Essays on Achieving Success in Peer Production: Contributor Management, Best Practice Transfer and Inter-Community Relationships

Haiyi Zhu

Human-Computer Interaction Institute

School of Computer Science

Carnegie Mellon University

Pittsburgh, Pennsylvania 15213

Committee

Robert E. Kraut (Co-chair), Carnegie Mellon University

Aniket Kittur (Co-chair), Carnegie Mellon University

Yochai Benkler, Harvard University

Yuqing Ren, University of Minnesota

Jason Hong, Carnegie Mellon University

Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

i

Keywords

Human-Computer Interaction, Social Computing, Computer-Supported Collaborative Work, Peer Production, Organizational Behavior, Contributor Management, Best Practice Transfer, Inter-Community Relationships.

Abstract

Since the late twentieth century, open source software projects (e.g., the GNU/Linux operating system, the Apache web server, Perl and many others) have achieved phenomenal success. This success can be attributed to a new paradigm of productivity in which individuals voluntarily collaborate to produce knowledge, goods and services. Benkler claims this productivity paradigm is a "new, third mode of production" particularly suited for "the digitally networked environment" (2002). In addition to its application to open source software projects, the peer production model, in different forms, has been used in areas such as science/citizen science (Silvertown, 2009), library science (Weinberger, 2007), politics (Castells, 2007; Jenkins, 2006), education (Daniel, 2012), journalism (Gillmor, 2004), and culture (Jenkins, 2006; Lessig, 2004).

As peer production has flourished, merely describing successful cases has become less useful. Instead, scholars must identify the dynamics, structures, and conditions that contribute to or impede that success. In this dissertation, I focus on three management challenges at three distinct levels that impede the success of peer production. *At the individual level*, one significant question is how to best organize individual contributors with differing goals, experience, and commitment to achieve a collective outcome. *At the practice level*, peer production communities, like corporations, must often transfer best practices from one unit to another to improve performance. This transfer process poses the challenge of how to adapt and modify an original practice to make it effective in the new context. *At the community level*, peer production communities must learn to survive and succeed in a large ecosystem of related communities. This dissertation combines theoretical approaches in organization science with in-depth empirical analysis on a range of peer production communities to examine the mechanisms that help the communities overcome these three management challenges and succeed in peer production.

The contributions of my dissertation are twofold. For scholars and researchers, my dissertation advances the theoretical understanding of the underlying mechanisms of successful peer production systems. For practitioners, my dissertation offers practical advice to build more effective peer production projects and platforms.

Acknowledgements

I am deeply thankful to my advisors, Robert E. Kraut and Aniket Kittur. When I first met Bob Kraut and Niki Kittur, I was living in a new country twelve time zones away from home, had difficulty speaking and writing in English, and didn't know anything about peer production or social science research. My advisors are responsible for the gains I've made since. They have been ideal advisors, providing me with as much support—both intellectual and financial—as I needed over the past six years while allowing me to experiment, tinker and explore. I am deeply indebted to Bob and Niki for their guidance, mentorship and friendship.

I am also grateful to Yochai Benkler, Ching (Yuqing) Ren and Jason Hong. Their invaluable academic inspiration and constructive feedback have made this dissertation possible.

I am thankful to the many organizations that helped fund my research and education, including the National Science Foundation, Facebook, HP labs and IBM labs.

My co-authors, collaborators and colleagues have shaped my research and career over the past six years. I am extremely thankful to Bernardo Huberman, Tara Matthews, Benjamin Mako Hill, Steven Dow, Laura Dabbish, Sara Kiesler, Yi-Chia Wang, Jilin Chen, Andrea Forte, Amy Bruckman, Tun Lu, Guo Li, Xianghua Ding, Ning Gu, Yarun Luon, Lisa Yu, Yla Tausczik, Kurt Luther, Rosta Farzan, Paul André, Amy Zhang, Jiping He, Suavik Das, Yiqun Cao, Maggie Yu and Guanjie Li.

I am indebted to my friends for their patience, kindness, and encouragement throughout these years. A special thanks to Yanjin Long, Ruogu Kang, Kerry Chang, Xiang Chen, Julia Schwarz, Nan Li, Kevin Huang for standing by me. Finally, I owe thanks to the three most important people in my life: Wei You, Songbao Zhu and Xiaoyu (Leon) Ding.

Table of Contents

viii

List of Tables

List of Figures

List of Reproduced Publications

The following presents a list of published works that constitute, in part or in whole, a portion of this thesis work.

Zhu, H., Kraut, R.E., Wang, Y.C., & Kittur, A. (2011) Identifying Shared Leadership in Wikipedia. In CHI'2011: Proceedings of the 2011 annual conference on Human factors in computing systems. New York: ACM Press.

Zhu, H., Kraut, R.E., & Kittur, A., (2012). Effectiveness of Shared Leadership in Online Communities. In CSCW'2012: Proceedings of the ACM conference on computer-supported cooperative work. New York: ACM Press.

Zhu, H., Kraut, R.E., & Kittur, A., (2012). Organizing without formal organization: Group Identification, Goal Setting and Social Modeling in Directing Online Production. In CSCW'2012: Proceedings of the ACM conference on computer-supported cooperative work. New York: ACM Press.

Forte, A., Larco, V., Kittur, A., Zhu, H., Bruckman, A., Kraut, R.E., (2012) Coordination and Beyond: Social Functions of Groups in Open Content Production. In CSCW'2012: Proceedings of the ACM conference on computer supported cooperative work. New York: ACM Press.

Zhu, H., Kraut, R.E., & Kittur, A., (2013). Effects of Peer Feedback on Contribution: A Field Experiment in Wikipedia. In CHI'2013: Proceedings of the 2013 annual conference on Human factors in computing systems. New York: ACM Press.

Zhu, H., Kraut, R.E., & Kittur, A., (2013) The Effectiveness of Shared Leadership in Wikipedia, Human Factors. The Journal of the Human Factors and Ergonomics Society.

Zhu, H., Chen, J., Matthews, T., Pal, A., Kraut, R.E, (2014) Selecting an Effective Niche: An Ecological View of the Success of Online Communities. In CHI'2014: Proceedings of the 2014 annual conference on Human factors in computing systems. New York: ACM Press.

Zhu, H., Kraut, R.E., & Kittur, A., (2014). The Impact of Membership Overlap on the Survival of Online Communities. In CHI'2014: Proceedings of the 2014 annual conference on Human factors in computing systems. New York: ACM Press.

Matthews, T., Chen, J., Whittaker, S., Pal, A., Zhu, H., Badenes, H., Smith, B.,(2014) Goals and Perceived Success of Online Enterprise Communities: What Is Important to Leaders & Members? In CHI'2014: Proceedings of the 2014 annual conference on Human factors in computing systems. New York: ACM Press.

Zhu, H., Dow, S., Kraut, R.E., & Kittur, A., (2014) Reviewing versus Doing: Learning and Performance in Crowd Assessment. In CSCW'2014: Proceedings of the ACM conference on computer-supported cooperative work. New York: ACM Press.

Li, G., Zhu, H., Lu, T., Ding, X., & Gu, N. (2015). Is It Good to Be Like Wikipedia?: Exploring the Trade-offs of Introducing Collaborative Editing Model to Q&A Sites. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (pp. 1080-1091). ACM.

INTRODUCTION

Since the late twentieth century, open source software projects (e.g., the GNU/Linux operating system, the Apache web server, Perl and many others) have achieved phenomenal success. This success can be attributed to a new paradigm of productivity in which individuals voluntarily collaborate to produce knowledge, goods and services. Benkler claims this productivity paradigm is a "new, third mode of production" particularly suited for "the digitally networked environment" (2002). Labeled "peer production," this paradigm contrasts with market and managerial hierarchies.

Perhaps the most visible and successful peer production project is Wikipedia, a platform that allows people to collaboratively edit online encyclopedia articles. Founded in 2001 by Jimmy Whales and Larry Sanger, Wikipedia has grown to include more than 19 million editors and contains 30 million articles in 287 languages (Wikipedia, 2013a). It is the sixth most visited website in the world (Alexa Internet, 2013) and has an estimated 365 million readers worldwide (West, 2010).

In addition to its application in open source software projects and Wikipedia, the peer production model has been used in citizen science (Silvertown, 2009), library science (Weinberger, 2007), politics (Castells, 2007; Jenkins, 2006), education (Daniel, 2012), journalism (Gillmor, 2004), and culture (Jenkins, 2006; Lessig, 2004).

As peer production projects have become more popular, merely describing successful cases has become less useful. Instead, researchers should identify the dynamics, structures, and conditions that enhance or prevent the success of these systems. Thus, this dissertation combines theories from organization science with in-depth empirical analysis on a range of peer production projects to examine the mechanisms that affect the success of peer production. Specifically, I examine three management challenges at three distinct levels that prevent the success of peer production: the individual level challenge, the practice level challenge and the community level challenge.

THESIS OVERVIEW

Individual Level Challenge: Contributor Management Challenge

Most peer production projects rely on a paradigm of self-direction in which contributors are motivated to work on tasks due to personal interest or expertise. However, this approach breaks down when conflicts arise between the contributors' interests and those of the project as a whole. For example, many people

may want to work on popular areas in Wikipedia (e.g., an article on "Barack Obama") while neglecting less popular areas (e.g., an article on "17th century philosophy"). Despite their respective popularity, both articles are needed to create a robust resource.

The contributor-management challenge is rooted in the nature of volunteerism. Simply put, volunteers are not as constrained as paid workers and are often free to adopt their own objectives (Pearce, 1993). Prior research has shown that volunteers, as compared to paid workers, more freely choose which tasks to work on based on their personal needs and interests. If the work they are expected to do is unattractive, volunteers simply do not show up (Pearce, 1993; Raymond, 1999).

This challenge is exacerbated in online communities. That is, many techniques used in conventional employment organizations are ineffective at managing online volunteers due to the fundamental characteristics of peer production projects. These characteristics include a lack of employment contracts, weak interpersonal bonds, impoverished communication, large contributor pool, and high contributor turnover. Thus peer production projects have to rely on other techniques to manage their online volunteer contributors.

In the first part of this chapter, I will report two studies that show how shared leadership (i.e., peer influence among project contributors) persuade and influence contributors to increase their contributions in general or on specific tasks. In the second part of the chapter, I will report another two studies that examine the effects of combining motivational mechanisms (increasing group identification) and directional mechanisms (explicit goal setting and implicit role modeling) in managing contributor behaviors. Theses studies together demonstrate how successful peer production projects manage to increase members' contributions, and most importantly, channel those contributions to important tasks that transcend individual interests.

Practice Level Challenge: Best Practice Transfer Dilemma

Online communities often need to transfer best practices internally from one unit to another to improve their performance. For example, communities in the Stack Exchange network of Question & Answer websites use a common reputation system modeled on Stack Overflow's original system. Similarly, many non-English language Wikipedia versions have borrowed policies and procedures originally developed in the English Wikipedia. Barnstars, the badges Wikipedia editors give to each other to reward meritorious work, originated in the MeatballWiki and were imported into Wikipedia in 2003. Since then Wikipedia has developed over 100 distinct Barnstars and thousands of Wikiprojects have created their own

2

specialized Barnstars. Similar tales could be told of Wikipedia's various quality improvement programs, such as Collaborations of the Week (CotW), a practice designed to increase the quality of under-developed content areas, which has diffused across hundreds of Wikiprojects (Warncke-Wang et al., 2015; Zhu et al., 2012a).

While the efficacy of particular practices has been studied in isolation (Butler et al., 2008; Kriplean et al., 2008; Ling et al., 2005; Warncke-Wang et al., 2015; Zhu et al., 2012a), we are unaware of any research that examines how the process of acquiring and changing these practices influences their effectiveness. Understanding the factors that determine how practices are internally transferred and effectively adapted could provide insights into community success that go beyond individual practices.

In this chapter, I propose that in order for peer production communities to successfully transfer best practices they should neither replicate an original practice without modification nor freely implement modification. Instead, I propose a contingency perspective and hypothesize that modifications are most successful if they are introduced *after* the receiving unit has experienced the imported practice. This allows for a form of iterative organizational design, in which a receiving site can tweak an imported practice based on experience. I also hypothesize that modifications will be more effective when introduced by core members of the receiving unit who also participate in other communities. These are the people most likely to be knowledgeable about what their unit needs and about alternative practice tweaks used by others.

To test these hypotheses, we analyzed historical data about Collaborations of the Week (CotW) in Wikipedia. A Collaboration of the Week is quality-improvement practice in Wikiprojects, which organizes editors collaboratively to improve a designated article in a limited time period. Collaborations of the Week spread from project to project and are often modified before they are imported and then as they are used. We collected the history of CotW in 146 Wikiprojects and measured how different types of modifications influenced their success.

Community Level Challenge: Survival in the World of Communities

Development of Internet technologies has significantly reduced the cost of creating virtual spaces to host collective content generation and has resulted in a large population of online communities. For example, Usenet (now accessible on the web via Google Groups) had over 189,000 active newsgroups as of 2005 (Wang et al., 2013); the well-known platform Wikia hosts more than 350,000 Wikipedia-like

communities; and Facebook provides infrastructure to host over a quarter of a billion groups (Kraut & Fiore, 2014).

The ecological structure complicates understanding of the success of peer production communities; merely investigating internal factors is insufficient. Instead, we need to take an ecological view to consider how the large number of peer production communities in the same ecosystem might influence each other's success and survival. For example, when programmers participate in many open source communities simultaneously, the time and effort they devote to one community will decrease the time and effort expended on others. Consequently, the competition for shared members' time and effort tends to reduce the resilience of these online communities. On the other hand, peer production communities might benefit from the existence of other communities in the ecosystem. The knowledge, experience, and technical and management skills that programmers obtain from one open source community might transfer to, and thus support, other communities. Understanding how a peer production community's success is affected by its relationship with other communities—such as how the topics it covers and members it attracts relate to those of other communities—can help us better understand the underlying principle of peer production success, as well as offer important practical insights to better manage peer production.

In this chapter, I adopt an ecological view to examine the community-level success of peer production. Two themes emerged in these studies: completion and complementarity. It is not surprising that communities compete with each other for common resources such as members' attention and efforts. Interestingly, the studies also demonstrate strong complementarity effects between production communities in the same ecosystem. For example, the analysis of 5673 Wikia communities suggests that the positive effects of membership-overlap on knowledge transfer outweigh the negative effects of competition for time and attention. Overall, having contributors with joint membership positively affected the survival rate of the Wikia communities. The study on 9,495 IBM connections communities suggested that the benefits of complementarity dominate when topic overlap is relatively low. The implications of the studies are discussed at the end of the chapter.

APPROACH AND IMPACT

In this thesis, I combine organization theory, computational techniques (e.g., machine learning), and qualitative and quantitative methods (e.g., case study, archival data analysis and field experiments) to understand the dynamics, structures, and conditions that contribute to or detract from the success of peer

production. The findings from this project offer practical implications for building more effective and successful peer production projects.

Furthermore, in-depth examination of peer production might provide new perspectives in studying important organizational phenomenon in traditional organization forms. For example, even conventional organizations are more likely to rely on experts who seek to apply their knowledge and skills autonomously (DeNisi, Hitt, & Jackson, 2003). Organizations in various fields use self-managing teams to boost productivity and motivate employees (Lawler, Mohrman, & Benson, 2001; Druskat and Wheeler, 2004). Research on volunteer control in peer production (Chapter 1) may help non-volunteer organizations organize their employees, who are more likely to be autonomous and empowered, to perform collective actions and achieve organizational goals. The best practice transfer dilemma (Chapter 2) is not only a problem for peer production projects, but also is a fundamental question for any organizations that try to replicate the success of other organizations. Furthermore, recent surveys conducted in conventional organization settings (Lu et al., 2003; Martin & Bal, 2006; Zika-Viktorsson et al., 2006; O'Leary et al., 2011) demonstrate that simultaneous membership on more than one team appears to be the norm for at least 65 percent of knowledge workers across a wide range of industries and occupations in the United States and Europe. Our findings on the effects of membership overlap on group survival (Chapter 3) provide new insights and empirical evidence to better understand the effects of multiple memberships in the offline context.

CHAPTER 1. INDIVIDUAL LEVEL SUCCESS OF PEER PRODUCTION

MOTIVATION: CONTRIBUTOR MANAGEMENT CHALLENGE

Without formal employment contracts and monetary incentives, peer production projects must determine how to best organize individual members with differing goals, experience, and commitment to achieve collective outcome. In other words, how can peer production projects encourage contributors to pay more attention and expend more invest more effort on those tasks that are unattractive but still important to the continued vitality of the project?

As I discussed in the Introduction, the contributor-management challenge is rooted in the nature of volunteerism. Simply put, volunteers are not as constrained as paid workers and are often free to adopt their own objectives (Pearce, 1993). Pearce explains this problem thusly: "[I]nstilling enthusiasm is not the problem. It is attracting the potential (volunteer) workers' attention and focusing their efforts on necessary, if routine, tasks that is the great difficulty." This challenge is exacerbated in online peer production projects due to the weak interpersonal bonds, impoverished communication, large contributor pool, and high contributor turnover. For example, if a peer production project tries to exert too much managerial control, contributors can simply leave, with fewer economic or social consequences than if they quit a job or leave a real-life social group.

The first part of this chapter examines how shared leadership (i.e., peer influence among project contributors) influences contributors to achieve community goals that transcend individual interests. This study was conducted through empirical analysis on Wikipedia's archival data over seven years and a field experiment. I identify four types of shared leadership behaviors: transactional leadership (i.e., providing positive feedback or reward to encourage desired behavior), aversive leadership (i.e., providing negative feedback, warning or reprimands to regulate undesired behavior), directive leadership (i.e., providing direction and instruction to guide other members' behavior) and person-based leadership (i.e., providing social support and maintaining close social relationships with other members). These results demonstrate the trade-offs between different types of shared leadership: transactional leadership and person-based leadership increased recipients' general motivation to work but could not channel their increased motivation to a specific task, whereas directive leadership and aversive leadership directed recipients' attention to the targeted task but did not increase (or even decrease) recipients' general motivation.

Transactional leadership and person-based leadership represent a similar underlying mechanism: exerting influence through encouraging and motivating contributors. This category of mechanisms is motivational but not targeted. Aversive leadership and directive leadership belong to another mechanism category: exerting influence through regulating and directing, which are targeted but not motivational. Thus, the next question that needs to be addressed is: can we combine motivational and directional mechanisms to manage volunteer contributors in peer production?

To answer this question, the second part of this chapter investigates and empirically tests the effects of managing volunteer behaviors by combining the motivational mechanism of increasing group identification and the directional mechanism of explicit goal setting and implicit role modeling. The study demonstrates strong effects of combining these two types of mechanisms on increasing members' contributions, and most importantly, channeling the increased contributions to important tasks that transcend individual interests.

PART I: EFFECTIVENESS OF SHARED LEADERSHIP

Empirical research from conventional organizations demonstrates the importance of leadership in managing individual members effectively achieve group goals. Burke et al.'s recent meta-analysis (2006) shows that both task-oriented leadership, which focuses on the group's work, and relational leadership, which focuses on interpersonal relationships within the group, are valuable in improving productivity, developing teamwork and developing increased capabilities. In a conventional organization, formal leadership roles are easily identified. For example, we see the CEO, department heads and supervisors as leaders of a firm. However, identifying the leaders in Wikipedia and understanding how they lead is a more difficult task. Who are the leaders in Wikipedia? Previous researchers who investigate leadership in online communities tend to use traditional vertical leadership models (Bass 1990, Hogan et al. 1994). They suggest that the leadership role is a specialized one. People who are appointed or elected to perform this role are designated as "leaders" (Cassell et al. 2006, Luther and Bruckman 2008, Luther et al. 2010, Misiolek and Heckman 2005, Yoo and Alavi 2004). According to this view, some of the responsibilities and functions associated with leadership cannot be shared too widely without jeopardizing the effectiveness of the group.

In contrast, we suggest a shared leadership framework to explain leadership in Wikipedia. The shared leadership framework was originally proposed by researchers investigating offline leaderless groups such as self-managing teams, volunteer organizations and employee-managed companies (Pearce and Sims 2002, Pearce and Conger 2003, Yukl 1998). They argue that leadership—involving persuading and influencing other people to pursue a common goal—emanates from members at all levels, not simply from elites in formal leadership roles. Any member of the group can exhibit some level of leadership at any time, and there is no clear distinction between leaders and followers. Members mutually influence each other on what tasks are to be done, how tasks should be done, and the ways they relate to each other. Rather than leadership being invested in specialized roles, leadership is viewed as a shared influence process.

Although each member can enact some level of leadership behaviors, the shared leadership model does not assume the same effectiveness of leadership behaviors across individuals. This essay investigates how distinct types of leadership behaviors, the legitimacy of the people who deliver the leadership, and the experience of the people who receive the leadership, influence the effectiveness of leadership behaviors. Here, we operationalize the effectiveness of leadership in terms of the extent to which those exhibiting

8

leadership behaviors can influence others to invest effort and contribution to the community, specifically efforts directed to a given focal task as well as general motivations to contribute.

In this article, we use Feedback Intervention Theory (FIT) (Kluger and DeNisi 1996) to explain the process by which leaders influence others' efforts on focal tasks and general motivation to work. We offer several hypotheses regarding the effectiveness of different types of leadership behavior, moderated by different types of leaders and different types of receivers. Subsequently, we describe our two studies, present our results, and discuss theoretical and practical implications.

Theory and Hypotheses

This section briefly summarizes the shared leadership framework and the four types of leadership behaviors. It then uses feedback intervention theory (FIT) to predict the effects of leadership behaviors on people's performance on specific task the leadership behaviors were designed to influence and on general work motivation.

Shared leadership framework

Traditional leadership literature has typically focused on the attributes and behaviors of the appointed or elected leader of some group or organization (cf. Bass, 1990). In contrast to this traditional 'heroic' view of leadership, shared leadership conceives leadership as a collective social process emerging through the interaction among multiple actors (Yukl 1998, Ensley, Pearson, & Pearce, in press; Manz & Sims, 1987, 1993; Pearce & Conger, in press; Pearce, Perry, & Sims, 2001; Pearce & Sims, 2000; Perry, Pearce, & Sims, 1999; Seers, 1996).   The concept of shared leadership was developed in the mid-1990s in response to the increasing use of self-managed teams in conventional organizations, along with the rising speed of delivery, the increasing richness of information, and greater job complexity (Pearce and Conger 2003). Unlike vertical leadership in a hierarchical managerial system, shared leadership is defined as "a dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals" (Pearce and Conger 2003). Pearce et al. (Pearce and Conger 2003) summarize three main characteristics of shared leadership as: 1) distributed and interdependent among people at all levels; 2) a social process embedded in the social context in which it occurs; and 3) focusing on the particular social interactions which lead to mutual learning, greater shared understanding, and eventually positive actions.

9

Types of shared leadership

Researchers investigating traditional vertical leadership have identified a range of effective leadership behaviors (Bass 1990, Burke et al. 2006, Yukl 1998). In a shared leadership context, these strategies continue to be relevant (Pearce and Sims 2002). Rather than prejudge results with terms like "leader" and "follower", in the following sections we use the term "influencer" to indicate the influence exercisers and "targets" to indicate those they are trying to influence.

The distinction between task-based leadership behaviors (those dealing with task accomplishment) and person-based (those facilitating team interaction and development) is common in nearly every taxonomy of leadership behaviors. Similar dichotomies include initiating structure versus consideration in Ohio State's program on leadership research (Fleishman 1953), task-oriented versus relationship-oriented in the University of Michigan research program (Katz et al. 1950), and task-focused versus person-focused behaviors in Burke et al's recent paper reviewing leadership behaviors (Burke et al. 2006). We follow this general classification and then specifically differentiate three subcategories of task-based leadership behaviors, using Pearce and Sims's classification (Pearce and Sims 2002).

Task-based leadership

Transactional leadership. The transactional leadership is generally similar to the components of the transactional-transformational paradigm of leadership (cite). With transactional leadership, leadership behavior is considered a transaction or exchange between the influencer and the target. Transactional influencers provide praise and rewards or withhold punishment from targets who comply with role expectations. The basis of transactional leadership is that people engage in behaviors that will maximize their expected return from performance. Representative transactional leadership behaviors include (1) providing personal rewards, (2) providing material rewards, (3) managing by exception (active), (4) managing by exception (passive) (Pearce and Sims 2002). Sample questionnaire items measuring this type of leadership include 1) "X will recommend that I am compensated well if I perform well"; 2) "X gives me positive feedback or special recognition when I perform well"; 3) "X tracks mistakes"; 4) "X delays taking action until problems become serious".

Aversive leadership. In contrast to transactional leadership, aversive leadership relies on coercive power (French and Raven 1959). Aversive leadership uses intimidation and reprimands to decrease undesired behaviors from targets (Pearce and Sims 2002). Sample questionnaire items measuring aversive leadership include 1) "X tries to influence me through threat and intimidation" and 2) "X lets me know about it when I perform poorly".

Directive leadership. Directive leadership emphasizes the need to provide direction to targets and specify their roles and responsibilities. Directive behaviors include issuing 1) instructions and commands and 2) assignment goals (Pearce and Sims 2002). Sample questionnaire items measuring directive leadership include 1) "when it comes to work, X gives me instructions on how to carry it out" and 2) "X establishes the goals for my work".

Person-based leadership.

In contrast to task-focused leadership behaviors, which directly focus on task accomplishment, person-based leadership behaviors emphasize the target as a person and personal relationships (Burke et al. 2006).

Consideration was first proposed as a type of person-based leadership behavior in 1950s in the Ohio State leadership research program (Fleishman 1953). Consideration is the degree to which an influencer acts in a friendly and supportive manner, showing concern for targets, helping them to develop, supporting group cohesion, and maintaining close social relationship with them (Yukl 1998). In general, dyadic relationships characterized by consideration reflect two-way open communication, mutual respect and trust, and an emphasis on satisfying employee needs. The concept of relationship-oriented leadership in the University of Michigan research on leadership (Katz et al. 1950) is similar.

Later, researchers developed and elaborated the concept of person-based leadership by proposing ideas such as transformational leadership (i.e., component of transactional-transformational leadership paradigm) which highlights encouragement, inspiration and intellectual stimulation (Bass 1990, Burns 1978, Pearce and Sims 2002), and empowering leadership, which focuses on self-management skills and team work (Thorenson & Mahoney 1974, Pearce and Sims 2002).

In general, person-focused leadership behaviors are friendly and supportive, aimed at maintaining close social relationships supporting group cohesion, and developing subordinates' self-confidence and skills.

Effects of shared leadership

Leadership behaviors as feedback.

Without authority derived from a formal position, we assume here that many leadership influence attempts from peers will be interpreted by the recipient as feedback about their prior behavior. Although feedback interventions, defined as intentional feedback given by an external agent, are not identical to leadership behavior, the concepts overlap substantially (See Table 1 for the relationships between leadership behavior and feedback). As such, Feedback Intervention Theory (FIT) can help to better

understand the effects of leadership behaviors on general motivation and performance on specific tasks (Kluger and DeNisi 1996).

The first key assumption of FIT is that feedback is processed hierarchically. To simplify the presentation, the hierarchy can be divided into two levels: meta-task processes involving the self (e.g., self-goals and self-beliefs) and task processes involving the focal task and the detail of the task . Processes at the higher level (i.e., the meta-task processes) can supervise the performance in the lower level (task level processes). The processes in the lower level may also divert attention up the hierarchy and influence higher level process.

The second key assumption of FIT is that people use feedback to evaluate their performance relative to their standards, often referred to as feedback-standard comparisons. When they note a discrepancy between performance and standard, people are motivated to reduce it. Typically people choose to eliminate the discrepancy by attempting to attain the standard.

Based on these two assumptions, we can predict people's reaction towards four types of leadership behaviors – transactional leadership (i.e., providing positive feedback and rewards), aversive leadership (i.e., providing negative feedback and punishment), directive leadership (i.e., giving directions and instructions) and person-based leadership (i.e., socializing and building person ability and inter-personal relationship).

First, transactional leadership behaviors, aversive leadership behaviors and directive leadership behaviors are all task-oriented and focus on details and progress towards a focal task. Aversive leadership, which provides negative feedback, signals that performance falls short of a standard and will lead people to increase effort towards the focal task. Directive leadership, which provides instructions to either achieve standards or raise standards, will also lead people to invest more effort in the focal task and improve performance. In contrast, providing positive feedback and rewards signals that performance exceeds the standard. Therefore, when people receive transactional leadership behavior, they typically maintain their effort or even reduce it (Kluger and DeNisi 1996). In contrast, person-based leadership focus on the person level rather than the task level, and therefore should have little effect on people's performance on specific task.

> **H1.** *Aversive leadership and directive leadership can increase people's effort on focal task and improve task performance; while transactional leadership and person-based leadership should have less effect on focal task performance.*

12

Although transactional leadership tends to have little effect on performance of specific tasks, it has its effects at the meta-task level, influencing people's view of themselves. Positive feedback and rewards might increase people's self-efficacy and self-esteem and thus increase their general motivation to work. This increased motivation might spill over to non-focal tasks (Kluger and DeNisi 1996), lead to persistence in an activity and increase self-report interest in the activity (Deci et al. 1999). Similarly, although person-based leadership behavior does not affect specific task performance, it can help to develop people's self-confidence, build commitment toward the community and thus increase general motivation. In contrast, aversive leadership might be perceived as a threat to self-esteem and decrease motivation. Directive leadership behaviors do not draw attention to the self-level and should not influence motivation.

> *H2. Transactional leadership and person-based leadership can increase people's general motivation to work; directive leadership has limited effects on general motivation, while aversive leadership might decrease people's motivation.*

Moderating effects of leader legitimacy.

Although the shared leadership behaviors do not necessarily require formal leadership positions to be effective, leadership behaviors exercised by legitimate leaders are still more powerful than leadership behaviors from ordinary members. Legitimate leaders are those who occupy formal leadership positions in an organization, volunteer community or other social system. The legitimacy stems from the selection process, whether appointed by supervisors, elected by the membership or appointed because they fulfilled more or less explicit criteria (Yukl 1998). The specific procedures for selecting the leader are often based on tradition and the provisions of the organizations. Deviations from the selection process that members consider legitimate will weaken the leader's legitimate power (Yukl 1998). In Wikipedia, legitimate leaders are the administrators who are appointed through a peer review and election procedure.

Their legitimacy gives these leaders the right to make requests within their leadership domain and requires the targets of their requests to obey (Yukl 1998). Legitimate leaders often have defined privileges, obligations and responsibilities. For example, administrators in Wikipedia have access to restricted technical features, such as protecting, restoring and moving pages (Wikipedia editors).

