that network analysis allows individuals to see the big picture when he uses the analogy that it removes the focus from the trees to the forest (Slancik, 2005). Thus, it is suffice to say, that I use the terminology social network to describe the relationship that exists among social actors. For the current study, I define these relationships as a co-publication, but they could easily be extended to any type of relationship and patterns of relationships that an individual may have with another individual (Wasserman and Faust, 2005).

Networks in Public Administration

The purpose of this section is to review the status of the network literature in public administration. This section also adds to the literature on network analysis by providing a discussion of what is meant by the word "network" in public administration as well as the types of networks that the field currently examines. This section demonstrates three gaps in the literature in which the current study addresses in order to advance the state of theory development in public administration. The first area that I advance is that I introduce a new network to the discipline and I test the properties and structure of that network. It is important to understand the structure of the network that exists in scientific collaborations because this is the way in which the discipline

communicates with each other. The second area is that I answer Isett et. al (2011) critique that many studies do not identify where their study falls into regarding network research in public administration. Further, I also utilize specific network techniques and theory to study the network in public administration. This portion of the literature review first defines how networks are used in public administration. I do this by identifying the various streams of network research, and then I proceed to define what scholars in public administration mean when they say "network". In the final portion of this section, I introduce the concept of scientific networks.

Much of the work on network analysis in public administration began with O'Toole (1997) making a call for the field to focus more on networks (Hwang & Moon, 2008). He argued that networks had not been a priority for public administration and that there was much work to be done for the field (O'Toole, 1997). According to O'Toole (1997) public administration scholars and practitioners were ill equipped to deal with networks as demonstrated by the extent to which network analysis was being incorporated into their work (O'Toole, 1997). O'Toole is the pioneer for network analysis research in public administration. O'Toole (2010) conveys a strong message to the field when he writes, "My argument is that the proper study of public administration as a field cannot be undertaken without taking into account the networked character of much of public action and the networking behavior" (O'Toole, 2010, p.9).

The traditional hierarchical view of public administration leads individuals to focus on the internal aspects of governmental organizations (Bogason & Tooner, 1998). It often fails to consider the networked behavior associated with the public sector. Other scholars have also noted the importance of considering the external attributes of public

administration. For example, Denhart (1999) argued that to be prepared for the future public administration must focus both internally and externally in order to be prepared to meet the challenges of the future (Denhart, 1999). Further, Bingham et. al. (2005) note the importance of developing tools that will enhance public administration's ability to consider more than just the internal processes of public administration when they argue that citizens will need to be included in the judicial and legislative processes of organizations (Bingham et.al, 2005). Bingham et.al (2005) argue that horizontal networks are important for public administration to consider. While these authors do not formally utilize a network approach, their arguments acknowledge the connectivity and need to consider the entire network associated with public administration. Bogason & Tooner (1998) argue that network analysis provides a technique that allows public administration to consider the external and internal structure of relationships that influences it (Bogason & Tooner, 1998). Further, in Fomburn's et.al. (1979) argument that network analysis techniques can enhance the study and understanding of organizational theory, they note that the technique provides insight into both the internal and external aspects of organizations by studying relationships (Fomburn et.al, 1979).

O'Toole (1997; 2010) led to a greater awareness of networks in the field. Prior to O'Toole's (1997) work and even after his writings scholars in public administration had not completely ignored networks, but networks had not received a great deal of attention and failed to examine the methodological implications of networks (O'Toole 1997; Rethemeyer 2005; Hwang & Moon 2008; Isett et.al, 2011). Since O'Toole's (1997) work there has been an increase in the number of articles using the phrase "network analysis" (Hwang & Moon 2008; Isett et al, 2011). Despite this, other disciplines are much further

along in regards to network analysis studies, and public administration stands to benefit from understanding the literature in these other disciplines (Isett et.al., 2011). For example, Toonen (1998) warns public administration scholars to consider the underlying assumptions that they make when conducting network research. The theoretical framework of networks in our discipline must be enhanced in order to do this effectively. Further, the arguments that the scholars listed above have noted regarding network research as being too metaphorical and lacking a theoretical framework in public administration is very similar to the critique that Freeman (1984) made about disciplines such as sociology and economics.

Defining Networks in Public Administration

Public administration scholars tend to use different definitions of the types of networks that are examined as well as debate the types of network research that is conducted in the field. Isett et al., (2001) describes three types of network research that is conducted in public administration. They describe the public administration network streams of research as governance networks, collaborative networks and policy networks (Isett et.al, 2011). These authors refer to governance networks by writing, "Governance networks are entities that fuse collaborative public good and service provision with collective policymaking" (Isett et.al., 2011, p.158). The authors then identify collaborative networks as public agencies, non-profit organizations and private sector organizations that work together to provide a service. Finally, the authors identify policy networks by writing, "Policy networks are a set of public agencies, legislative offices, and private sector organizations (including interests groups, corporations, nonprofits etc.) that have an interest in public decisions within a particular area of policy because they are

interdependent and thus have a 'shared fate' (Lauman & Knoke, 1987)" (Isett, 2011, p. 158).

Berry et.al (2004) provides another angle for identifying the different streams or traditions of research that network analysis falls into within public administration. They write regarding the traditions of network research, "…We have identified three major streams or traditions of network research, which can be labeled as (1) social network analysis, (2) policy change and impact of networks on policy outcome (political science) and (3) public management networks" (Berry et.al., 2004, p. 539-540). The authors' discussion of social networks analysis is where this current study falls into. These authors argue that social network analysis focuses primarily on structure. For example, they write, "Network structure matters as an antecedent to various outcomes, and it matters as an important outcome of other factors" (Berry et.al, 2004, p. 545). In contrast, policy networks focus on the individual as being rational and examines the way in which their participation in various networks affects policy outcomes. Finally, these authors argue that management networks examine how the actions managers take influences networks as well as the various networks that are present in organizations (Berry et.al, 2004).

In addition to identifying various types of networks that are examined in public administration, the term network is used in several ways when conducting studies. Isett et.al (2011) identifies three ways in which the term is used in public administration. The first way in which it is used is a metaphor. This approach consists of studies that do not necessarily examine a network, but rather utilize the concept as a way of thinking about a problem (Isett et.al, 2011). This approach is powerful as it allows public administration

scholars to think about the importance of relationships. An example of this type of study can be seen in Meier and O'Toole's (2003) examination of the role that managerial networking had on the performance of school districts (Meier & O'Toole 2003; Isett et.al, 2011). Their study did not specifically utilize network analysis, but it rather establishes the importance of thinking in terms of networks and relationships. The study is powerful in that it demonstrates that managers must work with a host of constituents in order to build relationships. Thus, their study illustrates that networks matter. Similarly, Agranoff (2006) uses the metaphor of networks to provide lessons for public managers to consider when working with interorganizational constituents. Further, O'Toole's (2003; 2010) call to focus more on networks arguments discussed networks from a metaphorical perspective. O'Toole simply noted that networks in public administration were important to study. He did not specifically define a network, but rather encouraged scholars and practitioners to think seriously about networks. The second approach that Isett et.al (2011) discusses is the notion that networks are used to accomplish a goal such as providing a service to the public. Isett et.al., (2011) argue that this is more of a utilitarian approach to networks. There are several scholars whose work can be classified from this approach in public administration. For example, Proven et.al. (2005) demonstrate this when discussing strengthening community partnerships. Further, Hunag and Provan (2007) utilize network concepts to assist in improving service organizations. In addition, Provan and Milward (2002) examine whether or not networks assist in enhancing the effectiveness of public sector organizations. These writings are important, as they seek to demonstrate how network analysis can be utilized to improve the quality of services that are provided to the public.

The final approach to studying networks in public administration is where a major gap in the literature exists. Regarding this third approach, Isett et. al (2011) write, "…The term is used to refer to the methods and methodological paradigm that surrounds networks, social network analysis. In this use, structure and measurement of structural dynamics is the focus" (Isett, 2011, p. i161). This illustrates a gap in the literature in public administration. Currently, studies use the terminology of networks to describe something. Simply utilizing metaphors without being able to provide specific definitions and terminology prohibits the development of theory that has explanatory power in a discipline (Leinhardt 1977; Kadushin 2002). Thus, we currently have studies that mention networks, but there is a need for more studies that use the appropriate network language and rigorous techniques to examine various network structures (Isett et al, 2011; Hwang & Moon 2008). Many of the current studies in public administration fail to utilize network analysis techniques to adequately examine networks. It is here that my work makes a contribution to the literature. When discussing social network analysis, this study falls into this particular category. It is important that I note this, as Isett et. al (2011) writes, "Importantly, scholars to date have not self-consciously placed their studies in a subsection of the literature, so there are few opportunities to determine whether findings are commensurate with one another and thus cumulative in their effect on the literature" (Isett et.al, 2011, p. i161). Some scholars in public administration recognize and seek to incorporate network concepts in their study. For example, Huang et. al. (2007) used the network concepts of centrality and position in the network to demonstrate how performance and perceptions of a service providing organization could be influenced. Similarly, Provan et al., (2005) introduced some basic network analysis

concepts in order to discuss how they could be utilized to strengthen the partnerships in communities. Further, Milward and Provan (2002) illustrate that network analysis can occur at multiple levels. These works are important, but there is still a need in public administration to demonstrate how network analysis concepts and theories can be used.

The literature reviewed above reveals several needs that public administration must address in order to adequately examine networks. In this section, I summarize those needs as they relate to areas that the current study provides insight into for the discipline. The first issue that the field must address is that much of the research on networks is very vague and simply used metaphorically (Hwang & Moon (2008); Isett et.al, 2011). Public administration is at the point that other disciplines were at when Freeman (1984) argued that networks were being used too metaphorical. Thus, he advocated the usage of precise terminology and methods in research on networks (Freeman 1984). Hwang & Chul (2008) argued that public administration has talked about networks in too vague of a manner. They argue that previously this was acceptable but that the discipline is now at a stage in which the field must test specific theories of networks (Hwang & Chul, 2008). Similarly, this has in-turn been a factor that has prevented public administration as well as other social sciences from realizing the power of network analysis as an analytical tool (Harvey et. al., 2006). Further, scholars tend to use differing definitions as to what network analysis is as well as what constitutes a network (Isett et.al, 2011). This problem is exacerbated as scholars often conduct studies without specifying the type of network they are exploring or how they are utilizing the terminology of networks (Isett et.al., 2011). In addition, the field is in need of the study of a network that allows researchers to

examine structures with a large n size (O'Toole & Meier, 2005)- scientific collaborations allow for such a study.

A New Type of Network

The purpose of my research is to advance the theory and usage of networks. Thus, I do not use network analysis in a metaphorical sense. I specifically identify the type of network that I will examine and use true network techniques to examine the network. Specifically, I introduce a new type of network to the field of public administration. These networks are co-authorship networks, or scientific networks, through public administration. This is an area that several other scholars and disciplines have identified and studied (Newman 2001; Otte 2002, Fafchamps et.al., 2006; Amaral et.al, 2007). Scientific networks refer to the network of individuals who publish in journals. This research will discuss scientific networks in greater detail later in this document, but now it will suffice to say that I add to the literature by introducing to public administration a fourth type of network, that of scientific networks. Studying this form of networks answers O'Toole's (1997) call when he writes, "Public administration should attend to several types of network-focused research efforts each aimed at addressing or dedressing a void in scholarship. Each agenda implies sustained, creative, and systematic research" (O'toole, 1997, p. 50-51).

There are a few studies in the discipline that I will explore in a later section that looks at who is publishing in various public administration journals. Kellough and Pitts (2005) examined the scholars who published in the *Public Administration Review*. Similar, Jonthan P. West (2010) provided some insight into co-authorship in the article "Thirty Years of ROPPA: Past Trends and Future Prospects". Further, Handley et. al

(2005) examined who publishes in all of the ASPA Journals. These studies are interesting and will provide some insight into the expectations that I have for the network that I construct, but these studies suffer from the fact that they do not examine the structure of networks. Further, they do not use network analysis techniques or terminology.

There is one study in public administration that utilizes social network analysis in a way that is consistent with the development of theory that I seek to advance with co-authorship studies using social network analysis. Hwang and Moon's (2008) study was the first study to attempt to construct a network using co-citations in public administration. Their study demonstrates how a social network of individuals who cite articles can be constructed. Their article represents the beginning phase of the next for theory development and usage of social network analysis in public administration. In other fields, works that sought to solidify scientific networks works have proceeded to look at co-authorship patterns began with studies of co-citations. For example, Bollen et.al (2005) note that their co-authorship studies build upon the theory identified through co-citation studies by writing,

> "Although somewhat similar to the much studied citation networks in the scientific literature (Garfield, 1979), co-authorship implies a much stronger social bond than citation. Citations can occur without the authors knowing each other and can span across time. Co-authorship implies a temporal and collegial relationship that places it more squarely in the realm of social network analysis" (Bollen et.al., 2005, p.1464).

O'Toole (1997; 2010) argues that public administration must treat networks more seriously. Similarly, Hwang and Chul (2008) argue that public administration is treating networks seriously, just not seriously enough. Further, scholars note that there is a need for the empirical examination of networks in the discipline (Hwang & Chul 2008; Rethemeyer 2005). Studies that examine networks theoretically are critical for our discipline, because currently many scholars and practitioners are operating from a theoretical perspective that does not take into account network models (O'Toole, 1997). This study is vital to public administration as it is time for scholars in our field to develop rigorous methods for studying networks by fostering "closer ties with technical disciplines that are developing new methods and measures, such as computer science and statistical physics" (Isett et.al, 2011, p. i168). The current study borrows from other schools of thought in order to study a public administration network. Further, this study answers Berry's et.al, (2004) call to guide our research by various theoretical frameworks by borrowing from social network analysis to utilize the small world theory.

Summary

To summarize this portion of my literature review, I wish to briefly highlight once more the areas in which I advance the theory of public administration. The first area is that I introduce the concept and study of scientific networks in the field of public administration. To date, no study has examined scientific networks of collaboration in public administration using network analysis techniques. The studies mentioned earlier set the stage for this type of study, but they only vaguely could be considered networks of collaboration and this would be from a metaphorical perspective. The second area in which I advance the theory of networks in public administration is that I clearly identify

which area that my study falls into. I also acknowledge the literature in other fields. Finally, I utilize specific analytical techniques, theories and methodologies that are specific to social network analysis. These areas advance the theory in public administration by using network analysis to examine a true network in the field.

Small World Theory

The small world theory is based on the argument that despite the world being large, that everyone is connected to each other through very few people. The small world theory has been found to be present in a host of environments. Watts (1999) writes "The motivation for the small-world phenomenon comes from social networks, but it turns out to be a much more general effect that arises under quite weak conditions in large, sparse, partly ordered and partly random networks" (Watts, 1999, p.524). The purpose of this section of my review of the literature is to review the small world theory, as this theory serves as the theoretical framework that I test in this analysis. This chapter adds to the advancement of knowledge in public administration in that it allows me to test the connectivity of the public administration scientific network that can be found in the journals that I review. I have divided this part of my review into three sections. In the first section, I introduce the small world theory. In the second section, I discuss how the small world theory and concept is measured. Finally, I discuss the small world theory in regards to arenas in which it has been found to exist.

I spent a summer participating in the American Economic Association Research Program studying statistical techniques associated with economics. When applying to graduate school, I was surprised to learn that my advisor from that program also knew several of the faculty members in the Economics department at the institution that I am

currently attending. Thus, I was connected to them through him. Similarly, I recently spoke to a friend who knew one of my close colleagues from my undergraduate institution. Many have had similar situations to this occur to them and often comment "It is a small world." The small world phenomenon is interesting as it highlights the notion that everyone is connected to each other in some way through very few acquaintances.

Studies have examined the notion of a small world and found evidence of a small world in both the natural occurring environments as well as manmade constructed environments (Crossley, 2008). Thus, while the basis for small world research comes from sociology and the interaction between humans, some authors have found that they also develop in other arenas (Watts, 1999). Further, the small world concept and theory is one that exhibits a great deal of interdisciplinary research that has its foundations in the social sciences as well as the physical sciences (Amaral et.al, 2007).

The first empirical study of the small world theory was conducted by Stanley Milgram. In 1967 Milgram published an article entitled "The Small World Problem" that serves as the foundation for most studies on the small world theory. It also provides the theoretical underpinnings of the present study. Milgram received funding from Harvard University to conduct a study to explore whether a small world truly existed. When discussing his goal, Milgram wrote, "I set out to find an experimental method whereby it would be possible to trace a line of acquaintances chosen at random" (Milgram, 1967, p. 63). Milgram (1967) argued that two perspectives existed regarding how people in the world are connected. The first is based on the notion that individuals form cliques and that ideas and relationships develop through those cliques. The second perspective which Milgram (1967) espoused and tested was based on the small world theory. He argued

that people are connected through acquaintances and that the links connecting the acquaintances are small (Milgram 1967). Milgram ultimately found evidence of his second hypothesis which was based on the small world theory.

In order to conduct his study, Milgram selected a "target" person that he wanted to see how many links it would take for a random person to reach. He then randomly selected citizens in which he gave a packet to them that he wanted delivered to the target person. The packet contained information regarding the target person's location, profession, and demographic make-up. Milgram requested that they use their circle of friends, relatives, and other people they knew to get the letter to the target person. The randomly selected citizen would send the letter to a friend who they believed would be most likely to know the target person. This would continue until the target person received the letter. Milgram's goal was to have the individuals passing the packets to attempt to get the packets to the target person with as few links as possible. Thus, his participants had to consider who they knew that would be most likely to know the target person. Milgram conducted this study twice using two different targets. One target was from Kansas and the other target was from Nebraska.

Milgram found that on average only 5.2 intermediate acquaintances were needed before the letter reached the target. He found that males were more likely to pass the letter through other males and that females were more likely to pass the letter through other females. Further, Milgram (1967) found that most of the letters that were sent came through the same four people. Amaral et. al (2007) argues that this finding indicates that individuals are connected to each other through people who are disproportionately connected to everyone else (Amaral et.al., 2007). These individuals

who are disproportionally connected to everyone in the network are referred to as superconnectors (Amaral et.al, 2007; Burt 1992; Barbabasi et.al 2002). When the superconnectors are removed from the network, it leaves the network in a fragile position because if the superconnectors are removed the network would fall apart (Amaral et.al, 2007; Burt 1992; Barbabasi et.al, 2002). Milgram's (1967) most important finding was that a small world does indeed exist. Mathematically speaking, the small world theory is based on the notion that "It is possible to connect any two vertices in the network through just a few links…" (Amaral et.al., p. 11149, 2007).

In the article "An Experimental Study of the Small World Problem" by Jeffrey Travers and Stanley Milgram, the discussion of the small world theory and how the original study was conducted was replicated but the authors varied the starting positions. These authors wanted to know if evidence of a small world would be present if they selected different starting locations. The authors again found support for the notion that a small world indeed exists. Similarly, Davidson et.al. (1997) conducted a study that tested the small world theory in the university environment. They used an administrator as the target and requested that students pass a folder. They found that the links needed to reach the administrator was very small. Further, they found that graduate students and faculty members were more connected to the administrator than undergraduate students (Davidson et.al, 1997).

Milgram's study was interesting, but had several methodological flaws. One flaw is that less than 50 percent of the letters that Milgram sent reached its target. Another flaw is that his study may not actually demonstrate a true understanding of how long the chains really were. Some individuals may have sent their letter to someone who was less

likely to know the target person. Thus, this would have increased the length of the chain as well as the likelihood that the chain would not reach its target (Watts, 1997). While Milgram's study did have flaws, it is also well worth noting as it set the stage for the systematic study of the small world theory. Further, Whites (1970) conducted a study in which he controlled for the possibility of the chains in Milgram's (1967) being short as a result of longer chains not reaching the recipient. His study revealed that the average number of intermediacies, people needed to reach the target person, were about seven (White, 1970). Thus, this is indeed still small given the size of the population at the time of their studies.

Quantification of the Small World Theory

Watts and Strogatz's (1998) study demonstrated that the small world theory could be quantified using computer simulations and graph theory techniques (Watts & Strogatz, 1998). Watts and Strogatz (1998) argued that relationships developed within the small world arena were neither completely random nor solely a result of a systematic effort. Their research demonstrated three important elements as it relates to real world networks and the small world theory. The first finding is that the average number of relationships that an individual has in a network is much smaller than the size of the entire network (Watts & Strogatz 1998; Fowler, 2005). The second finding of their research was that networks tended to exhibit a high degree of clustering. This supports the notion that individuals tend to have the same circle or clique of friends. Watts demonstrated this by using the network concept of a clustering coefficient (CC). The clustering coefficient is measured on the scale of 1 to 0. It is a measure of the probability that two individuals who are connected with each other will have a third person of which they both are

connected. Thus, it examines the likelihood of two people being friends with each other and having a third friend in common (Watts & Strogatz, 1998; Amaral et.al, 2007; Wasserman & Faust, 2005). The third finding is that the network has a short average path length. The finding of a short average path length and a high degree of clustering supports the notion that the relationships that develop occur at random, but is also a result at least in part of some systematic efforts. The path length is a measure used in graph theory that measures the number of steps between individuals in a network (Watts & Strogatz, 1998; Amaral et.al, 2007; Wasserman & Faust, 2005). Thus, what makes their research unique is that using computer simulations, they found that in very large networks despite a high degree of clustering, that the path lengths were very short. Their research demonstrated that small world networks had short path lengths and very large clustering coefficients (Amaral et al, 2007).

Watts & Strogatz's (1998) study was important as it examined three different types of networks to study the small world theory. When discussing the networks that they examined, Watts & Strogatz (1998) write, "The neural network of the worm Caenorhabdits elegans, the power gird of the Western United States, and the collaboration graph of film actors…" (Watts & Strogatz, 1998, p. 440). Watts (1997) notes that these networks were important as the data were easily accessible and reliable. For example, his graph of collaborations of film actors was a study of Kevin Bacon's collaboration with other actors. His graph measured the relationships between actors based on whether or not they appeared in a movie together. The goal was to see how connected to Kevin Bacon other actors were. Watts was able to obtain data using Internet Movie database. Similarly, the other networks had data that was very accessible.