Legitimate leaders, who occupy formal leadership positions, are in general more powerful in influencing and motivating others' activities compared to peers who perform comparable leadership behaviors (Cialdini and Goldstein 2004). People in leadership roles are perceived to have the legitimate right to issue directions and distribute rewards and punishment. Because of past socialization experiences (e.g.,

with parents, teachers, religion), complying with legitimate requests from authorities is often intrinsically satisfying (French and Raven 1959). Furthermore, formal leaders are often perceived as central members of the social system and may induce a sense of connection and identification with the community, which in turns increases the positive valence of contributing to the community.

> *H3. Legitimate leaders are more powerful in influencing members' behaviors than regular members.*

Moderating effects of prior experience.

The effect of leadership behavior is substantially influenced by the willingness of the recipients to respond to the leadership influence (Ilgen and Fisher 1979). Specifically, prior experience is an important variable moderating the reaction to the leadership behavior (Ilgen and Fisher 1979). People with little experience in a task are less certain about standards and their abilities. In conventional organizations, newcomers, in contrast to more established members, have greater uncertainty regarding role requirements. As a result, they are especially eager to try to learn the beliefs, values, orientations, behaviors, skills, and so forth necessary to fulfill their new roles and function effectively within an organization (Ashforth and Saks 1996). Therefore, we expect that newcomers will be particularly susceptible to influence, compared to experienced members (Ashforth and Saks 1996). Therefore, we propose our fourth hypothesis.

> *H4. Leadership is more influential on newcomers than experienced users.*

Study 1: Observational Study

Study settings

Wikipedia is the site of our empirical investigation. Wikipedia, formally launched in January 2001, has become the free, web-based, collaborative, encyclopedia project and is the largest encyclopedia in the world. We used a complete download provided by the Wikimedia Foundation from Wikipedia's inception to January 2008 (approximately 182 million revisions) to analyze Wikipedia editors' behavior. To handle this data volume, we used the Yahoo! M45 computing cluster running Hadoop and Pig.

Measurement of shared leadership behavior

In online communities like Wikipedia, people communicate and interact with each other predominantly through written text that is visible to all other community members. People tend to exert influence on each other through text-based communication. Therefore, we measured leadership behaviors by examining the messages exchanges between Wikipedia editors, specifically, those messages they left on each others' personal profile pages.

Without automated coding of behavior, research on leadership is restricted to relatively small samples. For example, meta-review (Burke et al. 2006) shows that the average sample size is about several hundred. In this study, we demonstrate the possibilities of going beyond these small samples by using automated coding of leadership behaviors. We propose that we can use machine learning techniques to automatically classify the messages into different leadership categories. The four categories and sample messages for each category is shown in Table 1.

A machine learning approach has three main components - training sets (hand-coded data), representation of messages for machine learners (feature sets), and training algorithms. The process is that first we train statistical models on a small set of human-coded data and evaluate it using a separate set of human-coded data. If the evaluation shows that the model is accurate, we can apply the model to a larger data set that had not been human coded. Details of the machine learning approach are shown in Table 2. In the table, we report results of ten-fold cross-validation of the trained model. The accuracy is four categories are all quite high (0.91, 0.87, 0.86 & 0.92). Kappa, which represents agreement between machine and human judges (Stemler 2001), is moderate for aversive leadership (0.48), but is very substantial or excellent for the other three categories (0.75, 0.71 & 0.80).

Applying these classifications to 4 million messages sent between editors, we found that a large proportion of leadership behaviors were performed by editors without formal leadership roles in Wikipedia (Table 3). For example, non-administrators contributed 64% of directive leadership behaviors. In this study we go beyond characterizing the types of leadership behaviors evinced in Wikipedia to examining the effects they have on their targets.

Leadership Type	Corresponding feedback Type	Hypotheses	
		Effects on the focal task (H1)	**Effects on general motivation (H2)**
Transactional leadership (Task-focused)	Positive feedback	**No effects** Positive feedback signals that performance already exceeds the standard, so people do not invest extra efforts on the specific tasks receiving feedback.	**Increase** Positive feedback and rewards increase people's self-efficacy and self-esteem, and thus increase general motivation
Definition: Behaviors intended to energize people through acknowledging work and provides rewards. **Example 1:** *"I award this barnstar* to XXX for your help and assistance in getting the WikiProject user warnings to the review phase, and to let you know your work has been appreciated."* **Example 2:** *"Thanks for all your work on the Survivor articles"*			
Aversive leadership (Task-focused)	Negative feedback	**Increase** Negative feedback signals that performance falls short of a standard, so people invest more effects on the specific task to reach the standards	**Decrease** Negative feedback decreases people's self-efficacy and self-esteem, and thus decreases general motivation
Definition: Behaviors intended to regulate people through negative messages, warnings and reprimands. **Example 1:** *"If you continue in this manner you will be blocked from editing without further warning."* **Example 2:** *"...there is a concern that the rationale you have provided for using this image under "fair use" may be invalid. ... If it is determined that the image does not qualify under fair use, it will be deleted within a couple of days according to our criteria for speedy deletion."*			
Directive leadership (Task-focused)	Directive feedback	**Increase** Directive behavior provides instructions to either achieve standards or raise standards, will also lead people to invest more effort to the specific task.	**No effects** Has no effects on people's general motivation
Definition: Behaviors intended to direct people through issuing instructions, commands, assigning tasks, setting goals. **Example 1:** *"Please read the instructions at... Using one of the templates at..., but remember that you must complete the template..."* **Example 2:** *"... one of these days do you think you could take some pictures at Mission Mill? I'd like to spruce up the article but it really needs some photos..."*			
Person-focused leadership	Social feedback	**No effects** Person-based leadership behavior (social feedback) is not directly related to any specific task.	**Increase** Develops people's self-confidence, builds commitment toward the community and thus increases general motivation.
Definition: Behaviors intended to maintain close social relationships, support group cohesion, and develop subordinates' self-confidence and skills. **Example 1:** *"Hi XX. Welcome to WikiProject XXX! I saw your name posted on the members list and wanted to welcome you... Anyway we are glad to have you. If I can help at all let me know :) ..."* **Example 2:** *"[[Image:Smiley.svg]] has smiled at you Smiles promote WikiLove and hopefully this one has made your day better... Happy editing"*			

* Barnstar is a type of virtual award in Wikipedia.

Table 1. Four types of leadership behaviors, the corresponding feedback types, example messages and summary of hypotheses.

Training sets	We hand coded 500 messages into each of the four leadership behaviors to provide training data for the model. Messages could be assigned to multiple categories if they exhibited more than one leadership behavior. To assess the reliability of the coding, two human judges annotated 100 messages. The Cohen's Kappa measure of inter-judge agreement averaged across the four categories was 0.82 (positive 0.81, negative 0.80, directive 0.79, social 0.88), which is very high (Stemler 2001).
Representation of Messages (Feature set)	We used features based on domain knowledge, realizing that message senders tend to frequently use certain words and phrase patterns to express different intents. We identified 21 domain knowledge features: Strong/weak, positive/negative polarity words. Four features based on the combination of strength and polarity derived from the subjectivity lexicon of OpinionFinder (Wilson et al. 2009). • Strong positive adjectives. Seventeen strong positive adjectives used in praise, such as "excellent", "great", and "impressive". • Negation. Seventeen negation words and phrases (e.g., "not", "shouldn't", "doesn't"). • Negative jargon. Nineteen Wikipedia-specific negative words such "vandalism" and "blocked". Causative/subjunctive verbs. Twenty-seven causative or subjunctive verbs including "make", "suggest", "recommend", "wish" and "need". • <You+modal>. Sentences starting with a pronoun "you" immediately followed by a modal word (e.g., "should", "might", "must") or vice versa. • Acknowledgements. Phrase patterns of "thank you/thanks for". • Smiley. Textual expressions such as :), ;). • Greetings. Greeting words/phrases, such as "hello", "congratulations", and "happy birthday". • He/she. Number of "he, him, his, she, her". • Length. Number of word tokens in a message. • Variants of the following words/phrases was included as a separate feature: "if you", "newsletter", "Wikiproject", "congrats", "welcome", and "please"+ verb.
Learning Algorithm	Support Vector Machine (Sebastiani 2002)
Validation of the measurement	• Accuracy: Transactional (0.91) Aversive (0.87) Directive (0.86) Person-based (0.92) • Kappa agreement between machine learning results and human coders: Transactional (0.75) Aversive (0.48) Directive (0.71) Person-based (0.80)

Table 2. Creating automatic measurement for leadership behaviors using machine learning

	Admin Vs Non-admin			
Num of People	1723		131,848	
	Per person	Aggregate	Per person	Aggregate
Transactional leadership	154.7	267K	4.3	569K
Aversive leadership	155.9	269K	3.9	509K
Directive leadership	483.8	834K	11.4	1503K
Person-based leadership	244.0	386K	4.6	602K
Overall Wikipedia activities per person	16977.7		573.7	

Table 3. Distributions of the leadership messages among administrators and non-administrators

Analysis strategy: Propensity score matching

We can measure the effects of different messages on people's general motivation by looking at the total number of revisions they make on any Wikipedia articles before and after receiving leadership messages. However, it is impossible to hand-code the millions of messages to identify which specific tasks these messages target, such as whether the message is about adding a photo to article A or it is about changing the reference for article B. Since there are too many potential categories, it is also not feasible to build machine learning to automatically categorize the messages. Therefore, Study 1 can only test hypothesis 2 (effects on general motivation) but not hypothesis 1 (effects on specific tasks).

The goal of this analysis is to identify the effects of receiving different types of leadership messages from other Wikipedia editors on changes in recipients' total editing behavior. In an analogy to a true experiment, we will compare the changes in editing behavior of those who received leadership messages (treated group) to those who do not receive messages (control group).

Unfortunately, although Wikipedia has an enormous amount of archival data, these data are observational, and the receipt of a leadership message is not a true experimental treatment. The treatment here, as with most events in real world, is endogenous in the sense that it is caused by other factors inside the system. In our data, the messages a recipient gets are partially a response to the recipient's previous behaviors. For example, the number of edits one person made in a previous week may cause others to send them messages in the next week. Similarly, experienced editors who produce good edits may cause others to send them transactional leadership messages, while those newcomers who produce poor edits may cause others to send them aversive leadership messages in a subsequent week. Not controlling for confounding

18

factors that influence both the treatment and the outcome can lead to biased estimation of the treatment effects.

To ameliorate the endogeneity problem, we use propensity score matching (PSM) to approximate randomization. PSM builds experimental and control groups by balancing the groups on potential confounding factors. These confounding factors include the number of edits the editors made before, the number of messages they received or sent before and their tenure in Wikipedia. PSM can effectively reduce the bias caused by these conditioning factors (Angrist and Krueger 1999, Rosenbaum and Rubin 1983). However, because PSM balances only on measured variables, it cannot adequately control for all variables relevant to treatment.

Since editors' prior experience is one important confounding factor for examining the effects of receiving different types of leadership messages, PSM will balance experimental and control groups on their prior experience. In other words, editors with similar experience in Wikipedia are compared. Therefore, hypothesis 4 is not examined in study 1.

In sum, we are going to test hypothesis 2 and hypothesis 3 in Study 1, examining the effects of receiving different types of leadership messages on recipients' total amount of contribution (i.e., a proxy of general motivation) and the moderating effects of the roles of messages senders. We use propensity score matching (PSM) to ameliorate the endogeneity problem.

Data preparation

We restricted the analysis to registered Wikipedia editors who had edited any Wikiproject page at least once, since this provided a basic filter against vandals and guaranteed that the editors had some experience in Wikipedia. The data were longitudinal, following the same editors across different weeks. For the analysis, we first defined whether an editor was active in a given week (the focal week) in terms of whether the editor made any edits during a five-week period (including the focal week, two weeks before, and two weeks after the focal week). Then we did an editor-week level analysis, restricted to the weeks in which the editor was active. The data comprised 31,676 unique editors, 2,053,405 editor-week observations and 1.6 million messages. All the variables are described in Table 4.

Variable name	Definition
Dependent variable of Study 1:	
General motivation	We measured editors' general motivation by calculating their revision count (i.e., number of edits). Edits are a direct measure of editors' effort, indicating the number of changes they made to articles during a period of time. Each edit indicates a set of editing actions, for example adding, changing, deleting or reverting text, references or illustrations, or communicating with other editors. To alleviate the endogeneity casued by individual difference, we measure the contribution change after receiving the message. The dependent measure was the log transformed edits in the week after the focal week minus the log transformed edits in the week prior to the focal week. Because the logarithm of zero is undefined, we added one before computing the logarithm. Therefore, this variable is defined as $\ln(edits_{t+1}+1) - \ln(edits_{t-1}+1)$
Independent variables of Study 1:	
Receive_msg	This dummy variable indicates whether the editor received any messages during the focal week. One indicates that the editor received at least one message, while zero indicates that the editor received no messages.
Transactional	This dummy variable indicates whether in the focal week the editor received any message categorized as transactional (i.e., providing positive feedback). One indicates that the editor received at least one transactional leadership message, and zero indicates that the editor received no transactional leadership message. The following three variables are similar.
Aversive	This dummy variable indicates whether the editor received any message categorized as aversive leadership message during the focal week.
Directive	This dummy variable indicates whether the editor received any message categorized as directive leadership message during the focal week.
Person	This dummy variable indicates whether the editor received any message categorized as person-based leadership during the focal week.
Admin	This dummy variable indicates whether the editor received any messages from any administrator during the current week. One indicates that the editor received at least one message from an administrator, while zero indicates that the editor received no messages from any administrator.
*Admin*Transactional*	This dummy variable indicates whether the editor received any messages categorized as transactional leadership message from any administrator during the focal week. One indicates that the editor received at least one transactional leadership message from an administrator, while zero indicates that the editor received none. The other three interactions were constructed similarly.
*Admin*Aversive*	This dummy variable indicates whether the editor received any messages categorized as aversive leadership message from an administrator during the focal week.
*Admin*Directive*	This dummy variable indicates whether the editor received any messages categorized as directive leadership messages from an administrator during the focal week.
*Admin*Person*	This dummy variable indicates whether the editor received any messages categorized as person-based leadership message from an administrator during the focal week.

Table 4. Variables of Study 1.

Receive Msg	Coef.	Std. Err.
Intercept	-2.8803**	.0046
$Edits_{t-1}$	.2906**	.0014
$MsgReceived_{t-1}$	.8926**	.0044
$MsgSent_{t-1}$	.1682**	.0039
$MsgReceived_{<t-1}$	.4730**	.0024
$MsgSent_{<t-1}$	-.0147**	.0018
Tenure	-.0062**	<.0001
Log likelihood	-828366.63	
Pseudo R2	0.2756	
Number of obs	2,053,405	

Table 5. Estimate the probability of receiving messages (propensity score) with logistic regression.

** indicates that p value is less than 0.0001

Propensity Score Matching

Propensity score matching (PSM) involved three steps. First was to estimate the propensity score (i.e., the probability of receiving messages from others) from a set of conditioning variables. The variables we used to predict receiving a message were the editors' prior activities (e.g., number of edits in previous week, number of messages received in previous week, tenure in Wikipedia). The rationale was that these factors might both cause other editors to communicate with them and also be correlated with subsequent changes in effort. Table 5 shows the results of estimating the probability of receiving messages (propensity score) with logistic regression, with six of the editors' previous activities as conditioning variables.

In the second step, we matched each editor who received leadership messages in a particular week (treatment group) with another editor who did not receive a message (control group), but who had the most similar propensity score based on the six behavioral indicators. Propensity scores allow researchers to control for many variables simultaneously by matching on a single scalar variable. At the end of the second step, we checked whether the treatment group and control group were well matched in terms of the conditioning variables we were interested in. From Table 6, we see that the bias was reduced over 90% for five of the six conditioning variables, indicating that the treatment group and control group is well balanced.

In the third step, we ran fixed effects regression analyses to estimate the effect of receiving messages, especially different types of leadership messages, on the treated groups and matched controls.

21

Number of observations	Full	Treat	503,259	Ctrl	1,550,146
	Matched	Treat	503,259	Ctrl	503,259
Variable	Sample	Treat Mean	Ctrl Mean	% bias	%red. bias
$Edits_{t-1}$	Full	3.33	1.44	109.8	
	Matched	3.33	3.36	-1.4	98.7
$MsgReceived_{t-1}$	Full	0.78	0.12	100.8	
	Matched	0.78	0.78	-0.7	99.3
$MsgSent_{t-1}$	Full	0.76	0.11	78.8	
	Matched	0.76	0.81	-5.8	92.6
$MsgReceived_{<t-1}$	Full	3.34	1.77	97.7	
	Matched	3.34	3.24	6.3	93.6
$MsgSent_{<t-1}$	Full	3.12	1.43	84.2	
	Matched	3.12	3.06	2.8	96.7
Tenure	Full	68.1	61.4	13.0	
	Matched	68.1	63.6	8.7	33.1
Dependent Variable	**Full**	**-0.055**	**-0.011**		
Contri_change	**Matched**	-0.055	-0.606		

Table 6. Comparison between treatment editors who received messages in the focal week (treat) and control editors (ctrl) before and after propensity score matching (full versus matched).

Dependent Variable *Contribution_change*	Descriptive Statistics		Model 1		Model 2		Model 3	
	Mean	Std.Dev.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Intercept			-.6059**	.0021	-.6059**	.0021	-.6059**	.0021
Receive_ msg	.5000	.5000	0.5507**	.0030	.3326**	.0054	.2956**	.0060
Transactional	.1872	.3901			.1927**	.0067	.1615**	.0079
Aversive	.0646	.2458			-.1442**	.0098	-.1003**	.0115
Directive	.2884	.4530			.0859**	.0064	.0585**	.0072
Person	.2511	.4336			.2290**	.0061	.1698**	.0071
Admin	.2264	.4185					.1584**	.0086
Admin X Transactional	.0657	.2478					.0278 *	.0118
Admin X Aversive	.0174	.1306					-.0945**	.0205
Admin X Directive	.1103	.3133					.0174	.0102
Admin X Person	.1090	.3117					.0579**	.0103
Number of obs					1,006,518			
Number of groups					503,259			

Table 7. . Regression predicting the effects of leadership behaviors on subsequent change in editors.

** indicates that p value is less than 0.0001; * indicates that p value is less than 0.05.

Results

To understand Table 7, we first need to understand how to interpret the dependent variable. The dependent variable is the log transformed edits in the week after the focal week minus the log transformed edits in the week prior to the focal week. Therefore, the sign of dependent variable indicates whether the editor's editing increased (positive sign) or decreased (negative sign) surrounding the focal week. Furthermore, increase of x in the dependent variable indicates that, holding the edits in prior week constant, the edits in the subsequent week increased approximately x%.

First, model 1 in Table 7 shows that editors who received messages in a focal week subsequently edited more than those who did not. Note that the intercept is significantly negative, indicating that those who received no messages reduced their editing surrounding a focal week. However, receiving messages slows this decline.

Secondly, model 2 demonstrates that different types of leadership behaviors differentially influenced subsequent motivation (Hypothesis 2). The effects of messages that were not one of the four leadership types resulted in a 33% increase in edits in the subsequent week. The 33% increase in people's motivation and contributions can be explained by the fact that receiving messages from other members or from the whole community, even without any specific directions, criticisms or praise, can elicit a sense of belonging to and identification with the community. Among task-focused leadership behaviors, receiving transactional leadership messages (i.e., positive feedback) led to an additional 19% increase in subsequent edits. Directive behavior messages led to an addition 8.6% in subsequent edits. In contrast, aversive leadership messages (negative feedback) decreased members' contribution by 14%. We can also see that the influence of person-based leadership was substantial, increasing edits by 23%. Therefore, hypothesis 2 is confirmed.

Thirdly, Model 3 demonstrates that messages sent by administrators were more influential than those sent by peers (Hypothesis 3). Receiving a non-leadership message from an administrator increased edits by 15% compared to messages from non-administrators. Transactional messages sent by administrators increased editing an additional 2.8% compared to those sent by peers. Conversely, aversive messages sent by administrators decreased editing an additionally 9.5% compared to aversive messages sent by peers. Finally, person-based messages sent by administrators increased editing by 5.8% compared to those sent by peers. Hypothesis 3 is also confirmed.

Limitation of Study 1 and motivation for Study 2

However, the previous research has three limitations. First and most importantly, as previously indicated, one cannot conclude from correlational research that leadership behavior actually changes the behavior of those who receive it. Although we have used sophisticated propensity score matching to try to equate pre-existing characteristics, some unmeasured variables, such as politeness or extraversion that potentially predict both the type of messages people receive and their subsequent behavior can still undermine causal inferences. In study 2, we randomly assigned someone to receive a particular type of leadership message or not. By doing so, we ensure that within the limits of chance those two groups were equivalent on both measured and unmeasured variables before the intervention.

Secondly, study 1 only investigated how leadership behaviors affected receivers' general motivation to work (e.g., total number of edits). It fails to examine how leadership affects people's performance on the specific tasks which the leadership behaviors explicitly target. As hypothesis 1 and 2 suggests, different types of messages have different effects on people' s efforts on focal tasks and general motivations. Study 2 will examine how different types of leadership messages influence both general work motivation and specific task performance (Hypothesis 1 and Hypothesis 2).

Finally, Study 1 suggests that leadership messages have stronger effects when delivered by formal leaders (hypothesis 3), it failed to examine how effectiveness varies with differences among people who receive them (hypothesis 4). We test this distinction more definitively in the experiment reported here.

In sum, Study 2 will resolve the limitation of Study 1 and examine Hypothesis 1, Hypothesis 2 and Hypothesis 4.

Study 2: Field Experiment

Study settings

To test the hypotheses, we conducted a field experiment in Wikipedia. In the experiment, we randomly sent different types of leadership messages or no message at all to editors who had recently created new articles.

Participants

Research participants were the original authors of newly created Wikipedia articles. They were randomly selected without replacement via a computer script from Wikipedia's new article list.

Each new article was evaluated on several dimensions to insure that potential leadership messages were relevant to it. If the article was not relevant to at least one template, the author was excluded. For example, authors of new articles with nothing explicitly incorrect were excluded, because that editor could not be randomly assigned to receive aversive leadership or not. Similarly, editors of an article that contains nothing praiseworthy were dropped because it could not randomly receive transactional message.

Seven-hundred and three editors were included in the experiment. The experiment period lasted from August 2011 to November 2011.

Experiment Design

Eighty percent of selected Wikipedia editors were randomly assigned to receive a message, and the remaining twenty percent who did not receive a message served as a control group. All messages contained some common content (the base). The additional components - positive feedback, negative feedback, directive message, and a social message (including a social greeting and a social closing) - each had a 50% chance of inclusion. Positive feedback corresponds to transactional leadership; negative feedback corresponds to aversive leadership; directive message corresponds to directive leadership; and social message corresponds to person-based leadership. We used a 2 (positive feedback vs not) x 2 (negative feedback vs not) x 2 (direction message vs not) x 2 (social message vs not) between subjects factorial design for the 80% who received a message. To understand the effects of different types of messages, we measured the users' contribution to the particular article we gave feedback to (efforts on focal task) as well as their contributions to any Wikipedia articles (general motivation) over the following month.

Materials

All messages contained some or all of the following components.

"[Social Greeting] + [Base Message] + [Positive Feedback] + [Negative feedback] + [Directive Message] + [Social Closing] + [Signature]".

Figure 1 is an example which contains all the components. All messages contained a base and signature. In order to provide experimental control, a computer script randomly decided whether to include the additional components - positive feedback, negative feedback, directive message, or a social message (social greeting plus social closing).
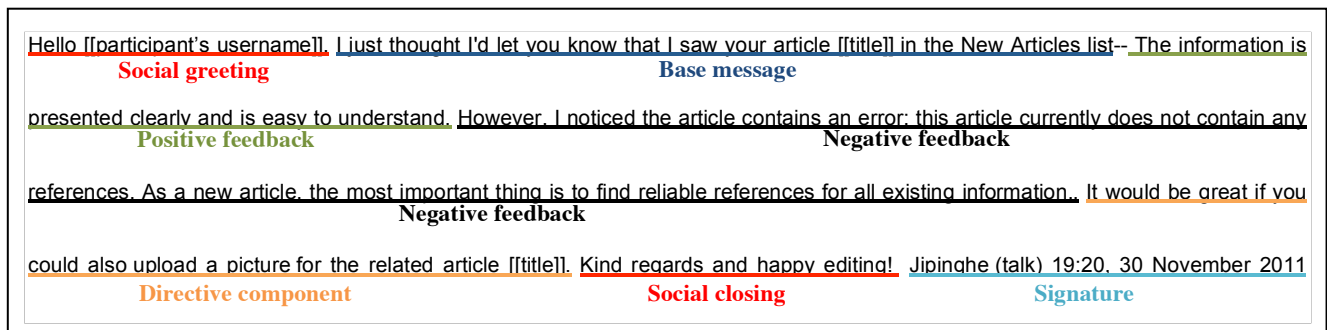
Figure 1. An example message containing all the elements.

We created twelve templates for positive feedback, ten templates for negative feedback, nine templates for directive messages, four templates for social greeting and eight templates for social closing. Table 8 shows two examples of each message component, and Figure 1 shows an example of a message assembled from the components.

To generate different components, a script was used to run through the various templates in a random order, asking the researcher if a specific positive or negative template applied to the article. This ensured that the aspect was both appropriate and randomly chosen. Note that the negative feedback only politely critiqued the editor's work by pointing out an error, but was not directive, such as requesting that the editor make a particular change. In contrast, directive messages asked for the editor's help with improving a related article without being positive or negative about the new article that the user created. We used Suggestbot (Cosley et al. 2007) to help find related articles that needed work.

Component Type	Leadership Type	Template 1	Template 2
Social Opening	Person-based Leadership	Hi XX,	Hey XX,
Base Message		I'm posting this message on your talk page because you've recently created the new article XX --	I saw your article XX in the new articles list --
Positive Feedback	Transactional Leadership	The content seems well-organized.	There is a good number of citations and references.
Negative Feedback	Aversive Leadership	However, I noticed the article contains an error: this article currently does not contain any references. As a new article, the most important thing is to find reliable references for all existing information.	However, I noticed the article contains an error: the article does not contain any Wikilinks, and so doesn't follow Wikipedia style guidelines.
Directive Component	Directive Leadership	It would be great if you could also improve the related article XX.	It would be great if you could also clean-up the related article XX.
Social Closing	Person-based Leadership	Happy editing! Hope your day is going well and you are having fun.	It's always nice to see users contributing to make Wikipedia better!

Table 8. Example templates for message components.

Research Ethics

We designed this experiment with the twin goals of observing how different types of leadership messages naturally affect Wikipedia editors while at the same time minimizing potential risk to Wikipedia editor-participants and the Wikipedia community as a whole.

First, we made sure that the leadership messages sent to Wikipedia editors who have created a new page were natural and appropriate. The researchers posting the messages are members of the New Page Patrol, a collection of Wikipedia editors who evaluate and comment on new articles. They both had experience editing in Wikipedia. Furthermore, all the component templates sent to editors were based on observations of messages on Wikipedia, suggestions by senior Wikipedia editors, and the guidelines of civility in Wikipedia. Thus, these messages are very similar to those that Wikipedia users might encounter in their everyday interactions on the website, although perhaps more polite.

In particular, negative feedback components in the experiment are milder than the messages categorized as aversive leadership sent between editors. In the wild, some editors use intimidation, threat and harsh language to decrease undesired behaviors from targets. Here are two examples: "If you continue in this manner you will be blocked from editing without further warning" and "Blech. This really needs

[[WP:TNT]]," which is Wikipedia's jargon for "Blow it up and start over.". In our experiment design, negative feedback consisted only of constructive criticism.

The experiment was approved by the Carnegie Mellon University Institutional Review Board, as well as the Wikipedia research committee. Information about the experiment was posted on public Wikipedia pages and received unanimous agreement of active discussants from the Wikipedia community (Wikipedia 2013b).

Variable name	Definition
Dependent variable of Study 2:	
Performance on focal task.	To measure participants' performance on their focal task (which the leadership message specifically targets), we calculated the number of edits they made in the month after receiving a leadership message on the article that was the target of the message. Note that for participants who received a directive message asking them to improve a related article, efforts on focal task also included edits on that related article.
General motivation	To measure the effects of leadership messages on participants' general motivation to work, we calculated the number of edits on any Wikipedia articles excluding the focal article(s) which the leadership messages target.
Independent variables of Study 2:	
Base message	This dummy variable indicates whether the participant receives a base message or not. One indicates that the editor was randomly assigned to receive a base message, while zero indicates that the editor did not receive one from us.
Transactional	This dummy variable indicates whether the participant received a message with the positive feedback component (1) or without this component (0).
Aversive	This dummy variable indicates whether the participant received a message with the negative feedback component (1) or without this component (0).
Directive	This dummy variable indicates whether the participant received a message with the directive component (1) or without this component (0).
Person	This dummy variable indicates whether the participant received a message with the social component (1) or without this component (0).
Receiver is a newcomer	This dummy variable indicates whether the receiver is a newcomer (1) or not (0). We define newcomers as editors with less than six months experience in Wikipedia and had received fewer than four messages before receiving our message.
*Newcomer * Base message*	This variable indicates the interaction effects of receiver experience and message type. This variable is one when newcomer receive base message; otherwise, it is zero.
*Newcomer * Transactional*	This variable indicates the interaction effects of receiver experience and message type. This variable is one when newcomers receive message with positive feedback element; otherwise, it is zero.
*Newcomer * Aversive*	This variable indicates the interaction effects of receiver experience and message type. This variable is one when newcomers receive message with negative feedback element; otherwise, it is zero.
*Newcomer *Directive*	This variable indicates the interaction effects of receiver experience and message type. This variable is one when newcomers receive message with directive feedback element; otherwise, it is zero.
*Newcomer *Person*	This variable indicates the interaction effects of receiver experience and message type. This variable is one when newcomers receive message with social elements; otherwise, it is zero.

Table 9. Variables of Study 2.

Analysis strategy & Results

The goal of the analysis was to measure the effects of leadership messages on participants' efforts on focal task and general motivation, moderated by the experience of receivers. Variables are described in Table 9.

Analysis strategy

Because the dependent variables (the number of edits editors made on particular target articles and other Wikipedia articles) are count data and because editors might not log in to Wikipedia and have a chance to see the messages during the time window (one month after receiving the message), we analyzed the data using a zero-inflated negative binomial regression.

Zero-inflated negative binomial regression (Hall 2004) is often used when the dependent variable is a upper bounded count value and is over dispersed, with more zeros than predicted by a regular binominal distribution. The basic idea is that the excess zeros can be generated by a separate process that can be modeled independently. In our case, the goal is to predict whether reading the leadership messages changes participants' behavior. Some recipients might not have been influenced by the message because they were not persuaded by its content. However, others might have failed to log in recently and hadn't actually seen the leadership message meant for them. To model these two separate processes, the zero-inflated negative binominal analysis has two stages. In the first stage, we used a logit regression to predict the excess zero (i.e., the likelihood of not seeing the message). In the second stage, given the likelihood of being exposed to the message, we predicted the effects of leadership messages on the number of edits. Specifically, we used the following two estimates of editors' recent activity to predict the likelihood of their seeing the message.

Number of edits one day before receiving our message. The more edits the participant did in the 24 hours before we sent them messages, the more active they were and the more likely they were to have seen our message.

Number of days between last edit and receiving our message. Similarly, we included the number of days between the last edit the participant made and the time we sent our message.

	Newcomers	Experienced editors
Number of people	132	473
Efforts on focal task Unit: # of edits	M = 2.1; SD = 7.6	M = 1.3; SD = 3.7
General motivation Unit: # of edits	M = 128; SD = 25	M = 403; SD = 959
# of people receiving messages	106	362
# of people receiving positive feedback	45	183
# of people receiving negative feedback	48	164
# of people receiving directive feedback	47	126
# of people receiving social feedback	61	194

Table 10. Descriptive Statistics of Participants.

Dependent variable	**Focal task**			**General motivation**		
	Model 1			**Model 2**		
Predictors	**Coef**	**S.E.**	**Change in edits**	**Coef**	**S.E.**	**Change in edits**
Intercept	.24	(.26)	N/A	6.3**	(.17)	N/A
Base message	.29	(.34)	1.34	-.090	(.27)	0.91
Transactional	.10	(.25)	1.11	-.051	(.19)	0.95
Aversive	.04	(.25)	1.04	-.16	(.20)	0.85
Directive	-.10	(.26)	0.90	-.038	(.20)	0.96
Person	.06	(.25)	1.06	-.13	(.19)	0.88
Receiver is newcomer	.89	(.65)	2.44	-3.8**	(.46)	0.02
Newcomer X Base message	-2.1**	(.94)	0.12	-.67	(.69)	0.51
Newcomer X Transactional	-.47	(.73)	0.63	1.3**	(.54)	3.67
Newcomer X Aversive	1.4**	(.67)	4.06	-.25	(.54)	0.78
Newcomer X Directive	2.2**	(.68)	9.03	.58	(.51)	1.79
Newcomer X Person	.23	(.71)	1.26	2.2**	(.50)	9.03
Inflate						
Number of edits during one day before receiving our message	-..03	(.09)		-20	(14580)	
Number of days between last edit before receiving our message and the time they receive the message	.48**	(.14)		.36**	(.06)	
Alpha	3.70			2.73		
Likelihood-ratio test of alpha=0	chibar2(01) = 624; Pr>=chibar2 = 0.0000			chibar2(01) = 3.9e+5; Pr>=chibar2 = 0.0000		
Vuong test of zinb vs. standard negative binomial	z = 3.60 Pr>z = 0.0002			z = 1.5 Pr>z = 0.07		

Table 11. Effects of leadership messages on focal task and general motivation.
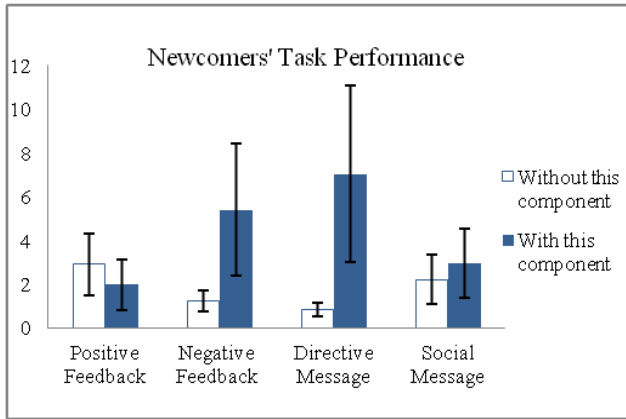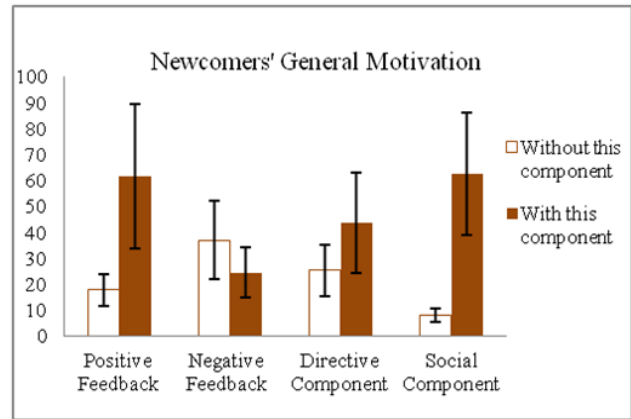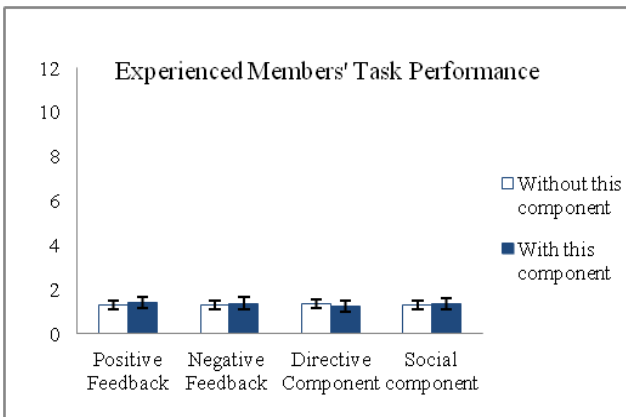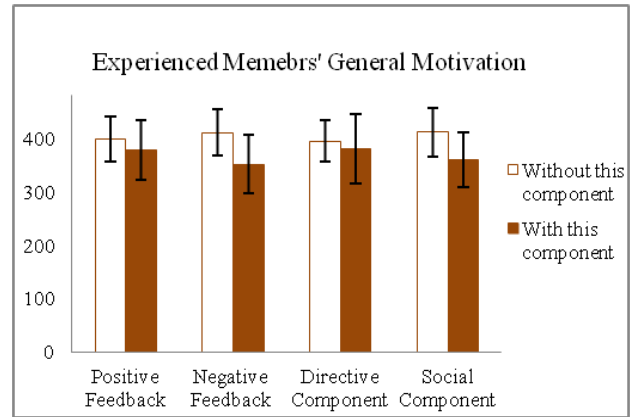
Figure 2. (a) The effects of receiving messages on newcomers' efforts on focal task. (b) The effects of receiving messages on newcomers' general motivation. (c) The effects of receiving messages on experienced members' efforts on focal task. (d) The effects of receiving messages on experienced members' general motivation.

Results

The descriptive statistics of participants in different condition is shown in Table 10. The results of zero-inflated negative binominal regression are shown numerically in Table 11 and graphically in Figure 2(a) to (d). The error bars in Figures 2 indicate 95% confidence internal. We report the main effects of receiving a particular type of leadership component. For example, in the figures, the condition of "with transactional components" includes "transactional" and "transactional + aversive" and "transactional + directive" etc; the condition of "without transactional components" includes "base" and "aversive" and

31

"directive" etc. We did not find significant interaction effects between different types of leadership components.

The bottom panel of Table 11 indicates that the likelihood ratio test of alpha = 0 is significantly different from zero.   This suggests that our data is overdispersed and that a zero-inflated negative binomial model is more appropriate than a zero-inflated Poisson model.   The Vuong test suggests that the zero-inflated negative binomial model is a significant improvement over a standard negative binomial model. These results suggested that we used the right statistics model.

The top panel of Table 11 shows analyses testing hypotheses 1, 2 and 4. Model 1 tests whether receiving leadership message led editors to edit more on the article the leadership message targets (focal task). Model 2 tests whether receiving leadership message increased editors' activities in general. Each coefficient represents the change in the log of the expected number of edits the editor will produce when increasing the independent variable by one unit, when other variables in the model are held constant at zero.   For ease of interpretation, we also included the change in edit counts in the original units.   Thus, the intercept indicates that old-timers who received no messages (baseline) can be expected to make 1.27 (e^.24) edits to the focal article. Newcomers made edits 2.44 ((e^0.89)) times compared to experienced editors because the coefficient of the variable of Receiver is newcomer is 0.89. Therefore, newcomers who received no messages make 3.10 edits (1.27*2.44) to the focal article.

For experienced editors, receiving any type of leadership message has no significant impact on their subsequent editing behavior, either for the specific articles on which we gave feedback (focal task) or any other articles (general motivation). For newcomers, the effects are significant. Therefore, hypothesis 4 is supported.

Model 1 shows that leadership messages had significant effects on newcomers' subsequent editing of the target as our hypotheses predict. While receiving a base message reduced the amount that newcomers changed the target article compared to receiving no messages, receiving aversive and directive leadership messages increased their editing in the target article. The coefficient of newcomer X aversive is 1.4, indicating that newcomers who received aversive leadership messages are estimated to make edits on focal articles approximately four times compared to newcomers who did not receive aversive leadership messages. The coefficient of newcomer X directive component is 2.2, indicating that newcomers who received directive messages are estimated to make edits on focal articles approximately nine times compared to newcomers who did not receive directive messages. Transactional and person-based

leadership message do not have effects on local tasks. The results are shown graphically in Figure 2(a). Hypothesis 1 is confirmed.

Results of Model 2 confirm our hypothesis 2 about the effects of leadership messages on editors' general motivation. In contrast to Model 1, aversive and directive leadership messages do not have effects on general motivation. Instead, transactional and person-based leadership substantially increase newcomers' general work motivation. The coefficient of newcomer X transactional is 1.3, indicating that positive feedback causes 3.67 times change in number of edits for newcomers. The coefficient of newcomer X person-based is 2.2, indicating that messages with social component cause 9.03 times change in number of edits for newcomers. The results are also graphically shown in Figure 2(b). The results are consistent with Hypothesis 2, except that aversive leadership does not have significant negative effects. However, in study 1we found aversive leadership reduced motivation. Remember that the aversive leadership messages in our Study 2 were intentionally designed to be milder than aversive leadership messages actually sent between Wikipedia editors as in Study 1.

Discussion

The results of two studies basically confirm our hypotheses: 1) aversive leadership and directive leadership increases recipients' efforts on specific tasks the leadership targets, while transactional leadership and person-based leadership has no effects on performance on specific task; 2) transactional leadership and person-based leadership increases people's general motivation to work while aversive leadership and directive leadership cannot; 3) the effects are stronger when senders are formal leaders; 4) the effects are stronger when receivers are newcomers.

Experienced Members' Reaction. Although we predict that the effects should be stronger for newcomers because they are particularly susceptible to influence, we are still surprised to see that in study 2 the messages had no significant effects at all on experienced members. When we dig deeper about the participants' editing behaviors on focal articles in addition to calculating the raw counts of edits, we even found evidence that experienced members went opposite direction as our leadership messages wanted them to, just like being influenced by a counterforce.

First, we examined the total number of words added to the focal articles (see Table 12). Similarly, we used zero-inflated negative binominal regression to measure the effects of different types of leadership messages. Experienced editors who received directive message even added fewer words compared to the condition when they did not received directive message: the expected number of words added to focal

articles decrease by 63% (Coef. = -1, Change = 0.37) when they received directive message. In contrast, the newcomers added 10 times more words when they received directive message.

Secondly, we examined the likelihood of participants' revisions being "self-removed". Removing one's own work indicates that the person accepts the external suggestions and is willing to revise and refine the previous work. To quantify the effects, we conducted a revision-level survival analysis. We defined the "death" of a particular revision as more than 50% of the words are removed by the same editor. Random-effect model is applied to control the intrapersonal similarity when the same person did multiple revisions. The results are represented as Hazard ratio in Table 13, which can be interpreted as the ratio change of the likelihood of being self-removed. The results show that aversive leadership reduced the likelihood of experienced users removing their previous edits by 61%.; while newcomers were 550% more likely to remove and refine their own edits after receiving aversive leadership.

We also found some qualitative evidence from the messages the participants sent back to the researchers' user pages. For example, some participants wrote to us and said that:

> *"Well, er, yes, I am not new here and the stub tag was intended as a cheerful acknowledgement of the effort's insufficiency." – P1.*

> "There are plenty of external references on that page for John Hess (journalist) for the information given. I can show you plenty of pages that do not have any external references - worry about those first..." – P2.

> "You're still wet behind the ears and have too little experience to have perspective." – P3.

We believe that experienced members might have psychological reactance to our messages. Psychological reactance was originally proposed by Brehm, in which a person has a negative emotional response in reaction to being persuaded, and thus chooses the option which is being advocated against (Brehm 1966). Experienced members might perceive aversive leadership and directive leadership as a challenge to their knowledge and expertise (P1 and P2), especially when noticing that the message senders have less experience than themselves (P1 and P3). Previous research shows that when people perceived feedback as self-threatening, they might avoid exposure to the feedback or even abandon the entire task (Kluger and DeNisi 1996). It is possible that experienced editors chose not to follow what their newbie colleagues suggested, so as to preserve positive self-belief about their expertise. The results suggest that although any member can try to conduct leadership behavior to others in Wikipedia, the relative status of the sender might still matter. Therefore, to ensure the effectiveness of shared

leadership on senior community members, it is probably better to have other senior community members to deliver the leadership messages.

Dependent variable	The number of words added to the focal articles		
Predictors	Coef.	S.E.	Change
Intercept	5.4**	(.42)	221
Base message	-.95	(.51)	0.39
Transactional	-.07	(.35)	0.93
Aversive	.51	(.37)	1.67
Directive	-1.0**	(.38)	0.37
Person-based	-.25	(.39)	0.78
Receiver is newcomer	-.94	(.91)	0.39
Newcomer * Base message	-.07	(1.2)	0.93
Newcomer * Transactional	-.07	(1.2)	0.93
Newcomer *Aversive	-.72	(.98)	0.49
Newcomer * Directive	2.4**	(.93)	11.0
Newcomer * Person-based	1.3	(1.2)	3.67

Table 12. The effects of leadership messages on the number of words added on the focal article.

Dependent variable	The likelihood of being "self-removed" for the revisions on the focal articles	
Predictors	Haz . Ratio	S.E.
Intercept	.02**	(.005)
Base message	1.5	(.95)
Transactional	.90	(.42)
Aversive	.39*	(.21)
Directive	.77	(.46)
Person-based	1.5	(.68)
Receiver is newcomer	2.6	(2.2)
Newcomer * Base message	.70	(.90)
Newcomer * Transactional	.80	(.63)
Newcomer *Aversive	6.5**	(6.0)
Newcomer * Directive	.44	(.36)
Newcomer * Person-based	.90	(.68)

Table 13. The effects of leadership message on the likelihood of being self-removed.

Theoretical contribution.

Our studies investigate shared leadership model in an online community setting, a condition that prior work has not studied. Our results confirm prior theory in this new condition by demonstrating the prevalence and effectiveness of shared leadership in Wikipedia. Our results suggest that share leadership model can not only effectively manage dozens of employees in companies' self-managing teams but also scale to millions of volunteers with differing goals, experience, and commitment in an online community.

Practical implication.

Our results provide practical implications to better manage the Wikipedia community. Our results demonstrate the tradeoff of different types of leadership behavior on recipients' focal task performance and general work motivation. Aversive leadership and directive leadership benefits focal task performance but do not have effects on general work motivation, while transactional leadership and person-based leadership can positively influence general work motivation but do not have effects on focal tasks. Practitioners can consider their primary goal (e.g., accomplishing current task or encouraging long-term motivation) when designing interfaces and mechanisms to encourage certain types of shared leadership behaviors. For example, to encourage general motivation, interfaces and mechanisms should be designed to make it easier for members to connect with, reward, and express their appreciation for each other. Our findings also reveal opportunities to design computer-supported shared leadership systems. Our results suggest that automatically generated leadership messages might be particularly effective to influence the behaviors of newcomers in the community.

Generalization. In the study, we examine the leadership behaviors in Wikipedia. Considering the unique elements of Wikipedia (e.g., the unique activity of collaboratively creating encyclopedia), it remains an unresolved question whether the results can apply to other types of online communities or large offline volunteer organizations. We expect further comparative studies can confirm the extent to which these findings are generalizable.

Conclusion

We conducted two studies in Wikipedia to examine how different types of leadership behavior affect receivers' focal task performance and general work motivation, moderated by receivers' prior experience and senders' role. This research suggests trade-offs between motivational influence (e.g., sending positive feedback and reward) and directional influence (i.e., sending negative and directive feedback) on managing contributors' contributions. In the next part, I will investigate the effects of combining motivational mechanism and directional mechanism in volunteer production management.

PART II: COMBINING GROUP IDENTITY AND DIRECTION SETTING IN VOLUNTEER PRODUCTION

Volunteering in general (not only limited in peer production) is valuable activity for society, with both social and financial benefits. Volunteers contribute to many critical social services, such as mentoring youth to help them stay in school, feeding the homeless at their local church or shelter, and building houses with Habitat for Humanity. In 2010, about 62.7 million Americans (26.5 percent of the adult population) gave 8.1 billion hours of volunteer service valued at $173 billion (Corporation for National and Community Service, 2011). Even within conventional organizations with paid employees, employees often exhibit some level of voluntary activity (often referred to as "organizational citizenship behavior") not explicitly called for in their job descriptions or explicitly recognized by the formal reward system, but vital to the continued functioning of the organization (Organ 1988).

It has been a long-lasting challenge for organizations that rely upon volunteers to manage their workforce, given that volunteers are not as constrained as paid workers and are often free to adopt their own objectives (Pearce 1993)? Compared to paid workers, volunteers more freely choose which tasks to work on based on their own personal needs and interests (Benkler 2002, Pearce 1993, Raymond 1999); if the work they are expected to do doesn't interest them, they might not show up. Yet, while this free choice may be ideologically attractive, it poses serious problems when there are conflicts between the personal interests of the volunteers and the needs of the organization. There are many essential tasks that must be completed for the organization as a whole to be successful, independent of whether individual volunteers find them interesting or rewarding. As Pearce stated, "instilling enthusiasm is not the problem. It is attracting the potential (volunteer) workers' attention and focusing their efforts on necessary, if routine, tasks that is the great difficulty." (Pearce 1993). For example, in Wikipedia or open-source software development, volunteers may want to add content to the organization's core product, but may not want to perform maintenance tasks, translation tasks, or personnel tasks even though these are important to the health of the organization as a whole.

Traditional governance techniques, such as authority-based hierarchies or price-based markets, may not be well suited for managing volunteers due to issues such as incentive mismatches or reduction of autonomy (which I will discuss in more details in this section). Instead, volunteer organization needs to turn to other means of motivating volunteers to accomplish tasks that are important for the welfare of the organization as a whole.

Research in social psychology, organizational behavior and experimental economics has highlighted social identity as an important element to trigger behavior that transcends individual interest and benefits

a larger social entity to which the individual belongs (Tajfel 1972, Tajfel and Turner 1979, Tajfel 1982, Hogg and Terry 2000, Ashforth et al. 2008, Bartel 2001, Kramer 2006, Simon 1976, Tompkins and Cheney 1985, Goette et al. 2006, Forsythe et al. 1994, Yamagishi and Mifune 2008, Fowler and Kam 2007). Social identity is defined as "the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of the group membership" (Tajfel 1982). If people feel that their identities are tied to the identity of the social group, their goals may be more likely to reflect those that are important to the group (Hogg and Terry 2006).

While social identity can motivate a variety of organization-beneficial tasks, by itself it does not specify which particular tasks a member should perform and what specific outcomes to achieve. To complement social identity, organizations may need to set direction by highlighting important tasks and desirable outcomes, for example, by specifying group goals (Beenen et al. 2004, Locke and Bryan 1969, Locke and Latham 1990) or providing role models for members to follow (Shamire et al. 1993, Kärreman and Alvesson 2004). When the tasks and goals are made clear, people who identify themselves as organization members should voluntarily follow these directions because they believe that investing effort in these tasks is important for the organization and thus validates their own identity. In sum, we hypothesize that volunteer organizations can manage volunteers' efforts by combining social identity and direction setting. Social identity can align the individual volunteer's goals with the organizational goals, while direction setting can channel their effort toward specific tasks that are important for the organization.

In the following sections, we review some of the limitations of markets and hierarchies in managing volunteers, then discuss how social identification and direction setting can complement each other in motivating members to perform targeted group-desired behaviors in volunteer organizations. We test the effects of combining social identity and direction setting in the context of Wikipedia, a peer production project where people create and edit encyclopedia articles. We investigate the role of two sources of direction setting – explicit direction setting based on publicized group goals and implicit direction setting based on role modeling. After presenting the main findings we also discuss design implications for governance in online communities and conventional organizations.

Theory and Hypotheses

Limitation of Market and hierarchy

This section provides an overview of thinking in economics and organizational theory on the role of markets and hierarchies on task assignment, and argues that neither are well suited to the challenge of ensuring that volunteers perform tasks that are important to the a organization's mission and goals.

Markets

Markets coordinate task assignment through supply and demand forces and external transactions between different individuals and organizations (Malone et al. 1987). Although there are many variations, in an anonymous typical spot market someone with tasks that need to be accomplish posts the request in front of others who are capable of fulfilling it. Workers independently choose which tasks to take on based on market prices, i.e., how much the requester is willing to pay in the context of other requesters offering different assignments. As Powell pointed out "no one need rely on someone else for direction, prices alone determine production and exchange." (Powell 1990). Open hiring halls for longshoremen and seamen (Groom 1965), the hiring sites for immigrant day laborers (Valenzuela 2000), and Amazon's Mechanical Turk (Howe 2006) are all illustrations of how markets for matching workers with tasks can be done. Markets use price (i.e., extrinsic incentives including monetary incentives and non-monetary rewards) to influence workers' choices. If the volunteer organization Wikipedia applied a market mechanism, it would pay editors more cash or virtual rewards (e.g., points) for editing important but unpopular articles or for engaging in important but tedious tasks such as maintenance work. Market mechanism is simple, fast and effective and does not reply on communication.

However, volunteer organizations, by definition, use volunteers and not paid staff; they do not have the resources to provide monetary incentives to get important work done. Furthermore, providing any type of extrinsic incentives might undermine volunteers' intrinsic motivation. Participants in volunteer activities are often intrinsically motivated and value their autonomy. Pay seems to crowd out altruistic motivations for some pro-social behavior, at least for some people (Ariely et al. 2009, Mellström and Johannesson 2008). More generally, when extrinsic rewards are introduced for doing an intrinsically interesting activity, people tend to feel controlled by the rewards, and thus decrease their intrinsic motivation to participate (Deci and Ryan 2000). In a meta-analysis of 128 studies spanning 3 decades confirmed that not only monetary rewards, but also many other types of contingent tangible rewards significantly undermine intrinsic motivation (Deci et al. 1999).

Finally, the presence of extrinsic incentives also undermines the reputational value volunteers get from doing pro-social acts, creating doubt about the extent to they do them for the selfish or altruistic reasons (Bénabou and Tirole 2006). One motivation for people to volunteer is that they care about both public

reputation and self-image. Participation in volunteer activities socially signal the volunteer's values and can lead to both respect from others and positive self-image (Batson 1998). However, when extrinsic incentives are introduced (even if they are non-monetary), the society and people themselves tend to attribute volunteer behaviors to extrinsic incentives, which undermines the value of voluntary activities and decrease volunteers' participation (Lepper et al. 1973).

Hierarchy

Hierarchies influence task assignment by controlling and directing it at a higher level in the managerial hierarchy. They rely on authority (legitimate power) and extrinsic incentives to control people's behaviors. Hierarchical control has become the primary control strategy in modern organizations. Ideally, within a hierarchy, workers do what their supervisors direct them to do. Hierarchy legitimizes the roles of supervisors, so that employees see themselves as having an obligation to adhere to the decisions made by them. Extrinsic incentives, including monetary rewards such as raises and bonuses, and social ones including promotions and better assignments, supplement this legitimacy and are also important in causing employees to follow the direction of their supervisors.

However, hierarchies are unlikely to be effective in managing volunteers to perform tasks important for organization goal. First, hierarchy and position-associated authority conflicts with the ideology of many volunteer organizations. As Harrison pointed out "the ideology of voluntary social groups in America tends to be anti-authoritarian. The constituency of these groups is distrustful of centralization." (Harrison 1960 p.232). Second, according to psychology the psychological contrasts that volunteers have with organizations in which they work is different from paid employees' psychological contract with employers. Psychological contract refers to "an individual's beliefs regarding the terms and conditions of a reciprocal exchange agreement between that person and another party" (Rousseau 1989). Employees have reciprocity-based obligations to perform tasks assigned by their managers, because they expect in return pay, job security, and opportunities for promotion and development (Rousseau 1989). Volunteers have lower expectations of reciprocity, however, because volunteer organizations cannot provide them these resources (Farmer and Fedor 1999). Even though volunteers expect organizations to help them fulfill some needs, such as value expression, job-related experience or social opportunities (Clary and Snyder 1991), expectations of reciprocity are much lower compared to the expectations held by paid employees. Therefore, volunteers have fewer obligations to conform to the directions of others and more license to pursue their own interests. Third, formal managerial control of volunteers, including regular supervision and communication with them, typically decrease volunteers' motivation to participate by

undermining their self-determination and autonomy. According to Hager and Brudney, too much control may cause their "volunteer experiences to feel too much like the grind of their daily work rather than an enjoyable avocation," (Hager and Brudney 2004 p.9) and thereby drives them away.

Motivating through Triggering In-group Favoritism: Social Identity

Three lines of research in social psychology, organizational theory and experimental economics have investigated the challenge of motivating people to act in ways that transcends their individual interests, when extrinsic incentives and authority are not effective. All the three point to the importance of social identity for surmounting this challenge.

In the early 1970s, psychologist Tajfel and his colleagues conducted a series of laboratory studies showing that perceiving oneself as belonging to a group – that is, social categorization per se – is sufficient to trigger intergroup discrimination favoring the in-group (Tajfel 1972, Tajfel et al. 1971, Tajfel and Turner 1979).When people perceive themselves as group members, their view of their self-interest expands to include the group. They come to believe that helping in-group members or the group as a whole serves their own self-interest in a way that identical behavior would not if they had not identified with the group. Tajfel and his colleagues introduced the concept of social identity and developed classic social identity theory. Social identity is "the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of the group membership" (Tajfel 1972).

Organization scholars have investigated how social identity and in-group favoritism operates in work environments. Social identity leads individuals to perform behaviors beneficial to the organization units of which they are part (see Ashforth et al 2008 for a review). The outcomes associated with social identity involve cooperation, effort, participation, organizationally beneficial decision making (Bartel 2001, Kramer 2006, Simon 1976, Tompkins and Cheney 1985), intrinsic motivation (e.g., Kogut and Zander 1996, van Knippenberg and van Schie 2000), citizenship behaviors (Feather and Rauter 2004), information sharing, and coordinated action (Cheney 1983a, Grice et al. 2006, Tyler 1999). Recent research has extended this analysis to online volunteer communities.   Kittur, Kraut and their colleagues have examined the effects of group identification in Wikipedia, finding that joining a WikiProject (a subgroup in Wikipedia) was associated with increased production work, coordination work and citizenship behaviors (Kittur et al. 2009, Zhu et al. 2012a).

Experimental economists have measured the effects of social identity by making the expression of in-group favoritism costly (Goette et al. 2006, Forsythe et al. 1994, Yamagishi and Mifune 2008, Fowler and Kam 2007). In the dictator game (Forsythe et al. 1994), for instance, subjects divide a resource between themselves and an anonymous recipient. To measure in-group favoritism, the recipient is identified as either a member of the subject's own group or a different group. On average, people give more to members of their group, no matter whether the basis of the group is trivial (e.g., preference for the paintings of Klee or Kandinsky (Yamagishi and Mifune 2008), or meaningful g (e.g., political affiliation (Fowler and Kam 2007, Rand et al. 2009). Economists do not necessarily evoke the concept of social identity to explain in-group favoritism. One explanation uses group selection models from evolutionary biology: groups whose members engage in these in-group favoring actions can out-compete groups that do not (Bowles 2006, Wilson 1975). A second explanation is based on a reciprocity heuristic: given that people are more likely to have future interactions with in-group members than out-group members, it is in their self-interest to preferentially cooperate with in-group members (Kiyonari et al. 2000).

In sum, social identity is a cognitive process whereby individuals expand the way they think about themselves to include the groups and larger social collections of which they are a part. Social identity leads to in-group favoritism and is the basis for people behaving in ways that they believe benefits the group. Even though social identity may motivate volunteers to work in the groups behalf, social identity by itself is often too diffuse to effectively direct volunteers toward specific important tasks. Volunteers must know what is needed. Groups need some mechanism to highlight important tasks and focus people's group-oriented motivation towards these tasks. Below we discuss how two direction setting mechanisms, explicit goal setting and implicit social modeling, can fill this gap and complement social identity to manage volunteers.

Setting Direction through Explicit Group Goal and Implicit Social Model

Explicit direction setting: group goal setting

Goals provide a performance standard again which actions or the outcomes of action are judged, often within a defined time limit (Locke and Latham 1990). Individuals set goals for themselves (e.g., New Year's resolution to lose weight) and organizations set it for them as well (e.g., management by objectives). Goal setting is an effective technique to direct human attention and efforts toward specific activities and away from other irrelevant activities (Locke and Latham1990, Locke and Latham 2002). For example, students with specific learning goals attend to and learn goal-relevant passages better than

goal-irrelevant passages (Rothkopf and Billington 1979). Similarly, when people receive feedback, they only improve their performance on dimensions for which they have goals even when receiving feedback on multiple dimensions (Locke and Bryan 1969). Therefore, goals serve as a lens in the sense that they can focus and channel people's exertion and thus positively impact task performance (Wegge and Haslam 2003).

Regarding to the effectiveness of different types of goal setting, there is a substantial body of research demonstrating the effectiveness of individual goals. One robust finding is that specific and challenging goals cause people to work harder on tasks and to perform better than people working without goals, with vague goals or with easy ones (Locke and Latham 1990, 2002). Given moderate task complexity, commitment, ability to achieve the task, striving for challenging goals leads to an on average 0.6(±0.2) SD increase in individual performance (Locke and Latham 1990, 2002). In contrast, far few studies have explored the impact of group goals (i.e., the goals that teams or other organizational unites are required to achieve) (Haslam et al. 2009). Nevertheless, there is some evidence showing that the group goals can be effective. For example, O'Leary-Kelly, Martocchio and Frink conducted a meta-analysis of 10 studies and found that the performance of groups striving for a specific, difficult group goal was almost 1 SD higher than the performance of groups that did not have specific, difficult goals (O'Leary-Kelly et al. 1994). However, the effectiveness of group goals falls apart when the group goal conflicts with the individual interests of group members (Hinsz 1995, Wegge and Haslam 2003, Wegge and Haslam 2006). As discussed previously, the traditional management mechanisms to ensure the alignment between individual goals and group and organizations goals is limited or unavailable in volunteer organizations.