Watts and Strogatz (1998) found that each of the networks they examined exhibited the properties of a small world network. In an interview conducted by ScienceWatch.com (2008), Watts and Strogatz discussed their research agenda. The first major finding that they discussed is similar to Stanley Milgram's (1967) work as, they too found evidence of the small world as their networks exhibited a lot of clustering and very short path lengths. The second major finding that they noted in the interview and is also noted in their 1998 article is that the small world theory has implications on how information flows through a network. They specifically note that the small world properties affect the spread of diseases as well as the capabilities of cell phones. This is important to the understanding of the potential impact of the small world theory, as it also has been found to influence voter turnout in communities (Fowler, 2005). The third finding they noted is that small worlds develop as part of the natural environment. This finding was based on their study of the three networks that they examined. These authors argued that given the evidence of a small world in three very different types of networks that they examined, that the small world theory could be generalized as a structure that can be captured across various structures (Watts & Strogatz, 1998; Watts& Strogatz, 2008).

Beyond these networks, there have also been several other networks in which the small world theory has been found. The notion that individuals were connected to each other was highlighted by the Broadway play, "Six Degrees of Separation" (Guare, 1990). Spiro and Uzzi (2005) found that a small world existed among artists of Broadway musicals (Spiro & Uzzi, 2005). Further, Adamic (1999) found that a small world existed among the World Wide Web (Adamic, 1999). In addition, Watts and Strogatz (2008)

argue that part of stopping the spread of diseases lies in understanding networks and the small world theory.

Small World Theory in Management

The networks mentioned afore are each interesting, but they are all not as relevant to public administration. The review of public administration requires a discussion of elements that are a bit closer to the social sciences. Given that at the time of this document being composed, the author was unable to locate any articles that examined the small world theory in relation to public administration, I reviewed articles in management. Luis Amarai, Brian Uzzi, and Felix Reed- Tschoas (2007) article "Small-World Networks and Management Science Research: A Review" served as a foundation for my review of articles examining the small world theory in management. Their work provided a review of the literature with a focus on real world networks (Amarai et.al, 2007). Their article assisted me in identifying literature to review. Thus, I reviewed their literature and then went back to the original works. I wish to discuss articles that do provide a little light into evidence of the small world theory in the private and public sector in the proceeding sections. This discussion may in turn shed some light on the small world theory in the public sector. Ultimately, my research will test the small world theory in one arena of public administration, but future studies will have to examine other areas.

Kogut and Walker (2001) conducted a study that looks at ownership of private sector companies in Germany. These authors noted that globalization and the acquisitions of firms were affecting their system of governance. It was also reasonable to assume that it would influence the ownership of their companies. Their study

examining the ownership from 1994-1997 revealed that a small world still existed among the owners of their companies. These authors also found that the small world was very robust. For example, they write,

> "To illustrate this robustness, potential disruptions to the observed German network are simulated. This simulation shows that the properties of the small world remain intact even when ownership ties are changed. These findings suggest that a more global economy in Germany need not lead to the dissolution of the ownership structure, but rather may be associated with a deepening of network ties" (Kogut & Walker, 2001, p. 317).

Their findings provide a discussion that a small world requires major changes in order to reduce its properties (Amaral et.al, 2007).

Another study that examined the small world theory was conducted by Duysters and Verspagen (2004). These authors tested the small world theory in the strategic technology industry of chemical and food companies. The previous study examined ownership of firms, but this particular study looked at strategic alliances in which they tend to have less connectivity (Amaral et.al, 2007). These authors defined a relationship between two firms if they were linked to each other through an alliance. These authors found that the firms linked to each other exhibited a small world in that there was a high degree of clustering, but each of the firms were connected to each through very small path lengths. They further argue that the small world properties were an important component of knowledge transfer. Similar, Davis et. al (2003) wrote an article titled, "The Small World of the American Corporate Elite, 1982-2001." In this article, the authors were interested in studying the connectivity to each of the other directors serving

on the 100 largest corporations in the United States. Their study examined individuals serving on boards in 1982, 1990, and 1999. These authors found evidence of a small world. They write, "The corporate elite is a small world-the average distance between directors and between firms is very short…" (Davis et al, 2003, p. 303). Similarly, Kogut & Walker (2001) also found that the small world among corporate directors was very robust. In addition to a small world being found in this study, their study also highlights an important transition to the discussion of what holds or connects small world networks together. This study had one individual who sat on multiple boards which ultimately enabled him to be a connector for the network. This finding is similar to Milgram's (1967) find that most of the post cards passed through the same four people.

Scientific Networks of Collaborations

Public administration has seen studies that examine the scholars who publish in the field as well as in particular journals (Kellough & Pitts, 2005; Handley et.al 2005; West 2010). Despite this, there has not been a study that utilizes SNA to examine the network of individuals who publish in the field of public administration. This research contributes to the field of public administration in that it utilizes SNA techniques to conduct such an examination. Further, this study advances the state of theory as it allows for a true evaluation of the scientific network in public administration. The purpose of this section is to review the works that have been conducted on scientific networks in other disciplines. I note the studies in which the small world theory has been confirmed as well as those in which it has not been confirmed. In addition to advancing the state of knowledge in public administration, the current study adds to the state of the literature in scientific networks and the small world theory. The studies that I review here examined

each of the journals in their discipline as a whole. They then comment that a small world is present or that it is not present. In this study, I test the small world theory across journals in public administration, but I also analyze individual journals as well. Furthermore, I devote a considerable amount of attention to the articles discussed in this section as they all provide insight into the current study. I conclude this portion of the literature review by conducting a discussion of other works that examine individuals who publish in public administration.

Analyzing scientific networks through the usage of social network analysis is an area that has not been studied in public administration. Research collaborations through co-publications are important, as with the advent of technology, research collaborations have become more prevalent and cost effective (Glanzel & Schubert, 2004). The foundations of scientific networks can be found in the information sciences. Information scientists study citations, publications, and how information flows. Their writings are unique in that it provides an opportunity for individuals to understand how scholarly work is disseminated. The scholars in this field have begun to advocate the utilization of SNA to understand publications. Otte and Rousseau (2002) argue that utilizing network analysis techniques can provide insight into journal publications and collaborations for the information sciences (Otte & Rousseau, 2002). Analyzing research collaborations is vital, and network analysis offers a wealth of opportunity to understand collaborations.

Networks of collaboration provide a unique way of understanding the small-world theory and research. Crane (1969) found that scholars develop "invisible colleagues". This is based on the notion that scholars develop cliques or communities based upon research problems that they are studying (Crane 1969). From Crane's perspective, these

groups develop because of highly productive scientists who are visible and able to connect new individuals in a network to others. According to Crane, these individuals create a social organization of researchers. Crane (1969) highlights this by writing, "Anyone choosing even one of these individuals was brought into contact with a large network of individuals. This is a reasonable outcome in science where students or collaborators of very productive scientists are brought into contact, directly or indirectly, with many other scientists in the field" (Crane, 1969, p.346).

The challenge to understanding relationships and networks is how one can actually measure the relationship and the strength of that relationship (Newman 2001). An individual may consider a person to be their friend, but those feelings of friendship may not be reciprocal. Milgram's (1967) study was interesting as it sought to map the relationships that individuals had and his study exhibited a small world. Despite this, his study was limited because "…Although cleverly conducted and in many ways revealing, does not, however, tell us much about the detailed structure of social networks, data that are crucial to the understanding of information…" (Newman, 2001, p. 404). Watts (1997, 1998) provided some insight into true networks and the small world theory, but it did specifically review scientific collaborations.

In the article, "The Structure of Scientific Collaborations Networks" the author presents a method for understanding collaborations that has served as the foundation for subsequent research on research collaborations. Newman's (2001) work served as a seminal piece when studying research collaborations through network analysis. His article presents one of the first scholarly works in which one examines a network based on co-publications using network analysis (Newman, 2001). For example, Newman

(2001) writes, “In this paper, I present a study of a genuine network of human acquaintances that is large-containing over a million people- and for which a precise definition of acquaintance is possible. That network is the network of scientific collaboration, as documented in the papers scientists write” (Newman, 2001, p. 404).

In academia, relationships develop through many avenues. Scholars may meet each other at a conference, they may work together in a department, or even have a mutual friend. These relationships are difficult to quantify because they are so subjective. One person may consider another as a close acquaintance while the other individual may not. Thus, research collaborations provide a true means of understanding relationships in the scientific community (Newman, 2001). Conducting scholarly work is rigorous and requires cooperation between scholars. If two researchers collaborate on a paper then they have some type of relationship and level of trust with each other. Furthermore, if they collaborate on multiple papers it can be assumed that they have a stronger relationship than if they simply collaborated on one paper.

Newman (2001) defined a relationship between two authors as a co-authorship of a paper. Newman (2001) notes that people who co-publish a paper together will know each other pretty well. He also writes,

> “It is a moderately stringent definition, since there are many scientists who know one another to some degree but have never collaborated on the writing of a paper. Stringency, however, is not inherently a bad thing. A stringent condition of acquaintance is perfectly acceptable, provided, as in this case, that it can be applied consistently” (Newman, 2001, p. 405).

Newman's (2001) study examined the areas of biomedical, theoretical physics, high-energy physics, and computer science. His study included papers that were published in these fields from 1995-1999. (Newman, 2001). The databases of articles that Newman utilized contained published material in both peer-reviewed journal articles as well as unreferred pre-prints of papers. Newman (2001) elected to include these articles in his study, as he argued that it was as important as peer-reviewed journal articles in understanding social connections (Newman, 2001). When constructing his study, it is important to note that Newman did not seek to develop a network among each of the disciplines. He rather examined each discipline individually.

Newman (2001) found support for the notion that a small world can be found in scientific collaborations. He found that amongst the researchers in his study, that on average six degrees of separation between researchers in the network existed. Newman also found that scientists in the areas that he examined tended to cluster together. For example, he notes that when scientists had collaborated with a third author that each of them knew (had collaborated with) that they were 30% more likely to collaborate on work together than they would have been if they did not know the third author (Newman, 2001). Newman (2001) conjectures, though he does not specifically test this, that his finding may provide evidence that scientific collaborators tend to introduce others to people in which they have collaborated with (Newman, 2001).

Newman (2001) found that the authors in his study had written about four papers during the time period that he examined with an average of three individuals collaborating per paper. Newman (2001) examined what is referred to as the giant component. The giant component consists of the largest group of actors in the network

that are connected to each other (Newman, 2001; Wasserman & Faust 2005). Newman's work (2001) exhibited a rather large giant component compared to several of the other networks that I will discuss. The networks that he examined had a giant component that had between 80-90 percent of the authors that he studied. In regards to the hard sciences, the network was very well connected (Newman 2001). A giant component is vital as Newman (2001) writes, "We conjecture that this has a profound effect on the way the scientific community operates. Despite the importance of written communication in science as a document and archive of work carried out, and of scientific conferences as a broadcast medium for summary results, it is probably safe to say that the majority of scientific communication still takes place by private conversation" (Newman, 2001, p. 407). Newman (2001) goes on to write,

> "The existence of a large giant component, as discussed in the previous section, allows news of important discoveries and scientific information to reach most members of the network via such private conversations, and clearly information can circulate far faster in a world where the typical separation of two scientists is six than it can in one where it is a thousand or a million" (Newman, 2001, p. 407).

Newman did find some differences amongst the communities that he studied. Specifically, he noted that individuals in the experimental high-energy physics were much more likely to have many collaborators on a project than the other areas that he studied (Newman, 2001). Newman (2001) also noted that in the biomedical field, individuals exhibited less clustering than other fields.

One limitation of Newman's work is that it contained both unreferred papers as well as peer-reviewed articles. Newman's (2001) argument that this should not be

viewed as a negative was "…Although unreferred preprints may be of lower average scientific quality than papers in peer-reviewed journals, as an indicator of social connection, they are every bit as good as their referred counterparts" (Newman, 2001, p. 405). Newman's notion that these assist in providing a good understanding of social connection is an important concept, though it would be interesting for his study to provide insight into solely peer-reviewed journals, as these are important to the promotion, tenure and transmission of knowledge in academic fields (Handley et.al, 2005). A second limitation of Newman's (2001) work is that he simply examined certain disciplines in the natural sciences such as biology and physics (Newman, 2001). He did not provide insight into fields related to the social sciences. Newman (2001) also fails to discuss the strength of relationships or frequency of publications with a particular author.

Barabasi et.al., (2002) conducted a study similar to Newman (2001), but these authors considered the network as evolving. In their study, they examined databases pertaining to research in mathematics and neuro-science that were published in the period of 1991-1998. One of the extensions to Newman's (2001) work that these authors made is that they argued that scholars must realize that many of the network characteristics are time dependent in that it gives you a snapshot of where the network is at a particular time. For example, they write, "Thus their value at a given moment tells us little about the network. They can be used, however, at any moment, to show that the network has small world properties, i.e., it has a small average separation, and a clustering coefficient that is larger than one expected for a random network" (Barabasi et.al., 2002, p.612). These

authors also note that the results obtained through the network can be opposite of what truly is present if you do not have data on the full system (Barabasi et. al., 2002).

This article is interesting and provides a great deal of theoretical development to my study. Newman (2001) examined a static network, but Barabasi (2002) introduced the important element that individuals may enter or exit the network. Despite this, both approaches are important to the development of theory as a snap shot of the current network is essential to understanding scholarly development. Similarly, it is important to understand how the network has evolved and is evolving.

Newman (2001) and Barabasi's et al. (2002) work only examine hard sciences. Further, they provide very little insight into the individual network. Newman's (2001) and Barabasi's et. al (2002) work both provided insight into the global network of scientific collaborations. Barabasi et.al. (2002) examined models of collaborations in the social sciences compared to other models to gain insight into its impact on the field (Acedo et.al., 2006). These studies were interesting, but another important aspect of the theoretical development involves understanding the individual actors in the network. For example, Acedo et.al, (2006) notes that their study extends upon the literature in that they explore actors at both the global level and micro-level (Acedo et.al., 2006). This is indeed an area in which I add to the literature for public administration. My study will provide insight into the global network, but it also gives information on the individual actors in the network.

In the proceeding sections, I now seek to address literature in which the authors address elements of both the global and individual network. It is important to note that Newman's (2001) article and Barbasi's (2002) article served as seminal works in the field

of studying research collaborations through social network analysis. Thus, the scholarship in this area is still very young, and as I will demonstrate in the latter section of this review, still suffers from challenges that make generalizations across academic disciplines problematic (differing methods of collecting data, ensuring authors have correct names, not reporting normalized values, etc.).

A seminal work that began to examine a discipline in the social sciences was James Moody's article, "The Structure of a Social Science Collaboration Network: Disciplinary Cohesion from 1963-1999". Until Moody's (2004) work the previous investigations into co-authorship using network analysis examined the hard sciences. Moody (2004) examines co-authorship collaborations in sociology. The author obtained data from the Sociological Abstracts. Unlike Newman (2001) and consistent with the current study, Moody (2004) examined only peer-reviewed journal articles. In addition, Moody did not include books in his analysis. Moody's study found that in sociology most papers were not co-authored. In fact, 67% of the papers in his study had a single author. Despite this, Moody did find an increasing trend towards co-publications. He further found evidence to suggest that individuals who were conducting quantitative studies were more likely to have co-published a paper than those doing more qualitative work (Moody, 2004). Finally, Moody (2004) also noted that men were more likely to co-author a paper than women. This is an interesting area that warrants future research.

In addition to providing insight into co-publications for sociology, Moody sought to advance the overall knowledge of scientific collaborations by testing three models of collaboration. The first model that Moody (2004) presented was the star actor model. This model was based on the notion of a power-law in that the network depended upon a

set of star actors. The star actor model postulates that there are some scholars in the field who are so well known that others latch on to them. If these individuals are removed from the network, it will then become scattered. Moody discussed this model by writing, "Although most scientists labor in obscurity, a small number of scientists receive disproportionate recognition. This has been clearly demonstrated for indicators such as citations, number of publications, or grants" (Moody, 2004, p. 216). Several authors have found support for the notion that a power law exists in fields as diverse as bio-medicine to more traditional social sciences such as economics (Newman 2001, Barbasi, 2004; Goyal et.al 2006). In contrast to these studies, Moody (2004) did not find support for this hypothesis. Thus, for Moody (2004), the star actors could be removed from the sociology network and the network would not become fragmented. The second model that he tested and is most relevant to my current study was based upon the small world theory. The author did not find evidence of a small world in his study of sociology. The third model is what Moody found to be very important in his study. This model was described as the disciplinary cohesion model. He found that the network was such that individuals from different theoretical disciplines were farther apart from each other. For example, Moody writes, "Permeable theoretical boundaries likely result in a network that folds in itself connecting people at greater distances from widely different specialties" (Moody, 2004, p. 228). Moody (2004) begins the process of examining both the global network as well as individual authors in the network, but he did not discuss information regarding the network concepts that relate solely to individual actors in the network. Thus, in this respect, his article is along the tradition of Newman (2001) and Barbasi (2002) in that they view the entire network.

In the article, "Co-Authorship in Management and Organizational Studies: An Empirical and Network Analysis" the authors examine research collaborations in management journals using network analysis. The authors examined 10 leading management journals in the field. The journals included the following: *Academy of Management Journal, Academy of Management Review, Administrative Science Quarterly, Journal of Management, Management Science, Organizational Science, Strategic Management Journal, Organization Studies, Journal of Management Studies, Human Relations, and British Journal of Management.* The authors looked at the years of 1980-2002. They utilized the Social Sciences Citation Index (SSCI) electronic database called the "Web of Science" in order to obtain data. The authors only utilized peer-reviewed journals in their study. Further, they also did not include books in their study. The authors obtained a total of 14,597 journal articles of which they used 11,022 in their study. This article contributes to the discussion of research collaborations in that the authors examine why individuals collaborate and the network that such collaborations create. While Newman's 2001 article sought to provide insight into the structure of the network, this particular article differs in that it had two purposes. The first purpose was to test the reasons why authors choose to collaborate. In this area, the authors did not add new variables to study, but rather tested variables that the literature had already highlighted as important (Acedo et.al., 2006). The second portion of the article is based on gaining an understanding of the co-authorship network that exist in the field of management and organizational studies based on the most prominent journals in this the field.

The authors found a very disconnected network. This indicated that very few of the individuals in their network had published an article together. Further, there were several individuals in the network who did not have a connection through a co-publication with anyone else in the network. The authors attributed this fragmentation to how large the network was (Acedo et.al., 2006). The authors also examined the giant component of the network. It consisted of 45.5 percent of the authors included in their study. As a whole, while their network was fragmented there was a high degree of clustering present. The clustering coefficient for the network was 0.681. This indicated that individual authors tended to cluster in regards to who they published with. The authors do not specifically note what their path length measure or whether or not their particular study supports the small world hypothesis. It is reasonable though to assume that it does not, given the fragmentation of the network. Further, the authors note that their network was very similar to the network found in sociology. As noted previously, Moody (2004) did not find support for the small world hypothesis in sociology.

While the path length and clustering coefficients of this study may not have supported the notion of a small world, these authors did find support for Burt's (1992) argument that there were structural holes in networks in which individuals could serve as brokers because of their ability to connect various parts of a network. These authors did report that there were some authors from various sub-fields that had published with individuals from other areas which allowed them to serve as a broker of knowledge between the disciplines. Further, despite the fragmentation of the network, there were authors who were described as "star authors". These individuals had published several times and with several people in the network. Despite this, similar to Moody's (2004)

findings the network was not dependent upon the star actors to maintain connection as there were other avenues to connect the network beyond the star actors (Acedo et.al., 2006).

The article "Mobilizing Ideas in Knowledge Networks: A Social Network Analysis of the Human Resource Management Community 1990-2005" builds upon the literature by using social network analysis to study the field of human resource management. In order to conduct their study, the authors examined five human resource journals from 1995-2005. The journals that the authors reviewed included the *Academy of Management Journal, Human Resource Management, Human Resource Management Journal, Human Resource Management Review, and the International Journal of Human Resource Management* (Henneberg et.al., 2009). The authors list the following research questions as guiding their research:

(1) How coherent is the HRM group community- are there dominant components within groups?

(2) Is there a 'centre' around which, or from which, knowledge (and hence, we might hypothesize research strategy), is pushed out, or does the structure reflect a more random process?

(3) What are the 'collaboration strategies' of the core individuals in the HRM group?

(Henneberg et.al., 2009).

The total number of authors included in the study was 13,977. The study of the human resource management community is important to my study as it extends beyond studying the natural sciences. In addition, the article builds upon Newman's (2001) work

by addressing questions that his article failed to discuss. This article examines the critical questions of what research strategies individuals use, the strength of relationships, the central components of the network and whether or not there were dominate components in a network. Similar to Newman's work, the authors then examined the relationship that existed among authors by measuring whether they had co-published together.

The average number of co-publications in this network was about 1.19 with a standard deviation of 0.637. The authors also found that similar to the organizational studies community that Acedo et.al. (2006) examined, that the network was not very connected. Despite this, the authors found that within the network, 30 cliques had developed. Thus, individuals in this network had developed the strategy of publishing with each other. The giant component of their network was smaller than that found by Acedo et.al., 2006 in that it included 30 percent of the authors included in the study. The authors argued that the main component was small because of the developing nature of their field (Henneberg et.al., 2009).

The authors also found that some of the researchers were more central to the network than others. The central researchers were those individuals who connected clusters of the network together. The entire network structure would become fragmented if these individuals were removed from the network (Henneberg et.al., 2009). Thus, these individuals occupied highly important positions in the network because they were directly assisting in the mobilization of ideas. Further, this idea that the network would become disconnected if the star actors were removed is inconsistent with what Moody (2004) found regarding the sociology network.

The authors also found that the most central figures in the network had developed relationships with a variety of scholars by co-publishing with them. These individuals had also developed a host of non-redundant relationships. Thus, while they had published multiple times, they did so with individuals outside of their cluster. Their research strategy was one in which they had several weak relationships and very few strong ones. This finding is consistent with the seminal 1973 article entitled, "The Strength of Weak Ties", in which Granovetter utilized network analysis terminology relating to the strength of ties to demonstrate that individuals with more weaker ties than stronger ties were more likely to obtain jobs than those with a few strong ties. He argued that individuals with weaker ties had a larger network of contacts than those with stronger ties. Further, Granovetter (1973) noted that the weaker ties are what allow for the transfer of information in a network because it connects various parts of the network. In social network analysis, ties refer to the number of relationships that exist and strength refers to the intensity of those relationships (Wasserman & Faust, 2005).

Of course, seeking to develop such relationships is tricky. For example, working with the same individuals creates a very strong bond. Henneberg et.al., write, "This strong cohesion is indicative of sustained collaboration over time, indicating what Burt (1982) called 'invisible colleges' as centres of knowledge creation" (Henneberg et.al., 2009, p. 452). In academia, these strong ties can assist in the development of a course of action for an entire field of study. Despite this, there are shortcomings to such an approach. Weak ties are vital to information being transferred across a scientific network (Henneberg et.al., 2009). Henneberg et.al., (2009) writes,

> "As such, weak ties are essential for the flow of information which integrates otherwise disconnected clusters (Burt, 1992). While strong ties support the high-speed circulation of information and local cohesion, they also lead to an overall fragmentation of the network (Granovetter, 1973)" (Henneberg et.al., 2009, p. 452).

Therefore, one of the strengths of this article is that it highlights the importance of researchers developing several relationships outside of a particular clique.

Henneberg et.al., (2009) note that as the network began to grow that it became more fragmented. Despite this finding, they did find support for Burt's (1992) structural holes argument in that they found that as the network grew that structural holes developed which connected various aspects of the network (Henneberg, 2009). The authors did not find a pure research strategy of the individuals included in the network, though they did see strong ties among the cliques.

Henneberg et.al., (2009) did not find support for the small world theory. Despite their finding, a replication of their study may prove otherwise. These authors examined several journals that looked at key words which were often unrelated. For example, three of the 12 key words were financial performance, knowledge worker, and holy grail (Henneberg et.al., 2009). Each of these topics represent different areas, which lends itself to a lack of connectivity. This is further exacerbated by the selection of different journals. Different journals focus on different themes and topics. When one conducts research by looking across journals and at unrelated topics, one may expect extreme fragmentation of the network. This would decrease the likelihood of the small world theory being supported. Furthermore, a better strategy would have been to look

specifically at the journals to see if a small world existed in the journals or look across the entire discipline. By failing to look across the entire discipline it is quite possible that a small world existed but that the authors may have left out key individuals in the network by not including everyone in the study

The previous works provide insight that is critical to the current study as they demonstrate the evolution of studies of co-authorship using network analysis. These studies are important, but Goyal's et.al, (2006) study of the economics community provides a theoretical framework. To date, this is the only network analysis study of scientific collaborations whose sole purpose was to examine whether or not a small world existed as well as whether or not one was emerging. In the article, "An Emerging Small World" by Goyal et.al. (2006) the authors examine the small world theory as it relates to the economics community. This article clearly lays out the expectations associated with the small world theory and then tests those theories. The authors build upon the work of Watts (1999) to lay out the expectations of the small world. I will return to these expectations in a moment, but I will first discuss their method of data collection and a little more background regarding the authors' study.

The authors examined the economics community from 1970-2000. According to the authors, part of the reason for their paper was to test the thought that due to technology, the internet and computers, that it has become easier to communicate with and establish links with others. Thus, in essence, the world has become smaller. In order to conduct their study, the authors obtained data from Economics Literature database for the afore mentioned time period. They broke their study into three decades (1970-1979, 1980-1989, 1990-1999) in order to see if the economics community was

emerging into a small world. For the purposes of their study, the authors included papers in conference proceedings, as well as peer reviewed journals, but did not include books. The authors tested the following propositions, which also serve as the foundation for my dissertation work:

> "We say that a network *G* exhibits *small-world* properties if it satisfies the following conditions: (1) The number of nodes is very large as compared to the average number of links: n>> n(G). (2) The network is integrated; a giant component exists and covers a large share of the population. (3) The average distance between nodes in the giant component is small: d(G) is order ln(n). (4) Clustering is high: C(G) >> n(G)/n. This definition extends the one given by Watts (1999) by adding requirement 2." (Goyal et. al, 2006, p. 405).

The authors found support during each of the decades for all of the requirements above with the exception of their second proposition. Goyal et.al, (2006) found evidence of their second proposition during the last decade that he examined, which thus still supports his hypothesis that it is a developing small world.

Goyal et.al., (2006) was also interested in understanding how robust the economics community was. Thus, the authors took the giant component and randomly removed authors in order to provide insight into what would happen to the network. The network remained strong until the authors removed the star actors to demonstrate how disconnected the network would become. I believe that this demonstrates Burk's (1992) structural holes concept, even though the author did not make this comparison.

The weakness of this article is similar to those shared by other articles that I have reviewed to this point. In other articles, the authors either provided a discussion of the

demographic characteristics of the network, or simply provide a good discussion of the network and cliques but do not mention the demographic make-up of the network as a whole. This article does the same. It does not speak to whether the main component and cliques were comprised of assistant professors, full professors, or even students. Providing insight into these areas of the literature is vital to understanding a scientific community.

Co-authorship Using Conference Papers

Some authors have also examined the network of co-authorship by using conference presentations as the point of which to collect data. For example, in the article "A Social Network Analysis of the Co-Authorship Network of the Pacific Asia Conference on Information Systems From 1993 to 2008" the authors examine papers published as part of a particular conference. Chenog and Corbitt's (2009) analysis contained 1, 437 papers. The giant component of their network consisted of 33 percent of the authors included in their study. The network was not very dense. The authors did find evidence of a small world in their study. Furthermore, there was an increasing trend toward co-authorship on papers during their study. In fact, the year that their study was conducted the network contained 80 percent of co-authored papers. There were also a group of key researchers, but these individuals were not vital to the network in that removing them would not cause a complete fragmentation of the network as the authors note that there were several star performers.

Bollen et.al., (2005) examined the co-authorship network in the Digital Library Research Community in conferences The authors specifically examined the years of 1994-2004. Their study included 1, 567 authors. The giant component of their network

contained 38% of the authors included in the study. As other authors have done, these authors equate the small percentage of authors in the largest component of their network partly as a result of the developing nature of their discipline. This study did find support for the small world theory. When discussing their evaluation of whether a small world was present, they write,

> "Since small world analysis can only be done in a connected graph, we used the largest component of the co-authorship network for our calculation. The largest component (599 authors and 1897 links) has a clustering coefficient of 0.89, and a characteristic path length of 6.58. With a similarly sized connected random graph, the clustering coefficient is 0.31 and the characteristic path length is 3.66. This means that the JCDL co-authorship network is a small world graph as can be expected" (Bollen et.al., 2005, p. 4).

This article is also important as the authors begin to do an important analysis of the various aspects of the network. The authors found that graduate assistants of more central actors also occupied more central positions in the network. Further, the authors examined the specific clusters and found an affiliation based on institutions.

Public Administration Co-Publication Articles

Public Administration has seen research that examines publications in the field from a perspective that does not utilize network analysis. Contributing to the research that simply reviews the publications that have occurred by analyzing it through the lenses of network analysis is vital to the development of theory in public administration. In this section, I seek to provide insight into the individual make-up of the network in order to

provide a foundation for my expectations regarding the local level of the network of publications in public administration.

Jonathan West (2010) examined research that has occurred in the *Review of Public Personnel Administration*. His article assists in setting the stage for analyzing research collaborations in the field of public human resource management. He found that most of the works included in his study had only one author as oppose to multiple authors. He also found that while papers tended to have only one author, that there was an increase throughout the years in the number of papers that were co-published. This demonstrates an increasing trend towards co-publications, which has also been found in other disciplines (Moody 2004; Chenog & Corbitt's 2009). Further, this study revealed that most practitioners who published did so with a faculty member. About 23 percent of practitioners published with another practitioner and a little less than 19 percent published as a sole author. West (2010) argues that his findings suggest that there is a greater need for the involvement of practitioners in the publishing of journals, as they were less likely to publish in the journal than academicians. Further, he found that there were several authors who published multiple times during the thirty year period that his article reviews, but that for the most part the authors who published only did so one time. In addition, the author notes that the individuals who published in the journal represent a diverse group of scholars, academic departments as well as governmental organizations.

Pitts and Edwards (2005) conducted a study of who contributes to *Public Administration Review* (PAR). The authors examined the time period of July 24, 2000-December 2, 2003. The authors sent a survey to all individuals who submitted an article to PAR during this time period. They obtained a 50 percent response rate. The authors

obtained the following information: level of education, career path, longevity in the profession, race/ethnicity, gender, and ASPA Affiliation is reviewed. Their study revealed several interesting results regarding the individual characteristics of those publishing in PAR. They found that most PAR articles were submitted by academicians and white authors. They found that minorities and practitioners were far less likely to submit to PAR than were their counterparts. Further, these authors found that minorities were less likely to have their articles accepted than whites even when academic rank was taken into account. Despite this, their research revealed that females were more likely to have their article accepted for publications than males.

This article is interesting and highlights the importance of gaining an understanding of who is publishing in PAR, but the authors' study does not take into account the importance of networks and relationships. For example, the authors note that a small percentage of minorities and practitioners published. In addition, they note that a small number of students published as well. Despite this, the authors do not provide insight into how these individuals gained access to the network. For example, while females were more likely to have a manuscript accepted, it would be interesting to know whether or not they were co-publishing with someone else in the network. Furthermore, students who published may have prior publications with faculty members. In addition, minorities may not be publishing because they may not be part of the small world that exists. This could have implications for theory and practice by highlighting the importance of mentoring programs and faculty members going beyond simply encouraging minorities to pursue graduate education by working with them to publish.

It would also be interesting to know if the individuals who publish are doing so as part of publishing with a "star actor."

Handley et.al (2005) conducted a more in-depth study on publications in public administration by reviewing publications in all the ASPA Journals from 1993 to 2002. They begin to examine some of the questions that I raise regarding the work of Pitts and Edwards (2005). Their study differed from Pitts and Edwards (2005) in that they only examined articles that were actually published as oppose to also reviewing articles that were submitted for publication. They were interested in understanding who was publishing and what institutions were most prevalent in publications. Their findings were consistent with Pitts and Edwards (2005). They found that most articles in the ASPA journals were single authored. Further, most of the articles were published by faculty members. Students and practitioners did publish, but they tended to do so with other faculty members.

Summary

Scholars in public administration often make a call for students and practitioners to be included more in the scholarly publications (Pitts & Edwards 2005; Handely & Watson 2005). Further, Denhart (2001) argued that one of the big questions of public administration education was whether faculty members would prepare students for their future careers. For doctoral students, preparing and equipping them to publish is part of answering this call. These scholars comments are well noted, but an important extension to their articles can be assisted tremendously through the usage of network analysis. Utilizing the small world theory and network analysis to examine public administration will provide insight into the positions that individuals in the network occupy. As Burt

(1992) notes, the position that individuals occupy in the network affects their access to information as well as their ability to influence the network. Bell and Zaheer (2005) demonstrate how positions in the network affect the performance of firms and their ability to be innovative. Furthermore, the strength and number of relationships that an individual occupies in the network is also important (Grannovetter, 1971).

At a more scholarly level, the research cited above suffers from a lack of a theoretical framework. Each of the studies are descriptive in nature but are not conducted under a strong theoretical framework. This does not minimize the importance of their work, as these scholars have laid a firm foundation to the development of theory. The current study is an extension to the literature as I answer the call of looking at real networks with the small world theory made by Crossley (2008). I utilize the work of the afore mentioned scholars to test the small world theory. My study will also provide a means for comparing a network in public administration to the previous studies that look at networks through a social network analysis lens.

CHAPTER III

THEORITICAL FRAMEWORK

This research is guided by social network theory and perspective. I utilize the small world theory as my overarching theoretical framework to guide this research. The social network concept of centrality bolsters my study by allowing me to identify the individuals who occupy central locations in the network. I have divided this chapter into three sections. In the first section I discuss the small world theory. In the next section, I provide a discussion of the concepts of centrality that guide my research. In the final two sections of this chapter I discuss the status of scientific collaborations research in public administration and how this research enhances the state of knowledge and theory development.

Small World Theory

The theoretical framework that guides this research is based upon Stanley Milgram's small world theory. According to the small world theory, even though the world is large everyone is connected to each other through very few people. Watts and Strogatz (1998) demonstrated how the small world theory could be tested mathematically. They demonstrated that small world networks exhibited a high degree of clustering, yet very small path lengths. Goyal et. al. (2006) used the work of Watts and Strogatz (1998) to study scientific collaborations in the economics community. I

follow the work of Goyal et.al (2006) who conducted a mathematical examination of the small world theory in economics, but I study public administration. My work is not a complete replication of Goyal et.al (2006) because in addition to discussing the entire network, I also discuss the individual actors (local level of the network) in the network. Their work focused primarily on the global network. They did not examine the local level of the network. Thus, I examine both the global and local level of the network. Further, I do not conduct a trend analysis. The small world theory is based on three assumptions that Goyal et.al. (2006) note when they write the following:

> "We say that a network *G* exhibits *small-world* properties if it satisfies the following conditions: (1) The number of nodes is very large as compared to the average number of links: n>> n(G). (2) The network is integrated; a giant component exists and covers a large share of the population. (3) The average distance between nodes in the giant component is small: d(G) is order ln(n). (4) Clustering is high: C(G) >> n(G)/n…." (Goyal et. al, 2006, p. 405).

This first condition indicates that there will be more authors in the network than there are relationships among the authors. This is important because what makes the small world phenomena intriguing is that in a large population the world is still small in relations to how connected people are to each other. The second condition is based on the notion that there will be a cluster in the network that contains more authors than any other cluster or component in the network. The articles reviewed in this literature review all had a giant component. While Goyal et.al. (2006) argues that this is a condition that they added to the original work of Watts and Strogatz (1998), it is really simply a clarification. The small world theory can only be tested on a completely connected graph

(Bollen et.al., 2005). Studies that tested the small world theory in scientific collaborations support the notion that a completely connected graph must be used, as they utilize the giant component to test the small world theory (Newman 2001; Barabasi et.al, 2002; Bollen 2005; Cheong & Corbitt, 2009). Thus, studies seeking to test this theory must use the giant component of the graph in order to test the assumptions of a small world theory. The third condition is that the distance between the authors in the network will be small. This concept is consistent with Milgram's (1967) finding that everyone in the network he examined was connected within five intermediacies. The final condition indicates that there will be a high degree of clustering in the network. Networks that are said to be small worlds exhibit these attributes of a high degree of clustering, yet very little separation between individuals in the network.

Small World networks are important as these types of networks are said to be an efficient means of communicating and sharing information despite having a very large network (Latora & Marchiori, 2001). Using this as the framework to evaluate scientific collaborations in public administration provides a framework for understanding not only if a small world is present, but also the structure of the network that is present in public administration. Scholars who wish to penetrate the network in order to become more influential will be able to identify the most central actors in the network.

Most Central Authors in Field

The evaluation of the public administration network will be enhanced greatly by the network analysis concept of centrality. Centrality is a measure that stands to provide a great deal of insight into the field of public administration. The scholars who previously conducted research into the public administration scientific collaborations

community have identified the authors who published the most articles or even those who had the most collaborators as central to the network. This approach again demonstrates an area in which a greater knowledge of social network analysis in the field can provide useful insight into the discipline by reframing how we think about the most central actors. In the following paragraphs I demonstrate how the network concepts of centrality can be used to reframe the discussion of who are the most central authors in the scientific network that I examine.

There are three measures of centrality that Freeman (1979) presents which will be used to evaluate the most central authors in public administration. Each of these measures warrants discussion as they evaluate who the central authors are from a slightly different perspective. The first measure of centrality is degree centrality. Degree centrality holds that the author who has the most relationships with other authors is most central to the network. Thus, those who have published with the most others will be considered more central to the network.

While degree centrality does provide some insight, it may be deceptive if used as a sole measure in evaluating someone's centrality in the network. For example, it is possible that an individual could have a lot of direct ties, but these ties could be confined to a particular area of the network. An actor in the network may be connected to a host of other individuals who are not very connected. Hence, a second measure of centrality that Freeman (1979) discusses is closeness centrality. This measure of centrality provides insight into the amount of time that it would take for an actor in the network to communicate with or reach others in the network (Wasserman and Faust, 2005). From this perspective, actors who are closer to other actors in the network are more central as

they are able to interact with a larger amount of people in the network quicker than others.

The final measure of centrality that Freeman (1979) discusses is betweeness centrality. Betweeness centrality refers to actors who are central to the network because they are between other actors on their shortest path (Wasserman & Faust 2005). This indicates that actors who are not connected or are not adjacent to each other must depend on a more central actor to connect them to others. Actors who are more central to the network in regards to betweenes could serve as brokers or even deny the passage of information to others in the network (Wasserman & Faust 2005). This could have implications regarding whether or not an individual can get a message or receive assistance from an editor or another person in a position of authority who could provide insight into critiques that may be needed to an article before it can be submitted for official review by the journal.

These three measures of centrality provide a theoretical framework for evaluating which authors are the most central and hold the best position in the network that I examine. These concepts have their root in network analysis and demonstrate how information regarding an actor's position can be enhanced when using the appropriate language. Thus, coupling these concepts with the small world theory provides insight into research collaborations for public administration.

Status of Theoretical Frame for Research Collaborations in Public Administration

Using the Small World Theory and network analysis to examine research collaborations in public administration will enhance the body of knowledge in the discipline in two overarching areas. The first is that I will provide insight into the new

work of scientific collaborations in public administration. There have been studies in public administration which have examined who publishes in various journals. These studies have been interesting as well as provided insight to the field, but they have lacked a theoretical lens. Network analysis provides the appropriate methodological and theoretical lenses for studying the network of individuals who publish in public administration. Further, the small world theory provides an approach for the discipline to step back and go beyond simply looking at the individual aspects of those who publish in public administration to viewing the global network. The second area in which I enhance the body of knowledge and theory development in the field of public administration is that I demonstrate how network analysis theories and techniques can be used to appropriately examine a network in the field. The techniques that I utilize can be used to examine any network that the discipline may wish to explore (Wasserman & Faust, 2005). This will assist in enhancing the field's ability to evaluate networks using the appropriate theories, terminology and methodological approaches. Having the ability to discuss the network of scholars in public administration with the appropriate scientific terminology is vital to the theory development of our field as well as our ability to compare our discipline to other fields of study.

Insight that Research Provides

This research will provide insight into the social network that exists in scientific collaborations that can be found through scientific networks in public administration. Specifically, I present the first study in public administration that uses social network analysis and the small world theory to provide insight into the structure of scientific collaborations in public administration. Once I have completed this research the field

will have a stronger theoretical framework into the following questions regarding scientific collaborations in public administration:

1. What is the structure and make-up of the network of research collaborations in public administration?
2. Is there evidence of the Small World Theory in public administration?
3. What is the level of homogeneity of the network in regards to the following: institution of employment, gender, area of teaching responsibility and profession?
4. How does the network compare to other scientific networks?

   Who are the central authors in the public administration network?

Conclusion

In this chapter, I have indicated that I will use the small world theory and the network analysis concepts of centrality to guide my research. Thus, I present a framework for evaluating scientific collaborations in public administration. I build upon the work of Goyal et.al (2006) to provide a frame work for the expectations that I have for the small world theory. I extend upon the overall small world theory and scientific network theory literature in that I examine the public administration community. The small world research has not reached a consensus regarding whether or not a small world is present when studying the academic co-publication communities (Amarai et.al, 2007). The small world theory has been found to exist in fields that range from the IMP group of market researchers all the way to the biological sciences (Morlacchi et.al., 2005; Newman 2001). It has also been found not to be present in other disciplines (Moody 2004). Thus, there is a need to review the literature in public administration in an effort to extend the state of knowledge.

CHAPTER IV

METHODOLOGY

The purpose of this chapter is to describe the procedures that I used in order to conduct this study. I specifically address how I collected and analyzed the data, the boundary specifications that I placed on my study, how I ensured that the research was valid as well as the network analysis definitions and techniques that I used in the study. I followed the examples of other scholars in that I devote a considerable amount of time describing the various network measures that I used in this study (Pepe 2010; Provan et.al, 2005; Parise 2007). I further differentiated between the global and local measures of the network. Global measures evaluate the entire network, where as local measures provide insight into the individual actors and the relationships that they have. In differentiating between the global and local measures, I follow the work established by other scholars (Marsden, 1990; Pepe 2010; Wasserman & Faust 2005; Coulon 2005; Parise 2007)

I have divided this chapter into three sections. In the first section, I review my overarching research questions and state the expectations that I have for the network. Social network analysis can be conducted at an individual level as well as at a global level in which the entire network is examined (Wasserman & Faust 2005; Marsden, 1990). My research questions led me to examine both the global network in addition to individual actors in the network. In the second section of this chapter, I discuss how I

collected the data. This section also provides insight into how I measured relationships as well as the way in which I ensured that the data was reliable, valid and accurate. I discuss how I analyzed the data in the final section of this chapter. This section is particularly important for public administration as I introduce the network measures and statistics that undergird my research. This section demonstrates how previous studies conducted by Kellough and Pitts (2005), Handley et. al (2005) and West 2010 would have been enhanced by utilizing the appropriate network measures.

Research Questions and Expectations

I have listed below the overarching questions and expectations that this research addresses. These overarching questions and expectations that I have for this research are based on the theoretical framework that I have already identified. While this research tests the small world theory in public administration, it is also a descriptive study that introduces a new network to public administration and allows our discipline to compare its network with other networks using the appropriate language. Descriptive studies are important, as they often represent the first examination of a phenomenon (Grimes & Schutz 2002). Further, this study is a quantitative study. Thus, in addition to having expectations regarding the small world theory, I also have several other expectations for the network.

1. What is the structure and make-up of the network of research collaborations in public administration?
    a. Make-up
        i. What is the overall connectivity of the network
            1. Density of the Network

ii. How many total articles

iii. How many total actors

iv. How many ties (relationships- co-publications)

b. **Expectation 1:** I expect that most articles will be single authored papers.

c. **Expectation 2**: I expect that students and practitioners will be present in the network less frequently than faculty members.

2. Is there evidence of the Small World Theory in public administration?

   a. Expectation 3: "The number of nodes is very large as compared to the average number of links" (Goyal et. al., 2006, p. 405)

   b. Expectation 4: I expect that a giant component will exist in the network that

      i. Expectation 4a: I expect that the giant component will cover at least 30% of the authors in the network.

   c. Expectation 5: I expect that the average distance in the network between actors will be smaller than what would be found in its random graph comparison.

   d. Expectation 6: I expect that the giant component of network will exhibit a higher degree of clustering than would be found by its random graph comparison.

3. What is the level of homogeneity of the network in regards to the following: institution of employment, gender, area of teaching responsibility and profession?

   a. Expectation 7: I expect that practitioners are more likely to publish with a professor than with another practitioner or alone.

b. **Expectation 8:** I expect that students are more likely to publish with a professor than with another student or alone.

c. **Expectation 9:** I expect that women are more likely to gain access to the network by publishing with men than they are with women or alone.

d. **Expectation 10:** I expect that public administration scholars are more likely to publish with another public administration scholar than someone outside of public administration

e. **Expectation 11:** I expect that there will be isolates in the network.

f. **Expectation 12:** I expect that cliques will develop within the network. Thus, many authors publishing strategies will be to simply publish with the same group of individuals.