Group goals, which highlight important tasks for the group as a whole, can direct people's attention and efforts towards the group-relevant tasks and improve their performance on them, although the effectiveness is dependent on the congruence between individual values and group goals. As we discussed previously, group identification can align individuals' own interest with the group's interest. Therefore group goal setting and group identification can complement each other to direct volunteers' actions. People who identify themselves as group members are more likely to invest their efforts to achieve group goal than people who do not identify with the group because they believe the goals are important to the group and thus important for themselves.

Hypothesis 5 (Direct effects of goal setting).

> **H5a.** *Highlighting tasks important to a group through group goal setting directs people' efforts towards these tasks and improves performance on them.*

H5b. *The effect of group goal setting on effort and performance is stronger for people who identify with the group than those who do not.*

Implicit direction setting: social modeling

Social influence processes affects a wide range of peoples' beliefs, attitudes and behaviors (Cialdini & Goldstein, 2004). People adjust their behaviors by comparing themselves to others and modeling others, especially when objective, non-social means are not available (Festinger 1954). They learn what is expected of them and what they should do in ambiguous situations by observing what others do (e.g., Darley & Latane, 1968). Others' behavior cues provide implicit directions for people's action.

Social modeling is enhanced by social identity processes. According to Hogg and Turner's referent informational influence theory (Hogg and Turner 1987, Hogg and Abrams 1988) and social identity theory of leadership (Hogg 2001), social identity occasions a self-stereotyping process and motivates people to want to be similar to prototypical members in the groups to which they belong Specifically, people who define themselves as members of a distinct social category learn the stereotypic attributes of that category (i.e., group prototypes), with the purpose of resolving subjective uncertainty and conferring objective validity upon perceptions and conduct. Group prototypes are best represented by a set of exemplary members in groups. These prototypical group members serve as models, conveying both to group members and outsiders the relevant or appropriate in-group norms and behaviors. Other group members tend to cognitively and behaviorally conform to the most prototypical members in the group (Hogg 2001). The process of self-stereotyping is a group process generated by self-categorization (Hogg and Abrams 1988). Self-stereotyping and social modeling can lead to well-known group phenomenon such as group polarization (Abrams et al 1990; McGarty et al 1992) and minority influence (Mugny & Papastamou, 1982).

Most volunteer organizations have a core-periphery structure, in which the core consists of a small set of members who perform large amounts of work, engage in coordination activities (Mockus et al, 2002), have significantly more knowledge of the group and the community, and exert more influence (Zhu, Kraut & Kittur, 2012b)   than do peripheral members (Pearce 1993, Preece & Shneiderman 2009). For example, the online community of volunteers who write the online encyclopedia, Wikipedia, 3% of the volunteers produce 86.5% of the content (Wikimedia Foundation 2012). This core comprises the prototypical members. According to social identity theory, people who identify themselves with a group tend to change their beliefs and behaviors to be more similar to prototypical members. In contrast,

prototypical members will have less of an effect on those who do not identity with the group and consider themselves group members.

Social modeling is not a purely cognitive process. Instead, communication, including observational, non-verbal and verbal interactions, plays a key role in social modeling (Hogg and Reid 2006, Brown and Duguid 1991). Within groups, information about who is most prototypical, how they behave and what the group values can be gleaned by simply observing. Such information can also be intentionally communicated nonverbally through gestures and expressions or verbally through conversations. When peripheral members can indirectly observe what the core members are doing and directly interact with them, they are more likely to be influenced by them.

Hypothesis 6. (Effects of social modeling)

> **H6a.** *Exposure to and interaction with prototypical group members should lead people to perform more of the group-valued behaviors that prototypical members often engage in.*

> **H6b.** *The effect is stronger for people who identify with the group than those who do not identify with the group.*

Study Platform

Wikipedia

Wikipedia is both the world's most comprehensive encyclopedia, and the community volunteers who write it. According to Wikipedia's article on itself, "Wikipedia is a free, collaboratively edited and multilingual Internet encyclopedia supported by the non-profit Wikimedia Foundation. Its 22 million articles (over 3.9 million in English alone) have been written collaboratively by volunteers around the world. Almost all of its articles can be edited by anyone with access to the site, and it has about 100,000 regularly active contributors. … It has become the largest and most popular general reference work on the Internet, ranking sixth globally among all websites on Alexa and having an estimated 365 million readers worldwide. (Wikipedia, 2012a)"

Wikiprojects – groups in Wikipedia

We chose Wikiprojects, subgroups in Wikipedia, as the domain in which to investigate the effects of group identification and direction setting on performance. Wikiprojects are collections of editors who curate articles in specific areas, such as military history, psychology or medicine, or band together to perform specific encyclopedia-relevant activities, like copyediting. As of March 2008, Wikipedia

contained more than 2000 Wikiprojects. Each Wikiproject has dedicated pages (known as project pages) on which editors can coordinate and organize the writing and the editing of project-related articles.

Wikiprojects have a loose membership structure. Any editor on Wikipedia can edit articles a project curates or participate in project activities on an ad hoc basis. Editors can "join" the project and express their identification with it by adding their name to a member list or tagging their personal user pages with the project template. Some projects have explicit coordinators, who are responsible for coordinating maintenance tasks and keeping the project functioning.

Wikiprojects employ a variety of techniques to direct members' attention to project valued-tasks (Kittur et al 2009). These techniques include: 1) Open task lists or article alerts. Many Wikiprojects list dozens to hundreds of open tasks in their project pages. These lists identify articles that need to be expanded, assessed, copy-edited or reviewed and discussions that need more participation. 2) Important article lists. Some Wikiprojects list their most valued articles in their project pages, encouraging people to improve these. 3) Contests. Some Wikiprojects set goals and then reward people who contribute the most to them over a defined time period. 4) Collaborations of the Week (COTW). Projects set one or two articles need to improve during a defined time period (usually one week to one month).

Collaborations of the Week (COTW)

We investigated the impact of Collaborations of the Week as a direction-setting mechanism. They are widely-used in Wikiprojects, with as of March 2008,189 Wikiprojects deploying them for at least part of their history.

Collaborations of the Week usually have a selection phase and a collaboration phase. In the selection phase the project chooses one or two articles on which members will collaborate. In some projects, the article is chosen through voting. In others, coordinators select the article. Finally some projects use an automated process, for example randomly choosing one article from a predetermined list of articles that need improvement. During the collaboration phase, the project tags the chosen article(s) with a special template in the article' talk page (as shown in Figure 3 left). This template is visible to all editors who read the article talk page, not just those who are members of the Wikiproject. In addition, the project typically announces the targets of the collaboration on its project pages (as shown in Figure 3 right). Some projects also send special reminders to project members (those editors with names on member list) on their personal talk pages.
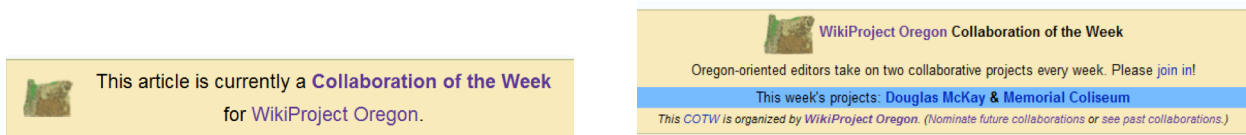
Figure 3. (Left)A Collaboration of the Week announcement in a target article's talk page. (Right) A Collaboration of the Week announcement in a project page

We chose to examine the Collaborations of the Week as group goal setting mechanism for several reasons:

- Collaborations of the Week are a goal setting mechanism that highlights tasks crucial for the project. For example, some projects explicitly claim that the goal of collaborations is to "fill the gap" for project (Wikipedia 2012c). Targets articles are typically ones that the project has evaluated as having high importance but low quality (Wikipedia 2012e). Furthermore, COTWs have many of the properties of effective goals (Locke & Latham 1990). Compared with a diffuse open task list, for example, COTWs set specific, concrete and time-limited requirements for editors. The limited number of articles and defined time period focus editors' attention on these articles, potentially leading to both production and social benefits.

- Collaborations of the Week are also social events. COTWs focus volunteers towards specific targets during a defined period, providing opportunities for volunteers to working on the article to plans and progress, and potentially to influence each other. According to Collaboration of the Week participants with whom we conducted with some preliminary interviews, Collaborations of the Week are "a chance to get to meet your collaborators and their interests". COTW participants are "virtually surrounded by peers who are into the topic, and you all have the common goal of sharing knowledge together." Discussions, when they occur, are most likely to appear on the target article's talk page. Both project members and other editors who are editing during the collaboration period can contribute to these discussions.

- Collaborations of the Week are salient. Notices for COTWs are displayed prominently both on project pages, thereby attracting people who care about the project, and on the talk pages of the

47

articles which are targets of the collaboration, thereby attracting editors interested in the specific article.

- Finally, Collaborations of the Week are amenable to analysis. Firstly, they have been used by multiple projects on multiple occasions, providing sufficient data for analysis. Second, they have clear-cut start times and end times, allowing comparisons of editors' behavior on the same articles when the articles were the subjects of collaborations and at other times.

Method

In the following analysis, we used a complete download provided by the WikiMedia Foundation from Wikipedia's inception to March 2008 (approximately 182 million revisions). To handle this data volume, we used the Yahoo! M45 computing cluster running Hadoop and Pig. Among the 189 projects that ever used Collaborations of the Week for goal setting, we chose projects that had used COTWs at least five times with explicit start and end dates and complete collaboration histories. We excluded two collaboration-oriented projects which do not have their own topics (which were these).   The remaining 26 projects carried out a total of 618 collaborations, which lasted 17.7 days on average. The analysis period spanned 2004 to 2008.

The 26 projects were large and important ones in Wikipedia. They include eight of the ten largest projects in Wikipedia. On average, each project encompassed 26,553 articles (median = 4,632) and 471 members (median = 255.5). Overall, these 26 projects contained 68.5% of all articles associated with any project in Wikipedia.

Analysis and Results

Study 1. Combing Direct Effects of Goal Setting

1.1 Analysis Strategy
H5 predicts that, although any editor can participate in the Collaborations of the Week, people who identify themselves as group members will be especially likely to be influenced by the collaborations to work on goal-related articles.

We included in our sample all editors who had edited a article either during the week-long or month-long period when it was the target of a collaboration or during the pre-collaboration or post-collaboration time

period (i.e., either a week or month). We assume that all of these editors were aware of the event, at least from the advertisement notice on the article talk page.

To test the direct effects of publicizing important tasks via group goals, we examined whether these editors' contributions increased during the goal period (the period when the articles are selected as collaboration targets) compared to the non-goal period (the pre- and post-collaboration period). For the effects of group identification, we further investigated whether the contribution increase during the goal period was larger for editors who have higher group identification than for those who have lower group identification.

1.2 Dependent Variable

Goal-relevant Contribution: The dependent variable is the number of revisions editor make to collaboration-related articles during a time period. Revisions are a measure of editors' effort, indicating the number of changes they make to the collaboration articles. A revision occurs when an editor saves the results of a set of editing actions, for example adding, changing, deleting or reverting text, references or illustrations, or communicating with other editors. In this analysis, the dependent measure was the number of revisions the editor made to the COTW articles or their associated discussion pages.

1.3 Independent Variables

Goal period: Collaborations of the Week are explicit group goals that designate one or two articles as targets of work during a defined time period. When editors revise these articles during that period, they are acting consistently with the group's goals. However, editing other articles or editing the COTW articles at other times did not fulfill the group goals in this context. To assess the effectiveness of these goals, we compared contributions towards the same target articles in different time periods – pre-collaboration, during collaboration and post-collaboration. In the analysis, pre-, during and post-collaboration periods were of the same length. For example, if the collaboration lasted one week, pre-collaboration is the week before the start of collaboration; while post-collaboration includes the week after the end of the collaboration. In particular, the dummy variable "Goal period" in our analysis was defined as 0 during the pre-collaboration and post-collaboration periods, and 1 during the collaboration period.

Group identification: This variable indicates the editor's level of group identification during the given period. As discussed previously, editors can express their identification with a project by adding their name to a member list (as shown in Figure 4) or tagging their personal user pages with the project template (as shown in Figure 5). We used an ordinal variable to indicate group identification: 0 indicates

the editor did not perform either of the social identity acts, 1 indicates that the editor performed one of the social identity acts and 2 indicates that the editor performed both.

Table 14 shows the percentage of editors participating in Collaborations of the Week in different group identification categories, averaged over 618 collaborations.
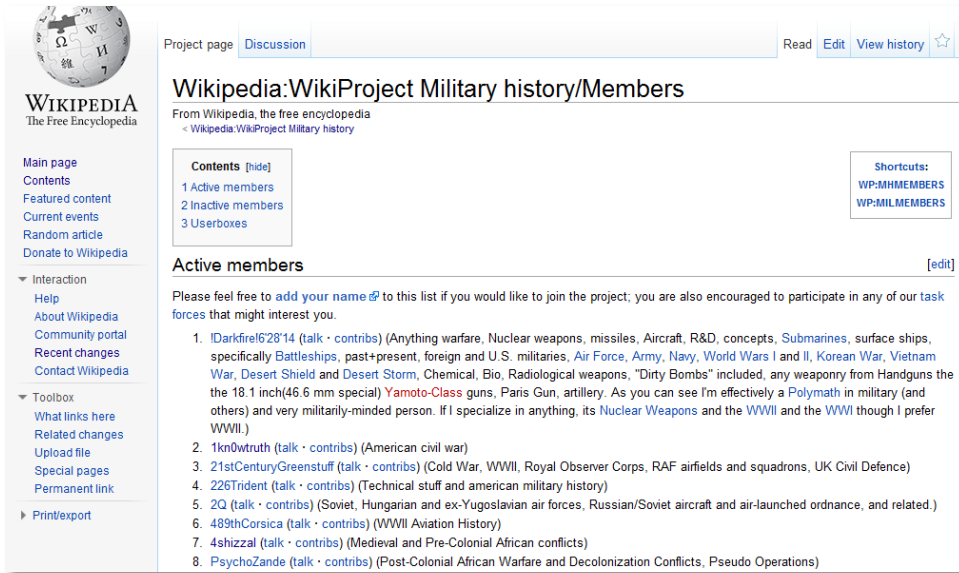
Figure 4. Examples of project member list.

Figure 5. . Examples of project member templates on editors' personal page.

Average number of participants in each COTW	11.3			
	Editors with low group identification	**Editors with medium group identification**		**Editors with high group identification**
Operationalization	1. Did not edit project (member) page 2. Did not add member template on user page	1. Edited project (member) page 2. Did not add member template on user page	1. Did not edit project (member) page 2. Added member template on user page	1. Edited project (member) page 2. Added member template on user page
Percentage of editors with different levels of identification with the Wikiproject	65.3%	28.3%	0.2%	6.2%
		28.5%		

Table 14. Average percentage of editors with different levels of group identification

1.4 Control Variables.

Goal length: the number of weeks the collaboration lasted.

Project articles: the total number of articles in the scope of the project during the given period.

Project members: the total number of project members during the given period.

1.5 Statistical Model

We conducted an editor–level analysis, with revision count of contributors to the article as the dependent variable. Because revision counts are count data with a non-normal distribution truncated at zero, we used a negative binomial regression model. Because the analysis compared the contributions from the same editor in different time periods (pre-, during, and post-collaborations), we used random effects methods to deal with the panel data set (Kennedy 2001).

1.6 Analysis Results

Figure 6 shows the average number of revisions per editor on collaboration targets in before, during and after collaboration periods, Editors in general contributed more during collaboration periods, but the effect is dramatically larger for those who expressed medium and high group identification than those who have low group identification.

Table 15 shows the results of the negative binomial regression analysis. The regression results are reported using both coefficients and Incidence Rate Ratios (IRR). IRR can be interpreted as the ratio

change in the dependent variable when increasing an independent variable by one unit. The model treats as the baseline contributions from low-group-identification editors during non-collaboration periods.

Model one shows that overall people who expressed more identity with a WikipProject made more revisions to the target article, but Model 2, which includes the social identity X collaboration period interaction, shows this effect occurs only during the collaboration period. During non-collaboration periods, there were no significant differences in the amount of contribution from people with different levels of group identification. However, during collaboration periods, low-self-identification editors increased their contributions 42%, while medium-self-identification editors increased 169% and high-self-identification editors increased 358% compared to baseline. The main effects of the collaboration period and its interaction with the social identity variable were both highly significant. These results support H5, suggesting that group goals had a strong motivating effect on contribution, and the effect was especially strong for editors who identify with the project.

The results also suggest that the number of weeks a COTW lasts has a slight negative effect on contributions. Although statistically significant, the size of this effect is quite small. Factors such as the total number of project articles and project members do not have significant effects. Together, these results suggest that the effects of group goal setting coupled with social identity are robust across variations in the length of goal period and project characteristics.
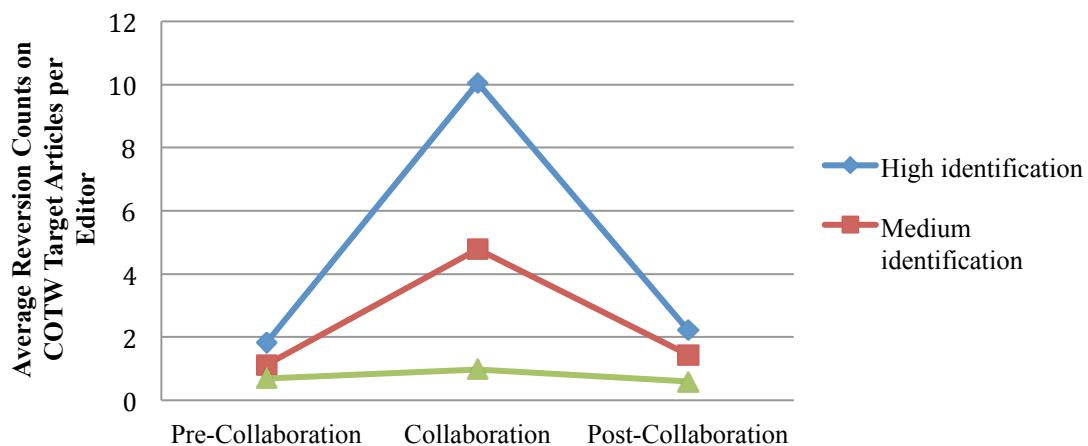
Figure 6. Average revision counts on collaboration target articles in different time periods from editors with different levels of group identifications.

Dependent Variable: Goal relevant contributions (revisions on collaboration target articles).					
	Model 1			**Model 2**	
Explanatory variables	**Coef (IRR)**	**S.E**		**Coef (IRR)**	**S.E**
Goal period					
0 - Pre & post collaborations (baseline);					
1- During collaboration period	.827 (2.29)**	.017		.351 (1.42)**	.023
Group identification					
0 – Low identification (baseline);					
1 - Medium identification;	.464 (1.59)**	.022		-.010 (0.99)	.029
2 - High identification	.730 (2.07)**	.038		.023 (1.02)	.052
Goal period * Group identification					
During collaboration * Medium identification				.990 (2.69)**	.037
During collaboration * High identification				1.52 (4.58)**	.060
Goal length	-3.6e-3 (1.00)*	1.4e-3		-4.3e-3 (1.00)*	1.4e-3
Project members	-5.3e-5 (1.00)*	2.2e-5		-6.0e-5 (1.00)*	2.2e-5
Project articles	1.1e-7 (1.00)	1.1e-7		1.5e-7 (1.00)	1.1e-7
Intercept	-1.24 (0.29)**	.025		-.94 (0.39)**	.026
Log Likelihood	-43380.886			-42814.495	
Observations	32187 (10729 groups)				

Incidence Rate Ratios (IRR) is reported in parentheses. IRR can be interpreted as the ratio change of the dependent variable when increasing an independent variable by one unit.   ** $p<0.01$, * $p<0.05$.

Table 15. Random effect negative binomial model predicting goal relevant contributions (revision counts on collaboration target articles).

1.7. Effects of Goal Setting on Goal-irrelevant Tasks

The previous analysis demonstrated that group goals set via Collaborations of the Week strongly energized editors who identified with the group to contribute more to achieve the goals compared to volunteers who didn't identify with the group. If we assume that volunteers' total efforts are fixed, increasing efforts on goal-relevant tasks will decrease efforts on other goal-irrelevant tasks. However, we have reasons to believe that group goals do not just redistribute people's efforts but actually increase their general motivations to work. First, according to expectancy effects, success and failure on one task may change motivations for subsequent tasks (Kernis et al 1982, Locke and Latham 2002, Roberts et al. 2006). It is possible that accomplishing group goals can lead to increase in people's self-efficacy, which activates people to continue working after the initial task is accomplished. Second, social identity affects attitudes and behavior to the extent that the individual is "made aware" of the membership in the group (van Knippenberg 2000). Although identification itself may contribute to social identity salience (Haslam

2006), contextual cues can also affect salience as well. Specifically, the presence of group goal serves as cues of group membership and renders the group identity salient (Wegge and Haslam 2003), which then leads to more group relevant activities and contributions. Since the cues are temporary and unstable, the effects might be time-sensitive.

Did group goals redistribute people's efforts or did they increase the overall contributions and spill over to other behaviors that could benefit the group? To examine this question, we compared the volume of contributions WikiProjects received for non-COTW articles during periods when they hosted a Collaboration of the Week and during other periods. If there are spill-over effects of group goal setting, then projects would receive more goal-irrelevant contributions during periods when the goals are activated. However, if group goals operate via a hydraulic model and only redirect a fixed amount of contribution to different causes, then projects should receive fewer contributions to goal irrelevant articles during periods when the goals are activated.

1.7.1 Dependent Variable

Non-related contributions: the average number of revisions done by each self-identified project member (i.e., identification level is medium or higher) on all articles in the scope of a project (including associated discussion pages) in a given month, excluding revisions on COTW target articles.

1.7.2 Independent Variable

Goal period: a dummy variable indicating whether the project posted Collaboration of the Week goals in a given month. Even though all of the projects in the sample used COTWs some of the time, they used them in only 46% of the months in the dataset.

1.7.3 Control Variables

Project articles: number of articles in the project.

Project members: total number of medium-identification and high-identification members during the given month.

Project coordination activity: number of revisions made to the project pages in the given month. Since these project pages are where editors organize and discuss project activities, this variable reflects the overall activity of the group during the time period. We used this variable to control for other project activities which might influence contribution towards the project.

Project age: number of months the project has been in existence, starting month one (the month when the project was created). We used this variable to control for the maturity of the project which might influence how much effort people will devote towards the project.

1.7.4 Statistical Model

Because the analysis compared the contributions (i.e., revision counts) from the self-identified editor in the same group during different time periods, we also applied a negative binomial regression model with random effects to fit the data. Unlike the previous study, which used editor-period as the unit of analysis, the current study uses month-period as the unit.

1.7.5 Analysis Results

The results reveal that the presence of a Collaboration of the Week substantially increased the average number of edits done by project self-identified members (i.e., people with medium or high level of group identification). During periods in which a group activated COTW goals self-identified members approximately doubled their contributions on non-target articles (Coef = 0.764, IRR = 2.15, P<0.001). To put this in context, during the month the project posted COTW goals, self-identified group members on average made 9 edits to the collaboration target articles and 60 more edits to other articles in the scope of the project compared to non-COTW month. Thus it appears that employing shared group goal mechanisms such as COTWs can have large benefits to contributions to the project that go beyond the articles identified as collaboration targets.

	Dependent Variable: Goal-irrelevant group-related contributions (revisions on non-target articles)			
Explanatory variables	**Coef**	**(IRR)**		**S.E**
Setting goals	.764	(2.15)	**	.045
Project Age	.041	(1.04)	**	.002
Project Members	-2.76 e-4	(1.00)	**	9.09 e-5
Project Articles	-2.86e-6	(1.00)	**	4.23e-7
Project Activities	2.93e-4	(1.00)	**	3.59e-5
Intercept	1.81e-3	(1.00)		.083
Log likelihood		-3334.0327		

Table 16. Negative binomial regression model with random effects predicting goal-irrelevant group-related contributions. Incidence Rate Ratios (IRR) is reported in parentheses.

IRR can be interpreted as the ratio change of the dependent variable when increasing an independent variable by one unit.   ** p<0.01, * p<0.05.

Study 2. Combining Group Identity and Social Modeling

The previous two sections examined how the goal-setting component of Collaborations of the Week seems to influence volunteers by explicitly indicating what tasks a project wants them to work on. In the current study, we examine more implicit direction setting that occurs though social modeling. Collaborations of the Week are not simply goals, but also represent opportunities for volunteers to come together interaction and social influence. During non-COTW periods, editors are widely distributed across work location and time. With N editors and M articles associated with a typical Wikiproject, a pair of editors is not likely to be working on the same article at approximately the same time. Much like a lollipop on the sidewalk concentrates ants from a nest foraging, collaborations of the Week concentrate volunteers, bringing them together during a defined time period to work on the same article. Here they can be exposed to each others' work on the article's page or their conversations on the article's talk page and can potentially interact with the other volunteers. Because in Wikipedia core volunteers are more active than peripheral ones, editors participating in a Collaboration of the Week are especially likely to come in contact with core editors. The behavior that core members engage in provides implicit direction to others about the norms of the group. Thus they serve as role models about what is appropriate in the group. Their behavior should be especially influential on people who identity with the group.

The previous two also focused on how Collaborations of the Week influenced the core work activity in Wikipedia, the writing of encyclopedia articles. Here we expand the focus to also look at the non-core, discretionary activities in Wikipedia that are analogous to organizational citizen behaviors in more conventional organizations. There are different types of activities in Wikipedia, they are not appreciated equally. For example, the central and most valued work in Wikipedia is creating good quality articles. Adding content to articles is not sufficient. Established editor brag about the number of articles they have brought to "featured article" status. In contrast, maintenance tasks, such as copy-editing, formatting citations, welcoming newcomers, reverting vandalisms, and assessing articles, are actually important to wikipedia as a whole, but characterized as "tedious, often unrewarding, and usually unappreciated" tasks (Wikipedia 2012d). However, these tasks are important for the continuing function of the organization. Kriplean et al identified a set of tedious but vital tasks in Wikipedia, including teaching rewarding welcoming others, finding sockpuppets, reverting vandalism, assessing articles and creating templates (Kriplean et al 2008). In the analyses below, we treat reverting vandalism, article assessment and talk page discussions as representative ones because they are most common activities in Wikipedia. We will test whether social modeling may be a useful way to influence people to accomplish these tasks.

2.1 Analysis Strategy

The goal of this analysis is to test whether editors treat the core members in a Wikiproject as role models and are influenced by them, and whether this influence effect is greater during Collaboration of the Week periods than at other times and when the editors subject to the influence are project members rather than editors who do not express any identification with the project. We define prototypical members as those who were the heaviest contributors in project pages. To be able to compare influence during COTW and non-COTW periods, we restricted the analysis to editors who had participated in COTWs at least once.

To measure the degree of the influence of core members, we ran regression models predicting regular members' behaviors from prototypical members' behaviors, whether the regular editors identified themselves as project members or not, and whether the regular editors participated in COTWs in the given period or not. Hypothesis 6 predicts that the effects of prototypical members' behaviors on the regular members' behaviors should be higher during periods when the regular editors participated in COTWs than during other periods (i.e., the interaction of core members' behavior and COTW period) and higher yet when the targets of influence identify more with the project (i.e., the three-way interaction of the core members' behavior, COTW period and the regular members' project membership). Because the analysis compared behaviors from the same editor in different time periods (e.g., including the monthly activity from the same editor when he/her participated in COTW and when not participating in COTW), we still used random effects methods to deal with the panel data set. The unit of analysis is the editor-month.

2.2 Dependent variables: performing unattractive but vital tasks

Regular members' anti-vandalism: Vandalism is defined as "any addition, removal, or change of content made in a deliberate attempt to compromise the integrity of Wikipedia" (Wikipedia 2012f). Anti-vandalism is the behavior of reverting a vandalized version of an article to a previous state. Following previous research (Kittur et al 2009), we quantified anti-vandalism as edits annotated with common vandalism-fighting comments, such as "Reverting vandalism" or variants such as "rvv". For this variable, we calculated the (log transformed) number of revisions with anti-vandalism comments on articles within the project done by each editor in the given month.

Regular members' assessment: Each article within the scope of a Wikiproject can have a quality rating and an importance rating in its Wikiproject template. Assessing an article involves adding or changing the rating of an article. Assessing articles is an important task for Wikiprojects, in which members identify important topics and assess the quality of the work done to date. There have been over 2.1 million

assessments made over the history of Wikipedia, with most being driven by individual projects. We calculated the (log transformed) number of revisions done by the editor which change the assessment rating of any article within the project.

Regular members' talk page edits: Coordination is another important type of unattractive but vital tasks. In Wikipedia, much of the coordination about articles happens on the articles' corresponding talk or discussion page. We calculated the (log transformed) number of revisions done by the editor on the discussion page of the collaboration targets.

2.3 Independent variables:

Core members' anti-vandalism: This variable indicates the (log transformed) number of revisions with anti-vandalism comments on articles within the project done by the prototypical member in the given month.

Core members' assessment: This variable indicates the (log transformed) number of revisions done by the prototypical member which change the rating of any article within the project.

Core members' talk page edits: This variable indicates the (log transformed) number of revisions done by the prototypical member on the discussion page of the collaboration targets.

Group identification: This variable indicates the editor's level of group identification during the given period. To simplify the interpretation, we used a binary variable to indicate group identification: 0 indicates the low level of group identification and 1 indicates medium or high level of group identification.

Participation in COTW: This variable indicates whether the editor has participated in COTW during the given period. We used a binary variable to indicate group identification: 0 indicates no participation and 1 indicates participation.