4. Who are the central authors in the public administration network?

    a. **Expectation 13:** I expect that some authors will be more central to the network than others.

5. How does the network compare to other scientific networks?

Data Collection

I sought to collect data that would provide insight at two levels. The first level was of primary interest to me, and it occurs at the global level of the network. This concern is whether a small world exists in public administration. The first step in testing the theory of a small world involves making a determination of what relationships will constitute a small world. I specifically measured and defined a relationship based on whether two authors had published a journal article together in the journals that I examined. If two authors had published together, this study indicates that a relationship

between those authors were present. If two authors had not published together, then a relationship was not present. A secondary interest of mine was simply to be able to provide a descriptive view of the individuals and make-up of the network. Thus, I also provided insight into information about the authors in the network from a descriptive perspective. I discuss the specific descriptive information that I sought to provide in the coming paragraphs.

In this research, I constructed a network that examined the relationship of individuals who published in the American Society of Public Administration journals from January 2003 through December of 2011. I specifically examined the journals titled *The Public Administration Review, American Review of Public Administration,* and *Review of Public Personnel Administration*. These journals represent a diversity of focus in public administration as they target both scholars and practitioners. Further, the *Review of Public Personnel Administration* enhances this research as it focuses on a particular sub-discipline of public administration. I collected data by visiting the websites of each of the respective journals. Specifically, I collected data on *The Public Administration Review* by visiting *http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1540-6210/issues*. I collected data from the *American Review of Public Administration by visiting http://arp.sagepub.com/content/by/year*. Finally, I obtained data from the *Review of Public Personnel Administration* by visiting http://rop.sagepub.com/content/by/year. By using the journal abstracts and biographies of the authors located on the website, I collected the following data: authors and co-authors of articles, institution of employment, occupation, the gender of the author, year the article was published, current

discipline of occupation, and whether the author co-published with someone else. In the following sections, I list how I defined the data that I collected.

Authors and Co-Authors of Articles

I defined an author of an article as the individual or individuals who wrote the article. A relationship between authors was measured by whether or not they had co-published an article together. The overall relationship of whether two individuals had published an article together provided the foundation for testing the small world theory. The other data that I collected below simply allowed me to provide a descriptive discussion of the publications in the journals that I examined.

Institution of Employment

I defined institution of employment as the primary university or organization that an author of an article is employed at during the time of their article publication. Further, for students, the institution of employment was defined as the university that they were attending.

Occupation

I defined an author's occupation as a student, practitioner, or professor. In this research, a student was defined as someone whose biography said that they were currently enrolled in a doctoral, masters, or undergraduate degree program. It is possible that a person can be employed full-time as well as is a student, but I used the primary "occupation" that is listed in the biography.

I defined a faculty member as someone whose primary responsibilities were listed as teaching. Individuals who were graduate teaching assistants were not defined as a

faculty member. Further, I classified faculty members as an instructor, assistant professor, associate professor, or professor. I obtained this information from the author information that was listed in each of the journals that I analyzed. Consistent with the other definitions that I used, I utilized the author's primary description that they listed of themselves when submitting their article for publication.

I defined a practitioner as someone whose primary employment was not listed as a student or faculty member. Further, when collecting data, I also differentiated between someone who was listed as a researcher at a think tank as opposed to someone who was an administrator. Thus, I coded the data for a researcher as a "researcher". In the current analysis, I included both of these individuals as a practitioner, but when collecting data I made this distinction for future research studies.

The occupation of employment is an interesting concept that I captured. It is quite possible that individuals crossed into various categories. For example, a student could have also been working full-time. Further, a practitioner may also have been teaching classes at a local community college. The journal information listed what the authors coined as their primary responsibilities, and thus alleviates this potential weakness of the study.

Discipline of Employment

The measure of discipline of employment is a descriptive measure that seeks to provide insight into the academic field with which a student or professor associates themselves. When I conducted an examination of cross disciplinary collaboration, I only included students and faculty members in the analysis. Specifically, I sought to gain insight into whether an author's academic discipline was outside of public policy and

administration (this included public affairs). I obtained this information from the author's description. For example, in the descriptions of the authors the information read "James Orr is a professor of public administration."

Gender of Authors

In regards to gender, I utilized the biographies of the authors in order to capture pronouns such as "he" or "she." This allowed me to determine the gender of the authors of the articles. When the biographies of the authors did not provide information on the gender of the author, I sought to identify the gender by visiting their institution of employment.

Organization of Data as Collected

I organized the data that I collected by placing it in a Mirocsoft Excel spreadsheet. I used the sheet to capture, maintain, and ensure the accuracy of the original data that I collected. I used this Excel sheet to code the relationships among those who had or had not published together.

Analyzing Data and Terminology

I used network analysis to analyze the data that I collected. Network analysis provides the ability to use specific terminology to study networks (Wasserman and Faust 2005). One of the contributions to the literature that this study makes is that it strengthens the methodology in public administration's network studies by demonstrating how a network of scientific collaborations can be studied using network analysis. In this section, I introduce the basic network concepts that guided my research. I used Ucinet 6 and SPSS in order to analyze the data. Ucinet 6 is a network analysis tool that is used for

displaying and analyzing network (Borgatti et.al, 2002). I graphically displayed the network by using Netdraw. Netdraw allows a researcher to manipulate and display the various features of the network that are developed (Borgatti et.al, 2002).

Validity, Accuracy and Reliability of Data

When conducting any research from a social network perspective, it is important to ensure that the data obtained is reliable, valid, and accurate. Scholars note that these questions are often of concern when individuals seek to conduct studies using network analysis (Wasserman & Faust 2005; Marsden 1990). I discuss how I ensured that the data I collect was indeed valid, accurate and reliable in the following section.

Berner et.al, (2008) notes that operational validity refers to ensuring that the data measures what the researcher intends for it to measure. Drawing conclusions based on measures that are not valid may yield inaccurate results (Berry 2008). In order to ensure that the data are valid in social network analysis, the researcher must first determine whether they intend to measure actual ties or perceived ties (Wasserman & Faust 2005; Marsden 1990). In this study, I chose to measure a true relationship regarding whether an individual published with another. As Newman (2001) notes, this is indeed a stringent definition of a relationship, but it can be measured. Of course, relationships develop through various channels. Some scholars may work with another scholar or even know someone through a conference. Further, some scholars may have a relationship with others of whom they do not publish with, but this current research sought to gain insight into the network of publications. I was interested in actual ties or relationships that existed. Affiliation studies in network analysis seek to measure relationships based on the affiliations that authors have with events, activities or organizations. Such studies

provide insight and are useful, but I chose to adopt a more stringent definition on what constitutes a relationship. I looked at the institution that an individual was employed by or attended school at during the time of their publication, but attending or working at the same institution does not necessarily mean that a relationship is present. In addition, the current study sought to examine a relationship that can be measured with a great deal of certainty. Thus, I chose to measure actual ties in this study. As I discuss below, I measured ties based on whether or not an author had co-published an article together. Authors who have not published together did not have a tie, while those who had published together were coded as having a tie present.

Similar to identifying how a relationship was measured, it is also important that network studies have the appropriate boundaries. Establishing boundaries is not new to public administration scholarly work or the work of practitioners, as Kettl (2006) argues that establishing boundaries of responsibility for public organizations is becoming more difficult (Kettl 2006). Similarly, network researchers have noted that establishing boundaries for network studies are important, yet difficult to do (Marsden 1990; Quatman 2006). The American Society of Public Administrations journals serve as primer journals in the field of public administration that produces research aimed at both academics and practitioners (Handley et.al, 2005). Of course, it is possible that scholars have published together in other journals or even worked on conference papers together. Despite this, my research is consistent with the work of previous scholars as I examine the major journals in the field (Acedo et.al., 2006; Henneberg et.al., 2009).

Berner et.al, (2008) argues that obtaining reliable data generally means that repeated measures to obtain information will yield the same results. I examined a static

network. I do not seek to provide insight into how the structure of network has changed over time. Thus, when I refer to reliability, I am evaluating the sources that I used to obtain the data. I am certain that my data is reliable, as I used the specific journals to obtain data. Further, Glanzel and Schubert (2004) note that scientific collaborations through co-authorship data represent one of the most reliable approaches to measuring collaborations among scientists (Glanzel & Schubert, 2004). The greater challenge was ensuring that I have captured the correct individuals.

One of the challenges that exist when conducting studies of co-authorship using network analysis involves ensuring that the correct authors are captured. It is possible that more than one author will have the same name or an author may use different initials with their names in various publications (Newman 2001; Acedo et.al., 2006; Henneberg et.al 2009; Cheong 2009; Barabasi, 2001). In order to correct for this possible error, I followed an approach similar to that espoused by Acedo et.al (2006). These authors reviewed each article and author who had the same surname and first initial. They verified their data by comparing where the individuals were employed. When two authors had the same surname and first initial in my study, I reviewed the biographies of the authors and institution of employment to ensure that my data captured the correct author.

Construction of Network

This study is guided by social network theory and analysis. The concept of social network analysis is a perspective that acknowledges the importance of relationships. The specific social network theory that I tested is the Small World Theory. Before discussing the theoretical assumptions of the Small World Theory in greater detail, it is first

appropriate to provide a review of how I constructed the network and the terminology that guide my research. In the next sections of this study I seek to provide insight into how the network was constructed. I then discuss the network terminology that I used to analyze the network. The construction of the network and terminology that guided this research provided insight into the structure of the entire network.

My first overarching research questions states, *what is the structure and make-up of the network of research collaborations.* There are several expectations that I have for the network, but before being able to answer this overarching question and examine my expectations, it is first important to construct a network. In this study, I constructed a network of scientific collaborations in public administration. In social network analysis, an actor is referred to as the individuals who comprise the network (Wasserman & Faust 2005). The actors of the network are the authors who published in the journals that I examined. I assigned a relationship for two actors if they had co-published a paper together. A relationship between two actors (authors) is referred to as a tie in social network analysis.

Now that I have defined who the actors in the network were and why those individuals were chosen, it is now appropriate to provide more insight into how the network was constructed. I constructed a one-mode network that was ego-centric. A one-mode network examines the relationship that an actor has with other actors (Wasserman & Faust 2005; Thomas & Aguilar 2010). An ego-centric network simply indicates that the network focuses on the individual actors. In order to provide insight into what a one-mode network is, consider the matrix listed as Table one. It has the same dimensions in that it is a 4X4 matrix. Each of the actors in the matrix is listed on the

rows and columns. A one represents that a relationship is present while a zero represents that no relationship is present. In contrast, a two- mode network, or affiliation network, may have different dimensions such as a 4X5 matrix. The columns in table two consist of the actors and the rows consist of the events. Table two illustrates how an affiliation matrix looks. The network that this study used is a one mode-network.

Construction of Network of Collaborations in Public Administration

When constructing my network, I utilized Microsoft Excel. Similar to table one, I placed the names of the authors down the rows and across the columns. If two actors published together, I assigned a one to those actors. If two actors did not publish together, I represented that relationship by assigning a zero. As with all one mode networks, the dimensions of matrix that I developed had an equal number of rows and columns. Further, as illustrated in table one, the diagonals of the cells were zero, as is always the case with one mode networks. This is the case because an actor is always assigned a zero when measuring whether they published with themselves, as this study measured relationships that an actor has with another through co-publication.

Table 1 Example of a One Mode Network

	Actor 1	Actor 2	Actor 3	Actor 4
Actor 1	0	1	1	0
Actor 2	1	0	1	0
Actor 3	1	1	0	0
Actor 4	0	0	0	0

Table 2 Example of a Two Mode Network

	Event 1	Event 2	Event 3	Event 4	Event 5
Actor 1	1	1	0	1	1
Actor 2	0	1	1	0	1
Actor 3	0	1	0	0	0
Actor 4	1	1	1	0	0

Graphical Representation of Network

Social network analysis also allows for the graphical representation of a network. This is powerful as it provides a visual picture of the network. Thus, now that I have noted the construction of network and how relationships were defined, it is equally important to discuss the network approach that I used to visually display the network. The actors in the network were viewed as nodes. A node represents a point on the graph (Wasserman & Faust 2005; Aguilar & Thomas 2010). Thus, when I graphically displayed the network, the actors were referred to as a node. In graph theory, ties in the network are represented by lines that are referred to as an edge (Wasserman & Faust 2005). The edges of a graph can be directional or undirectional. A directed edge is represented by a line with an arrow. These arrows can be in one direction, which demonstrates a flow going towards one node or they can have an arrow head on each end which would demonstrate a reciprocal flow of information. An undirected graph edge is represented by a line without arrows. In Figure 1, I show an example of an undirected graph, followed by a directed graph in Figure 2. It was appropriate for the lines to be undirected in this study. The undirected line is appropriate in this particular research because it examines a question of whether or not a relationship is present. I did not seek to answer the questions of whether or not a relationship was reciprocal or if each

individual had the same feelings for each other, as my research questions simply examined whether the actors had co-published a paper together.

When I organized the data in order to display the network, I utilized several approaches. The first approach that I used was to create a unique identifier for each author in the network. When I displayed the entire network, having each author's first, middle, and last name displayed on the network will make the graph too jumbled. Thus, I assigned each author an identifier based on their first, middle, and last initial. I found during my coding of the names of the authors, that some authors had all three of the same initials. In order to correct for this, I assigned a numerical value after those individuals who had the same initials. For example, if two individuals had the initial JEO, one of the authors was assigned JEO2. After coding the data, I proceeded to graphically displaying the network. The first approach that I took was to simply show the network as it randomly appears when the data is displayed. I also visually displayed the data so that the various groups that may exist could be seen. Finally, I sought to visually use the data to demonstrate who the primary connectors in the network were.

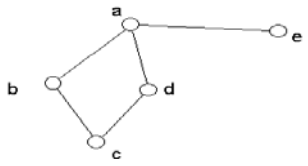

Figure 1 Undirected Graph

I obtained this figure from http://www.analytictech.com/networks/graphtheory.htm

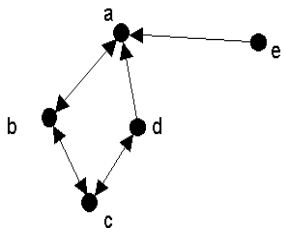

Figure 2 Directed Graph

I obtained this figure from http://www.analytictech.com/networks/graphtheory.htm

Make-up of the Network

It is now appropriate to return to my original first overarching question that states, *what is the structure and make-up of the network of research collaborations*. I have demonstrated how the actual network was constructed and visually displayed which is fundamental to discussing the structure and make-up of the network. Now, I will discuss how I evaluated the actual structure and make-up of the network.

Overall Connectivity of Network

My first sub-question under the overarching question of this section explores the overall connectivity of the network. When seeking to understand the overall structure of the network, it is important to examine the overall connectivity of the network. In order to measure how connected or unconnected that the network was, I utilized the density statistic. The density statistic can be both a global measure that provides insight into the entire network or it can be a local measure that provides insight into an individual actor. Density is used to provide a numerical value that represents the connectivity of the network and/or an actor in the network. Density measures the number of ties (relationships) present as a proportion of the possible ties that an actor or network could have (Hatala 2006; Coulon 2005). Density measures ranges from one to zero. Measures

that are closer to one indicate more cohesion amongst the network and measures closer to zero indicate less cohesion (Hatala, 2006). Utilizing the network analysis software Unicet 6, I computed a density statistic for the entire network.

Description of the Network's Make-up

After I described the overall connectivity of the network, I further discussed the make-up of the network. *In expectation 1, I write that I expect that most articles will be single authored*. I constructed a table that allowed me to examine this. The columns of the table listed how many actors or authors published, the number of articles that were published, and the number articles that were co-published. The rows of the table listed the number and percentage of each of those respective categories that were published each year. This allow me to demonstrate whether most of the articles were single authored. Further, I also able to evaluate each year to determine whether or not the percentage of articles that are co-authored were increasing, decreasing, or remaining the same. I also discussed the percentage of articles that were co-published, the mean, and standard deviation.

In expectation 2, *I write that I expect that students and practitioners will be present in the network less frequently than faculty members*. In order to evaluate this expectation, I discussed the percentage of the network that consisted of professors, students and practitioners. Further, I included descriptive statistics on the percentage of males and females in the network. Based on these frequencies, I was able to discuss whether or not the network consisted primarily of professors, students, or practitioners. I was also able to provide insight into number of males and females in the network.

Testing the Small World Theory

My second overall question addresses the small world theory by stating, *is there evidence of the small world theory*? In this section, I outline how I tested the small world theory. This theory serves as the foundation of my research. In order to test the small world theory there are four concepts that I needed to examine. These concepts were the giant component, clustering coefficient, path length, and the random graph. In the next sections, I will specifically outline what these concepts mean and how I measured them in order to test my theory.

Giant Component

The first concept that must be examined when studying the small world theory is that of components. A component of a network is a subset of the network in which each of the actors can be reached through a path in the subset of the graph (Wasserman & Faust 2005). Given that my study examined the small world theory, I specifically tested the small world theory by studying the giant component of the network. The giant component of the network consists of the largest connected component in the entire network. This will be the component that has most of the actors or nodes (Pepe 2010, Wasserman & Faust 2005). When testing the small world theory one must look at the connected areas of the graphs, as those who do not have a connection with anyone are completely outside of the network. This condition actually leads to an understanding that people who have a connection in the network are part of the small world.

In order to test the first assumption of the small world theory, I conducted a component analysis. I did this by first identifying how many components that the network had. I then proceeded to conducting the test associated with the small world

theory, the largest component. Specifically, I identified the largest component in the network. This was the component that contained the most authors in which there existed a path for which they could reach each other. Thus, no isolates were present. Bollen et. al, (2005) note that collaboration networks tend to have several components or sub-graphs in the network (Bollen et.al, 2005). Thus, those authors note the importance of identifying the largest component in the graph before conducting some studies. As discussed above, a small world theory can only be tested on a graph that has no isolates. Thus, in order to identify the largest component in the network, I used Unicet 6.

Clustering Coefficient

After identifying the giant component in the network, it was appropriate to use this component in order to compute a clustering coefficient and average path length for the giant component of the network. Amaral et. al, (2007) discussed the clustering coefficient by writing, "The CC measures how many of an actor's contacts are connected to each other" (Amaral et al, p. 78, 2007). Consider that we have three actors in a network. Suppose that these actors are referred to as Actor 1, Actor 2, and Actor 3. Now suppose that Actor 1 and 2 are connected to each other. The clustering coefficient measures the probability that Actor 1 and 2 will both have a direct connection with actor 3. For the purposes of this research, the connection is referred to as a co-publication (Watts & Strogatz, 1998; Amaral et.al, 2007; Wasserman & Faust, 2005). The clustering coefficient ranges from zero to one. It measures the average of the individual clustering (density) for each of the actors in the network. Values closer to one indicate more clustering while values closer to zero indicate less clustering. In this analysis, I utilized

the transitivity measure of centrality. This simply indicates that I weighed the clustering coefficient in order to account for the size of the network (Amaral et.al, 2007).

Average Path Length

The next concept that had to be examined is the average path length. Similar to understanding the concept of a path length, the notion of the diameter of the giant component and the geodistance must first be discussed. The diameter of the network is a global measure of the network. The diameter of the network provides insight into the size and breadth of the network (Pepe 2010). Wasserman and Faust (2005) provide insight into the importance of the diameter of a network by writing, "The diameter of a graph is important because it quantifies how far apart the farthest two nodes in the graph are" (Wasserman & Faust, 2005, p. 112). The geodesic is the shortest path between two actors in a network. Wasserman and Faust (2005) write, "The diameter of a connected graph is the length of the largest geodesic between any pair of node…" (Wasserman & Faust, 2005, p. 110). Thus, the average path length is a measure used in graph theory that measures the average of the shortest paths in the network (Watts & Strogatz, 1998; Amaral et.al, 2007; Wasserman & Faust, 2005, Peper, 2010). This measure provides insight into the degrees of separation that exist between individuals in a network. The average path length provides insight into the efficiency of communication in a network (Peper 2010). I computed the average path length (average geodistance) by using Unicet 6.

I utilized the network measures of the clustering coefficient (CC) and the average path length (L) to test the small world theory. As Watts & Strogatz (1998) argued, the

clustering coefficient and average path length concepts are the most important measures to examine when seeking to understand whether a small world is present.

Random Graph

As discussed previously, I built off of the work conducted by Goyal et.al., (2006). The question that they had to address as well as others is what constitutes a high degree of clustering and very short average path lengths in a network. Scholars who examined the small world theory in their network addressed this by utilizing Watts & Strogatz (1998) concept of a random graph (Amaral et.al, 2007; Goyal et.al, 2006; Moody, 2004; Newman 2001). I followed the work of other scholars who have conducted scientific network studies using the random graph comparison. A random graph in a scientific collaborations study is a graph that has the same number of authors as the network that is constructed, but the relationships or ties in the random graph are assigned randomly. A random graph is the appropriate graph to use for comparison when conducting small world research because these graphs tend to have very little clustering and a short average path lengths between actors in the network (Amaral et.al, 2007). Amaral et.al, (2007) discussed the expectations for the path length and clustering coefficient of a network that has been constructed compared to a random graph network by writing the following:

> "Using random networks as their relevant comparison, Watts and Strogatz (1998) showed that a network was a small world if its CC ratio (CC actual /CC random) was many times greater than 1.0 and its PL ratio (PL actual/PL random) was approximately 1.0, or if the CC ratio divided by the PL ratio was much greater than 1.0, a measure known as the small world Q…" (Amaral et.al, 2007)

Cliques of Networks

The third overall arching question that I examined in the network states, *what is the level of homogeneity of the network in regards to the following: gender, area of teaching responsibility and profession.* The first sub-question under this section seeks to provide insight into how students, practitioners, and women gain access to the network. Expectation 7 states, *I expect that practitioners are more likely to publish with a professor than with another practitioner or alone.* In order to examine this expectation, I created a chart similar to table 3. I titled this table "Practitioner Co-publications". In this table, I only included data for the articles that include a practitioner in the publication. The columns of this table listed the categories individually authored articles, co-publications, co-publications with students, co-publications with practitioners, and co-publications with professors. I then listed the percent and number of each of the articles that fell into those respective categories. I obtained the idea for constructing this table from the work of Handley et. al, (2005).

Table 3 Publication Preferences

Articles	**Percent**	**N**
Individually Authored Articles		
Co-publication Articles		
Total		
Co-publication Articles with Students		
Co-publication Articles with Practitioners		
Co-publication Articles with Professors		
Total		

I state in expectation number 8, *I expect that students are more likely to publish with a professor than with another student or alone.* In order to examine this

expectation, I created a table similar to table 3. I titled this table "Student Co-publications". In this table, I only included data for the articles that included a student in the publication. The columns of this table listed the categories individually authored articles, co-publications, co-publications with students, co-publications with practitioners, and co-publications with professors. I then listed the percent and number of each of the articles that fall into these respective categories.

I state in expectation number 9, *I expect that women are more likely to gain access to the network by publishing with men than they are by publishing with women or alone*. In order to examine this expectation, I created a chart similar to table 3. I titled this table "Co-publications by Gender". In this table, I only included data for women. The columns of this table listed the categories individually authored articles, co-publications, co-publications with women, and co-publications with men. I will then list the percent and number of each of the articles that fell into these respective categories.

I state in expectation 10, *I expect that public administration scholars are more likely to publish with another public administration scholar than someone outside of public administration*. In order to examine this expectation, I created a table similar to table 3. I titled this chart "Public Administration Scholars Co-Publications". The columns of this table listed the categories single authored articles, co-publications, co-publications with public administration scholars, and co-publications with non-public administration scholars. I then listed the percent and number of each of the articles that fell into these respective categories.

Cliques in the Network

In addition to exploring the collaborations that occurred through examining single articles, this research also provided insight that went beyond the work of others in that I looked at cliques and groups that occurred through co-publications. In expectation 12, I wrote that I expect that cliques will develop within the network. Thus, many authors publishing strategies would be to simply publish with the same group of individuals. In the current study, I explored the cliques that were present in public administration. In network analysis, a clique is a subset of the network that has a connection between everyone in that subset. When examining co-authorship as this study does, a clique would be a subset of the network in which each of the authors has co-published an article with the other person(s) in that clique (Peper 2010). Studying the various cliques that exist in the network is a global measure of the network.

Most Central Authors in Public Administration Network

In expectation 10, *I wrote that I expect that some authors will be more central to the network than others.* The discussion of centrality represents local measures that are specific for an individual actor in the network. In this research, I examined three measures of centrality. These measures were identified in a review of the literature by Freeman (1979) and are degree centrality, closeness centrality, and betweeness centrality.

Degree Centrality

Degree centrality examines how many ties an actor in the network has. In this study, degree centrality provides a measure of how many authors that an author has directly co-published with. The more individuals that a person has published with, the

higher their degree centrality measure will be. This measure suggests that an individual who has published with several others will be more central than authors to the network. I computed a degree centrality measure for each of the actors in the network.

Closeness Centrality

Closeness centrality is the second measure of centrality that I examined. Hanneman & Riddle (2005) argued that this measure provides insight into how close each actor is to other actors in the network. Wasserman and Faust (2005) notes that Bavelas 1950 and Leavitt 1951 highlighted those individuals who were more central in this respect did not have to rely on other individuals in the network in order to obtain information. According to Wasserman and Faust (2005) individuals who demonstrate a high-level of closeness centrality are able to communicate with others in the network in a more efficient manner because of the positions that they occupy in the network. From a graph theory perspective, Henneberg et. al., (2009) argues that Freeman 1979 defines closeness centrality by writing "…the average geodesic distance between a given actor and all other actors (Freeman, 1979)" (Henneberg et al., 2009, p. 450). This measure of centrality is the inverse of the average distance that each actor is from another actor in the network (Wasserman and Faust, 2005). This measure of centrality can only be performed on a fully connected graph (Wasserman & Faust 2005). Thus, I only provide this measure for actors located in the largest component of the network. This measure uses the shortest path in order to provide insight into how close an actor is to others in the network.

Betweeness Centrality

Betweeness centrality is the final measure of centrality that I examined. Betweeness centrality refers to actors who are central to the network because they are between other actors on their shortest path (geodesic) (Wasserman & Faust 2005). Wasserman and Faust (2005) describe this by writing, "For example, if the geodesic between actors n2 and n3n1n4n3- that is the shortest path between these actors has to go 'through' two other actors, n1 and n4- we could say that the two actors contained in the geodesic might have control over the interaction between n2 and n3" (Wasserman & Faust, 2005, p. 188). Wasserman and Faust (2005) note that this may have implications for the communication that occurs in a network. Actors who are more central to the network in regards to betweenes could serve as brokers or even deny the passage of information to others in the network (Wasserman & Faust 2005). This could have implications regarding whether or not an individual can get a message or receive assistance from an editor or another person in a position of authority who could provide insight into critiques that may be needed to an article before it can be submitted for official review by the journal. Freeman et.al (1980) found that a high betweeness centrality score was associated with an individual being nominated for leadership positions. Further, the authors found that it assisted in the control and access of information which ultimately aided in others viewing individuals as leaders (Freeman 1980). To provide a summary of betweenes centrality, Wasserman and Faust 2005 write,

> "Let us simply quote from Shimbel (1953), reiterated by Pitts 1979, who stated the importance of geodesics and the actors they contain for measuring betweeness and network control: 'Suppose that in order for [actor] I to contact [actor] j,

> [actor[k must be used as an intermediate station. [Actor] k in such a network has a certain 'responsibility' to [actors] I and j. If we count all of the minimum paths which pass through [actor] k, then we have a measure of the 'stress' which [actor] k must undergo during the activity of the network (page 507)" (Wasserman & Faust, 2005, p. 188).

Correlating the Three Measures of Centrality

In the sections above, I described three measures of actor centrality that I used in order to evaluate the most well positioned authors in the network. After exploring each centrality measure and discussing the most central authors in respect to those measures, I compared the top 36 authors based on each measure. I also conducted a correlate analysis on the three measures combined in order to gain insight into how consistent the measures were with each other. I then identified the authors who appeared in as leaders in all three of the centrality measures.

Public Administration Network Compared to Other Academic Disciplines

My final overarching question seeks to provide insight into how the public administration network compares to other academic disciplines. I specifically examined sociology, economics, and management. I have chosen these networks because they represent disciplines in the social sciences in which authors have conducted a similar study to what I have conducted. In order to compare the public administration network to these networks, I created a table in which I displayed the following network concepts: density, percentage of authors captured in the main component of the network, clustering coefficient, path length, random graph path length, and random graph clustering

coefficient. I listed each of these measures in a table for each of the networks in order to discuss these characteristics as they related to public administration. I obtained these measures by reviewing Goyal et.al., 2006 and Amaral et.al, (2007).

Conclusion

This chapter has discussed how I conducted my study. This study uses social network analysis to examine scientific collaborations in public administration. I have assigned relationships to individuals when they have co-published articles together. I have outlined how I used the small world theory to test the overall structure of network in public administration. If the world is indeed small, theoretically individuals and ideas will be closer to each other. I have borrowed the concept of a random graph that was espoused by Watts and Strogatz (1998) for a comparison regarding whether the public administration world is indeed small. This approach to testing whether a small world is present is consistent with each of the other scholarly works that tested the small world theory in their discipline.

This analysis allowed me to provide insight into the local structure of the network as well. I have presented the network concepts of centrality as the basis for understanding who the central actors in the network are. This will advance the theory development in our discipline by providing a new concept regarding what constitutes being central to the network. In addition, at the global level, I have noted that I indeed expect a small world to be present in public administration scientific collaborations.

CHAPTER V

RESULTS

Introduction

The purpose of this chapter is to present the results of the analysis conducted in this study. I have divided this chapter into three sections. In the first section of the chapter, I provide a descriptive review of the network that I examine. In the second section, I test the small world theory. In the third section of this chapter, I examine the local structure of the network and then return to the global structure. In order to examine the local structure of the network, I look at who the central authors are as well as whom authors tend to publish with. I examine the global structure of the network by presenting results regarding the various cliques that are present. I conclude this chapter by comparing the results from the public administration network to other disciplines that have conducted a network analysis on scientific collaborations.

Make-up of the Network

My first overarching question states, *what is the structure and make-up of the network of research collaborations*? This network has 1, 252 different actors and 1,175 publications. There are 1,931 different relationships present in the network. The number of publications per author in this analysis ranges from one publication to as many as 16 publications. In table 4, I have listed the authors who published 6 or more times and the

number of articles that they published in this analysis. Donald P. Moynihan published the most articles at 16 and he was followed by Kenneth J. Meier who published 15 articles. In the following section, I provide additional information regarding the descriptive make-up of the network.

Women appeared on articles in the network less frequently than men. In fact, 70.5 percent of the articles that were published contained men while only 29.5 percent consisted of females. These findings are highlighted in table 5.

Table 4 Most Publications in Network

Author	Number of Publications	Author	Number of Publications
Donald P. Moynihan	16	Anne M. Khademian	7
Kenneth J. Meier	15	George A. Boyne	7
James L. Perry	12	Jerrell D. Coggburn	7
Sanjay K. Pandey	11	Meredith A. Newman	7
David H. Rosenbloom	10	Sally Coleman Selden	7
Jonathan P. West	9	Sergio Fernandez	7
Richard C. Feiock	9	Gregory B. Lewis	6
Barry Bozeman	9	Aimee L. Franklin	6
Bradely E. Wright	9	Charles R. Wise	6
David M. Van Slyke	8	Doug Goodman	6
David W. Pitts	8	Edward P. French	6
James R. Thompson	8	Hal G. Rainey	6
James S. Bowman	8	Heather Getha-Taylor	6
Jeffrey L. Brudney	8	Jos C. N. Raadschelders	6
Laurence J. O Toole Jr	8	Patricia W. Ingraham	6
Norman M. Riccucci	8	Paul C. Light	6
R. Paul Battaglio, Jr	8	Richard M. Walker	6
Rosemary O Leary	8	Robert F. Durant	6
Terry L. Cooper	8	Soonhee Kim	6
Kaifeng Yang	7		

Table 5 Gender of Authors

Gender	Number	Percentage
Female	369	29.5%
Male	883	70.5%

Overall Connectivity of Network

My first sub-question under the overarching question of this section explores the overall connectivity of the network. The density statistic is used to provide insight into the connectivity of the network. Measures that are closer to one represent a more cohesive network, while measure closer to zero represent less cohesion. The density statistic for the overall network is 0.0012. Thus, this network is not a very cohesive network. This is further demonstrated by the average degree. This measure provides insight into how many collaborators the actors in the network have on average. The average number of co-publication in the network per actor is less than 2. In table 6, I list the network statistics in regards to the overall connectivity of the network.

Table 6 Network Density

Density	Number of Ties	Average Degree
0.0012	1931	1.5436

Descriptive of the Network's Make-up

In expectation 1, I write that I expect that most articles will not be co-authored. I examine this expectation in table 7. As table 7 indicates, 49 percent of the articles in this network were co-published. In the network, 51 percent of the articles were not co-published. In 2003, the number of articles that were co-published and those that were not co-published were equal to each other. The percentage of articles that were co-published then exceeded the percentage of articles that were not co-published until 2007. In 2007, 54 percent of the published articles contained only one author. After this time, the percentage of articles that were co-published did not reach 50 percent again. While overall the percentages of articles that are single authored exceed the percentage of articles that are co-published, the average number of authors per article was two people. The standard deviation is 1.28. Overall, these results confirm expectation 1 which states that most articles will be single authored. The findings that on average articles have two individuals present, provides early indication that the network of collaborators in public administration will exhibit a great deal of cliques.

Table 7 Publications

	03	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**Total**	**Percentage**
Co-Published Articles	44	50	57	76	62	55	78	76	77	575	49%
Single Author	44	46	42	70	73	76	77	83	89	600	51%
Articles Published	**88**	**96**	**99**	**146**	**135**	**131**	**155**	**159**	**166**	**1175**	**100%**

Articles published from 2003-2011.

Table 8 Authors Per Article

Avg. Number of Actors	2
Maximum	7
Minimum	1
Standard Deviation	1.28

Expectation 2 states that students and practitioners will be present in the network less frequently than faculty members. Table 9 examines this expectation. Individuals who identified themselves as a faculty member appeared on articles in the network more often than both students and practitioners. Faculty members appeared on 78.6 percent of the articles that were published. In contrast, students appeared on 5.5 percent of the articles while practitioners appeared on 14.5 percent of the articles.

The numbers that constitute the faculty members and practitioners who appeared on journal articles are interesting and require further analysis. While 14.5 percent of those appearing as authors on articles were practitioners, further analyses reveal that many of these individuals were associated with academics or some form of research as their profession. Of the individuals who identified themselves as practitioners, about 12 percent of the authors served in some type of research position. Thus, if one were to combine the percentage of students who published and those in faculty or research positions, approximately 85 percent of the articles published came from academia. This number may also be slightly higher as 29 individuals in the study did not have their position listed nor was their resume online. I suspect that many of these individuals were students, as most of them listed a university that they were affiliated with, but did not have their position online. Overall, this table confirms my expectation that faculty

members would appear on articles in the network in the network more often than students and practitioners.

Table 9 Profession

Actors	Appearance on Articles	Percentage
Faculty Member	1538	78.6
Students	107	5.5
Practitioner	283	14.5
Not Listed	29	1.5
Total	**1957**	**100%**

This indicates the number of times that the profession appeared on articles.

This network consisted of individuals who published as faculty members ranging from lecturers to full professors. There were a total of 1538 faculty members appearing on an article that is included in the network. Of those appearing as faculty members on articles, 45% of the time these individuals reported that they were full professors. The second closest category was assistant professors followed by associate professors. There were also 44 individuals in the network that I have listed in the other category. These individuals identified themselves as holding positions such as department heads, associate deans, and even two people who served as a chancellor of a university.

Table 10 Academic Rank

Position	Number	Percentage
Professor	689	45%
Assistant Professor	442	29%
associate professor	323	21%
Other	44	3%
Lecture	11	1%
Senior Lecture	11	1%
Emeritus Professor	10	1%
Adjunct Professor	5	0.3%
Instructor	2	0.1%
Not Listed	1	0.1%
Total	**1538**	**100%**

This indicates the number of times that the academic rank appeared on articles.

Testing the Small World Theory

My second overall question addresses the small world theory by stating, *is there evidence of the small world theory*? The small world theory is tested by examining the presence of a giant component, the clustering coefficient, and the average path length. The average path length and the clustering coefficient of the giant component of the network are then compared to a random graph of similar size. I test the small world theory in expectations 3-6.

Average Number of Links Compared to Actors

Expectation 3 states, "The number of nodes is very large as compared to the average number of links" (Goyal et.al., 2006, p. 405). Thus, in order to begin the process of studying the small world theory, it must first be demonstrated that the network is large compared to the average number of relationships. Expectation 3 is confirmed as the

average number of links per actor in this network is 1.5, but there are 1252 actors in the network.

Giant Component

In expectation 4, I test the network for the presence of a giant component. This expectation indicates that overall the entire network will not be completely connected, but that there will be sub-graphs in the network that are completely connected. Thus, I expect that various connected groups in the network will be present. Table 11 lists the total number of components in the network. This table assigns a unique number to each of the components. Consistent with other collaboration networks through co-authorship, this network contains several components. In fact, this network contains 541 components. These components demonstrate that there are several authors who are completely disconnected from the network or are isolates, as the components range in size from 1 node to 242 nodes. In figure 6, I listed the entire collaboration network that I have examined. In this figure, I have color coded each of the different components in the network to demonstrate the various sub-graphs that are present in the public administration network.

The giant component of the network has 242 nodes and 653 ties. The giant component consists of 19.3 percent of the authors in the network. This component is indeed the largest component. The next closest component to the size of this one consists of only 29 authors. In figure 4, I have included a graph of the giant component of the network. Each of the authors is connected to the network even if it is only by one other author. The density statistic for the giant component of the network is 0.0112. The average degree or number of collaborators per author in the giant component is 2.7.

Table 11 Number of Components and Actors Per Component

Number of Components	Size of Each Component
300	1
145	2
53	3
19	4
11	5
5	6
1	7
1	8
1	11
1	13
1	14
1	17
1	29
1	242

My fourth expectation is that a giant component will be present in the network is confirmed. This indicates that the network does indeed have a group of authors who can reach each other through a path. Based on a review of other collaboration networks, a second expectation that I state regarding the giant component is that it will cover at least 30% of the authors in the network. This expectation is not confirmed, but the presence of a giant component in the network allows for further testing of the small world theory.

Table 12 Connectivity of the Giant Component

Density	No. of Ties	Avg. Degree
0.0112	653	2.6983

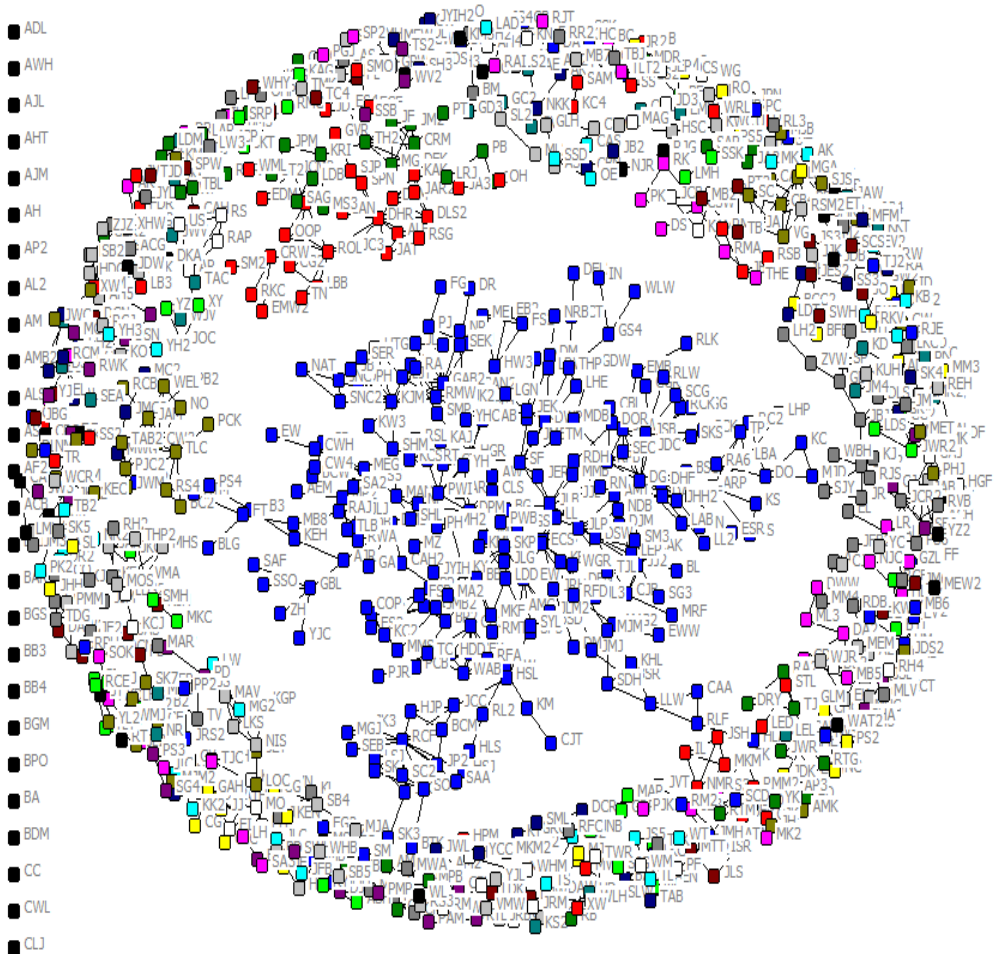

Figure 3 Public Administration Network

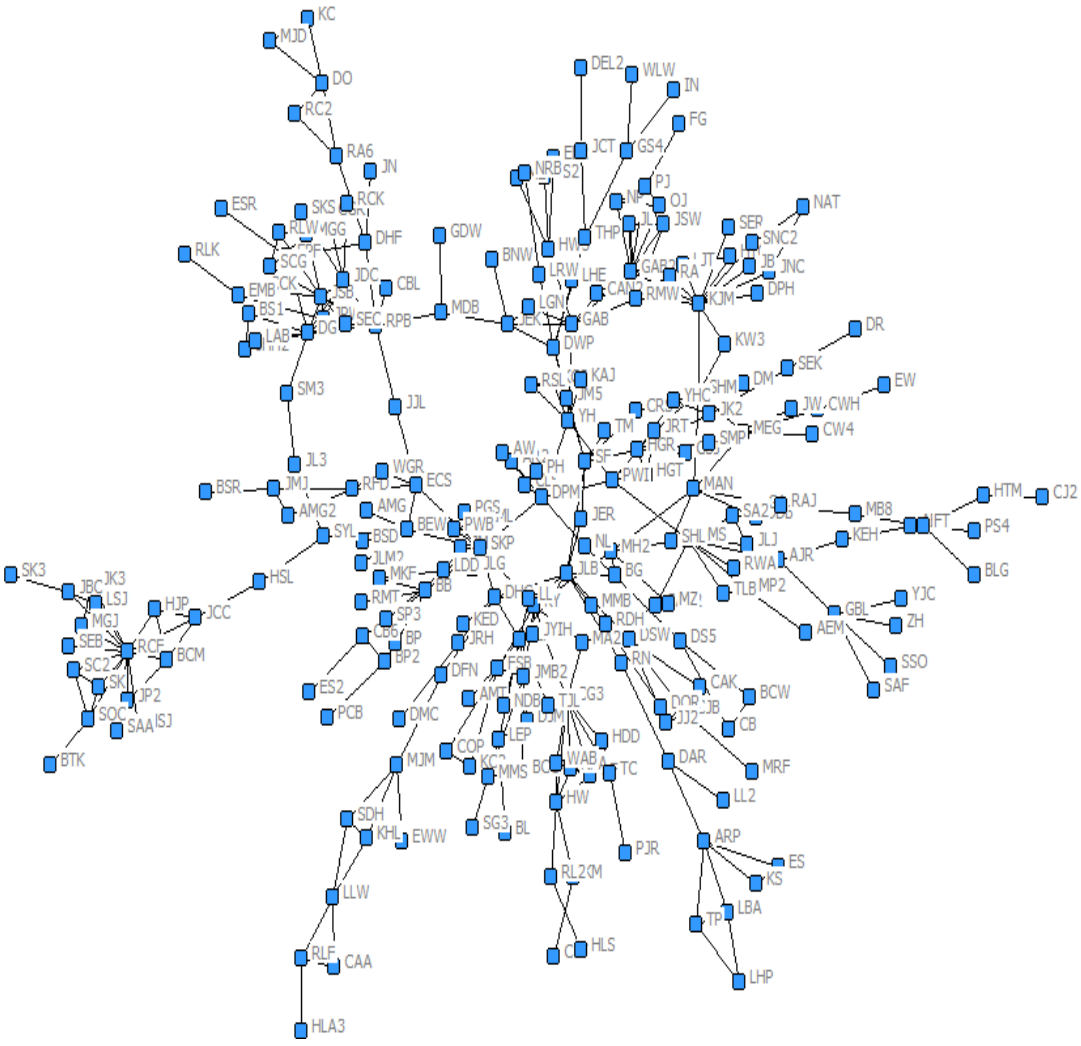

Figure 4 Giant Component of Network

Average Path Length

The third concept that must be examined is the average path length. The average path length provides insight into how close the actors in the network are to each other. The average path length is a measure used in graph theory that measures the average of the shortest paths in the network (Watts & Strogatz, 1998; Amaral et.al, 2007; Wasserman & Faust, 2005, Peper, 2010). This measure provides insight into the degrees of separation that exist between individuals in a network. The average path length in this

analysis is 6.433. Thus, individuals in this network are 6.433 steps away from each other. In order to provide insight into whether or not this is large, this measure will be compared to a random graph below to test expectation 5.