Explanatory variables	Dependent Variable: Monthly article assessment (a measure of maintenance activity).					
	(1)		(2)		(3)	
	Coef	S.E	Coef	S.E	Coef	S.E
Group identification	.3608**	.0201	.3246**	.0215	.3255**	.0215
Participation in COTWs	.0272*	.0112	.0133	.0140	.0140	.0139
Core members' assessment	.0360**	.0022	-.0051	.0031	.0019	.0033
Group identification * Participation in COTWs			.0415	.0232	.0385	.0232
Group identification * Core members' assessment			.0825**	.0045	.0644**	.0052
Participation in COTWs * Core members' assessment			.0228**	.0035	.0034	.0045
Group identification * Participation in COTWs * Core members' assessment					.0496**	.0072
Within R-square	0.03		0.05		0.05	
Between R-square	0.09		0.15		0.15	
Overall R-square	0.07		0.11		0.11	

*** p<0.01, * p<0.05*

Table 17. Random-effects generalized least square regression (with observations from the same person as a group) predicting monthly assessment (a measure of maintenance activity).

Explanatory variables	Dependent Variable: Monthly Talk Page Edits(a measure of collaboration activity)					
	(1)		(2)		(3)	
	Coef	S.E	Coef	S.E	Coef	S.E
Group identification	.2574**	.0129	.0524**	.0149	.0501**	.0149
Participation in COTWs	.4660**	.0102	.2668**	.0125	.2687**	.0125
Core members' talk page edits	.0173**	.0039	-.0159**	.0055	-.0053	.0059
Group identification * Participation in COTWs			.5292**	.0206	.5255**	.0207
Group identification * Core members' talk page edits			.5293**	.0079	.0010	.0099
Participation in COTWs * Core members' talk page edits			.0293**	.0074	.0226*	.0095
Group identification * Participation in COTWs * Core members' talk page edits					.0772**	.0153
Within R-square	0.15		0.20		0.20	
Between R-square	0.16		0.19		0.19	
Overall R-square	0.18		0.22		0.22	

*** p<0.01, * p<0.05*

Table 18. Random-effects generalized least square regression (with observations from the same person as a group) predicting editors' monthly talk page edits.

	Dependent Variable: Monthly article anti-vandalism (a measure of maintenance activity).					
	(1)		**(2)**		**(3)**	
Explanatory variables	**Coef**	**S.E**	**Coef**	**S.E**	**Coef**	**S.E**
Group identification	.2614**	.0193	.2639**	.0213	.2639**	.0213
Participation in COTWs	.0696**	.0114	.0728**	.0143	.0728**	.0143
Core members' anti-vandalism	.0282**	.0057	.0250**	.0082	. 0245**	.0087
Group identification * Participation in COTWs			-.0079	.0237	-.0080	.0237
Group identification * Core members' anti-vandalism			-.0220	.0117	-.0206	.0142
Participation in COTWs * Core members' anti-vandalism			.0340**	.0110	.0356*	.0141
Group identification * Participation in COTWs * Core members' anti-vandalism					-.0039	.0225
Within R-square	0.012		0.014		0.014	
Between R-square	0.032		0.033		0.033	
Overall R-square	0.020		0.021		0.021	

** p<0.01, * p<0.05

Table 19. Random-effects generalized least square regression (with observations from the same person as a group) predicting monthly anti-vandalism.

2.4 Analysis Results

The results are shown in Table 17, 18 and 19. For assessments (Table 17), the results are consistent with the Hypothesis 6. Compared to editors who did not participate in collaborations of the week, editors who were exposed to prototypical members through the Collaborations of the Week performed more similarly to prototypical members in terms of helping assess articles (coefficient = 0.0228, p<0.01). Editors who strongly self-identified as group members acted even more similar to prototypical members compared to weakly self-identified editors, in the month participating collaborations (coefficient = 0.0496, p<0.01).

For talk page edits (a type of coordination activity), editors who participated in collaborations also behaved more similarly to prototypical members compared to editors who did not participate (coefficient = 0.0293, p<0.01). Editors who strongly self-identified as group members acted even more similar to prototypical members compared to weakly self-identified editors, in the month participating collaborations (coefficient = 0.0772 , p<0.01).

For anti-vandalism, editors who participated in collaborations also behaved more similarly to prototypical members compared to editors who did not participate (coefficient = 0.0340, p<0.01). However, the difference between strongly identified members and weakly identified members is not significant

(coefficient = -0.0039, p= 0.861). Thus we have mixed results about the interaction effects of group identification and social modeling in the case of vandalism reversion.

Discussion

This research has demonstrated that publicizing important group goals via COTW can have a strong motivating influence on editors who highly identified themselves as group members. We examined three types of editors: editors with low level of group identification – those who neither added their names on the member list nor added membership template on their personal pages; editors with medium level of group identification – those who either added their names on member list or added membership template on their personal pages; and editors with high level of group identification – those who not only put their names on the member list and also put project membership template on their user pages. Results show that, during non-goal periods, there is no significant difference between people with different levels of group identification. During goal periods, low-self-identification editors increased their contributions 42%, while medium-self-identification editors increased 169% and high-self-identification editors increased 358% compared to baseline. The results support our hypothesis that people who self-identified as group members voluntarily follow directions from groups and perform group goal related tasks. We also examined the effects of COTWs on goal-irrelevant tasks and found that the effects of COTWs spill over. The presence of COTW goals induced high self-identified members and medium self-identified members to approximately double their contributions on non-target articles. The results suggest that volunteers' total efforts are not fixed. Group goals do not just redistribute people's efforts but actually increase their general motivations to work.

Second, our results confirmed the effects of social modeling by showing that editors exposed to prototypical group members are more likely to behave similarly to those members than editors not exposed to prototypical members. However, the effects are not always stronger for self-identified members. For assessing articles (a maintenance activity) and talk page edits (a coordination activity), strongly self-identified members (high and medium level) indeed performed more similar with prototypical members when exposed to them than weakly identified members (low level). However, for reverting vandalism, there is no significant difference between strongly identified members and weakly identified members. One possible explanation for the latter findings is that, reverting vandalism, although an important behavior to protecting the article, is not an activity that is strongly identified with any

particular group. Actually, one single article is often belongs to multiple Wikiprojects in Wikipedia. This suggests that social modeling may not be effective for behaviors that are not specific to the group.

Theoretical implications

Despite its importance, how to manage volunteers has heretofore been a relatively neglected area of research in organizational behaviors. In this research, we identified the unique challenges of volunteer management compared to paid worker management, and then demonstrated that incorporating group identity (which provides the motivational basis) and group goal setting and social modeling (which provides directions) can effectively direct volunteer workers' behaviors.

Second, even though a substantial body of research on social identity shows that identification is positively associated with the willingness to exert effort on behalf of the collective, this does not necessarily mean that identification results in work motivations on the specific tasks that are important for the success of the group. Little research has distinguished the motivation to exert efforts on behalf of the collective in general and the motivation to perform specific important task for the collective. In this research, we demonstrated that direction setting mechanisms such as group goal setting and social modeling can transform the diffused motivation caused by group identification to efforts on specific tasks. One direction for future research is to create taxonomy for different direction setting mechanisms that can complement group identification and harness its potential effects.

Third, some evidence regarding to spillover effects of goal setting for self-identified members has been found in the experiment. One explanation is that the presence of group goals is a group identity cue and makes the group identity salient, leading to a increase in the overall motivation which spills over to goal-irrelevant tasks. The findings point to several research directions. What contextual cues can activate the group identity? How do the effects of contextual cues interact with the level of innate group identity? How do the contextual cues of a certain level of social identity (e.g., goals of Wikiproject) affect identity of a higher level (e.g., identity as a Wikipedia editor) or the identity of a lower level (e.g., identity as a member of a work group inside Wikiproject)? In other words, what are the boundaries of the effects of the social identity cues?

Forth, compared to the large amount of research on individual goal setting, research on group goal setting is limited. Group goal setting is not just a parallel of individual goal setting at the collective level as some researchers claimed (Locke & Latham 1990). Group goal setting has rich content and also involves several group processes that are not available in individual goal setting. Weldon and Weingart (1993)

developed a model that incorporates processes including group planning (e.g., talking about who should do what), cooperation within the team (e.g., listening to each others' ideas) and morale building communication (e.g., statement that stimulates supportive emotions and enthusiasm to achieve the group goal). In addition to these processes directly relevant to goal achievement, in this study, we also demonstrate that group goal setting has positive effects beyond the goal-relevant tasks. For example, group goals serve as group identity cues and might lead to motivational spillover on goal-irrelevant tasks. Group goal setting also facilitate group processes such as social modeling to influence goal-irrelevant but group-valued behaviors. The future research of goal setting should take into account the rich nature of group goal setting, which might be a promising way out of the dad end in which current goal setting research seems to have.

Practical implications

Implications for Wikipedia

Association for Psychological Science (APS) collaborating with Wikipedia recently announced APS Wikipedia Initiative (APSWI). The goal of APSWI is to ensure that Wikipedia articles about psychological research and theory are accurate, up-to-date, complete and written in a style appropriate for the general public. APSWI is another example of combining social identity and direction setting to accomplish critical tasks in Wikipedia. On one hand, APSWI encourages APS members, who developed their identification with the psychological community after years of socialization, to improve Wikipedia articles about psychology. APS members are motivated to contribute to these encyclopedia articles because they are important for the psychological community and also validate their own identity. On the other hand, APSWI sets explicit directions (e.g., providing editing recommendations) to guide APS members' effort toward specific articles especially need efforts.

Implications for volunteer organizations

Developing social identity in organizations. Our results show that identifying with a group is the basis to motivating volunteers to perform tasks important for the group. A rich literature in psychology has worked to identify the constructions of social identity. Kraut and his colleagues synthesized previous work and proposed several practical design suggestions to increase people's social identity (Kraut & Resnick 2012), such as 1) providing a collection of individuals with a name or other indicator that they are members of a common group, 2) providing tagline that articulate the shared interests of volunteer members or the shared value of the organization, and 3) highlighting an out-group (and competing with it) will increase members' group identity.

Defining group goals and facilitating social modeling. There is a large body of research investigating the effectiveness of different types of goals (see Locke et al 1990, 2002 for revies). For example, difficult goals produce higher levels of effort and performance than easy goals; specific goals are more effective than "try your best goals"; and providing feedback about the progress is important for goals to be successful. These findings can help practitioners to design more effective group goals. However, there may also be limits to the applicability of group goal setting, which simply highlight tasks important for the group. If these tasks involve high coordination costs, the benefits of adding more effort may be offset by the difficulties of coordinating that effort; or, as Brooks aptly states, "Adding manpower to a late software project makes it later" (Brooks 1975).   However, in the cases when group goal setting can be used, our results suggest it is remarkably powerful and leads to benefits not only to the targeted goals but also to other group-relevant tasks.

Compared to group goal setting, which focuses attention on a specific set of tasks, social models may be especially effective in drawing in peripheral members and training them in a wide range of subtle behaviors. Therefore, we recommend practitioners pay close attention to encouraging the desired behaviors from core members and then providing social opportunities (such as communication channels and collaboration tasks) for core members to interact with and potentially influence the others.

Implications beyond volunteers. As globalization and hypercompetition intensifies (D'Aveni 1994), as the technology explosively grows and the cost of communication dramatically decreases   (Malone 1987), as the complexity of technical and social interaction increases (Flint 2002), organizations are forced to be changed from tightly bounded systems which are centralized, monitored, and hierarchical managed, to loosely-coupled systems which enables fluidity and continuous change and empowers individuals (Brown and Eisenhardt 1998, Ciborra 1996, Garud et al 2002, Benkler forthcoming). Human autonomy, creativity, insight, wisdom, and learning capability are more and more valued. The research of volunteer control can provide useful insight for non-volunteer organizations to organize their employees, who are more and more likely to be autonomous and empowered, to perform collective actions and achieve organizational goal.

Limitation

In the study, we deliberately introduce variance by examining 618 Collaborations of the Week events in 26 different Wikiprojects in Wikipedia spanning from 2004 to 2008. Still, people might argue that all the events occurred in Wikipedia, which is not a typical volunteer organization. Indeed, Wikipedia is special

since it is larger than many other volunteer organizations (i.e., Wikipedia has more 100,000 active contributes and each Wikiproject on average has more than 400 contributors); contributors in Wikipedia communicate via Internet which is different from many offline organizations; the activities in Wikipedia are collaboratively creating encyclopedia are different from other volunteer activities. Despite all the differences, Wikipedia meets the one and the only one critical criterion that identifies volunteer organizations: people contribute without payment. Therefore, we believe that the results can apply to other types of online and offline volunteer organizations. We expect further comparative studies can confirm the extent to which these findings are generalizable.

Conclusion

This research investigated how combining group identification with direction, either explicit direction through group goals or implicit direction through social modeling, can motivate volunteers to accomplish tasks important to the success of the group. We tested our hypotheses in the context of subgroups within Wikipedia (Wikiprojects), examining a common group activity (Collaborations of the Week). Our results demonstrate that 1) highlighting important group goals can have a strong motivating influence on editors who have self-identified as group members compared to comparable others who have not self-identified; 2) the positive effects spill over to non-goal related tasks; and 3) editors exposed to prototypical group members are more likely to behave similarly to those members than editors not exposed to prototypical members.

CHAPTER 2. PRACTICE LEVEL SUCCESS OF PEER PRODUCTION

MOTIVATION: BEST PRACTICE TRANSFER DILEMMA

Online communities, like companies in the business world, often need to transfer best practices internally from one unit to another to improve their performance. For example, communities in the Stack Exchange network of question and answer websites use a common reputation system modeled on Stack Overflow's original one. Similarly, many non-English language Wikipedia versions have borrowed policies and procedures originally developed in the English Wikipedia. Barnstars, the badges Wikipedia editors give to each other to reward meritorious work and motive each there, originated in the MeatballWiki and were imported into Wikipedia in 2003. Since then Wikipedia has developed over 100 distinct Barnstars and thousands of Wikiprojects have created their own specialized Barnstars. Similar tales could be told of Wikipedia's various quality improvement programs, such as Collaborations of the Week (CotW), a practice designed to increase the quality of under-developed content areas that has diffused across hundreds of Wikiprojects (Warncke-Wang et al. 2015, Zhu et al. 2012a).

While the effectiveness of particular practices has been studied in isolation (Butler et al. 2008, Kriplean et al. 2008, Ling et al. 2005, Warncke-Wang et al. 2015, Zhu et al. 2012a), we are aware of no research that examines how the process of acquiring and changing these practices influences their effectiveness. Understanding the factors that determine how practices are internally transferred and effectively adapted could provide insights into community success that go beyond individual practices. This is also one of the central topics in the field of organization research in the last two decades (Amburgey et al. 1993, Szulanski 2000, Lee et al. 2015). As organization scholar Szulanski noted, "Identification and transfer of best practices is emerging as one of the most important and widespread management issues" (Szulanski 1996).

One important question regarding best practice transfer within organizations is the extent to which recipients need to modify an original practice to make it effective in a local context (Winter et al. 2012). Organization scholars have a long-standing debating on this topic. According to the *re-creation perspective*, strict replication leads to incompatibility between the new practice and the recipient's environment, rendering the imported practice less effective (Cummings & Teng, 2003, Kim & Nelson, 2000, Orlikowski 1993, Orlikowski 1996). The recipient units need to continuously modify the original practice and create their own practice that better fits with their culture, structure and approach. For example, according to this approach, McDonalds, which sells billions of beef-based burgers in the US,

needed to change its menu by introducing localized products like McVeggie™ to appeal in India, where half of the population is vegetarian (Kannan 2014).

In contrast, the *replication perspective* argues that modifying a successful practice for a new environment increases the risk that the modifications will harm performance (e.g., Amburgey et al. 1993, Dowell & Swaminathan, 2000, Mitchell & Singh, 1993, Singh et al. 1986, Winter & Szulanski 2001, Winter et al. 2012). Some empirical evidence shows that in a large franchise organization changing a successful practice (by selling non-standard products) harms franchisees' survival. A one-standard-deviation increase in revenue derived from nonstandard products more than doubles a franchise unit's hazard of failure (Winter et al. 2012, p. 678).

In this chapter, we propose that in online communities neither replicating an original practice without modification nor freely implementing modification is a successful approach to transfer best practices. Instead, we propose a contingency perspective and hypothesize that modifications are most successful if they are introduced *after* the receiving unit has had experience with the imported practice. This allows for a form of iterative organizational design, in which a receiving site can tweak an imported practice based on experience. We also hypothesize that modifications will be more effective if they are introduced by people who are core members of the receiving unit and who participate in a variety of other communities. These are the people who likely to be knowledgeable about what their unit needs and about alternative practice tweaks used by others.

To test these hypotheses, we analyzed historical data about Collaborations of the Week (CotW) in Wikipedia. A Collaboration of the Week is quality-improvement practice in Wikiprojects, which organizes editors collaboratively to improve a designated article in a limited time period. Collaborations of the Week spread from project to project and are often modified before they are imported and then as they are used. We collected the history of CotW in 146 Wikiprojects and measured how different types of modifications influenced their success, in terms of the length of time the CotW continued to be used in a project, the amount of work they elicited from project members and the number of unique editors who contributed to them. The results generally supported the hypotheses.

THEORY AND HYPOTHESES

Best Practice Transfer Dilemma: To Modify or Not to Modify

Practice refers to an organization's routine use of knowledge for conducting a particular function (Szulanski 1996). According to organization scholars, the ability to transfer best practices internally within a firm provides a competitive advantage (Argote & Ingram, 2000) and is one reason they can be more effective than other institutional arrangements such as markets (Arrow 1974, Kogut & Zander, 1993). The benefits of transferring good practices between parts of a single organization have been documented in many different organization settings (see Argote & Ingram, 2000 for a review). For example, Darr et al. (1995) showed how pizza franchises benefited from learning from other franchise stores how to place pepperoni. Similarly, Baum and Ingram (1998) found that hotels within a single chain benefited from the experience of other hotels in their chain that were in the same environment.

An important question is the extent to which units within a larger organization benefit by modifying practices received from another parts of the organization to fit their local environments. On one hand, modifying a successful working practice increases the risk that the modifications will harm performance. However, on the other hand, strict replication might lead to incompatibility between the imported practice and recipient's environment, reducing the benefit derived from the imported practice. In this section we review existing evidence on both the replication perspectives and re-creation perspectives of best practice transfer. Based on the prior research, we suggest a contingency perspective to understand best practice modifications and develop testable hypotheses about the conditions under which source practices should be modified and re-created in order to be more successful.

Not to Modify: The Replication Approach

Winter and Szulanski (2001) claimed that knowledge transfer is maximally effective when only necessary value-creating facets of the knowledge are replicated, and no time or effort is devoted to the creation of addition features, which could harm performance. There is evidence showing that attempting to modify a successful working practice could be harmful, even when they initially seemed sensible, promising, or desirable. Work in population ecology has found negative survival effects of modifying core features of organizations in a variety of contexts, including voluntary social service organizations (Singh et al. 1986); Finnish newspapers (Amburgey et al. 1993); U.S. medical diagnostic imaging firms (Mitchell & Singh, 1993); U.S. bicycle manufacturers (Dowell & Swaminathan, 2000); and French, German, and British auto

manufacturers (Dobrev et al. 2001). Recent work on franchise provides empirical evidence supporting the replication perspective. There results showed that deviation from a franchisor template (i.e., a source practice) has negative consequence on the survival of franchise units within a large franchise organization (Winter et al. 2012). According to the replication perspective, modification of a working practice introduces risks, and the risk increases when the practice is complex. Modification of complex practice can lead to unanticipated deleterious interaction effects that are causally ambiguous and difficult to interpret (Winter et al. 2012, Lippman & Rumelt 1982).

Modify: The Re-creation Approach

However, the problem of the replication approach is practice might encounter incompatibility problems when moving from a source environment to the recipient one. According to Argote and Ingram (2000), practice is often embedded in structural elements of an organization, such as its people and their skills, technical tools, or other routines and systems used by the organization, as well as in the networks formed between and among these elements. Failure of practice transfer thus often results from incompatibility with the new context. And the risk of failure caused by incompatibility increases when the practice is more complex (Argote and Ingram, 2000, Galbraith, 1990).

In contrast to the replication approach that emphasizes accurate replication, the re-creation approach focuses on modifying and adapting the source practice in the recipient site to reduce incompatibility. The re-creation perspective on practice transfer is influenced by literature in organization innovation, technological adaptation and organization routine (Cummings, & Teng, 2003, Kim & Nelson, 2000, Orlikowski 1993, Feldman & Pentland, 2003). Kim and Nelson (2000) examined learning and innovation in newly industrializing economies and proposed that knowledge transfer is a dynamic learning process where organizations continually interact with customers and suppliers to innovate or creatively imitate. Wanda Orlikowski (1993) explored the introduction of groupware into an organization to understand the changes in work practices and social interaction it facilitated. She found that people's mental models and an organization's structure and culture significantly influenced how technology is actually used. She further proposed that change is endemic to the practice of organizing and is enacted through the situated practices of organizational actors as they improvise, innovate, and adjust their work routines over time (Orlikowski 1996). Feldman and Pentland (2003) challenged the traditional understanding of organization routines as creating inertia in organizations. They argued that organization routines are a source of change that create on-going opportunities for variation, selection and retention of new practices. Synthesizing

these perspectives, practice is seen as being continuously modified in the transfer process. Practice transfer is a dynamic learning process, involving the continuous modification, re-configuration and re-creation.

Contingency view of best practice modification

Prior research suggests that modifying best practice can ameliorate the incompatibility between a source practice and the local environment, but increases the risk of introducing deleterious features to a successful working practice. Both the risk of incompatibility and unanticipated deleterious modification increases when the practice is more complex.

We suggest that not all modifications are equally effective. Either strictly replicating an original practice without modification or freely implementing modifications is unlikely to optimize the utilization of the imported practice. Instead, we need to understand the conditions under which modifications are more or less effective. In the following sections, we develop testable hypotheses about *when* and *who* should make modifications in order to achieve optimal utilization of the imported practice. Specifically, we propose hypotheses about the effectiveness of modifications at an early stage (i.e., pre-implementation) versus later (i.e., post-implementation), and the influence of characteristics of the people involved in the modification on their success.

When to modify: Effectiveness of Pre- versus Post-implementation Modification

Tyre and Orlikowski's (1994) examined the temporal pattern of modifications to a new technology in organizations. The authors found modifications disproportionately occurred when the technology was first introduced (and even before its official use). Thus, they suggested that there exists a relatively brief window of opportunity to explore and modify new technology. However, the authors only examined the temporal pattern of the modifications, not their effectiveness at different stages.

We propose that modifications at early stages are often based on people's presumptions (i.e., predictions about which components of the new practice might go wrong) and therefore may be wrong because they are not based on evidence. In contrast, modifications after implementation are based on experiences with using the practice and can respond to actual compatibility problems between the imported practice and the receiving site. This allows for a form of iterative organizational design, in which a receiving site can tweak an imported practice based on experience. Therefore, we hypothesize that post-implementation

modifications are less likely to introduce deleterious changes compared to pre-implementation modifications, and thus will be more effective than pre-implementation modifications.

The idea that experience-based, post-implementation modifications are effective is consistent with the organization learning and knowledge creation literature (see Argote & Miron-spektor, 2011 for a recent review). According to organization learning theories, new knowledge is iteratively created as experience interacts with context. We propose to use an iterative organization design model to depict the post-implementation modification of source practice as an ongoing use-mismatch-create cycle. In this cycle, the recipient site adopts and implements the new practice, uses it, detects mismatch, fixes the mismatch, and creates a new iteration. Each iteration results in more effective utilization of the practice. The re-creation process does not end when the new practice achieves satisfactory results at the recipient site. Even after successfully implementing the new practice for a period of time, any change in the local context at the recipient site (e.g., environmental change, member turnover, introduction of new tools or policies) might result in a new mismatch and thus prompt a new iteration.

The process of post-implementation, organizational iterative design is analogous to the iterative user-interface design (Nielsen 1993, Shneiderman 1992). Nielson proposed that software improves more rapidly when users use the interface and developers learn from their feedback, rather than designing and iterating without evidence (Nielsen 1993). He provided data to show that redesigning user interfaces on the basis of user testing substantially improved usability (Nielsen 1993).

This hypothesis might reconcile the difference between the replication and re-creation perspective discussed above. Szulanski and Jensen (2006) and Winter et al. (2012) provided empirical evidence showing that deviation from the corporate templates negatively affect the survival chances of franchise units within a large organization. However, those studies only focused on the presumptive modification (i.e., ones based on managers' non-evidence-based assumptions about what should work) (Szulanski & Jensen 2006) or conflated presumptive modifications and post-implementation modifications (Winter et al. 2012). We suggest that modification made before implementation (presumptive modification) will generally not lead to successful use of the practice, while the post-implementation modifications should significantly improve its successful utilization.

H7. Modifications made after implementing the practice are more effective than modifications made before implementation.

Who to modify: Effectiveness of Modifications Created by Different People

The next hypothesis considers the individuals who are eligible to propose and implement new iterations in the recipient site. Specifically, we ask: which characteristics of people in the modification process affect successful modification?

First, we hypothesize that central members in the local site are more likely to create better modifications because these central people know more about the local environment. Central people are more likely to identify a mismatch between the new practice and local needs, and craft a good solution to fix the mismatch.

Second, we propose that members' social network might also affect whether they will create successful post-implementation modifications. Prior research has examined how social network ties affect practice transfer. It is natural that external ties will benefit the search of available knowledge/practice and initial implementation of the new practice at the recipient site (Hansen 1999, 2002). However, we propose that external ties will also benefit successful post-implementation modifications at the recipient site.

To support this view, we draw on the concept of "learning in a world of learners" from Levitt and March (1988) and adopt an ecological view to understand the role of external ties in successful post-implementation modification. The key element of creating an effective modification is to resolve the mismatch between the local environment and the new practice in the new iteration. Note that each recipient site attempts to fix the mismatch of the source practice. It is possible that other recipient sites, especially those that are similar to the local site, have encountered and solved similar mismatch problems. Members with external ties with other sites that have also adopted the new practice can better search for solutions from other sites. Furthermore, according to the work on analogical reasoning (Thompson et al. 2000), even though mismatch problems are not identical in other recipient sites, exposure to the mismatch-fixing cycle in other recipient sites might inspire good solutions at the local site.

Although people who have external ties with other recipient sites are more likely to generate good solutions for mismatches at the local site, acceptance of their solutions cannot be taken for granted. Gruenfeld et al. (2000) investigated the consequences of temporary membership changes for itinerant members (i.e., those who leave their group of origin temporarily to visit a foreign work group) and indigenous members of those origin and foreign groups. They found that, although itinerant members produced more unique ideas than indigenous members, their ideas were significantly less likely to be utilized by the group. Kane et al. (2005) later found that groups were more likely to adopt the ideas from a

rotator when they shared a superordinate social identity with that member than when they did not. Therefore, our final hypothesis is that people with external ties who are also central in the local units can generate good solutions that result in a higher acceptance rate. Those persons, therefore, are most likely to create more effective modifications.

H8a. People who are central at the recipient units are more likely to create effective post-implementation modifications.

H8b. People who have external ties with other recipient units are more likely to create effective post-implementation modifications.

H8c. People who have external ties with other recipient units and are central in the focal unit are most likely to create effective post-implementation modifications.

STUDY PLATFORM

We conduct our studies in the context of Wikiprojects (subgroups organized around different topics in Wikipedia). Particularly, we investigate a widely adopted project-based practice called Collaboration of the Week (CotW).

Collaborations of the Week (CotW)

CotW is a mechanism that designates one or two articles to be improved within a defined time period. Previously, CotW was a Wikipedia-wide activity that was not restricted to any specific project. Since 2004, hundreds of Wikiprojects have adopted this practice and created their own CotW, which often have dedicated project pages. Figure 7 shows the CotW project page in Wikiproject Video Games (WVG).

CotWs have two phases: selection and collaboration. In the selection phase, project members nominate candidates and then elect members to collaborate. During the collaboration phase, the project tags the chosen article(s) with a special template in its talk page. In addition, the project typically announces the targets of the collaboration on its project pages.

CotW is an important practice to direct volunteer editors' attention to articles that are important to the group but which may not attract individual members' interests. As discussed in Chapter 1, editors may want to work on popular articles, and thus neglect less popular articles. CotW can effectively direct contributions to these less popular, but important, articles. Research also showed that, in addition to increasing contributions on important but less popular articles, CotWs have other benefits. For instance,

the effects of CotWs carry over to non-CotW-target articles. Contributions on non-CotW-target articles also increased during the CotW period. Furthermore, editors exposed in CotW were more likely to perform similarly to their role models in the project and increased their contributions on assessment and anti-vandalism.
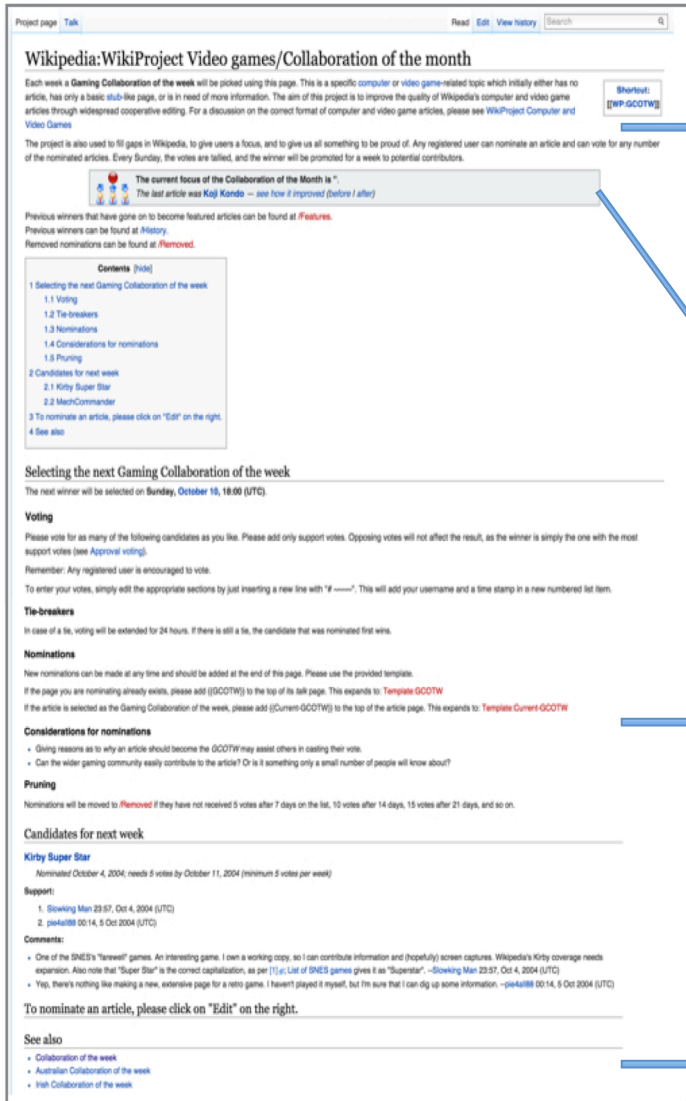
1. Illustrate the goal of CotW. For instance, this page says: "Each week a Gaming Collaboration of the week will be picked using this page"…"The aim of this project is to improve the quality of Wikipedia's computer and video game articles through widespread cooperative editing." "The project is also used to fill gaps in Wikipedia, to give users a focus, and to give us all something to be proud of."