Clustering Coefficient

In my fourth expectation regarding the small world theory, I wrote that I expect that the network will exhibit a high degree of clustering. This expectation examines the extent to which individuals who have published with each other group together. The clustering coefficient ranges from zero to one. When conducting the analysis to examine the clustering that exists in the largest component of the network, I obtained two coefficients. One of the coefficients is an un-weighted measure while the other is weighted. Hanneman and Riddle (2005) discuss this by writing, "The 'weighted' version gives weight to the neighborhood densities proportional to their size; that is, actors with larger neighborhoods get more weight in computing the average density" (Hanneman & Riddle, 2005, p. 124). The unweighted clustering coefficient for this network is 0.491. The weighted clustering coefficient is 0.282. I use the weighted clustering coefficient for the purposes of this analysis. Using the weighted clustering coefficient provides me with a standardized measure of the clustering in the network so that I can compare it to other networks.

Random Graph

In order to answer the question regarding whether the path length and clustering coefficient constitutes a small world, I utilized a random graph. Using Unicet 6, I generated a graph that consists of the same number of nodes and density of the giant

component of the network. The random graph network has a clustering coefficient of 0.003 and a weighted value of 0.007. The average path length of the network is 5.124. The clustering coefficient of the random network is smaller than the clustering coefficient that I obtained from the public administration network. In contrast, the average path length of the public administration network is longer than what is expected in a random graph network.

Amaral et.al, (2007) discussed the expectations for the path length and clustering coefficient of a network that has been constructed compared to a random graph network by writing the following:

> "Using random networks as their relevant comparison, Watts and Strogatz (1998) showed that a network was a small world if its CC ratio (CC actual /CC random) was many times greater than 1.0 and its PL ratio (PL actual/PL random) was approximately 1.0, or if the CC ratio divided by the PL ratio was much greater than 1.0, a measure known as the small world Q…" (Amaral et.al, 2007).

When testing Watts and Strogatz (1998) argument regarding how the ratio of clustering coefficients compares to the value of 1, I obtained 40.29. This is several times larger than 1. The clustering coefficient meets the criteria of a small world thereby confirming my expectation 6. When I compared the path lengths using Watts and Strogatz (1998) method, I obtained the value of 1.26. This is slightly longer than the path length expected in a small world graph. Thus, my expectation 5 that the path length will be short is not satisfied, though it is only slightly larger than expected.

This analysis reveals that three out of the four, or 75 percent, of my expectations of the small world theory is accepted. Despite this, the path length of public

administration network was slightly longer than what is expected in a small world network. Thus, my overall expectation that a small world is present in the public administration network was not found.

Table 13 Small World Measures

Component	Clustering Coefficient	Random Graph Cluster Coefficient	Average Path Length	Random Graph Average Path Length
242 Nodes	0.282	0.007	6.433	5.124

Cliques of Network

The results of this analysis have thus far demonstrated that the public administration network has a very high degree of clustering. Despite this, individuals in the network appear to be farther away from each other than what is expected in a random graph. In this section, I examine the various cliques that are present in the network. I first conduct this examination by providing insight into the level of homogeneity in the network in regards to who the actors tend to co-publish with. I then return to the global network in order to provide insight into the number of cliques present and how they are connected to each other.

Homogeneity of Cliques and Publications

While understanding the global structure that cliques exist in is interesting, it is also important to gain insight into who the actors in the network tend to gravitate towards. I address this question in the following section of this analysis. The third overall arching question that I examine in the network states, *what is the level of homogeneity of the network in regards to the following: gender, area of teaching*

responsibility and profession? The first sub-question under this section seeks to provide insight into how students, practitioners, and women gain access to the network.

Expectation 7 states, I expect that practitioners are more likely to publish with a professor than with another practitioner or alone. Table 14 examines this expectation. Table 14 reveals that most practitioners who appear on articles did so through co-publishing an article as oppose to publishing by themselves. Approximately 68 percent of the articles that were published by practitioners had more than one author. In contrast, 32 percent of the articles that practitioners appeared on only had one actor. In the articles that practitioners did co-publish, 73 percent of the time they did so solely with a faculty member. Further, a faculty member was present on 13 percent of the other articles that were co-published by practitioners. This indicates that 86 percent of the time in the network when practitioners co-published an article, they did so by publishing with a faculty member. In contrast, only 15 percent of the articles that were co-published by a practitioner did not include a faculty member. Thus, my expectation that practitioners are more likely to publish with a faculty member than with another practitioner or alone in this network is confirmed.

Table 14 Publications by Practitioners

Articles	N	Percentage
Individually Authored Articles	80	32%
Co-publication Articles	170	68%
Total	**250**	**100%**
Co-publication with Students	3	2%
Co-publication with Faculty Member	125	73%
Co-publication with Practitioner	20	12%
Co-publication with Student and Faculty Member	10	6%
Co-publication with Practitioner and Faculty Member	10	6%
Co-publication with Student and Practitioner	1	.5%
Co-publication with All Groups	1	.5%
Total	**170**	**100%**

Expectation 8 states that students are more likely to publish with a professor than with another student or alone. Table 15 examines this expectation. Table 15 demonstrates that most students who appear on articles in the network did so through co-publishing or by becoming part of a clique as oppose to publishing by themselves. On the articles in which a student appeared on, 87 percent of those articles had more than one author. In contrast, only 13 percent of the articles in which students appeared on did they do so as the sole author. In the articles that students did co-publish, 76 percent of the time they did so solely with a faculty member. Further, on 13 percent of the other articles that were co-published by students, a faculty member was also present on the article. This indicates that 89 percent of the time in the network when students co-published an article, they did so by publishing with a faculty member. In contrast, only 11 percent of the articles that were co-published by a student did not include a faculty member. Despite this finding, it is also interesting to note that in the network of individuals who

published together, there is one clique in which seven students published a paper together without the presence of a faculty member or a practitioner. Despite this, most articles that were published by students included a faculty member. My expectation that students are more likely to publish with a faculty member than with another student or alone in this network is confirmed.

Table 15 Student Publications

Articles	**N**	**Percentage**
Individually Authored Articles	12	13%
Co-publication Articles	80	87%
Total	**92**	**100%**
Co-publication with Students	3	4%
Co-publication with Faculty Member	62	76%
Co-publication with Practitioner	2	3%
Co-publication with Student and Faculty Member	3	4%
Co-publication with Practitioner and Faculty Member	4	5%
Co-publication with Student and Practitioner	3	4%
Co-publication with All Groups	3	4%
Total	**80**	**100%**

Expectation 9 states that women are more likely to gain access to the network by publishing with men than they are by publishing with another woman or alone. I examine this expectation with table 16. Table 16 illustrates that most of the articles in which women appear on are done so through co-publishing as oppose to publishing alone. 63 percent of the articles in which a woman appeared on had more than one author. In contrast, 37 percent of the articles contained only one woman. In the articles that women did co-publish, 65 percent of the time they did so by publishing with a male. Further, on 13 percent of the articles that were co-published, a male and female were part

of the co-publishing. For example, there may have been two women and a male who published on a paper or even two women and two males. This indicates that 78 percent of the time in the network when women co-published an article, they did so by publishing with a male. In contrast, only 22 percent of the articles that were co-published by a woman did not contain a male. Thus, my expectation that women are more likely to gain access to the network by publishing with men than they are by publishing with another woman or alone in this network is confirmed.

Table 16 Women's Publications

Articles	**N**	**Percentage**
Individually Authored Articles	169	37%
Co-publication Articles	285	63%
Total	**454**	**100%**
Co-Publication with Women	62	22%
Co-Publication with Men	185	65%
Both Men and Women	38	13%
Total	**285**	**100%**

I state in expectation 10 that I expect that public administration scholars are more likely to publish with another public administration scholar than someone outside of public administration. Table 17 examines this expectation. In this table, I have only included information for those who are either students or faculty members. These were the individuals in which data could be collected on their academic discipline. This table demonstrates that most of the public administration scholars appeared on articles as the sole author as oppose to co-publishing with someone else. When conducting an examination of whom public administration scholars tended to publish with, 64 percent of the time they did so by publishing with someone inside of the academic discipline of

public administration. In contrast, 32 percent of the articles were published with an individual from another discipline. While this may seem promising, most of these articles were published by those in political science. Despite this, my expectation that public administration scholars will publish with other public administration scholars is confirmed.

Table 17 Publications by Public Administration Scholars

Articles	**N**	**Percentage**
Individually Authored Articles	446	52%
Co-publication Articles	415	48%
Total	**861**	**100%**
Co-Publication with Public Administration	264	63%
Co-Publication with Other	133	32%
Co-Publication with PA and Outside of PA	15	4%
Not Listed	3	1%
Total	**415**	**100%**

Now that I have examined how individuals in the network tend to group together, I return to the global network. Expectation 11 states that I expect isolates to be present in the network. This indicates that there would be some individuals who have not collaborated with anyone else on a paper. This expectation is confirmed in Table 11 where it shows that there are 300 authors who are completely disconnected from everyone else in the network.

In expectation 12, I wrote that I expect cliques will develop within the network. A clique can be as small as two actors, but for the purposes of this analysis in table 18 I only note the cliques which contain three or more actors. I have only shown the cliques that contain three or more actors in order to illustrate the groups that develop within the network. Further, the default of the Unicet 6 is to show only those cliques that contain

three or more actors. Again, a clique is defined as group in which each of the actors present have a direct connection between each other. There are 142 cliques in the entire network that contain at least three actors. Thus, my expectation that cliques will be present in the network is confirmed.

While some cliques in this network are completely separated from the others in the network, there is some overlap present among cliques. For example, there are 49 individuals in the network who appear in more than one clique. DHR, ROL, and GAB2, each are present in four different cliques. RCF is part of the most cliques in the network. He is present in seven different cliques.

While being present in multiple cliques may indicate that one is able to reach several parts of the network, it is possible that the cliques are representing primarily redundancy. In the public administration network, we find that individuals appear in multiple cliques, but they often consist of primarily the same individuals. For example, the first three cliques consist of RCF and BCM. These cliques only change as a result of the introduction of one new person in each clique.

Given the multiple cliques that are present, as I have only listed the ones that contain three authors, I also graphed the public administration network and searched for structural holes. Structural holes are individuals in the network who connect various portions or groups of the network that would not be connected if it were not for their presence. In figure 5 I have made the name and nodes larger that play a primary role in connecting various cliques and groups in the network. An inspection of this graph reveals that SKP, RCF, KJM, and DHR play the most important structural role in connecting various parts of the network together.

Table 18 Network Cliques

Number	Membership	Number	Membership
1	RCF BCM HJP	42	AMB EG2 NMH SM
2	RCF BCM JCC	43	AES LS2 RR2
3	RCF BCM JP2	44	AD RTG YK
4	RCF JK3 MGJ	45	AME CHO JH3 NC PS2
5	RCF JBC LSJ	46	ACG CCL EJ MDZ
6	RCF SOC SK	47	AH3 TS2 WV2
7	RCF SOC SC2	48	AM2 JC2 RS3
8	BS1 DG JHH2	49	AMH CCP MPB
9	CAW JFW LML	50	AZ EK WJR
10	DJA CKR MFR MWA	51	AP3 CJK RMM2
11	EHK BS3 JE3	52	AH5 HRK SB2
12	ES ARP KS	53	BB BP2 CB6
13	GS LAR TBL	54	BF BS2 MDR
14	JKT RMC SRP	55	BK BS3 BV
15	JVT JE3 PJK	56	BCW CB DS5
16	JLC JFB MSR	57	BAC EN LKC2 TAB
17	JPW DG JSB JDC RPB SEC	58	BC2 RS4 TLC
18	KY CG3 MA2	59	BEW ECS SKP
19	KY FSB JMB2	60	BD HLA WHB
20	KC DO MJD	61	BK2 GWR WHM
21	LHE DWP THP	62	BSF EI FH KR MO
22	LY HVS RKV	63	CT LRJ PB
23	MH GPW LAS	64	CAS OE SSD
24	MP LD TC4	65	CCO JJM JAS2 TDG
25	PP CA JA LB SC VG	66	CG2 LBB ROL
26	PP CA CB4 JA LB VG	67	CG3 RFA WAB
27	PS CR DSN	68	CAH3 LED STL
28	AB SS2 TR	69	CAK CJB DSW JJ2
29	SP ADS JM4 KD	70	CRM DEK JM2 JF MG
30	SB GWR RM	71	CW3 JAM NO WEL
31	VMA JAK MHS MOS THP2	72	CW3 JAM TAB2
32	ALF DHR JAT RSG	73	CC2 DAL JWR2 LDS
33	AJ MM4 RDB	74	CH2 GB2 TS
34	AHB AMH JZG	75	COP FSB KC2
35	ALF2 JAB JCR2 PO PS6 RVB	76	CAA LLW RLF
36	AN JLS MTT	77	CAN2 GAB GAB2 RMW
37	AK2 AK3 NKK	78	CB5 DP FH2
38	ADF CB2 MT	79	CF JL2 LH3 SK7 YL2
39	AP RAP RS US	80	CBL2 KTL PAM
40	AS2 CWW GLH	81	CW5 GAJ HGF
41	AMG2 JMJ RFD	82	DJ LS OOP ROL

Table 18 (Continued)

Number	Membership	Number	Membership
83	DJ EDM JCM2	124	JES2 JS3 SCS
84	DLS JM JBJ	125	JCB KAM LWB
85	DLB2 GER2 GBA	126	JMH RM2 SCD
86	DA2 GD2 MB5	127	JOC XY YZ
87	DF GW SH3	128	JS5 TL WT
88	DHC JLP JLB LL	129	JPM KRI ST2
89	DHR DLS2 DFM JAR2	130	JYH KAN SLW
90	DHR DLS2 DFM KAK	131	JEY LOC MMH
91	DHR JC3 ROL	132	KCS KAJ RSL YH
92	DJH DLF PKF	133	KGP LKS MAV NIS
93	DMS JLJ SA2	134	KML PWB SKP
94	DMS MP2 TLB	135	KJM KW3 SHM
95	DWP JM5 SF	136	KRI LDB MS3 SAG
96	DJM JLP LEP	137	LBB ROL TN
97	DRY RA2 TJ	138	MH2 MAN SHL
98	DPM PWI YH	139	MB2 PT2 TB
99	DO RA6 RC2	140	MEG MAN SHM
100	DDB MAN RAJ	141	MBC NR WMJ
101	DD2 MMH MJM2	142	MJL TWR WM
102	ECS RFD WGR		
103	EB2 FS2 HW3 ME		
104	EGF JD SMO		
105	FB2 HM MB6		
106	GZL LR NJC		
107	GZL HLA2 NJC		
108	GAB JEK LGN		
109	GW2 KB MPM2 RK2		
110	GAB2 KJM LJT RA RMW		
111	GAB2 JL JSW RMW		
112	GAB2 NP OJ PJ		
113	GJM2 JR SJY WBH		
114	GV PS3 SG4		
115	HGR HGT JRT PWI		
116	HGR JK2 YHC		
117	HTG KJM LJT		
118	IL JSH MKM		
119	JWM TLC TAB2		
120	JSB MGG RLW SCG		
121	JBT RSB RMM		
122	JER JLB SF		
123	JFP OJS TV		

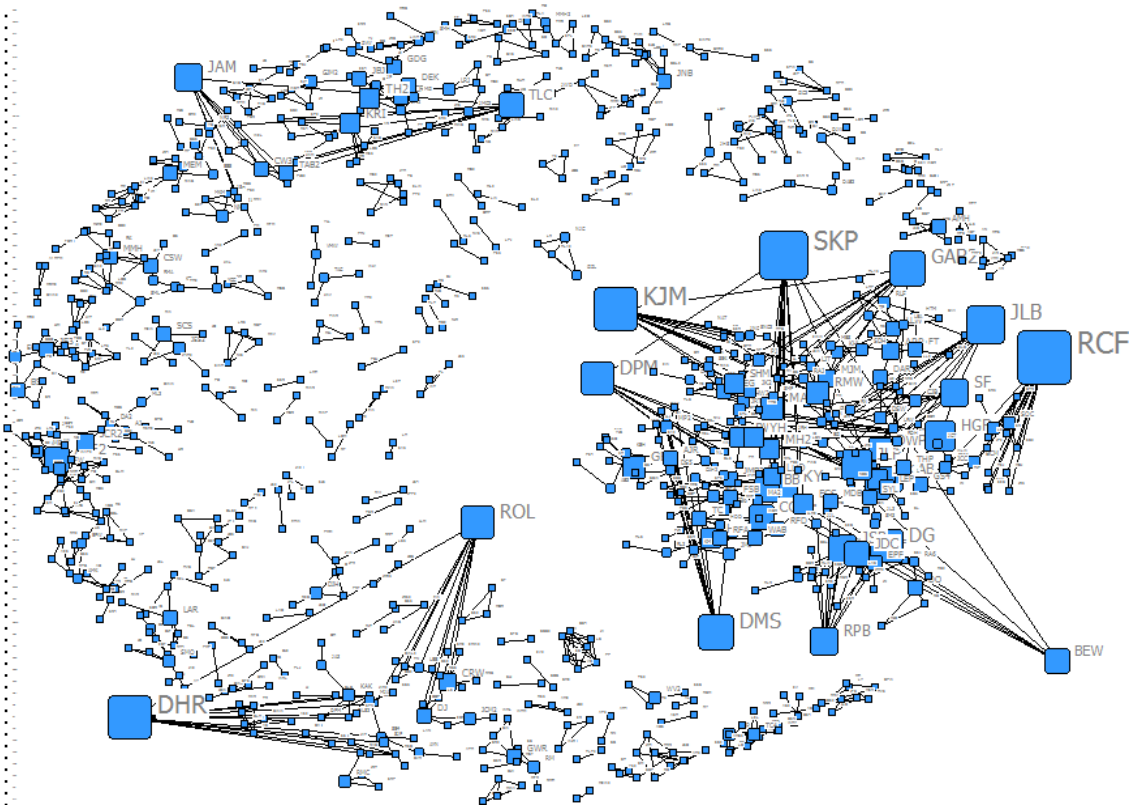

Figure 5 Authors Connecting Sub-Groups

Most Central Authors in Public Administration

I wrote in expectation 13 that I expect that some authors will be more central to the network than others. In this research, I examined three measures of centrality. These measures were identified in a review of the literature by Freeman (1979) and are degree centrality, closeness centrality, and betweeness centrality.

Degree Centrality

The first measure that I calculated in regards to centrality was the degree centrality. I calculated this measure for the entire network. This approach to centrality that identifies the most central authors in the network is based on the notion that the more

direct ties that an actor has, the more important that they are to the network. I have listed the actors with the top 39 degree centrality scores. As indicated in the table 19, RCF has the highest degree centrality measure at 14. This indicates that he has co-published directly with 14 others in the network. There were five other authors who published with 10 or more individuals in the network. As the table 19 indicates, these individuals were DHR, SKP, KJM, GAB2, and JLB.

The average degree centrality score is 1.544. This network contained authors who had as few as no direct ties to the most ties that were 14. The standard deviation for the degree centrality is 1.642.

Betweeness Centrality

The second centrality measure that I examine is betweeness centrality. This measure of centrality argues that the most central authors to the network are those who are between other authors on their shortest path. Thus, from a betweeness centrality perspective, more people would depend on a particular actor in order to reach others. They derive power because they are between individuals on their shortest paths. Table 19 lists the top 39 authors who have the highest betweeness centrality score. SKP has the highest score at 20547.398. There were five other authors whose betweeness centrality score exceeds 8, 000. These authors were DPM, RPB, PWI, DHC, and JLB.

The average betweeness centrality score for the entire network is 191.659. There is a very large range of betweeness centrality scores for the entire network in that the scores range from as low as 0 to as high as SKP's score of 20547.398. The variability in scores as indicated by the standard deviation is 1100.121.

Closeness Centrality

The final measure of centrality that I examined is closeness centrality. This measure of centrality can only be computed in networks that are fully connected. Thus, when exploring this measure, I only used the giant component of the network. This measure of centrality provides insight into how close an actor in the network is to other actors in the network. The actor with the highest closeness centrality score measure is SKP. This individual has a measure of 24.343. There were six other actors in the network whose centrality score exceeded 21. These actors were DPM, DHC, KY, ECS, PWI, and BEW.

The average closeness centrality measure for the giant component of the network is 15.291. The closeness centrality scores range from as low as 9.644 to as many as 24.343. The standard deviation for the network is 2.816.