2. Template designed to announce targets of the collaboration each week. The template shows "the current focus of collaboration of the week is XX. The last article was XX – see how it improved."

3. Policies and guidelines about running the collaborations. The policy on this iteration includes five parts: how to vote, how to deal with vote ties, how to nominate a candidate, what to consider before nominations, and how to prune nominations that do not receive enough votes. For instance, the policy for voting says "Please vote for as many of the following candidates as you like. Please add only support votes. Opposing votes will not affect the result, as the winner is simply the one with the most support votes (see Approval voting). Remember: Any registered user is encouraged to vote."

4. This is the area for editors to participate in the nomination and voting. They post the title (with a link) of the article they nominate and reasons why they want to nominate this article. Other users will support the nominations or leave comments about the nominations.

Figure 7. The page for the collaboration of the week in Wikiproject Video Game on Oct. 5th 2004.

Despite the benefits of CotWs, their utilization in Wikiprojects varies widely. Among 146 Wikiprojects that adopt CotWs, 74 Wikiprojects have hosted more than a single collaboration, and 55 Wikiprojects successfully hosted more than five collaborations. The significant discrepancy in CotW utilization proves the need to further understand the process of transferring and adapting best practices in online communities.

CASE STUDY: CotW IN WVG

We conducted an in-depth case study on the Wikiproject Video Games (WVG)'s Collaboration of the Week, named "Gaming Collaboration of the Week" (GCOTW). The case study can help us better understand the hypotheses in the context of Wikipedia and CotW.

Method

We analyzed the complete revision history of GCOTW project page (3431 revisions) and discussions on WVG's talk page that mentioned GCOTW. We also cross-linked key participants' activities in GCOTW and other parts of Wikipedia during the given time period. Wikipedia records almost every single activity and provides data and API for researchers to conveniently retrieve and analyze the activities. We rely on the complete records to reconstruct WVG's experience of using CotW.

Findings

On 3 Oct 2004, editor pie4all88 started a discussion thread on WVG's talk page, and expressed an interest in developing a WVG-specific CotW similar to those of Wikipedia's many other projects. After receiving supportive messages from two other members within 24 hours, pie4all88 created a CotW page on 4 Oct 2004 called "Gaming Collaboration of the Week" (GCOTW).

Modifications of GCOTW

Table 20 shows five iterations of GCOTW as examples to illustrate what we mean by "modifications" in the context of CotW. The first example discusses the guidelines for nomination. The original guideline inherited from the source CotW simply reminded people to justify their chosen candidates. Editor pie4all88e had a concern that members of WVG might be enthusiastic about a particular niche topic yet not consider its importance for the whole gaming community. Therefore, in the new iteration, a new

guideline was added by pie4all88 to remind nominators to consider the impact of their desired articles to the wider gaming community.

The second modification example considers the pruning policy, which defines the threshold to prune unsuccessful nominations (i.e., those that fail to receive adequate support). After implementing the original pruning policy for a while, users stated that the threshold of receiving votes in a week was too high. In the talk page, people proposed to lower the number of needed votes per week because "this CotW does not get as much traffic as the original CotW gets." That change is reflected in the new iteration.

The third example relates to the voting policy. The original policy encouraged members to "vote for as many of the following candidates as you can." That policy, however, allowed people to vote but not contribute. As such, articles selected as GCOTW targets received little contribution during the collaboration period. One member expressed this problem in the discussion and suggested that the weekly improvement drive (itself a variant of the source CotW) create a template to remind voters to contribute. As a result, two changes were made in the new iteration. First, the description was changed to "A vote … shows your commitment to support and aid in collaborating on that specific article if it is chosen." This change highlighted the meaning of votes as a commitment to contribute as opposed to a simple social gestures. Second, a new template was created to remind voters when the articles they voted for were chosen.

The fourth example also concerns voting policy. The original policy stated that any registered user is encouraged to vote. To increase the likelihood that their preferences would be selected, some members created "sockpuppets" to cast false votes. In the new iteration, sockpuppets were forbidden from voting.

The final example relates to the selection mechanisms in GCOTW. After implementing GCOTW for over four years, member enthusiasm eroded. Low participation frustrated members who were still actively organizing the nomination and voting. To address the problem, the nominate-vote-select schema was changed to a bot-selecting schema. Each week, a bot would randomly select an article from the low-quality-high-importance category and post it as GCOTW. In the discussion, people claimed that the goal of the change was to remove the stress caused by nomination and voting and focus on the contribution. Also, the random nature of the selection was more enjoyable. After implementing the new bot-selecting schema, GCOTW ran successfully for another 2.5 years.

Pre- and Post- implementation Modifications

The first example modification was made before the WVG officially implemented the GCOTW (i.e., the date of announcing the first GCOTW). The remaining four example modifications were made after the GCOTW was officially implemented. Prior to the official implementation, the modifications were created based on people's predictions about which component might go wrong. For instance, in the first example, editor pie4all88e predicted that members of WVG might be enthusiastic about a niche topic without considering its importance for the whole gaming community. No discussion found related to the problem of proposing a niche topic. In other words, it was uncertain whether nominating niche topic articles would be problematic. In contrast, the remaining four examples were all based on lessons learned from previous iterations, such as the high pruning threshold, the lack of contributions despite the number of votes, false votes, and decreased enthusiasm. We found discussion histories related to each of these four examples. The post-implementation modifications are more targeted to actual problems compared to pre-implementation modifications.

People in the modification process

The third example about the voters not contributing shows how people with external ties can generate good solutions to resolve problems of using new practice at the local site by borrowing solutions. The editor (Jacoplane) mentioned that another project created a template that "gets put on every user's talk page that vote". The editor suggested borrowing this solution: "I think we should do something similar to remind people that they voted to remind people that they voted." We checked Jacoplane's editing history and found that this editor participated in nine other Wikiprojects that hosted CotWs that year. Despite the multiple project participation, the editor was based in WVG (87.7% of his/her project page contributions are devoted to WVG at that year). In WVG, the editor was a top 3 contributor among the group's 347 members. The central role of this editor in WVG might make it easier for him/her to identify the problem. Second, the external relationship with other projects was an advantage for him/her to find a solution. Finally, the central role of this editor made it easier for his/her suggestions to be accepted.

The case study provides real examples to help better understand the hypotheses about modification of best practice in the context of CotW in Wikiprojects. In the following section, we conduct quantitative analysis to test the hypotheses.

Old Iteration	Discussion	New Iteration (Changed are highlighted in blue)
Guidelines for nominations **- Giving reasons as to why an article should become the COTW may assist others in casting their vote.**	*No discussion found specifically related to this change.*	Guidelines for nominations **- Giving reasons why an article should become the GCOTW may convince others to support your nomination.** **- Can the wider gaming community easily contribute to the article? Or is it something only a small number of people will know about?**
Pruning policy: **Nominations will be moved to /Removed if they have not received 5 votes after 7 days on the list, 10 votes after 14 days, 15 votes after 21 days, and so on.**	*5 votes per week?* *"I propose we lower the needed votes per week to 4 or even 3, as this CotW does not get as much traffic as the original CotW gets."*	Pruning policy: **Nominations will be moved to /Removed if they have not received 5 votes after 3 days on the list, 9 votes after 14 days, 12 votes after 21 days, and so on.**
Voting policy: **Please vote for as many of the following candidates as you like. Please add only support votes. Opposing votes will not affect the result, as the winner is simply the one with the most support votes**	*People voting but not contributing* *"I've noticed that there seems to be a lot more people voting in the GCOTW lately, but the number of contributors hasn't really seemed to increase much. Is the idea that anyone can vote, or only people who intend to contribute? With the Weekly improvement drive, the Template:AIDvotes gets put on every user's talk page that voted. I think we should do something similar to remind people that they voted."*	Voting policy: **A vote or a show of support for an article shows your commitment to support and aid in collaborating on that specific article if it is chosen. Although you are not required to fulfill that commitment, we ask that you only support articles that you are able to contribute to so that this collaboration's goals of expanding and improving articles can adequately be achieved. Feel free to** **vote for as many of the following candidates as you like.** Add template to remind voters:
Voting policy: **Remember: Any registered user is encouraged to vote.**	*Fake votes* *"It seems that someone is adding other people's signature to the nomination XXX"*	Voting policy: **Any registered user is encouraged to vote so long as you abide by the policies of Wikipedia, especially Wikipedia:Sockpuppets.**
The selection of collaboration article is based on nomination and voting.	*GCOTW is big letdown this week* *"This week's Wikipedia:Gaming Collaboration of the week was Prima Games. It's been rather a poor show."* *No longer working?* *"So, is Gaming Collaboration of the week now nonfunctional? As is, no one working on it."* *Reactivating Collaboration of the Week –with ROBOTS!!!* (Propose the plan of having robots randomly select one article from the category of low quality but high importance as collaboration) *"Removing the stress of nomination and voting will reduce frustration, and make participation the focus, not bureaucracy (this isn't an RfA). The random nature will make it more fun, as part of it is wondering which article will be chosen. "*	Introduction: **The WikiProject Video games collaboration is a collective effort to improve related articles covered by the project's scope. An article is chosen every Monday, by a bot that randomly selects one video game-related article that is rated Stub or Start or C class, and Top or High priority for WP:VG. The bot then updates Template:Collab-gaming with the pick, and the collaboration begins. If there is consensus that a selected article is not felt to be suitable for collaboration, then the bot will be requested to "re-roll" and select a different article. Articles that have previously been chosen for collaboration will not be chosen again. Previous collaborations can be found at /History.**

Table 20. Example modifications in Wikiproject Video Games.

Method

We ran a quantitative analysis on 146 Wikiprojects that adopted CotW. The first step is to identify the modifications of CotW in these projects.

Automatically identify modifications in CotW

We want to automatically identify modifications from the CotW pages' historical revisions. Modifications are defined as the changes to the practice, which is modifying the way of organizing and operating CotW. Not all the historical revisions of CotW pages were "modifications". The goal of this section is to automatically identify the modifications.

We found that a large proportion of the historical revisions on the CotW pages are actually candidate nominations or votes to select collaboration articles, rather than modifications to the CotW rules. To rule out these nomination and voting activities, we excluded the revisions that only modified the sections of nomination and voting. Results show that 88.6% of the revisions on the CotW pages are the nomination and revision activities.

To further detect the modifications in the remaining 11.4% revisions we used a machine-learning approach in which we hand-coded 335 non-nomination-voting revisions from two Wikiprojects' CotWs as a training set. We then created a feature set containing nine different features (see Table 21 for details). We trained statistical models (rule-based model generated based on our domain knowledge, decision-tree, and SVM) on the training set and evaluated them using a separate set of hand-coded data (113 non-nomination-voting revisions from another two Wikiprojects). Details of the feature set and model shown in Table 21.

We compared the performance of rule-based model, decision-tree and SVM. Results are shown in Table 22. The rule-based model and decision tree outperformed SVM on both the training set and test set. On the training set, the decision-tree performed slightly better than the rule-based model. However, in the test set, the rule-based model performed slightly better than the decision-tree model. Because the rule based-model performed the best in the test set and is easy to interpret we used it in the following analysis.

	Feature Set	Number of total inserted characters, Length of the longest inserted word sequence, Number of total deleted characters, Length of the longest deleted word sequence, Add templates, Add sections, Maintenance, Being reverted in the next revision, Revert previous revision
	Model	• Rule-based model: 1) Must have the length of the longest inserted word sequence no less than five Or Add new sections Or Add new templates but excluding the Wikipedia's maintenance templates; 2) Must not being reverted in the next revision or reverting previous revision. • Decision-tree • SVM

Table 21. Feature set and model to classify modifications

	Rule-based		Decision Tree		SVM	
	Pre.	Rec.	Pre.	Rec.	Pre.	Rec.
Train	93%	93%	94%	94%	82%	81%
Test	93%	92%	91%	91%	84%	84%

Table 22. Performance of three models on training & test set.

Analysis overview

This analysis seeks to identify the effects of different types of modification on the successful utilization of CotWs. We measured the success of CotW according to three criteria: (1) the survival of CotW (i.e., the likelihood that projects continuously use CotW), (2) the number of contributions on CotW target articles during the collaboration period, and (3) the unique contributors to CotW target articles during the collaboration period. The analysis was conducted on the project-collaboration-period level. We predicted outcomes (i.e., survival, contribution, and participants) in the current collaboration period according to whether the project made a new iteration in the last collaboration period.

Since we used observational data to run the analysis, the creation of a new iteration is not a true experimental treatment. New iteration creation (i.e., modification on CotW), as with most events in the real world, is endogenous in the sense that it is caused by other factors inside the system. In our data, Wikiproject activity correlates to project members' participation in CotW, as well as their likelihood to modify its procedures of CotW. Not controlling for confounding factors that influence both the treatment (CotW modifications) and the outcome (CotW utilization) can lead to biased estimates of the treatment effects. To ameliorate the endogeneity problem, we used propensity score matching (PSM). We will discuss the details of PSM method later.

Data preparation

The data were longitudinal, following the same project across multiple collaboration periods. The data comprised 1588 project-collaboration-period observations.

Dependent variables

Practice Death. We defined a CotW as near abandonment (i.e., dying) if the project did not have at least two collaborations after a focal collaboration period (a sensitivity analysis with differing threshold values showed no difference in the pattern of results). This variable is assigned to 1 if the project's CotW was dying (i.e., had no more than two collaborations in the future); it is assigned 0 if the project's CotW was still active (had more than two collaborations in the future).

Contributions. We measured the number of revisions to the target articles during the collaboration period, controlling for the number of revisions on these articles during the non-collaboration period. Particularly, we divided the number of revisions on the target articles during the collaboration period by the number of revisions on the target articles during the pre-collaboration period. The pre-collaboration and collaboration periods lasted the same length (e.g., normally a week to a month).

Participants. We measured the number of unique contributors who edited the target articles during the collaboration period, controlling for the number of unique contributors during the non-collaboration period. Particularly, we divide the number of contributors during the collaboration period by the number of revisions during the pre-collaboration period. Both periods lasted the same length.

Independent variables

Post-implementation modification. We measured the number of modifications the project's CotW had in post-implementation periods.

Pre-implementation modification. We measured the number of the modifications the project's CotW had in the pre-implementation period (i.e., the preparation period).

We further divided the modifications according to which editors would implement the modifications.

Modification made by core members in the recipient project versus **Modification made by non-core members in the recipient project**. We defined core members as those whose overall contributions to the project are among the top 10%. We then divided the modifications into two groups: those made by core members versus those made by non-core members.

81

Modification made by members with more external ties versus **Modification made by members with fewer external ties**. We measured external ties as multiple memberships in other projects that also adopt CotWs. If a member participates in three projects in addition to the focal project, he/she has three external ties. We defined members with more external ties as those participated in more than the medium number (the medium number in the data is 3). Similarly, we define member with fewer external ties as those with ties less than medium number.

In addition to the above variables designed to measure the main effects of core-ness in the focal project and external ties, we also measured the interaction effects. We defined four more interaction measurements: (1) modifications made by core members in recipient project and have more external ties, (2) modifications made by core members in recipient project but do not have many external ties, (3) modifications made by non-core members in recipient project but have more external ties, and (4) modifications made non-core members in recipient project and do not have many external ties.

In addition, we measured the popularity of the source.

Popularity of the source. In our data, we observed that Wikiprojects have different sources. Many of the earliest projects learned and copied rules and policies from the Wikipedia-level CotW (which has since been terminated). Some projects started by copying other Wikiprojects' CotW. The very first revision of the CotW page is likely to be the source CotW. We calculated the popularity of the source by comparing the structural similarity of the given project's first CotW page revision with all the other CotWs in other projects at that time period. Higher similarity indicated that more projects were using the same structure, and that focal project was starting with a more popular "branch".

Propensity score matching

The basic idea of PSM is to pair the treated project and the control project. For a given project that had modifications, we selected a comparison project that was most similar on confounding variables but did not have modifications. We used Propensity score matching (PSM) to pair the projects (more precisely, project-collaboration-periods).

PSM involved three steps. In the first step, we estimated the propensity score (i.e., the probability of having modifications) from a set of conditioning variables. We chose four variables indicating the activity level of the project listed below as conditioning variables. In the second step, we matched each project that had modifications in a particular week with another project that did not have modifications, but

which had the most similar propensity score based on four activity indicators. Propensity scores allow researchers to control for many variables simultaneously by matching on a single scalar variable. To conclude the second step, we tested whether the treatment group and control group were well matched in terms of the conditioning variables. In the third step, we ran fixed effects regression analyses to estimate the effect of modifications on the treated groups and matched controls.

Step 1: Estimate propensity score

We first used logistic regression to estimate the probability of having modifications based on the project activity level. The estimated probability is the propensity score. The four predictors are listed below.

Active members. We measured the number of active members during the period of time.

Number of CotW hosted before. We measured how many CotW were hosted. The logarithmic transformed number of CotW was added in the regression to represent the baseline hazard function in the survival analysis.

Project page activities. Project pages are places where Wikiproject organize activities. CotW is one of activities organized through project pages. We measured the amount of contributions on the project pages during the given period, indicating whole project activity during the given period of time.

Number of project pages. We measured the number of pages the project had during the given period, which indicates the size of the project.

		Treat mean	Control mean	Bias %	Reduced bias
Active members	**Full**	40.4	35.0	7.3	86.3
	Match	40.4	39.7	1.0	
N of prev. CotWs	**Full**	31.9	32.9	-3.1	70.8
	Match	31.9	32.2	-0.9	
Proj page activities	**Full**	277.5	215.9	8.1	88.3
	Match	277.5	270.3	0.9	
N of proj pages	**Full**	83.3	89.0	-5.2	-59.9
	Match	83.3	92.4	-8.3	

Table 23. Comparison between treatment projects that made modifications (Treat) and control projects that did not make modifications (Control) before and after propensity score matching (Full vs. Match). *bias in* % = $100(\bar{x}_t - \bar{x}_c)/\sqrt{\{(s_t^2 + s_c^2)/2\}}$, where $\bar{x}_t$ and $\bar{x}_c$ are the sample means in the treated and control groups, and s_t^2 and s_c^2 are the corresponding sample variance.
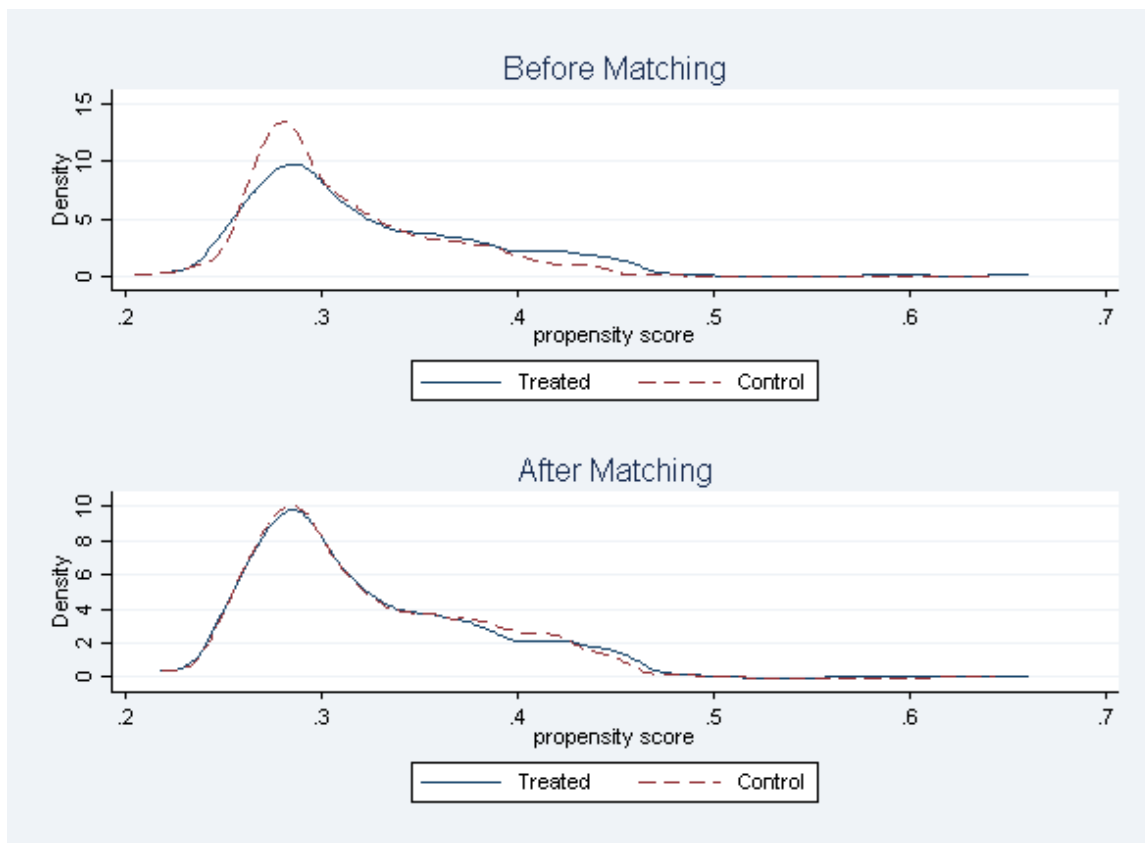
Figure 8. The distributions of propensity score for treated group,(i.e., projects made modifications, indicated by blue solid lines) and control group (i.e., projects that did not make modifications, indicated by red dot lines) before matching (top) and after matching (bottom). This figure shows that after matching, the treatment group and control group has more similar distribution of propensity score.

Step 2: Matching based on propensity score.

In this step, we matched projects that modified their CotWs with projects that did not, based on the estimated propensity score. To do this, we ordered the treated and control projects according to their propensity scores. For each treated project, we then selected a control project with the closest propensity score within a maximum distance.

Figure 8 reports the histogram of the propensity score (i.e., the likelihood of making modifications) for treated groups and control groups before and after matching. Here the treated group contains projects that

indeed made modifications at the given time period and the control group contains projects that *did not* make modifications at the given time period. Figure 8 shows that the treated group and control group are balanced on the likelihood of making modifications after matching.

Table 23 reports the details of the matching process. Note that variables that correlate highly with the treatment (also having higher risk to introduce bias) will be balanced better than variables with lower correlation with the treatment. This explains why PSM tends to favor page activities, active members and previous CotWs over the number of project pages during balancing.

There is an interesting observation that the bias (i.e., unbalance) between the treatment group and control group is not that serious even before matching. In Zhu et al's (2012b) study where they used PSM to match an editor who received messages with editors who did not receive messages, the bias was 79%-110% before matching. In this analysis, the bias is only 5%-8% before matching.

The statistical results are consistent with our observations. We observe that project activity and project size do not correlate with the number of modifications made on the CotWs (and the success of CotWs). For example, Wikiproject Military History is considered the largest and most active Wikiproject, with eight times as many active members and five times more project pages than Wikiproject Oregon. But Wikiproject Military history only made four modifications in total while Wikiproject Oregon made 77 modifications. Wikiproject Oregon hosted 89 CotWs while Military history only hosted 24 CotWs, although the latter project generally much more active than the former project.

Step 3: Run the analysis on the match sample

Using the matched sample, we then examined the effects of modifications on the outcomes (survival, contributions and participants). We used fixed effects linear regression to predict outcomes, with each treated control pair as a group.

Results

The temporal patterns of the modifications are shown in Figure 9 (Top). The results are consistent with Tyre and Orlikowski's (1994) findings (Figure 9 Bottom) that a substantial proportion (about 30%) of modifications happened in the pre-implementation stage. Far fewer modifications happened in each post-implementation CotW period.

	Survival				Contributions				Participants			
	Hazard Ratio				Coefficients				Coefficients			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Source Popularity	0.99	0.99	0.99	0.99	0.03**	0.03**	0.03**	0.03**	0.03**	0.03**	0.03**	0.03**
Pre-implement Modifications (V1)	0.97**	0.97**	0.97**	0.97**	0.007	0.007	0.006	0.006	0.01**	0.01**	0.01**	0.01**
Post-implement Modifications (V2)	0.38**				0.17**				0.07*			
Modifications by core (V3)		0.32**				0.22**				0.10**		
Modifications by non-core (V4)		0.76				-0.12				-0.11		
Modifications by external (V5)			0.17**				0.31**				0.13**	
Modifications by non-external (V6)			0.87				0.01				-0.01	
Modifications by core & external (V7)				0.18**				0.32**				0.13**
Modifications by core & non-external(V8)				0.77				0.09				0.05
Modifications by non-core & external (V9)				0.04				0.20				0.16
Modifications by non-core & non-external (V10)				1.13				-0.23				-0.21*

Table 24. Effectiveness of the modifications.

Table 24 shows the main findings of the analysis on the effectiveness of the modifications. Models 1-4[1] test how modifications affect the survival of CotW in Wikiprojects. Each coefficient in Models 1-4 represents the hazard ratio. A hazard ratio is the ratio of the risk of a CotW being abandoned in a given time period associated with a one-unit change in the explanatory variables. A hazard ratio smaller than 1 indicates decreased rate of abandonedness (i.e., increased survival rate), while a hazard ratio larger than 1 indicates increased rate of abandonedness (i.e., decreased survival rate). Models 5-8 test how modifications affect the amount of contributions received by CotW target articles. Models 9-12 test how modifications affect the number of unique contributors in CotW. Models 5-12 report the regular coefficients.

Model 1 shows that a one-unit increase in pre-implementation modification decreases the hazard ratio by 3%, while a one-unit increase in post-implementation modification decreases the hazard ratio by 62%.

---

[1] Note that here we do not use the traditional interaction model (e.g., with modification, modification X pre-post, and modification X pre-post X the types of people as explanatory variables in the regression) but divide the number of modifications into different groups. Our analysis is essentially the same as the traditional interaction method but is easier to interpret.

The difference between the pre- and post-implementation modification is significant ($\chi2=14$, P < .01). The results confirm Hypothesis 7, showing that post-implementation modifications have a much stronger positive effect on the practice survival. Models 2-4 show that modification effectiveness is influenced by editor type (e.g., core vs. non-core member and strong external ties versus weak external ties). Model 2 shows that the modification created by core members were more effective in decreasing hazard rate (68%) than non-core members (24%) and the difference is marginally significant ($\chi2=3.0$, P = .09). Model 2 confirmed Hypothesis 8a partially. Model 3 shows that the modifications introduced by contributors with more external ties were more effective (decreasing the hazard rate by 83%) than modifications introduced by people with fewer external ties (decreasing the hazard rate by 13%). This difference is also statistically significant ($\chi2=14$, P <.01). The results of Model 3 confirmed Hypothesis 8b. Regarding the interaction effects of being a core member with external ties, Model 4 provides mixed results. The modifications introduced by core members with more external ties (V7) significantly decrease the hazard rate by 82%. The modifications introduced by the other three types of contributors (core members with fewer external ties—V8, non-core members with more external ties—V9 and non-core members with fewer external ties—V10) did not significantly decrease the hazard rate. Also, core members with more external ties tend to create more effective modifications than those with fewer external ties ($\chi2=8.5$, P <.01), which indicates that external relationships help core members create effective modifications. However, among the people with external ties, the difference between being core members and non-core members is not significant ($\chi2=.62$, P =.43). The results support Hypothesis 8c partially.

Models 5-12 present similar patterns as Models 1-4. The results collectively support Hypothesis 7, and 8b, and provide partial support for Hypothesis 8a and 8c.
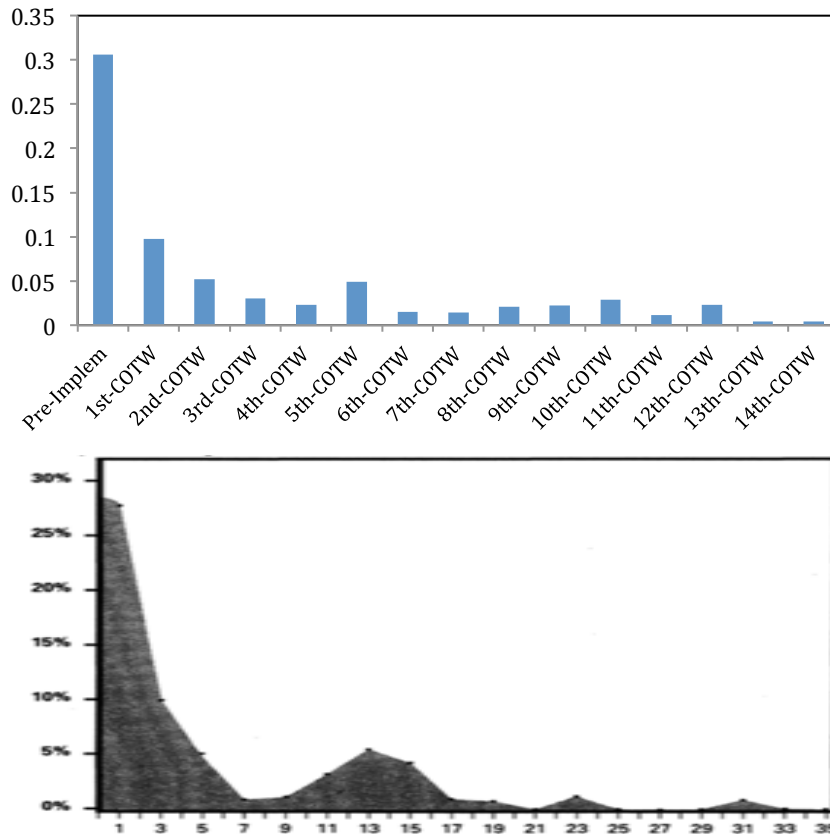
Figure 9.　(Top) Temporal patterns of the modifications on CotWs. (Bottom) Temporal patterns of new practice modifications in eight plants of a big manufacturing company. The graph is from Tyre and Orilikowski's study (1994).

DISCUSSION

Modification timing of imported practice

Research by Tyre and Orlikowski (1994) as well as our own, although conducted in different organization settings, reveal similar patterns of new practice modifications (see Figure 9, top and bottom). Specifically, we find that a substantial proportion of modifications were made relatively soon after receiving the new practice and far fewer modifications were made afterwards. The underlying psychological process might be as follows: when the recipient site receives a new practice, people are excited to adopt it yet believe that they can improve its potential contribution value by modifying it. However, after implementing the

practice for a while, people tend to become reluctant to make changes. When the imported practice does not achieve expected performance, they might simply abandon rather attempt to further modify the practice.