Table 19 Authors with Top 39 Centrality Scores

Actor	Degree	Actor	Betweeness	Actor	Closeness
Richard C. Feiock	14	Sanjay K. Pandey	20537.498	Sanjay K. Pandey	24.343
David H. Rosenbloom	12	Donald P. Moynihan	10172.493	Donald P. Moynihan	22.523
Sanjay K. Pandey	12	R. Paul Battaglio, Jr	9697.167	David H. Coursey	21.751
Kenneth J. Meier	11	Patricia W. Ingraham	9217.646	Kaifeng Yang	21.576
George A. Boyne	11	David H. Coursey	8881.283	Edmund C. Stazyk	21.309
Jeffrey L. Brudney	10	Jeffrey L. Brudney	8742.586	Patricia W. Ingraham	21.29
David M. Van Slyke	9	Sergio Fernandez	7768.679	Bradely E. Wright	21.048
James S. Bowman	9	Gene A. Brewer	7642.314	Yilin Hou	20.975
Rosemary O Leary	9	Edmund C. Stazyk	7423.25	Jeffrey L. Brudney	20.83
Doug Goodman	9	Kaifeng Yang	7220.088	Sergio Fernandez	20.598
R. Paul Battaglio, Jr	9	David M. Van Slyke	6612.333	Hal G. Rainey	20.151
Hal G. Rainey	8	J. Edward Kellough	6371.05	Marc Holzer	20.151
Jerrell D. Coggburn	8	David W. Pitts	5846.383	Gene A. Brewer	19.884
James L. Perry	8	Jared J. Llorens	5558.417	Barry Bozeman	19.819
Richard M. Walker	8	Yilin Hou	5537.014	Leisha DeHart-Davis	19.673
Aimee L. Franklin	8	Bradely E. Wright	5531.333	Justin Marlowe	19.641
Donald P. Moynihan	8	Hal G. Rainey	5524.395	Kelly M. Leroux	19.609
Juliet A Musso	7	Mark D. Bradbury	4701.417	Paul W. Brandenburger	19.609
Sergio Fernandez	7	Sharon H. Mastracci	4510.686	James L. Garnett	19.593
Gene A. Brewer	7	Soonhee Kim	4259.667	Patrick G. Scott	19.593
Tanya Heikkila	7	Kenneth J. Meier	3949.776	James R. Thompson	19.173
Jos C. N. Raadschelders	7	Hyang Soo Lee	3536	James L. Perry	19.157
David W. Pitts	6	James C. Clinger	3344	Jared J. Llorens	19.157
Jonathan P. West	6	George A. Boyne	3328.824	Laura Littlepage	19.051
Meredith A. Newman	6	Meredith A. Newman	3254.812	J. Edward Kellough	19.036
Jean Accius	6	James R. Thompson	3226.541	David W. Pitts	18.887
Yilin Hou	6	Author C. Brooks	3222	Jay Eungha Ryu	18.682
Harnold Wolman	6	Marc Holzer	3015.645	Beth Gazely	18.668
Patricia W. Ingraham	6	James L. Perry	2837	Heather Getha-Taylor	18.653
Chao Guo	6	Richard C. Feiock	2823.5	Muhittin Acar	18.567
Vassia Gueorguieva	6	Barry Bozeman	2633.5	David M. Van Slyke	18.51
Kaifeng Yang	6	Doug Goodman	2541	Noel Landuty	18.482
Barry Bozeman	6	Chao Guo	2226.667	Alasdair Roberts	18.397
Panote Preechyanud	6	Donald F. Norris	2040	Amber Wichowsky	18.397
Lamar Bennett	6	Theodore H. Poister	2037	Carol L. Silva	18.397
Carmen Apaza	6	Richard M. Walker	1700.824	Pamela Herd	18.397
Shea Cronin	6	M. Jae Moon	1649	Meredith A. Newman	18.369
Kimberley R. Isett	6	Gregory B. Lewis	1640	Chao Guo	18.313
Taehyon Choi	5	James S. Bowman	1634	Soonhee Kim	18.258

Discussion of Overall Results

The next question that I examined was who the overall most central actors in the network were. In order to begin to understand this, I first conducted a correlation analysis to see how close the measures of centrality that I used were to each other. In table 20, I

have listed a correlation matrix that examines this relationship. Using Unicet 6, I correlated each of the measures of centrality for the actors in the network. The Freeman measures of centrality (degree, betweenenss, and closeness) were highly correlated with each other. I found that degree centrality and betweenness centrality were the most correlated with each other with a value of 0.676. Closeness centrality and betweeness centrality also exhibited a high degree of correlation at 0.561. The Cronbach's Alpha score of 0.685 provides insight into the notation that the authors exhibiting the highest centrality are indeed the most influential authors in the network structure, as their measures exhibit internal consistency.

Overall, there were 13 authors who were in the top 39 authors across all three measures of centrality. These authors are displayed in table 21. Based on their centrality scores, these authors occupy the most central positions in the network.

Table 20 Correlation Matrix

	Degree	**Closeness**	**Betweeness**	**Eigenvalue**
Degree	1	0.418	0.676	0.333
Closeness	0.418	1	0.561	0.033
Betweenness	0.676	0.561	1	0.093
Eigenvector	0.333	0.033	0.093	1
Cronbach's Alpha = 0.685				

Table 21 Most Central Authors

Barry Bozeman	James L. Perry
Chao Guo	Jeffrey L. Brudney
David M. Van Slyke	Kaifeng Yang
David W. Pitts	Meredith A. Newman
Donald P. Moynihan	Patricia W. Ingraham
Gene A. Brewer	Sanjay K. Pandey
Hal G. Rainey	

Public Administration Network Compared to other Academic Disciplines

In table 22, I provide a comparison between some of the network statistics in public administration and the fields of sociology, economics, and management. It is important to note that it is difficult to make a strong comparison and generalize across networks, because the data for each of these studies were collected in different ways as well as using different databases. Further, as table 22 indicates, some of the studies do not report all of the network measures that I examine. For example, Goyal et.al. (2006) argues that his study demonstrated a small world. He further notes that he obtained this by comparing his findings to a random graph. Despite this comparison, Goyal et.al. (2006) do not report the statistics that they obtained for the random graph.

My current study illustrates that with the exception of the Economics community from 1970-1979, the largest component in the public administration community covers the smallest percentage of authors in each of the networks. This is partially due to the interdisciplinary and developing nature of public administration. When conducting an examination of the giant component of the network, each of the studies report a weight value of the clustering coefficient and path length. This allows for a comparison across networks of different sizes. This reveals that the public administration network that I

examine has more clustering than the other networks, with the exception of the management community. Further, while the path length in this study is slightly larger than what is expected in a random graph, it is smaller than the path length of the other studies.

Table 22 Network Comparison

Network	Density	Giant Component	CC	RCC	L	RL
Management	0.0002	45.45%	0.681	?	?	?
Sociology	?	53.30%	0.194	0.94	9.81	7.57
Economics						
1970-1979	?	15.60%	0.193	?	12.86	?
1980-1989	?	28.40%	0.182	?	11.07	?
1990-1999	?	40.70%	0.157	?	9.407	?
Public Administration	0.0012	19.3%	0.282	0.007	6.433	5.124

CC= Clustering Coefficient, RCC= Random Clustering Coefficient
L= Path Length, RL=Random Graph Path Length

Conclusion

This chapter presented reviewed the results of my analysis. The chapter reveals that all of my expectations were confirmed with the exception of the expectation that the path lengths would be short when compared to a random graph and the expectation that the giant component of the network would cover at least 30 percent of the network of collaborators. In the next chapter, I provide an in-depth discussion of the results from this analysis as well as a discussion regarding the significance of these findings.

CHAPTER VI

CONCLUSION

O'Toole (2010) argued that the proper study of public administration could not occur without considering the networked behavior of public administration. This research has enhanced the state of knowledge by introducing scientific networks of collaborations to public administration. Specifically, this research examined collaborations that occur through peer-reviewed journal articles. The discipline has not completely ignored who publishes in scholarly journals in public administration, but it has not used the proper methodology framework. In this study, I utilized social network analysis to examine research collaborations in public administration. Social network analysis is different from other analytical techniques in that it focuses on the structure of relationships as oppose to individuals (Wasserman & Faust, 2005). This technique allows a researcher to understand the importance of relationships and how information flows through those relationships.

I have divided this chapter into five sections. In the first section, I discuss the problem statement that I presented in chapter one and the significance of this study. In the second section, I summarize the results of my analysis and note which expectations were accepted. In the third section, I discuss my results and their broader implications for academia as well as the practice of public administration. In the fourth section, I

make recommendations based on this analysis. In the final section of this chapter, I recommend areas for future research.

Problem Statement/Significance of Study

Scholars have made a call for public administration to utilize network analysis in their studies (O'toole 1997;2010; Isett et.al, 2011). Further, it has been noted that networks have implications for a wide range of issues in public administration (O'toole 1997; 2010). Despite this, there is very little research in public administration that specifically uses network analysis techniques and methodological approaches to conduct studies. Using network analysis techniques and theoretical frameworks, I have demonstrated how a large network can be examined and tested. The small world theory was the specific network theory that undergirded this research. The small world theory suggests that individuals in a network can reach others within a few steps, even in large populations. While the network that I examined consists of scientific collaborations, the techniques used in this analysis can be applied to other networks as well.

Results and Discussion

My analysis revealed that expectations 1-4 and 6-13 were confirmed. In table 23, I list each of my expectations and whether the results of my analysis confirmed those expectations. The purpose of this section of my conclusion is to highlight and discuss selected results from this analysis. I have divided this section into three parts. In the first part, I discuss the overall structure and make-up of the network. In the second part, I discuss the small world theory. In the final portion of this section, I return to a global

discussion of the public administration network by providing insight into the various cliques that are present.

Table 23 Expectations

Expectation Number	Expectation	Confirmation
1	I expect that most articles will be single authored papers.	Yes
2	I expect that students and practitioners will be present in the network less frequently than faculty members.	Yes
3	"The number of nodes is very large as compared to the average number of links"	Yes
4	I expect that a giant component will exist in the network.	Yes
4a	I expect that the giant component of the network will cover at least 30% of the authors in the network.	No
5	I expect that the average distance in the network between actors will be smaller than what would be found in its random graph comparison.	No
6	I expect that the giant component of network will exhibit a higher degree of clustering than would be found by its random graph comparison.	Yes
7	I expect that practitioners are more likely to publish with a professor than with another practitioner or alone.	Yes
8	I expect that students are more likely to publish with a professor than with another student or alone.	Yes
9	I expect that women are more likely to gain access to the network by publishing with men than they are with women or alone.	Yes
10	I expect that public administration scholars are more likely to publish with another public administration scholar than someone outside of public administration	Yes
11	I expect that there will be isolates in the network.	Yes
12	I expect that cliques will develop within the network. Thus, many authors publishing strategies will be to simply publish with the same group of individuals.	Yes
Expectation 13	I expect that some authors will be more central to the network than others.	Yes

Make-up of Network

The scientific network of collaborations that I examined consisted primarily of faculty members. Students and practitioners published, but they were not present in the network as much as faculty members were present. When students as well as practitioners appeared in the network, they did so primarily through co-publishing with a faculty member. Students were more likely to publish with a faculty member as oppose to publishing with a practitioner, alone, or with another student. Further, practitioners were more likely to publish with a faculty member as oppose to publishing with another practitioner, alone, or with a student.

The results of this analysis also revealed that most of the articles in the public administration network had only one author. The finding that most of the articles were not co-authored is consistent with what other studies that have examined scientific networks in the social sciences have found (Moody, 2004; Acedo et.al., 2006; Henneberg et.al., 2009; and Goyal et.al., 2006). In contrast to the social sciences, Newman's (2011) study yielded different results regarding presence of authors on articles when he examined the hard sciences. For example, Newman's (2001) study examined biomedical, theoretical physics, high energy physics, and computer science. Newman (2001) found that there were more co-publications in the articles that he studied than single authored articles. This may be due to the quantitative nature of the hard sciences, as Moody (2004) found that there was a positive and statistically significant relationship between quantitative methods being used in an article and that article having more than one author.

The finding that most articles in public administration were not co-authored is consistent with what other scholars have found when examining other scientific networks that are closely related to the social sciences. Despite this, the results of this analysis revealed that the public administration network's trend towards co-publications was different from other studies conducted in the social sciences. In other disciplines, the authors found that the percentage of co-published articles tended increase during the more recent years of their studies when compared to the earlier years of their study (Moody 2004; Chenog& Corbitt 2009; Goyal et.al., 2006). This study does not reveal such a relationship for public administration. In fact, during the latter years of this study, the percentage of articles that were co-published decreased. This finding highlights a need for future research. For example, it would be interesting to study why individuals choose to collaborate. As noted previously, the decision to co-publish an article with someone else is a strategic choice that one makes. Other research has indicated that the length of the article and whether the article is quantitative or not plays a role in whether an article is co-published (Acedo et.al., 2006).

Similarly to the notion that the network consisted primarily of articles that were not co-authored, the public administration network appears to be difficult to penetrate, as it exhibited several cliques and actors who were completely disconnected from the network. There was very little overlap between the cliques in the public administration network that were not redundant. For example, the cliques that did have some overlap among its members tended to be cliques in which the same people were publishing together, but that there was one new individual present in the clique. The cliques in which this was not the case was rare and tended to be joined together by only one

individual. Another indication that the network was a fairly disconnected group can be seen in the finding that only 19 percent of the authors were part of the giant component of the network. This indicates that only 19 percent of the authors in network could be connected to each other by at least one path. Thus, there were several actors who could not reach anyone else in the network. The small giant component and various disconnected groups may be a result of the developing nature of public administration, as other scholars have noted this as a reason for the small giant component in the network studies that they conducted (Bollen et.al., 2005; Henneberg et.al., 2009). This is also consistent with those who have differing views on the development of public administration as well as what the future holds for the discipline (Fry & Raadschelders 2008; Guy 2001; Henry 1989).

Small World Theory

I tested the small world theory in expectations 3-6. Three out of the four expectations that I made regarding the small world theory were confirmed. The number of nodes or actors present in the network was much larger than the number of relationships present in the network. This finding allowed me to begin the process of testing the other expectations related to the small world theory. In expectation 4, I expected that a giant component would be present in the network. After identifying the giant component in the network, I examined the amount of clustering present in the public administration network compared to the clustering that was expected in a random graph of similar size. This examination further supported the notion that a small world would be present in public administration, as the network was one with a high degree of clustering when compared to a random graph.

Expectation 5 is what led me to reject my hypothesis that a small world was present in the public administration network. I expected that the average distance or path length in the network would be shorter than what was expected in a random graph; and this expectation was not confirmed. This indicates that the paths that actors in the network had to go through in order to reach another person in the network was longer than one would expect if the relationships were distributed randomly. In small world networks, the path lengths are short despite a high degree of clustering.

Small world networks tend to be more efficient than other networks because they allow for the flow of information between various groups and individuals who are in the network (Latora & Marchiori, 2001). This suggests that new ideas are able to develop in one part of the network and then easily move to other parts of the network. The public administration network had a high degree of clustering as was expected, but individuals in the network were farther away from each other than what was expected in a random graph network. Most would agree that those who are part of the scientific network in public administration tend to know each other. This research examined a much more stringent definition in that I sought to gain insight into those who had a true relationship through co-authoring an article. This approach is important, as it is measurable.

The result of this analysis provides indication that much work still needs to be done in the area of understanding small world networks in regards to their applicability to networks of scientific collaborations, as the current study did not support the small world theory. This finding still contributes to the body of knowledge, as this area of study is still very young. Newman's (2001) work represented the first study to use network analysis techniques and the small world theory to examine scientific networks.

Network Cliques

The public administration network had several cliques or groups present. Further, as indicated by the long path length, on average the path lengths connecting individuals in the network were long. There was not a path for which several in the network could reach someone else. These findings highlight the notion that positions that individuals in the network hold is important. The public administration network was not completely separated, as there were some individuals who assisted in connecting the network because their membership spanned across various cliques and subgroups. This is particularly seen in the discussion of the most central authors in the network. One's initial inclination may be that the person who publishes the most times will be the most central actor in the network. This study highlighted the importance of examining how one is actually embedded into the network. For example, while KJM published the second most articles in the network, he was not listed as one of the most central actors in the network, as others occupied more structurally important positions.

Recommendations

One of the first elements that can be gleaned from this study is that human interaction often creates a network. The position that one occupies in the network matters, even if it does not appear to be a position of power. In order to effectively intervene with a network one must identify the central authors and cliques. While at a glance, frequency may lead one to believe that an actor is the most influential in a scientific network, but this may not actually be the case. Network analysis offers a host of tools for identifying the major players in the network. This study demonstrates that using Freeman's centrality measures is important. Organizations as well as those seeking

to affect a network must examine the central actors in the network. The way in which one would like to influence the network may provide a framework for understanding which of the theoretical frameworks for indentifying the central actors should be used.

One way in which someone can increase their influence in the network is to develop non-redundant ties. This refers to the notion that it is important for scholars to publish with those outside of their immediate clique. The individuals who spanned various aspects of the network had several non-redundant relationships in regards to the various cliques. Thus, they tended to publish with several different people. When an actor publishes or has ties outside of one group, it allows that actor to be a connector to various segments of the network. In this analysis, the network did not have a high density measure. This indicates that authors collaborated with other authors from their particular clique or that they did not collaborate on article. While publishing simply with authors from one specific clique allows an actor to develop cohesiveness among that clique, this may limit their influence in the network to that particular group. The individuals who were central to the network in this study were connected to more than one clique. Thus, when scholars seek to enhance their position in the scientific network, they should seek to develop relationships and collaborations with individuals in multiple cliques. This is important because it allows them to become a connector in the network (Henneberg et.al., 2009). Further, as Granovetter (1973) noted, having multiple relationships with different individuals in a network may also be beneficial when searching for new employment. For example, Granovetter (1973) found that individuals who had several weak ties were able to find employment easier than others because of the breath of acquaintances and information that they were able to utilize.

The public administration scientific network could benefit from more collaboration, especially among those from different disciplines and between practitioners and students. The current research revealed that our field collaborates mostly with those from within public administration. The field of public administration is interdisciplinary in nature, and I believe that the discipline may benefit from the scholarship and insight from outside of our discipline. Further, practitioners offer experience that can provide insight into issues that they deal with on a daily basis.

Further Studies

This study has laid the foundation for future studies that examine scientific collaborations in public administration. Futures studies should examine co-publications that can be found in all public administration peer-reviewed journals. This approach will be a major task, but can provide additional insight into scientific collaborations. Such a study would be difficult to do if one seeks to provide the depth of knowledge about each authors as the current study does. For example, seeking to identify the academic rank, gender, profession, and discipline for everyone who has published in a public administration journal for the past nine years will be challenging. Thus, I suggest that individuals map solely co-authorship relationships in all public administration journals. Using biblometic software, it is possible to simply map the co-publications that authors have with other authors in the discipline.

The second area of research that future studies could examine is the relationship that authors have with editors of journals as well as the editorial boards. Conducting a study of this nature would require that researchers create an affiliation network and then map relationships based on the affiliations that authors have with these individuals. My

current study has demonstrated that the public administration network is a group that tends to publish in several cliques. Gaining insight into the relationships that authors have with editors of journals may provide more information on the structure of scientific networks in public administration.

A third area for future research should examine the stability and robustness of the public administration network. The network of collaborators in public administration consisted of several cliques and subgroups. It may be important to gain insight into what happens to the network when key actors are removed. This can be examined by randomly deleting some of the actors who are connectors to various segments of the network. After these connectors are deleted, one should see if the network becomes completely disconnected or if other paths exist that allows the network to remain stable. Studies conducted by Goyal et.al., (2006) and Barabasi et.al., (2002) provides a theoretical framework for conducting such an analysis.

Finally, in the current study, I examined the public administration network as a static network. This approach to studying networks is important, but it may also be useful to gain insight into how the network of public administration has developed. Thus, future studies should examine the structure of the network as authors enter and exit the network. Utilizing this approach, one may provide insight into how actors' positions when they enter the network influences their development throughout their career in academia.

Conclusion

This research contributes to public administration by providing insight into scientific collaboration networks in public administration. Further, it demonstrates how

network analysis can be used to systematically examine a network. The work of West (2010), Pitts & Edwards (2005), and Handely & Watson (2005) provided a foundation for understanding who publishes in public administration. My research has contributed to the state of knowledge in the discipline, as I examined scientific networks. How knowledge is transmitted throughout the field is critical to understanding where the discipline stands.

This research is significant as it highlights the various aspects of the public administration network and potential areas that may need to be addressed to strengthen the network. For example, despite being an interdisciplinary field of study, public administration scholars tend to collaborate only with each other. Further, Denhardt (2001) argued that the future of public administration involves questions of how public administration students are educated and developed by those in academia. In this analysis, 5.5 percent of the network consisted of students. When students did publish in the network, 92 percent of the time they did so with a faculty member. It is imperative for the future of public administration that faculty members mentor students through collaborating with them on journal articles in order to increase the number of graduate students who enter the scientific network of collaborations. Further, it is important that networks are should not be ignored in public administration because "…the proper study of public administration as a field cannot be undertaken without taking into account the networked character of much of public action and the networking behavior" (O'Toole, 2010, p.9).

REFERENCES

Acedo, F., Barroso, C., Casanueva, C., and Galan, J. (2006). "Co-authorship in Management and Organizational Studies: An Empirical and Network Analysis" Journal of Management Studies. 43:5.

Adamic, L. (1999). "Tie Small World Web". ECDL '99 Proceedings of the Third European Conference on Research and Advanced Technology for Digital Libraries.

Adams, G. , Forrester, J. and White, J. (1996). "Knowledge and Theory Development in Public Administration: The Role of Doctoral Education Research." Public Administration Review. V0l. 56, No. 5.

Amaral, LAN, Scala, A, Barthelemy, M, Stanley (2000). "Classes of Small-World Networks". Natl. Acad. Sci. U. S. A. 97. 11149-11152.

Amaral, L. , Uzzi, B. and Reed- Toschas, E. (2007). "Small- World Networks and Management Science Research: A Review". European Management Review Volume 4. P. 77-91.

Agranoff, R. (2007). "Inside Collaborative Networks: Ten Lessons for Public Managers" Public Administration Review. Vol 66.

Baker, W., Davis, G. and Yoo, M. (2003). "The Small World of the American Corporate Elite, 1982-2001". Strategic Organization. Vol. 1: 301.

Barabasi, A., Jeong, H., Neda, Z., Ravasz, E., Schubert, A. and Vicsek, T. (2002). "Evolution of the Social Network of Scientific Collaborations". Physica p. 590 614.

Bell, G. and Zaheer, A. (2005). "Benefiting from Network Positions: Firm Capabilities, Structural Holes, and Performance". Strategic Management Journal. Volume 26. Issue 9.

Berner, M., O'Sullivan, E., and Rassel, G. (2008). Research Methods for Public Administrators. 5th edition. Longman; New York; 2008. ISBN No. 9780321431370

Berry, F., Browen, R. Choi, S., Goa, W., Jang, H., Kwon, M., and Ward, J. (2004). "Three Traditions of Network Research: What the Public Management Research Agenda Can Learn From Other Research Communities." Public Administration Review. Vol. 64, p. 539-552.

Bingham, L., Nabatchi, T., and O'Leary, R. (2005). "The New Governance Structure: Practices and Processes for Stakeholder and Citizen Participation in the Work of Government" Public Administration Review. Vol 65. No. 5.

Bogasson, P. and Tooner, T. (1998). "Introduction Networks in Public Administration." Public Administration Review. Vol. 76. P. 205-227.