However, empirical analysis reveals that modifications introduced before implementation are less effective than those introduced after implementation. Results show that the benefits of pre-implementation modifications are one order of magnitude lower than post-implementation modifications. A one-unit increase in pre-implementation modification decreased the hazard of failure by only 3%, while a one-unit increase in post-implementation modification decreased the hazard of failure by 62%. Similarly, a one-unit increase in pre-implementation modifications increased member contributions on targeted articles by only 0.7%, while a one-unit increase in post-implementation modifications increased the contributions by 17%.

The results suggest an alternative way to treat an imported practice. It might be better for a recipient unit to change the imported practice only slightly—if at all—before trying it because pre-implementation modifications (although initially deemed sensible and promising) minimally improve practice utilization. In contrast, more resources should be devoted to modifying the practice *after* the receiving units have experienced it.

Effects of modifications introduced by core members

Hypotheses related to core members (2a and 2c) are weakly supported by the data. For instance, modifications created by core members decreased hazard rate of CotW by 68% and those modifications created by non-core members decreased hazard rate by 24%, but the difference is only marginally significant (p=.09).

One possible reason why the effects are not as strong as anticipated is that the operationalization of core members—top 10% contributors—might be arbitrary. According to this operationalization, some peripheral members might be labeled as core members or vice versa, which might explain the relatively low significance.

Second, the current core-ness measurement, which essentially measures people's contribution levels, might not be a good proxy. There are two possible underlying mechanisms of the effects of modifications introduced by core members. The "expertise-based" mechanism suggests that core members are more experienced and better understand the local project. Thus they can better identify or proactively search for

effective modifications. The "influence-based" mechanism suggests that core members are more influential in the project and thus their modification suggestions are more likely to be accepted by other project members. Contribution levels might be a first order of approximation of the expertise or influence people have in the projects. However, this study will benefit from a closer examination on the roles of core members play in the practice adaptation process and more nuanced and precise measurements of member core-ness. Future work should attempt to address these aspects.

Generalization to offline organizations

This chapter proposes a contingency theory aimed at answering one management question that applies to any online community or offline organization that attempts to transfer best practices from one unit to another. The empirical study presented in this chapter provides evidence that the theory holds in the context of online communities. However, it remains unknown to what extent the findings may be generalized to an offline context.

One conjecture is that the findings might translate to offline organizations that share the some of the same features as online communities, especially those "organic organizations". Roughly fifty years ago, Burns and Stalker (1961) proposed the concept of "organic management system" as an alternative to bureaucratic management systems (what they called a "mechanistic system"). They suggested that organic systems and mechanistic systems represent two poles of organizing forms: a mechanistic system is highly formal, rigid and centralized, while the organic system is informal, dynamic and flat. Organic management systems feature "the contributive nature of special knowledge and experience to the common task" and "lateral rather than a vertical direction of communication through the organization" (Burns & Stalker, 1961, Page 121). Organizations fall on different positions on the organic-mechanistic spectrum. For example, universities, offline volunteer organizations, design studios and research labs are more organic and thus more similar to online communities in terms of organization structures than, for example, the military and government, which are more mechanistic. Recently, there has been an increasing trend to adapt organizations to be "more organic" (DeNisi et al., 2003; Druskat & Wheeler, 2004; Lawler et al., 2001; Pearce & Conger, 2003).

Given the similarity between organic organizations and online communities, we conjecture that the findings of this chapter might be easier to transfer to organic offline organizations as compared to mechanic organizations. However, this conjecture must be regarded with caution until it is confirmed by empirical work. Our intent of connecting online communities and organic organizations is to stimulate

readers to bridge the CSCW and organization science areas, and consider new perspectives in studying important organizational phenomenon in both new and traditional organization forms.

Internal versus external practice transfer

This chapter focuses on examining the best practice transfer within the same community or organizations. Practice transfer across different communities or organizations is a different story. External practice transfer is often hindered by confidentiality and legal obstacles (Szulanski 1996), which makes it difficult or even impossible for the recipient site to accurately replicate the original practice. Sometimes, it is legitimacy rather than effectiveness that becomes the priority concern in the recipient site (Levitt & March, 1988). For example, firms adopt the ISO 9000 Quality Certificates primarily to legitimate themselves and ensure public and customer support, which leaves little room for modification.

CONCLUSION

In this chapter, we propose a contingency perspective to understand the process of incorporating and adapting best practice within online communities. We conducted quantitative analysis on the transfer of a quality-improvement practice between 146 Wikiprojects within Wikipedia. The results show that modifications were more helpful if they were introduced *after* the receiving project already had experience with the imported practice. Modifications were more effective if they were introduced by people who had experience in a variety of other projects.

CHAPTER 3. COMMUNITY LEVEL SUCCESS OF PEER PRODUCTION

MOTIVATION: SURVIVAL IN THE WORLD OF PEER PRODUCTION COMMUNITIES

Development in Internet technologies has significantly reduced the cost of creating virtual spaces to host collective content generation and has resulted in a large population of online communities. For example, Usenet (now accessible on the web via Google Groups) had over 189,000 active newsgroups as of 2005 (Wang et al., 2013); the well-known platform Wikia hosts more than 350,000 Wikipedia-like communities; and Facebook provides infrastructure to host over a quarter of a billion groups (Kraut & Fiore, 2014). However, communities in these platforms are not equally successful or active. On Wikia, 22% of the communities received no contributions one month after being created. On Facebook, where members create well over 100,000 new groups a day, 20% have no content production after the first day they were created and 53% have stopped all activity within three months of creation (Kraut & Fiore, 2014).

The ecological structure complicates theories of success in peer production communities. Merely investigating the internal factors is insufficient. Instead, we need to take an ecological view to also consider how the presence of other peer production communities in the environment might influence each individual community's success and survival. For example, when programmers participate in many open source projects simultaneously, the time and effort they spend on one project will divert their time and effort from the others. As a result, competition for shared members' time and effort tends to reduce the resilience of these communities. On the other hand, peer production communities might benefit from the presence of other communities in the ecology. For example, the knowledge, experience, and technical and management skills that programmers obtain from one open source project may transfer to other projects, and thus increase the recipient projects' ability to survive. Understanding how a peer production community's success is affected by its relationship with other communities—such as how the topics it covers and the members it attracts relate to those of other communities—can help us better understand the underlying principle of peer production success, which should offer practical insights to better manage peer production.

In this chapter, I use the ecological view to examine community-level success of peer production. Two themes emerged in this thread of studies: completion and complementarity. On one hand, communities compete with each other for common resources such as members' attention and effort. On the other hand, communities also complement each other. Members who join more than one community in an ecosystem

may share knowledge across communities. Community leaders can benefit by learning from the successes and failures of other similar communities.

In the first part of this chapter, I will report a study that examines effects of membership overlap on community survival in Wikia projects. The analysis of 5673 Wikia projects suggests that the positive effects of membership overlap on knowledge transfer outweigh the negative effects of competition for time and attention. We found that the overall effects of having members with joint membership improved the survival rate of the Wikia projects. The positive effects are even stronger when the joint members are core members of other mature communities.

In the second part of this chapter, I will report a study on 9,495 IBM connections communities. The study confirmed that communities that overlap in topic within the same ecosystem both complement and compete with each other. The benefits of complementarity dominate when overlap is low, while the drawbacks of competition dominate when the overlap is high. These effects lead to a sweet-spot where communities with a moderate overlap achieve the highest activity levels. I also found that sharing members and linking content intensifies the effect of topic overlap, which strengthens complementarity and competition stronger and sweetens the sweet-spot.

PART I: MEMBERSHIP OVERLAP AND COMMUNITY SURVIVAL

If people belong to multiple online communities, their joint membership can influence the survival of each of the communities to which they belong. On one hand, when people participate in many communities simultaneously, the time and effort they spend on one community will take time and effort from the others, reducing the resilience of them all. On the other hand, the knowledge, experience and social capital members obtain from one community can be transferred to other communities they concurrently participate in, and thus increasing the communities' ability to survive. For example, the spread of Wikipedia policy from the English Wikipedia to Wikipedia in other languages probably helped these smaller communities to thrive. Although the explosive growth of online communities and their impact on society have attracted hundreds of researchers to study the factors that lead to community success (e.g., Kairam et al. 2012, O'Mahony & Ferraro 2007, Ren et al. 2007), very few of them have investigated how the relationship with other communities, including membership overlap, can influence their success. Wang et al. conducted a relevant study of Usenet groups, showing that sharing members with other groups reduced future growth rates, suggesting that membership overlap puts competitive pressure on online groups (Wang et al. 2013). However, this research examined only the detrimental effects of membership overlap. We know of no research that has studied the potential benefits that membership overlap can bring to online communities.

This part of the chapter examines the effects of membership overlap on the survival of online communities. We use panel data from Wikia, a software platform that supports Wikipedia-like online communities. For example, there are Wikia communities organized around topics like movies (e.g., Star Wars), video games (e.g., World of Warcraft), and lifestyles (e.g., healthy recipes). Our analysis is based on archival data about 5673 communities from their inception to 2008. Our main finding is that higher levels of membership overlap was positively associated with greater survival of online communities. Furthermore, the beneficial effects of membership overlap on the survival of a particular, focal community were stronger when 1) the focal community is young; 2) the intersecting communities with which the focal community share members are mature; and 3) the shared members are core members in the intersecting communities. However, membership overlap is negatively associated with the survival when shared members are core in the focal community.

The contributions of this work are two-fold. First, we examine how membership overlap with other communities influences the survival of a focal community, providing new insight into mechanisms

underlying successful online communities. Second, on the practical side, our findings may guide community leaders to better manage their members and build successful online communities

Theory and Hypotheses

Survival of Online Communities

Research investigating the factors leading to continued functioning of online community falls into three categories: research on motivations of individual members in the community, research on dynamics of individual communities, and research on inter-community relationships. Research on the inter-community relationships is quite neglected.

The first type of research focuses on individuals in the community. The survival of online communities relies on the continuous participation of individual members. There is a large literature investigating the factors that motivate individuals to participate (e.g., Weber 2004, Nov 2007). Weber (2004) and Lerner and Tirole (2005) use a cost-benefit framework for member motivation. The basic idea is that people act as if they are performing a calculation to assess the net benefit they will receive in return for their efforts in the community. The benefits include having enjoyment and fun (Nov. 2007, Lakhani and Wolf 2003), pursuing beliefs and values shared with other people (Stewart & Gosain 2006), expressing humanitarian concerns for others (Nov. 2007), developing careers (Lakhani and Wolf 2003), and protecting oneself from negative emotions and enhancing positive attitudes (Burke et al. 2010). One implication of this type of research is that online communities need to continuously provide benefits to members in order to keep active and healthy.

The second type of research investigates how the community-level characteristics influence the success of online communities. Research has explored two main types of community-level characteristics: composition (i.e., the makeup of the community, such as its size or age and gender composition) and structure (i.e., the patterns of the relationship among the members such as social network structure, leadership structure and governance structure). Examples of research investigating composition characteristics include Chen et al's work about diversity (Chen et al. 2010) and Butler's work on membership size and communication activity (Butler 2001). Examples of research examining structural characteristics include Kairam et al's work on members' social ties (Kairam, et al. 2012), Zhu et al's work on shared leadership (Zhu et al. 2011, 2012, 2013), Choi et al's work on socialization (Choi et al. 2010), and O'Mahony and Ferraro's work on governance (O'Mahony & Ferraro 2007). An implication of the

research on community-level characteristics is that communities can become successful by adjusting their input (e.g., diversity of members, group size) and optimizing their internal structures (e.g., governance structure).

The third type of research investigating the survival of online communities adopts an ecological view. All online communities exist within a larger population of communities, with which they cooperate and compete.   The relationship among these communities can affect the survival of all communities within a niche.   Although there is a long tradition of ecological research about offline organizations (Baum & Shipilov 2006), ecological research about online communities has been quite neglected. The only relevant research we know of is Wang et al's work about membership overlap on the growth of Usenet groups (Wang et al. 2013). Wang et al took a competition view of membership overlap. They argue that an individual's time is scarce. When multiple online communities rely on the participation of the same members, the time members spent on one community takes time away from another community, thus reducing the chance of survival for both communities.

However, Wang et al. (2013) did not completely characterize the effects of membership overlap on the survival of online communities. Research in organizational ecology has demonstrated that organizations that exist in a common population do not merely compete with each other, but can also learn strategies, practices and technologies from their "competitors" (e.g., Baum & Shipilov 2006). For example, Ingram and Baum (1997) found that the survival a hotel chain is positively related to the total operating experience other hotel chains had accumulated.   Moreover, organizational behavior researchers (e.g., O'leary et al. 2011) argue that shared team membership (i.e., membership overlap in work teams) can have positive effects on team productivity and team learning. Specifically, more shared membership and shared membership with more teams can improve a focal team's efficiency and diversity. Although these finding are based on research in offline organizations and groups, the mechanisms involved are likely to be applicable to online communities. Additional evidence is directly relevant to online communities. Hill and Shaw (Forthcoming) have challenged the assumption that competition between projects is an important dynamic driving contribution to online communities. Hill and Shaw argue that the volunteer resources are not fixed and participation in one community does not necessarily take detract from participation in similar communities.   Their analyses showed that the volume of contribution to pages within Wikipedia is positively related to the volume of contribution on related topics in other encyclopedia wikis run by Wikia. In sum, there are several reasons to believe that membership overlap might have positive as well as negative effects on the survival of online communities.

In the following section we will predict the effects of membership overlap on the survival of online communities. Particularly, we are interested in the conditions under which the beneficial effects of membership overlap are stronger. We use the following vocabulary in describing the hypotheses. A focal community is the community of interest (especially we are interested in its likelihood to survive). Intersecting communities are the communities with which a focal community shares members. Shared members are the participants who participated in both the focal community and the intersecting communities.

Effects of Membership Overlap

We hypothesize that membership overlap can benefit online communities for three reasons. First, overlapping members may bring skills, knowledge, and experience they gain from their participation in one community to the others. According to theories of bridging social capital theory (e.g., Burt 1987), people who participate in multiple communities connect relatively disconnected groups of people. These overlapping members can bring in valuable resources and novel information to the communities they belong to. For example, through participation, members learn basic technical skills (e.g., using editing tools in Wiki-like websites), implicit social skills (e.g., communicating and collaborating with other members) and community building skills (e.g., organizing activities, socializing new members, and resolving conflicts) (Bryant et al. 2005). The skills and knowledge may be transferred across communities when people participate in multiple online communities. Second, communities may gain diverse perspectives when their members participate in a variety of communities (O'leary 2011). Research shows that a moderate level of diversity can increase productivity and decrease member turnover in online communities (Chen et al. 2010). Therefore, a moderate level of membership overlap may positively affect the survival of online communities through increased diversity. Third, according to network diffusion theories (Kairam et al. 2012), people are more likely to join a community if people in their social networks are already participating. Therefore, members participating in multiple communities might increase the probability that friends in one community will join in the other community, thus benefiting both communities.

At the same time, there are three reasons why high levels of membership overlap will harm online communities. By high levels, we refer to a large proportion of members belonging to many other communities. First, although Hill and Shaw showed that participating in two communities did not decrease contributions to either, there is still likely to be limits on members' time and effort. When

individuals participating in too many communities exceed their limits, communities will start to compete with each other for their mutual members' time, thus reducing the chance of survival. Second, high levels of overlap might harm the survival of online communities by lowering members' identification with the communities. Common identity is a powerful way to keep members around in the community (Ren et al. 2007). The basic cause of common identity is social categorization, in which people perceive themselves as members of a social category and contrast themselves with people outside the category (Hogg and Turner 1985). However, as membership overlap becomes high, the boundaries between communities become ambiguous, which lowers people's identification with a certain community. With lowered group identification, people are less likely to participate, leading to decreased community survival. Third, high levels of membership overlap lead to high levels of diverse experiences which might harm the community by increasing the chances of conflicts. Chen et al. (2010) found out that diversity in experience in Wikipedia keeps members in the community only up to a point. Beyond that point (i.e., when the diversity is high), members are more likely to withdraw. In sum, high levels of membership overlap may decrease the chance of survival for online communities.

Therefore, we hypothesize that membership overlap has a curvilinear effect on the survival of online community:

> **Hypothesis 10**. *Moderate levels of membership overlap enhance community survival, but very low or very high levels of membership overlap diminish community survival*.

The beneficial effects of membership overlap on the survival of focal community might be moderated by the maturity of both the focal community and intersecting communities (i.e., ones with which the focal community shares members). Also the roles of shared members in both focal communities and intersecting communities may influence the effects of membership overlap.

Specifically, we hypothesize that the beneficial effects of membership overlap are stronger when the communities with which focal community shares members are more mature. First, mature communities are likely to have developed skills, knowledge, and ways of operating compared to young communities, and shared members provide the conduit to transfer these resources. Second, mature communities have longer operating history, which may enrich members' experience and enhance diversity. Third, more mature communities are often larger, providing more opportunities for the focal community to recruit. In sum, members who participate in more rather than less mature communities are likely to acquire useful knowledge and experiences, diverse perspectives, and contact with potential recruits, which in turn are more likely to benefit the other communities they simultaneously participate in.

Moreover, we hypothesize that the beneficial effects of membership overlap are stronger when the focal communities are young. Online communities are fragile when they are young, and the majority never get off the ground. For example, SourceForge hosts over 300,000 software development projects, but 90% have fewer than four members (Resnick et al. 2012, p. 231). When they are young, communities have greater uncertainty about what their goals are, how to manage their members, and how to attract new members. Shared members who had experiences in other communities can benefit younger communities most since they can import technical skills, community building experience and human resources which are crucial to the survival of young online communities.

> **Hypothesis 11a**. *Membership overlap is more likely to enhance community survival when the intersecting communities are mature.*

> **Hypothesis 11b**. *Membership overlap is more likely to enhance community survival when the focal community is young.*

Furthermore, we hypothesize that the beneficial effects of membership overlap should be stronger when the shared members are core members in other communities. Most online communities have a core-peripheral structure (Bryant et al. 2005). Take Wikipedia as an example: peripheral members tend to participate in tasks that are useful but not crucial, such as correcting spelling and grammar errors. In contrast, core members tend to take on tasks central to the functioning of the communities, such as discussing policies, voting for or running for administrators, and socializing and educating newcomers (Bryant et al. 2005). Shared members who are core in other communities are more likely to have knowledge, experiences and social capital the focal community needs than are those who are peripheral in the other communities.

However, the beneficial effects of shared membership might be weakened when the shared members are core members in the focal communities. Core members carry on tasks central to the communities, which take much more time and efforts than peripheral members. In Wikipedia, administrators made 5010 revisions (a measure of contributions) on average (Burke and Kraut 2008), while the median number of revisions from non-administrators is 1. Therefore, when core members are participating in multiple communities simultaneously, they may reach limits of their energy, which decreases their participation in the focal community and decreases the likelihood of survival of the focal community.

> **Hypothesis 12a.** *Membership overlap is more likely to enhance community survival when shared members are core in the intersecting communities.*

Hypothesis 12b. *Membership overlap is less likely to enhance community survival when shared members are core in the focal community.*

Effects of membership overlap on community survival			
	Pros • Transfer knowledge • Gain diverse perspective • Recruit new members	**Cons** • Compete for shared members' time and efforts	**Overall effects (H10)** Moderate levels of membership overlap enhance community survival. Low or high levels of membership overlap diminish community survival.
Maturity of the intersecting communities	Pros dominate when the intersecting communities are mature		**Moderating effects (H11a)** Membership overlap is more likely to enhance community survival when the intersecting communities are mature.
Maturity of the focal community	Pros dominate when the focal community is young		**Moderating effects (H11b)** Membership overlap is more likely to enhance community survival when the focal community is young.
Role of shared members in intersecting communities	Pros are stronger when the shared members are core members in intersecting communities		**Moderating effects (H12a)** Membership overlap is more likely to enhance community survival when shared members are core in the intersecting communities.
Role of shared members in the focal community		Cons are stronger when the shared members are core members in the focal community	**Moderating effects (H12b)** Membership overlap is less likely to enhance community survival when shared members are core in the focal community.

Table 25. Summary of the hypotheses about the effects of membership overlap on community survival

Method

Study Platform and Data collection

Wikia, a free web hosting service for wikis, provides the data for this research. A wiki is a type of website which allows its users to add, modify, or delete its content via a web browser. Wikia is based on the same technology that powers Wikipedia. Wikis in Wikia cover a broad range of topics, including education, entertainment, finance, food and drink, gaming, politics, technology, sports and others.

Each wiki has project pages on which members can coordinate and organize the writing and the editing of articles. Once they have joined a wiki, members can create a personal profile to share information about themselves and interact with others. Since each wiki has a unique topic, dedicated pages to coordinate

activities, and distinct places for users to interact with each other, we consider each wiki as an independent community.

Once a user creates an account in one wiki, this account can be used to participate in any other wiki in Wikia. The universal Wikia account allows us to track shared members among wikis. The dataset includes 5673 wikis from their inception to 2008. The oldest wiki has 7 years' history and the median age is 10 months.

Analysis strategy: survival analysis

The purpose of the analysis is to estimate how membership overlap influences the survival for online communities. Because Wikia communities are organized to produce content, we consider a community "alive" (i.e., active) if it is producing content and "dead" or at least dormant when it stops. We conduct a survival analysis, a statistical technique for modeling time to an event (Singer & Willett 2003). While survival analysis can be used to analyze death in biological organisms, it is appropriate for modeling many other types of event histories, like an appliance's time to failure, the time until an ex-smoker resumes smoking and or the time until a restaurant goes out of business. Unlike conventional regression techniques, it is robust to censored data, in which the event of interest does not occur during the period of observation. Because membership overlap for a given community varies over time, we used discrete time proportional hazard models (Jenkins 2005). The unit of analysis is the community-month. We used ln(t), where t denotes the month, as the baseline hazard function.

Measurement

Dependent variable

Community dormancy. We define a community to be dormant (the inverse of active) in a given month if the community did not have any activity (including discussion pages and community pages) in the given month and the preceding two months. Community dormancy is a binary variable. This variable is assigned to 1 if the community was dormant during month t; it is assigned 0 if the community was still active in month t. A dormant community can subsequently become active again. Dormancy is ambiguous and thus the data are right censored when the month t is within three months of the end of the data collection period (Jenkins 2005).

Independent variables

Membership overlap. We consider two communities as sharing a member if the member made revisions to both communities in a given month. Members who made revisions to more than 10 communities

simultaneously (in any given month) are excluded because they are often either Wikia administrators or non-human software agents (i.e., "bots"). The percentage of these users is 0.2%. We used the same membership overlap measurement as Wang et al. (2013). They first counted the number of members that the focal community shared with another community (i.e., the amount of overlap between two communities). Then, they calculated the sum of the overlap between the focal community and all the other intersecting communities. Finally, they calculated membership overlap by dividing this sum by the focal community size (see formula (1)). This is equivalent to calculating the mean shared membership per focal community member (see formula (2)). This measure considers both the proportion of members who participate in multiple communities and the number of other communities they participate in.

$$Membership\ overlap_{community\ i} = \frac{\sum\limits_{Any\ community\ j\ (j \neq i)} Number\ of\ shared\ members\ between\ i,\ j}{Number\ of\ members\ in\ community\ i} \quad (1)$$

$$= \frac{\sum\limits_{Any\ member\ M\ in\ community\ i} Number\ of\ other\ communities\ M\ participating\ in}{Number\ of\ members\ in\ community\ i} \quad (2)$$

Formula for calculating membership overlap

Mature intersecting communities overlap. This variable is used to measure the degree of overlap with mature intersecting communities, based on a median split of community age. That is, it is the average number of mature communities a member belongs to per focal community member. Specifically, formula (1) is adjusted so that number of shared members is added only when community j is mature. A mature community is one that has existed for at least 10 months, which is the median community age.

Young intersecting communities overlap. This variable is used to measure the degree of overlap with young intersecting communities (communities younger than 10 months). To calculate this variable, formula (1) is adjusted so that number of shared members is added only when community j is less than 10 months old.

Mature focal community overlap. We differentiate whether the focal community is mature or not. When the focal community is younger than 10 months, this measure is zero. When the focal community is at least 10 months old, this variable is equal to membership overlap.

Young focal community overlap. We differentiate whether the focal community is young or not. When the focal community is 10 months or older, this measure is zero. When the focal community is less than 10 months old, this variable is equal to membership overlap.

Mature intersecting x mature focal, mature intersecting x young focal, young intersecting x mature focal, and young intersecting x young focal. These four variables are intended to investigate interaction between the maturity of the focal community and its intersecting communities.

Core in intersecting communities overlap. We calculate this measure by focusing on shared members who are core members in the intersecting communities. We define core members as those in the top 25% of degree centrality in the co-authorship network. We define co-author relationship as editing the same community page in the same period of time (a month) at least once prior to the given month. Note that this definition of core members does not make much sense if the community size is too small. Therefore, we only define people who are top 25% degree centrality in communities with at least eight numbers as core members. Otherwise, they are peripheral members. To calculate this measure, formula (1) was adjusted so it included only the number of shared members who were core in the intersecting communities.

Peripheral in intersecting communities overlap. Similarly, we calculate this measure by focusing on the shared members who are peripheral members in the intersecting communities (i.e., in the bottom 75% of the degree centrality distribution or in communities smaller than eight).

Core in focal community overlap. Similarly, we calculated this measure by focusing on the shared members who were core in the focal community (i.e., in the top 25% of the degree centrality distribution in focal communities with at least eight membership).

Peripheral in focal community overlap. Similarly, we calculated this measure by focusing on the shared members who are peripheral members in the focal community (i.e., in the bottom 75% of the degree centrality distribution in the focal community or in focal communities with at least eight membership).

Core in intersecting x core in focal, core in intersecting x peripheral in focal, peripheral in intersecting x core in focal, and peripheral in intersecting x peripheral in focal. These four variables are designed to test the interaction effects of members' roles in intersecting communities and focal community.

Control variables

Number of members. This variable is the number of members who made revisions to any page (including discussion pages) in the community in the given month.

Amount of activity. This variable is the number of total revisions that members made to the articles in the community in the given month.

Wikia staff. This variable indicates the number of Wikia administrators who made revisions to the articles in the community in the given month.

ln(t). This variable represents the baseline hazard function, where t denotes the month.

Note that all the independent variables and number of members and amount of activity were log transformed in the analysis to reduce non-normality in the data. Because the number of articles was highly correlated with number of members and amount of activity, we did not include it in the analysis.

Results

Table 26 shows the descriptive statistics. The mean of community dormancy is 0.13, which means that on average in any given month 13% communities have been inactive for at least three months. The mean of membership overlap in all the communities is 1.13, indicating that, on average in any given month members in a community tend to participate in one other community.

	Mean	S.D.
Variables internal to the community		
Community dormancy	0.13	0.34
Number of members	17.69	141.56
Amount of activity	508.91	2983.4
Wikia staff	0.83	1.90
Membership overlap variables		
Membership overlap	1.13	1.51
Mature intersecting communities overlap	0.80	1.15
Young intersecting communities overlap	0.33	0.74
Mature focal community overlap	0.48	1.07
Young focal community overlap	0.65	1.33
Core in intersecting communities overlap	0.20	0.44
Peripheral in intersecting comm. overlap	0.93	1.31
Core in focal community overlap	0.03	0.10
Peripheral in focal community overlap	1.10	1.51
N=5673 communities, 37665 community-month observations		

Table 26. Descriptive Statistics

Explanatory variables	Hazard Ratio (H.R.)	[95% Conf. Interval]	
Membership Overlap	.922**	[.869	.978]
Quadratic Term for Membership Overlap	1.06	[.980,	1.14]
Number of members	.229**	[.202,	.260]
Amount of activity	.704**	[.697,	.722]
Wikia staff	.847**	[.816,	.880]
Ln(t): baseline hazard function	.690**	[.673,	.708]
Log likelihood = -11571.206	** p<0.01,	*p<0.05	

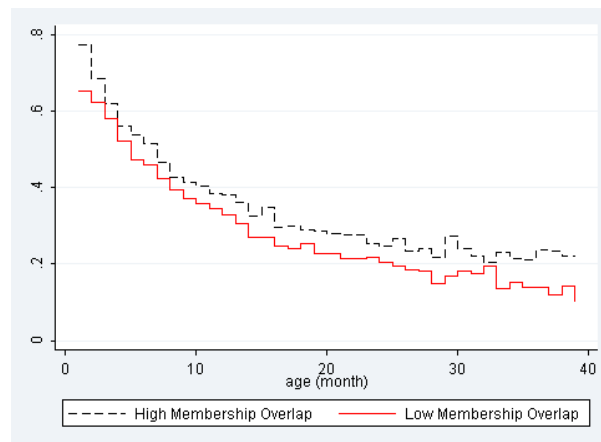Table 27. Predicting the effects of membership overlap on survival (Hypothesis 10)

Figure 10. Average survival rate for communities with different levels of membership overlap. (This visualization corresponds to the results in Table 27.)

Interpreting the Results

Tables 27-29 show the results of survival analysis, reporting hazard ratios and their 95% confidence intervals. A hazard ratio is the ratio of the risk of a community becoming dormant in a given month-long period associated with a one unit change in the explanatory variables. A hazard ratio smaller than 1 indicates the decreased rate of dormancy (i.e., increased survival rate), while a hazard ratio larger than 1 indicates the increased rate of dormancy (i.e., decreased survival rate).

Testing Hypothesis 10: Effects of membership overlap

Table 27 tests hypothesis 10, i.e., a curvilinear relationship between membership overlap and community survival. The analysis tested both linear and quadratic terms for membership overlap. We see that the hazard ratio of linear term of membership overlap is significantly smaller than 1 (H.R. = .922, 95% C.I. is [.869, .978], p<0.01), which shows that as membership overlap increases so does community survival. A community where members are on average also members of one other community is 7.8% more likely to

105

be active in a typical month than a community where members do not belong to any other communities. Figure 10 show this result graphically. We divided the community-month observations into two equal-sized groups, those with high and membership overlap, and plotted community survival separately for each group. Communities with high levels of membership overlap are more likely to survive, compared with communities with low levels of membership overlap. However, the hazard ratio for quadratic term is not significant (H.R. = 1.06, 95% C.I. is [.980, 1.14]), indicating that community survival is not highest at intermediate values of membership overlap. Therefore, the curvilinear effects are not confirmed.