Bollen, J., Liu, Z., Nelson, M., and Sompel, H. (2005). "Co-authorship Networks in the Digital Library Research Community" Information Processing and Management. Volume 41, Issue 6, p. 1462-1480

Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Brian, C. (2004). "The Small World of Educational Research: The Network Dynamics of the Teachers College Record" Dissertation. Columbia University.

Cheong, F. and Corbitt, B. (2009). "A Social Network Analysis of The Co-Authorship Network of the Pacific Asia Conference on Information Systems From 1993 to 2008" Pacific Asia Conference on Information Systems.

Coulon, F. (2005). "The Use of Social Network Analysis in Innovation Research: A Literature Review" Division of Innovation-Lth. Lund University, Sweden. Working Paper.

Crane, D. (1969). "Social Structure in a Group of Scientists: A Test of the 'Invisible College' Hypothesis" American Sociological Review, Vol. 34. No. 3. P. 335-352.

Cresswell, A., Dawes, S., and Pardo (2009). "From Need to Know to Need to Share: Tangled Problems, Information Boundaries, and the Building of Public Sector Knowledge Networks" Public Administration Review. Vol. 69, Issue 6, p. 392 402.

Crossley, N. (2008). "Small- World Networks, Complex Systems and Sociology." Sociology. Vol. 42(2); p. 261-277.

Davidson, B., Manev, I., Stevenson, W., and Walsh K. (1997). "The Small World of the University: A Classroom Exercise in the Study of Networks" Connections. ISNA. 20(2): 23-33.

Denhart, R. (1999). "The Future of Public Administration" Public Administration and Management: An Interactive Journal. 4; 2 pp. 279-292.

Denhart, R. (2001). "The Big Questions of Public Administration Education." Public Administration Review, 61(5): 309-317.

Douglas, J. (1996). "Faculty, Graduate Student, and Graduate Productivity in Public Administration and Public Affairs Programs, 198601993" Public Administration Review. Vol. 56. No. 5.

Duysters, G. & Verspagen, B. (2004). "The Small Worlds of Strategic Alliances" Technovation. Vol. 24 p. 563-571.

Fafchamps, M., Leij, M. and Goyal, S. (2006). "Scientific Networks and Co-authorship". Oxford University Department of Economics Discussion Paper Series. http://economics.ouls.ox.ac.uk/12185/1/paper256.pdf

Freeman, L.C. (1979), "Centrality in social networks: I. Conceptual clarification", Social Networks, Vol. 1, pp. 215-39.

Freeman, L.C., Roeder, D.R. and Mulholland, R.R. (1980), "Centrality in social networks, II. Experimental results", Social Networks, Vol. 2, pp. 119-41.

Fomburn, C., Tichy, N., and Tushman, M. (1979). "Social Network Analysis for Organizations" *The Academy of Management Review.* Vol. 4. pp.507-519.

Forrester, J. and Watson, S. (1994). "An Assessment of Public Administration Journals: The Perspective of Editors and Editorial Board Members". Public Administration Review. Vo. 54. No. 5.

Fowler, J. (2005). "Turnout in a Small World" Social Logic of Politics. University Press, p.269-297.

Freeman, L.C. (1984). Turning a profit form mathematics: The Case of Social Networks. Journal of Mathematical Sociology. 10, 343-360.

Fry, B. and Raadschelders, J. (2008) . Mastering Public Administration: From Max Weber to Dwight Waldo. Washington, D.C.: CQ Press.

Gerand and Giles (2003). " Journals in the Discipline: A Report on a New Survey of American Political Scientists" Political Science and Politics, Vol. 26, No. 2 pp. 293-308.

Giles, M. and Wright, G. (1975). "Political Scientists' Evaluation of Sixty-Three Journals". American Political Science Association. Vol. 8 . No. 3.

Glanzel, W. & Schubert, A. (2004). "Analyzing Scientific Networks Through Co Authorship". Hand Book of Quantitative Science and Technology Research. Kluwere Academic Publishers. p. 257-276.

Goyla, S., Morage-Gonzalez, J., and Leij, M. (2006). "Economics: An Emerging Small World" Journal of Political Economy, Vol 114. No. 2 p. 403-412.

Granovetter, M. (1973). The strength of weak ties. American Journal of Sociology, 78 (6)

Grimes, D. & Schutz, K. (2002). "Descriptive Studies: What They can and Cannot Do" The Lancet; 359: p. 145-49.

Guare, J. (1990). "Six Degrees of Separation: A Play." New York: Vintage Books.

Guy, P. (2001). The Future of Governing. Lawrence, Kansas: University Press of Kansas.

Handley, D., Hassett, W., and Watson (2005). "The ASPA Journals: Who is Publishing?". Journal of Public Affairs Education. Vol. 1; 53-60.

Hanneman, R. and Riddle, M. (2005). Introduction to social network methods. (free introductory textbook on social network analysis). Read on-line as .html

Harvey, P., Knox, H. , and Savage, M. (2006). "Social Networks and the Study of Relations: Networks as Method, Metaphor and Form". Economy and Society. Volume 35. Issue 1.

Hatala, J. (2006). Social Network Analysis in Human Resource Development: A new Methodology. Human Resource Development Review.

Henneberg, S., Jiang, Z., Mouzas, S., Naude, P. Swart, J. (2009). "Mobilizing Ideas in Knowledge Networks: A Social Network Analysis of the Human Resource Management Community 1990-2005". The Learning Organization. Vol. 16. No. 6.

Huang, Kun, and Keith G. Provan. 2007. "Structural embeddedness and organizational social outcomes in a centrally governed mental health services network". Public Management Review 9:169–89.

Hwang, S. and Moon, C. (2008). "Are We Treating Networks Seriously? The Growth of Network Research in Public Administration and Public Policy" Obtained From: https://www.insna.org/PDF/Connections/v29/2009_I-2_P-4-17.pdf

Isett, K., Mergel, I., Leroux, K., Mischen P., and Rethemyer, K. (2011). "Networks in Public Administration Scholarship" Journal of Public Administration Research and Theory. 21; i157-i170.

Kadushin, C. (2002). "The motivational Foundation of Social Networks." Social Networks 24, p. 77-91.

Kellough, J. Edward and Pitts, D. (2005). "Who Contributes to Public Administration Review? Examining the Characteristics of Authors Who Submit Manuscripts to the Journal". Public Administration Review. Vol. 5, No. 1.

Kettl, D. (2006). "Managing Boundaries in American Administration: The Collaboration Imperative" The Public Administration Review. Special Issue.

Latora, V. and Marchiori, M. (2001). "Efficient Behavior of Small-World Networks". Physical Review Letters. Volume 87, Number 19.

Lee, J. and Kim, S. (2011). "Exploring the Role of Social Networks in Affective Organizational Commitment: Network Centrality, Strength of Ties, and Structural Holes." The American Review of Public Administration. 41(2) p. 205-223.

Kogut, b. & Walker, G. (2001). "The Small World of Germany and the Durability of National Networks." American Sociological Review, Vol. 66, No. 3. pp. 317 335.

Leinhardt, S. (ed.) (1977). Social Networks: A developing Paradigm. New York: Academic Press.

Marsden, P. (1990). "Network Data and Measurement". Annual Review of Social. 16.435-463.

Meier, K. and Morgan, D. (1982). "Reputation and Productivity of Public Administration/Affairs Programs: Additional Data" Public Administration Review. Vol. 42. No2.

Meier, Kenneth J. and Lawrence J. O'Toole. 2003. Public Management and Educational Performance: The Impact of Managerial Networking". Public Administration Review 63:689–99.

Meier, K. and O'Toole, L. (2004). "Desperately Seeking Selznick: Cooptation and the Dark Side of Public Management Networks". Public Administration Review. Vol. 64, No. 6.

Meier, K. and O'Toole (2005). "Managerial Networking: Issues of Measurement and Research Design" *Administration & Society*. 37: 523.

Milgram, S. (1967). "The Small -World Problem". Psychology Today, Vol. 1, No. 1.

Milgram, S. and Travers J. (1969). "An Experimental Study of the Small World Problem". Sociometry, Vol. 32, No. 4.

Moody, J. (2004). "The Structure of a Social Collaboration Network: Disciplinary Cohesion from 1963 to 1999". American Sociological Review. Vol. 69

Morlacchi, P., Wilkinson I., and Young, L. (2005). "Social Networks of Researchers in B2B Marketing: A Case Study of the IMP Group 198401999". Journal of Business to Business Marketing, Vol. 12 (1).

Milward, H. and Provan, K. (2001). "Do Networks Really Work? A Framework for Evaluating Public Sector Organizational Networks". Public Administration Review. Volume 51, Issue 4.

Newman, M. (2001). Scientific Collaborations Networks. *Physical Review E. Vol 64*

Newman, M.E. J. (2000). "Models of the Small World" Journal of Statistical Physics, Vol. 101, p 3-4.

Nicholas, H. (1989). Public Administration and Public Affairs, 4th Edition. Englewood Cliffs, New Jersey: Prentice Hall, 1989.

O'Toole, L. (1997). "Treating networks Seriously: Practical and Research- Based Agendas in Public Administration." Public Administration Review. January/ February. Vol 57, No. 1.

O'Toole, L. (2010). "The 2009 Gaus Lecture: The Ties that Bind Networks, Public Administration and Political Science" Political Science and Politics. Volume 43, No. 1.

Otte, R. and Rousseau, R. (2002). "Social Network Analysis: A Powerful Strategy, Also for the Information Sciences". Journal of Information Science, 28(6) p. 441-453.

Parise, S. (2007). "Knowledge Management and Human Resource Development: An Application in Social Network Analysis Methods" Advances in Developing Human Resources. 9: 359.

Pepe, A. (2010). "Structure and Evolution of Scientific Collaboration Networks in a Modern Research Collaboratory" Dissertation. University of California at Los Angeles.

Provan, K., Shone, N., Stalen, L., and Veazie, M. (2005). "The use of network Analysis to Strengthen Community Partnerships". Public Administration Review. Vol 65. Issue5.

Quatman, C. (2006). "The Social Construction of Knowledge in the Field of Management: A Social Network Perspective" Dissertation. The Ohio State University.

Reuters, T. (2008). Interview with Duncan Watts & Strogatz. Essential Science Indicators. www.sciencewatch.com . Accessed on January 21, 2012.

Rethemeyer, R., (2005). "Conceptualizing and Measuring Collaborative Networks". Book Review. Public Administration Review. Vol. 65, No. 1.

Rodgers, R. and Rodgers N. (1999). "The Sacred Spark of Academic Research" Journal of Public Administration Research and Theory. 9(1999): 3; 473-492.

Toonen, T. (1998). "Networks, Management and Institutions: Public Administration as 'Normal Science". Public Administration. Vol. 76 p. 229-252.

Topham, P. (2011). "How to Use Social Network Analysis to Pinpoint more than KOLS" http://www.pharmaphorum.com/2011/04/11/how-to-use-social-network analysis-to-pinpoint-more-than-kols/ .

Salancik, G. (1995). "Wanted: A Good Network Theory of Organization" Administrative Science Quarterly, 40 p. 345-349.

Spiro J and Uzzi, B. (2005). "Collaboration and Creativity: The Small World Problem" AJS. Volume 111. Number 2: p. 447-504.

Wasserman, S. and Faust, K. (2005). Social Network Analysis: Methods and Applications. Cambridge University Press.

Watts, D. & Strogatz, S. (1998). "Collective Dynamics of Small-world Networks". Nature. Vol. 393.

Watts, D. (1999). "Networks, Dynamics, and the Small-World Phenomenon" AJS. Volume 105, Number 2. P. 493-527.

Watts, D. & Strogatz, S. (1998). Interview with Science Indicators http://sciencewatch.com/inter/aut/2008/pdf/08decWattsET.pdf

Wellman, B. (2008). "The Development of Social Network Analysis: A Study in the Sociology of Science". Contemporary Sociology: A Journal of Reviews. 37: 221.

West, J. (2010). "Thirty Years of ROPPA: Past Trends and Future Prospects". Review of Public Administration.

White, H. (1970). "Search Parameters for the Small World Problem". Social Forces 49: p. 259-264

APPENDIX A

NETWORK COMPOENTS

Component Number	Size	Percentage of Network
1	3	0.002
2	242	0.193
3	4	0.003
4	4	0.003
5	8	0.006
6	5	0.004
7	4	0.003
8	3	0.002
9	3	0.002
10	3	0.002
11	5	0.004
12	2	0.002
13	7	0.006
14	3	0.002
15	4	0.003
16	4	0.003
17	6	0.005
18	5	0.004
19	29	0.023
20	2	0.002
21	1	0.001
22	14	0.011
23	1	0.001
24	1	0.001
25	2	0.002
26	5	0.004
27	2	0.002
28	2	0.002
29	2	0.002
30	2	0.002
31	1	0.001
32	1	0.001
33	3	0.002
34	3	0.002
35	2	0.002
36	3	0.002
37	5	0.004
38	2	0.002
39	1	0.001
40	4	0.003

41	3	0.002
42	4	0.003
43	1	0.001
44	1	0.001
45	4	0.003
46	1	0.001
47	2	0.002
48	3	0.002
49	3	0.002
50	3	0.002
51	2	0.002
52	2	0.002
53	6	0.005
54	4	0.003
55	1	0.001
56	2	0.002
57	2	0.002
58	1	0.001
59	4	0.003
60	4	0.003
61	3	0.002
62	1	0.001
63	2	0.002
64	1	0.001
65	2	0.002
66	3	0.002
67	3	0.002
68	1	0.001
69	2	0.002
70	2	0.002
71	2	0.002
72	2	0.002
73	3	0.002
74	2	0.002
75	1	0.001
76	2	0.002
77	2	0.002
78	2	0.002
79	2	0.002
80	1	0.001
81	1	0.001
82	4	0.003

83	1	0.001
84	1	0.001
85	13	0.01
86	1	0.001
87	1	0.001
88	2	0.002
89	1	0.001
90	3	0.002
91	2	0.002
92	1	0.001
93	5	0.004
94	6	0.005
95	5	0.004
96	2	0.002
97	2	0.002
98	1	0.001
99	2	0.002
100	6	0.005
101	17	0.014
102	1	0.001
103	1	0.001
104	1	0.001
105	2	0.002
106	1	0.001
107	3	0.002
108	2	0.002
109	4	0.003
110	2	0.002
111	2	0.002
112	2	0.002
113	2	0.002
114	1	0.001
115	2	0.002
116	2	0.002
117	1	0.001
118	1	0.001
119	2	0.002
120	2	0.002
121	1	0.001
122	3	0.002
123	2	0.002
124	2	0.002

125	1	0.001
126	2	0.002
127	1	0.001
128	1	0.001
129	1	0.001
130	2	0.002
131	2	0.002
132	4	0.003
133	3	0.002
134	2	0.002
135	1	0.001
136	2	0.002
137	1	0.001
138	1	0.001
139	2	0.002
140	3	0.002
141	5	0.004
142	3	0.002
143	1	0.001
144	1	0.001
145	3	0.002
146	3	0.002
147	3	0.002
148	3	0.002
149	1	0.001
150	1	0.001
151	1	0.001
152	2	0.002
153	2	0.002
154	2	0.002
155	11	0.009
156	5	0.004
157	1	0.001
158	3	0.002
159	1	0.001
160	2	0.002
161	1	0.001
162	2	0.002
163	2	0.002
164	2	0.002
165	2	0.002
166	3	0.002

167	4	0.003
168	2	0.002
169	1	0.001
170	1	0.001
171	1	0.001
172	2	0.002
173	1	0.001
174	2	0.002
175	1	0.001
176	2	0.002
177	2	0.002
178	1	0.001
179	2	0.002
180	1	0.001
181	3	0.002
182	2	0.002
183	1	0.001
184	2	0.002
185	2	0.002
186	3	0.002
187	2	0.002
188	3	0.002
189	1	0.001
190	1	0.001
191	1	0.001
192	2	0.002
193	2	0.002
194	3	0.002
195	1	0.001
196	5	0.004
197	1	0.001
198	5	0.004
199	1	0.001
200	2	0.002
201	3	0.002
202	2	0.002
203	1	0.001
204	1	0.001
205	2	0.002
206	2	0.002
207	1	0.001
208	1	0.001

209	1	0.001
210	1	0.001
211	1	0.001
212	1	0.001
213	1	0.001
214	1	0.001
215	1	0.001
216	1	0.001
217	1	0.001
218	1	0.001
219	2	0.002
220	1	0.001
221	1	0.001
222	3	0.002
223	1	0.001
224	2	0.002
225	2	0.002
226	1	0.001
227	4	0.003
228	1	0.001
229	1	0.001
230	1	0.001
231	1	0.001
232	2	0.002
233	4	0.003
234	4	0.003
235	1	0.001
236	1	0.001
237	3	0.002
238	1	0.001
239	1	0.001
240	2	0.002
241	1	0.001
242	1	0.001
243	1	0.001
244	2	0.002
245	1	0.001
246	1	0.001
247	1	0.001
248	2	0.002
249	1	0.001
250	2	0.002

251	1	0.001
252	3	0.002
253	2	0.002
254	2	0.002
255	1	0.001
256	1	0.001
257	1	0.001
258	1	0.001
259	3	0.002
260	1	0.001
261	1	0.001
262	1	0.001
263	1	0.001
264	2	0.002
265	1	0.001
266	2	0.002
267	2	0.002
268	2	0.002
269	2	0.002
270	2	0.002
271	2	0.002
272	1	0.001
273	1	0.001
274	1	0.001
275	3	0.002
276	1	0.001
277	2	0.002
278	2	0.002
279	2	0.002
280	1	0.001
281	2	0.002
282	1	0.001
283	1	0.001
284	3	0.002
285	1	0.001
286	1	0.001
287	2	0.002
288	2	0.002
289	3	0.002
290	3	0.002
291	1	0.001
292	2	0.002

293	2	0.002
294	1	0.001
295	1	0.001
296	3	0.002
297	1	0.001
298	2	0.002
299	1	0.001
300	1	0.001
301	2	0.002
302	2	0.002
303	1	0.001
304	2	0.002
305	1	0.001
306	1	0.001
307	2	0.002
308	1	0.001
309	2	0.002
310	2	0.002
311	2	0.002
312	3	0.002
313	1	0.001
314	6	0.005
315	3	0.002
316	1	0.001
317	2	0.002
318	1	0.001
319	1	0.001
320	2	0.002
321	2	0.002
322	1	0.001
323	2	0.002
324	3	0.002
325	1	0.001
326	1	0.001
327	1	0.001
328	2	0.002
329	2	0.002
330	3	0.002
331	2	0.002
332	1	0.001
333	2	0.002
334	2	0.002

335	2	0.002
336	1	0.001
337	1	0.001
338	1	0.001
339	1	0.001
340	3	0.002
341	3	0.002
342	1	0.001
343	1	0.001
344	3	0.002
345	2	0.002
346	2	0.002
347	1	0.001
348	2	0.002
349	1	0.001
350	2	0.002
351	2	0.002
352	1	0.001
353	1	0.001
354	1	0.001
355	4	0.003
356	1	0.001
357	2	0.002
358	1	0.001
359	1	0.001
360	2	0.002
361	1	0.001
362	1	0.001
363	2	0.002
364	1	0.001
365	1	0.001
366	1	0.001
367	2	0.002
368	2	0.002
369	2	0.002
370	1	0.001
371	1	0.001
372	1	0.001
373	1	0.001
374	1	0.001
375	1	0.001
376	2	0.002

377	1	0.001
378	1	0.001
379	2	0.002
380	2	0.002
381	1	0.001
382	2	0.002
383	2	0.002
384	1	0.001
385	1	0.001
386	2	0.002
387	1	0.001
388	2	0.002
389	1	0.001
390	1	0.001
391	1	0.001
392	1	0.001
393	1	0.001
394	1	0.001
395	1	0.001
396	1	0.001
397	1	0.001
398	1	0.001
399	3	0.002
400	1	0.001
401	1	0.001
402	1	0.001
403	2	0.002
404	1	0.001
405	1	0.001
406	1	0.001
407	2	0.002
408	1	0.001
409	1	0.001
410	1	0.001
411	1	0.001
412	1	0.001
413	1	0.001
414	1	0.001
415	2	0.002
416	1	0.001
417	1	0.001
418	1	0.001

419	1	0.001
420	2	0.002
421	1	0.001
422	1	0.001
423	1	0.001
424	3	0.002
425	1	0.001
426	3	0.002
427	1	0.001
428	3	0.002
429	2	0.002
430	1	0.001
431	1	0.001
432	1	0.001
433	2	0.002
434	1	0.001
435	1	0.001
436	2	0.002
437	1	0.001
438	1	0.001
439	1	0.001
440	1	0.001
441	1	0.001
442	1	0.001
443	1	0.001
444	1	0.001
445	1	0.001
446	1	0.001
447	1	0.001
448	2	0.002
449	1	0.001
450	1	0.001
451	1	0.001
452	1	0.001
453	1	0.001
454	2	0.002
455	1	0.001
456	1	0.001
457	1	0.001
458	1	0.001
459	1	0.001
460	1	0.001

461	1	0.001
462	2	0.002
463	1	0.001
464	1	0.001
465	1	0.001
466	1	0.001
467	1	0.001
468	2	0.002
469	1	0.001
470	1	0.001
471	1	0.001
472	1	0.001
473	1	0.001
474	1	0.001
475	1	0.001
476	1	0.001
477	1	0.001
478	1	0.001
479	1	0.001
480	1	0.001
481	1	0.001
482	1	0.001
483	1	0.001
484	1	0.001
485	1	0.001
486	1	0.001
487	1	0.001
488	1	0.001
489	1	0.001
490	1	0.001
491	1	0.001
492	1	0.001
493	1	0.001
494	1	0.001
495	1	0.001
496	1	0.001
497	1	0.001
498	1	0.001
499	1	0.001
500	1	0.001
501	1	0.001
502	1	0.001

503	1	0.001
504	1	0.001
505	1	0.001
506	1	0.001
507	1	0.001
508	1	0.001
509	1	0.001
510	1	0.001
511	1	0.001
512	1	0.001
513	1	0.001
514	1	0.001
515	1	0.001
516	1	0.001
517	1	0.001
518	1	0.001
519	1	0.001
520	1	0.001
521	1	0.001
522	1	0.001
523	1	0.001
524	1	0.001
525	1	0.001
526	1	0.001
527	1	0.001
528	1	0.001
529	1	0.001
530	1	0.001
531	1	0.001
532	1	0.001
533	1	0.001
534	1	0.001
535	1	0.001
536	1	0.001
537	1	0.001
538	1	0.001
539	2	0.002
540	1	0.001
541	1	0.001