Testing Hypothesis 11: Moderating effects of the maturity of the communities

Table 28 shows analysis testing the moderating effects of the maturity of the communities. Model 1 in Table 28 examines two types of membership overlap: overlap with mature communities (i.e., mature intersecting communities overlap) and overlap with young communities (i.e., young intersecting communities overlap). We can see that the hazard ratio of mature intersecting communities overlap is significantly smaller than 1 (H.R. = .880, p<0.01) while the hazard ratio of young intersecting communities overlap is significantly larger than 1 (H.R. = 1.20, p<0.01). The results suggest that overlapping with mature communities is beneficial but overlapping with young communities is harmful. In Model 2, we examine the influence of membership overlap on two types of focal community: young and mature. Young communities tend to benefit from membership overlap (H.R. = .861, p<0.01) while mature communities do not (H.R. = 1.18, p<0.01). Model 3 shows the interaction between the types of focal communities and the types of intersecting communities. Membership overlap is most beneficial when young focal communities are overlapping with other mature intersecting communities (H.R. = .794, p<0.01), and membership overlap is least beneficial when mature focal communities are sharing members with young intersecting communities (H.R. = 1.45, p<0.01). In sum, we found broad support for hypothesis 11.

We show the effects of different types of intersecting communities visually in Figure 11. We divide the observations into two buckets: high and low mature intersecting communities overlap. In the visualization, we can see that communities with high overlap with mature communities are more likely to survive. We do not include a graph comparing mature and young focal communities because it is difficult to visualize the influence of membership overlap on different age periods using survival curves.

Testing Hypothesis 12: Moderating effects of the roles of the shared members

Table 29 shows the results of the moderating effects of roles of shared members in focal communities and intersecting communities. Model 1 shows that a community where members are on average also core

106

members of one other community is 24.5% more likely to be active in a typical month than a community where shared members are not core in any other communities. (H.R. = .755, p<0.01). In contrast, they gain no benefit from sharing members who are peripheral members in intersecting communities (H.R. = 1.03, 95% C.I. is [.977, 1.08]). Model 2 suggests communities are more likely to be active if they share their peripheral members with other communities are beneficial for the focal communities (H.R. = .949, p<0.01). However, they get no benefit from sharing their core members (H.R. = 2.14, 95% C.I. is [.203, 22.5]). In contrast, Model 3 shows that shared members who are both core members in focal community and intersecting communities are associated with significant decrease in the likelihood of survival of focal community (H.R. = 804, p<0.01). Note that the hazard ratio and its value for core in intersecting x core in focal is large, probably because it is rare in the dataset for shared members to be core in both the focal and intersecting communities. Communities are most likely to be active when they have shared members who are peripheral members in focal community and core members in intersecting communities (H.R. = .754, p<0.01).

We draw survival curves to show the results graphically. Figure 12 shows that communities with their core members participating in other communities are less likely to survive, compared to those communities with fewer core members participating in other communities. In sum, we found support for hypothesis 12.

Explanatory variables	Model 1		Model 2		Model 3	
	H.R.	[95% CI]	H.R.	[95% CI]	H.R.	[95% CI]
Mature intersecting communities overlap	.880**	[.831, .931]				
Young intersecting communities overlap	1.20**	[1.03, 1.18]				
Mature focal community overlap			1.18**	[1.09, 1.26]		
Young focal community overlap			.861**	[.816, .908]		
Mature intersecting x mature focal					1.02	[.923, 1.12]
Mature intersecting x young focal					.794**	[.740, .851]
Young intersecting x mature focal					1.45**	[1.26, 1.69]
Young intersecting x young focal					1.03	[.955, 1.11]
Number of members	.224**	[.198, .254]	.228**	[.201, .258]	.225**	[.198, .255]
Amount of activity	.705**	[.688, .723]	.704**	[.687, .722]	.706**	[.689, .724]
Wikia staff	.853**	[.822, .886]	.845**	[.814, .877]	.854**	[.823, .888]
Ln(t): baseline hazard function	.697**	[.679, .715]	.653**	[.634, .673]	.658**	[.639, .678]

Log likelihood = -11533.524   ** p<0.01,   *p<0.05

Table 28. The moderating effects of tenure of communities (Hypothesis 11)

Explanatory variables	Model 1 H.R.	[95% CI]	Model 2 H.R.	[95% CI]	Model 3 H.R.	[95% CI]
Core in intersecting communities	.755**	[.678, .840]				
Peripheral in intersecting communities	1.03	[.977, 1.08]				
Core in focal community			2.14	[.203, 22.5]		
Peripheral in focal community			.949*	[.907, .992]		
Core in intersecting x core in focal					804**	[14.7, 44000]
Core in intersecting x peripheral in focal					.754**	[.677, .839]
Peripheral in intersecting x core in focal					.017	[.000, 3.51]
Peripheral in intersecting x peripheral in focal					1.03	[.978, 1.08]
Number of members	.229**	[.202, .259]	.226**	[.199, .256]	.227**	[.200, .258]
Amount of activity	.703**	[.686, .721]	.704**	[.687, .721]	.703**	[.686, .721]
Wikia staff	.845**	[.813, .877]	.845**	[.814, .877]	.844**	[.813, .877]
Ln(t): baseline hazard function	.696**	[.678, .714]	.691**	[.674, .709]	.696**	[.678, .714]

Log likelihood = -11557.379   ** p<0.01,   *p<0.05

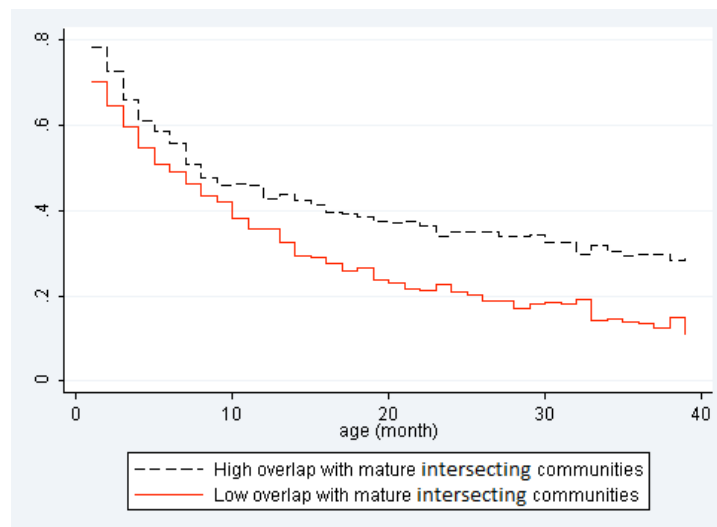Table 29. The moderating effects of roles of shared members (Hypothesis 12)

Figure 11. Average survival rate for communities with different levels of membership overlap with mature intersecting communities. (This visualization corresponds to Model 1 in Table 28.)
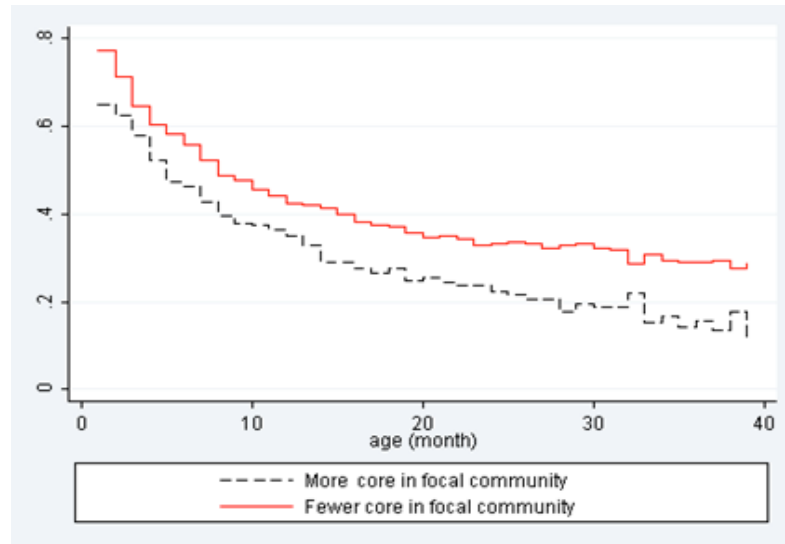
Figure 12. Average survival rate for communities varying core in focal community (i.e., shared members who are core members in focal community). (This visualization corresponds to Model 2 in Table 29.)

Discussion

This section examined the effects of membership overlap on the survival of online communities. With archival data from 5673 Wikia communities, we found that 1) higher levels of membership overlap are associated with increased community activity; 2) the beneficial effects of membership overlap are especially strong when the focal community was young and the intersecting communities were mature; 3) membership overlap increases the chances of survival more when the shared members are core members in the intersecting communities but reduces the chance of survival when the shared members are core members in the focal community.

Although we predicted that membership overlap should have a curvilinear effect on community survival, our results only confirmed the linearly positive relationship (see Table 27). Our results contrast with those of Wang et al (2013), who found a negative relationship between membership overlap and community growth for Usenet groups. The reason of these different findings might be that membership overlap was much higher in the Usenet groups that Wang et al. studied, with Usenet group members participating in 7.56 additional groups, compared to the Wikia communities we studied, where members participated in 1.13 additional communities on average. It is possible that that the overall effects of membership overlap on the survival rate are indeed curvilinear as hypothesized, but the current study and Wang et al.'s study of Usenet groups were studying different locations in the membership overlaps distribution.

Our results have guidance for community practitioners. The proliferation of communities that exist on the Internet brings in uncertainty to community managers and creators. Our results show that communities can potentially benefit from other communities in the environment. Specifically, in the communities we studied, the beneficial effects of membership overlap (i.e., learning, knowledge sharing, diverse perspectives and new member recruiting) outweigh the negative effects (i.e., competition for the members' efforts), resulting in increased capability to survive. To exploit the beneficial effects of membership overlap, community practitioners can design recruiting strategies to specifically target members who have experience in other mature communities, especially those core members in other communities.

This study is also subject to limitations. First, our data analysis provides limited support for understanding why the membership overlap is associated with community survival. It would be more convincing if mediating variables which directly relate to membership overlap and the survival rate of community could be included in the analysis. Example mediating variables might include organization or content similarity between communities (which are indicators of learning and knowledge sharing) and diluted members' attention and efforts (which is an indicator of competition). We will investigate these in future research.

Second, our study used community activity and dormancy as a proxy for community success, while in reality success can be measured in many aspects such as quality of deliverables in Wikipedia-like communities and progress towards particular business-oriented goals in enterprise communities. Nonetheless, as activity level is indeed a widely-used measure of community success, we believe our results are still valuable. Future research could extend this work, by incorporating more nuanced success measures as appropriate.

Lastly, we used a homogeneous platform in Wikia. Doing so was important for our research for two reasons: 1) we were able to compare across communities since they shared the same UI and backend; and 2) we were able to track member migration across communities since member identifiers were Wikia-wide. However, one caution in generalizing from this homogeneous system is that knowledge, experience, and human capital may be easier to transfer among similar types of organizations or projects than they would be in more heterogeneous environments of communities. We would like to examine communities with different UIs and affordances in future research in order to understand how these findings are similar or different in heterogeneous communities.

Conclusion

Online communities play an important role in society. In this study, we study the effects of membership overlap on the survival of online communities. These findings provide new insight into an important mechanism underlying successful online communities and practical implication for the hosts and creators of online communities.

PART II: TOPIC OVERLAP AND COMMUNITY SUCCESS

Another important success factor for any community is its topically relationship with other communities. For example, if employees in a company have already set up many communities on the topic of Java programming, a newly created community on Java may be doomed to failure, because it directly competes with many established communities on the same topic for a shared pool of members. On the other hand, a new community on the Eclipse programming environment—an overlapping but still distinguished topic—might flourish, because many of the existing Java communities have members who use Eclipse and have the knowledge to contribute, a relevant but not redundant content base, and thus complement the new community. Due to these interactions, anyone starting a new community will have to carefully define its niche by examining other related communities, and may even decide a new community is not needed.

In this work we studied community success from an ecological view by examining how a community's activity level is impacted by its niche, i.e., its relationship with other communities in an ecosystem. We use the word ecosystem to mean the collection of all communities in a given environment, such as a shared technology platform or organization. Of the various dimensions defining a niche, we focus particularly on topic, because a community's topic strongly influences its scope, its audience, and the type of content that is relevant. We measure a community's topic niche through its topic overlap with other communities, and propose a series of hypotheses describing how a community's topic overlap affects its activity level. Beyond topic overlap, we also hypothesize how other dimensions of niche, such as shared members, content linking, and offline organizational affiliation can interact with topic overlap to impact activity level. We test our hypotheses on the internal use of online communities within a large global company. We used a mixed-method approach, combining quantitative analysis of 9,495 communities and qualitative interviews of community users.

The contributions of this work are two-fold. Theoretically, we show how a community's relationship with other communities in a larger ecosystem influences its activity levels, and gain new insights on important mechanisms that affect community success in large ecosystems. Practically, our findings may guide community creators on how to effectively position new communities within an ecosystem, and tool designers on how to support creators with this task.

112

Theory and Hypotheses

Prior research on factors leading to the continued success of online communities fall into two main categories: individual community dynamics and inter-community relationships.

Individual community dynamics: A large body of literature investigates how community-level characteristics influence the success of online communities. This research has focused on two kinds of community-level characteristics: composition (i.e., the makeup of the community, such as its size or composition Butler 2001, Chen et al. 2010) and structure (i.e., the patterns of relationships among members, such as social network, leadership and governance structures Kairam et al. 2012, O'Mahony & Ferraro 2007, Zhu et al. 2012). The assumption of this group of research is that communities can achieve continued success by adjusting their composition (e.g., diversity of members, group size) and optimizing their internal structures (e.g., governance).

Inter-community relationships: Though most online communities cooperate and compete within a larger population of communities, only a few researchers have investigated community activity from an ecological perspective. The recent book by Kraut and Resnick (2012) surveys hundreds of research papers and proposes design claims about building successful online communities. Among the 176 claims, 171 are about internal dynamics. We know relatively little about how success is influenced by external factors, such as other related communities. The closest prior work are Wang et al. (2013) and Zhu et al. (2014) which examine the impact of membership overlap on community activity. Wang et al. argued that membership overlap caused competition among communities for member time and attention that reduced the chance their opportunities for growth (Wang et al. 2013). Zhu et al. (2014) built on Wang et al.'s work, finding that moderate levels of membership overlap between communities may bring benefits that out-weigh the negatives, such as knowledge transfer and new member recruitment. However, research on inter-community relationships is in its infancy and many open questions remain. We contribute to this emerging area of study by examining the impact of shared topics, members, content, and offline organizational affiliation.

Ecological View of Community Success

To further explore inter-community relationships, we examine the online community success from an ecological perspective. This perspective is based on organization ecological research, which examines traditional organizations such as hotel chains and newspaper publishers (Baum & Shipilov 2006, Hannan & Freeman 1977). Organization ecology research suggests that two ecosystem mechanisms—competition

and complementarity—influence the success of organizations (Baum & Shipilov 2006). However, prior work has not studied how these mechanisms manifest in online communities, something we contribute in this study.

Online Communities' Competition and Complementarity

Competition is a core concept in organization ecology. Organizations compete with others in the same ecosystem for common resources (Hannan & Freeman 1977). Furthermore, the intensity of competition between organizations is largely a function of how similar their resource requirements are: the more similar their resource requirements, the greater the potential for intense competition (Hannan & Freeman 1977).

Applying this finding to online community ecosystems, we would expect communities to compete with each other for common resources such as members' attention and efforts. Members have a certain amount of time in the day, some of which they may allocate to community participation, but it is not possible for them to keep track of what is going on in all the communities in a large ecosystem. Competition might result in decreased activity in the communities vying for member attention, which is a common resource.

Complementarity in organization ecology describes benefits organizations may get from the existence of "competitors". Researchers in offline organizations found evidence that knowledge and operating experience can be transferred among similar organizations, thus increasing the survival rate of the organizations. For example, Ingram and Baum (1997) found that a hotel chain's survival rate was positively related to the total operating experience accumulated by other hotel chains in the same country.

Similarly for online communities, members who join more than one community in an ecosystem may share their knowledge across communities. Community leaders can benefit by learning from the success and failure experiences of other similar communities. Complementarity might result in increased activity in the communities that share knowledge and experience.

Effects of Topic Overlap on Community Success

In this study, we apply the mechanisms of competition and complementarity to explain different success levels across an ecosystem of related online communities. We center our exploration on understanding the effects of topic overlap on community success, because a community's topic defines its content scope and member audience, thus centrally defining its relationship to other communities in the ecosystem. We also

study the moderating effects of other dimensions that help define a community's niche, including shared members, content linking, and shared offline organizational affiliation with other communities.

To estimate community success in this study, we use the overall activity (i.e., number of posts created, commented on, and viewed) in the community. Multiple researchers argue that these are reasonable approximations of community success, since ongoing activity and interactions among members are necessary for a healthy community and volume indicates levels of engagement and value (Preece & Maloney-Krichmar 2003).

When communities have higher topic overlap (i.e., more communities in the ecosystem with similar topics), communities have more intense competition for members' time, and hence lower activity levels. Thus, we hypothesize that competition between communities leads to a negative relationship between topic overlap and activity level. See row 1(a) of Table 30 for an illustration of this prediction.

On the positive side, when communities have higher topic overlap, they are more likely to complement each other by increased learning and content sharing. However, we predict that this benefit will slow down (or even plateau) as the topic overlap becomes higher. We base this prediction on the mechanism behind previously studied "learning curve" plateaus (Yelle 1979): as topic overlap and sharing increase, there is less new information and experience available for a community to learn from. Furthermore, low topic overlap will hurt communities, because there will be less able to learn or borrow content from other complementary communities. Thus, we hypothesize that complementarity, as manifested through learning and content sharing between communities, leads to a positive relationship between topic overlap and activity level with diminishing returns. See row 1(b) of Table 30 for an illustration of this prediction.

When we put these predictions for competition and complementarity together, we expect that the effects of topic overlap should have a curvilinear shape (see the right-most column of Table 30, row 1). Too little or too much topic overlap will negatively impact a community's activity, for the arguments outline above: either complementarity will be too low or competition too high. Only when the topic overlap is moderate will the activity level be highest.

> *Hypothesis 13. There is a curvilinear relationship between the topic overlap of a given community with other communities and the activity level of this community. Low topic overlap and high topic overlap results in low activity level, while moderate topic overlap results in highest activity level.*
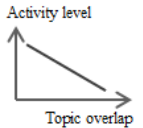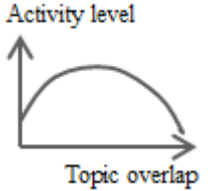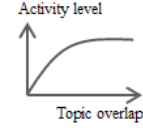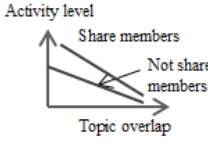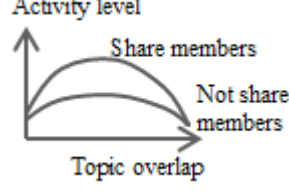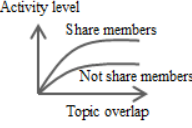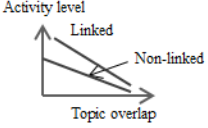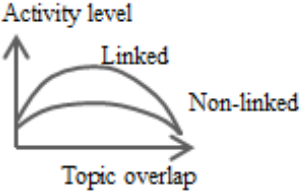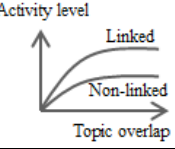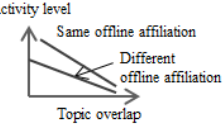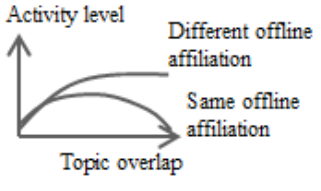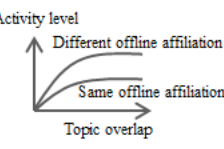
	Mechanisms		Overall effects
(1) How does topic overlap influence activity level?	**(a) Competition:** Dilute members' time and attention.		**Hypothesis 13:**
	(b) Complementarity: Share information on common topic and learn success and failure experience from each other.		
(2) How do shared members moderate the effects of topic overlap?	**(a) Competition:** Competition is stronger for communities that share members.		**Hypothesis 14**
	(b) Complementarity: Complementing is stronger for communities that share members because shared members can transfer knowledge and experience.		
(3) How does content linking moderate the effects of topic overlap?	**(a) Competition:** Competition is stronger if the communities are linked with each other because it is easier for members to go from one to the other.		**Hypothesis 15**
	(b) Complementarity: Complementing is stronger if the communities are linked because information is easier to access and transfer.		
(4) How does shared offline organizational affiliation moderate the effects of topic overlap?	**(a) Competition:** Competition is stronger for communities that share the same offline organizational affiliation because they share the same new member pool and their growth space overlaps.		**Hypothesis 16**
	(b) Complementarity: Complementarity is stronger for communities that do not share the same offline organizational affiliation because communities from a different network are more likely to bring in valuable information and experiences.		

Table 30. The effects of topic overlap on community activity.

Hypothesis 13 is about the general effects of how other communities with similar topics in the ecosystem can influence the activity of a given community. However, each of the other communities in the ecosystem does not equally influence a given community. For example, communities that share both members and topics should impact each other even more than communities that only share topics. Therefore, in the following section we propose hypotheses about the moderating effects of other ecosystem relationships, including shared members, shared content (approximated by measuring content linking), and shared offline organizational affiliation. Understanding the moderating effects of these other relationship aspects can provide a more complete view of the ecosystem's impact on community activity, as well as further our understanding of the underlying mechanisms of competition and complementarity.

Moderating effects of shared members

Shared members are the medium by which knowledge and experiences are transferred between communities, as well as the resources that communities compete for. Having shared members might intensify both complementarity and competition processes. Therefore, topic overlap with communities that share members should have a stronger curvilinear effect on the activity level (i.e., steeper increase and then steeper decrease), compared to the same amount of topic overlap but no shared members. See Table 30, row 2.

> **Hypothesis 14.** *The effects of topic overlap are stronger for communities that share members than for communities that do not share members.*

Moderating effects of content linking

In an online setting, it is common that communities link to content in other relevant communities. These linking relationships on one hand encourage knowledge sharing and enhance complementarity (see Table 30, row 3(b)). But on the other hand, linking may intensify competition because the existence of "potential competitor communities" is more visible to members. Members may find the linked-to community more useful and spend more time there instead (see Table 30, row 3(a)).

> **Hypothesis 15.** *The effects of topic overlap are stronger with linked communities than with non-linked communities.*

Moderating effects of offline organizational affiliation

For many communities, members share not only their online affiliation, but also their offline affiliation. In some communities, people get to know each other or are affiliated in an offline setting, and then maintain social or work contact in online communities. Examples include enterprise communities where

employees, who already have their affiliations in a hierarchical company, participate in online communities to fulfill business-centric goals such as learning, collaboration and professional networking (Muller et al. 2012). In other cases, communities in which people mainly interact online also have offline structures determined by members' geographic or demographic distribution. For example, Wikipedia has language-based sub-communities and geographic-based local chapters. The offline organizational affiliation might influence the strength of competition and complementarity among the online communities.

We propose that the competition is stronger among communities that share offline organizational affiliation compared to communities that do not. High turn-over is an issue for most communities, and so their continued activity depends on the supply of new members (Kraut & Resnick 2012). According to prior research, network diffusion is one of the major mechanisms of community growth (Kairam et al. 2012), i.e., new individuals participate because of their offline ties to current community members. Therefore, offline organizational affiliations often define a pool of people who can become new members in the online communities. Communities within the same offline organizational group recruit from a new member pool that overlaps, intensifying competition. See row 4(a) of Table 30 for an illustration of this prediction.

Separately, we propose that the complementarity (e.g., experience learning and content sharing) might be stronger if communities are from different offline organizational affiliation. According to weak tie theories (Granovetter 1973), communities with members from different networks might provide more novel information and experiences than communities with members from the same network. See row 4(b) of Table 30 for an illustration of this prediction.

When we put these two predictions together, the resulting hypothesis is illustrated in the right-most column of Table 30, row 4, and described here:

> ***Hypothesis 16.*** *Topic overlap with communities that do not share offline organizational affiliation has a greater increase and a smaller decrease on activity level. Topic overlap with communities that do share offline organizational affiliation, has a smaller increase and a greater decrease on activity level.*

Method

We test our hypotheses in the context of an enterprise online community platform. Here we describe the platform and our quantitative analysis and interview methods.

Study platform

This research was conducted in a global enterprise offering technology products and services to businesses. The company widely encouraged employee leadership of, and participation in, internal online communities and made commercial technology, Connections Communities ("Communities"), available to all employees. All communities we studied used this tool, which enabled leaders to easily create a community space with various social tools like forums, blogs, wikis, files, and bookmarks. As a result, there was a proliferation of communities and widespread membership, with over 166 thousand communities and over 580 thousand distinct members over five years. Communities ranged in size from a couple to tens of thousands. Many employees were members of multiple communities.

Connection Communities within the company studied provides a good platform to test the impact of ecosystems on community success for three reasons: First, the Connections platform supports the fundamental features that define online communities: (1) members have a shared goal/activity that provides the primary reason for belonging to the community, (2) members engage in repeated active participation, (3) members have access to shared resources, (4) there is reciprocity of information and services between members, and (5) there is a shared context of social conventions, language and protocols (Preece & Maloney-Krichmar 2003). Second, the vast number of communities in the company studied has resulted in a community ecosystem crowded with similar communities, enabling the study of topic overlap. Third, members of Connections communities are authenticated, enabling us to collect data on their offline organizational affiliation. This provides a unique opportunity to examine hypothesis 16.

Due to the enterprise nature, Connection communities still differ from public online communities in several ways. For example, the Connection communities share organizational context, have business-centric goals, and members are authenticated. However, there is no strong reason to believe that these differences will confound the impact of ecosystem factors on community success. Therefore, we believe our results can generalize across most online communities.

Analysis strategy

We used a mixed methods approach to characterize our findings from both qualitative and quantitative perspectives. We chose 9495 active communities and ran our quantitative analyses on historical data to

test the relationship between topic overlap and activity level. Meanwhile, we also conducted interviews with active community members to provide rich descriptions and concrete examples of the phenomena studied.

Quantitative analysis: Data collection

We selected the 10K communities that had most recently been updated over a 14-day period prior to March 28th 2013. 9495 communities remained in the dataset after excluding those using non-English languages. We collected data at two time points: March 28th 2013 and June 9th 2013. In the analysis, the outcome variable is the activity of the community between March 28th 2013 and June 9th 2013; the independent variables and control variables (including topic overlap, number of members, and age) were collected in March 28th 2013.

Quantitative analysis: Dependent variable

Activity level. To measure the activity level, we calculated the sum of the counts of new content produced (the number of new wiki edits, wiki comments, forum topics, forum replies, blog entries, blogs comments, idea entries, idea comments, file entries, file comments, bookmarks, and activity entries) and the counts of content consumed (number of blog views, idea views, and file downloads), in the three-month period note above. We calculated the sum of production and consumption counts because (1) both are widely used measures of community activity (Cothrel 1973, Iriberri and Leroy 2009), (2) production and consumption highly correlate with each other, and (3) we found that the result is the same if we considered these two measures separately. We log transformed this variable in the analysis.

Quantitative analysis: Control variables

Number of members. We included the number of community members as control variable. We define members as those who have edited any page of a community at least once, not just those people whose names appear on the member list. The reason is that, by definition (Preece & Maloney-Krichmar 2003), the members in communities should engage in repeated active participation.

Age of the community. We included the age of the community as control variable. We measured age in number of months

Quantitative analysis: Independent variables

Topic overlap. We operationalized the topic overlap of one community as the sum of content similarity between the focal community and all the other communities in our dataset. We represented the content of each community through a vector of TF-IDF (term frequency-inverse document frequency) scores, where each score represented how important a word was to the content of a given community (Salton & Buckley

120

1988). The TF-IDF score increases proportionally to the frequency of the word in the given community, but is offset by the frequency of the word in all the communities. Then for the focal community, we calculated the cosine similarity between its TF-IDF vector and the TF-IDF vectors of all other communities, and summed these similarity scores together. Take the Java Developer community in Table 31 as example, the topic overlap of the Java Developer community is the sum of its cosine similarity with all the other communities: 0.9+0.4+0.1=1.4.

Topic overlap with shared members. This variable measures the topic overlap with communities that share members. We calculated this measure by only summing the similarity of communities that shared members with the focal community. For example, since the Java Developer community only share members with the Software Engineer community (see Table 31), its topic overlap with shared members is 0.9. This measurement is operationalized as the sum (not mean) of the similarity score because the underlying competition and complementarity effects are stronger both when many communities overlap a little and when few communities overlap a lot. For example, a community will likely learn comparably from 30 communities that share members and some topic relevance, OR from 3 communities that share members and nearly identical topic focuses.

Topic overlap without shared members. This variable measures the topic overlap with communities that do not share members. We calculated this measure by only including communities that do not share members. Therefore, the value of the Java Developer community is 0.5 for this measure (see Table 31).

Topic overlap with linked communities. We defined two communities as linked if one had hyperlinks that directed to pages of the other community. We calculated this measure by only including linked communities. The value of the Java Developer community is 1.3 for this measure (see Table 31).

Topic overlap with non-linked communities. We calculated this measure by only including communities not linked with focal community. The value of the Java Developer community is 0.1 for this measure (Table 31).

Topic overlap in the same offline organizational affiliation. The variable measures the topic overlap with communities that share offline organizational affiliation. We define communities as sharing offline organizational affiliation when they are from the same business division. Connections communities are inside a large global company, which includes divisions such as Marketing, Software Development, Hardware Development, Business Services, and Research. We operationalized the division of each community as the division of the majority of community owners. We calculated this measure by

including communities from the same division as the focal community. The value of the Java Developer community is 0.9 for this measure (Table 31).

Topic overlap in different offline organizational affiliation. The variable measures the topic overlap with communities that belong to different offline organizational affiliation. We calculated this measure by including communities that belong to different divisions. The value of the Java Developer community is 0.5 for this measure (see Table 31).

All the independent variables are normalized to [0,1]. Also, note that the four niche dimensions (i.e., topic overlap, shared members, content linking and shared offline organizational affiliation) are independent and only minimally correlated. Take topic overlap and shared members as example: because each member has multiple interests and needs they tend to join many communities with very different topics, and thus topic irrelevant communities may also share members. The statistics confirm the above observations: the correlation between topic overlap and shared members is 0.16 in our dataset.

Name	Division	Cosine similarity between TF-IDF (Share members or not) (Linked or not)			
		1. Java Developer	**2.Software Engineer**	**3.Data Analytics**	**4.Human Resource**
1. Java Developer	Engineer		0.9 (1) (1)	0.4 (0) (1)	0.1 (0) (0)
2. Software Engineer	Engineer	0.9 (1) (1)		0.6 (1) (1)	0.1 (0) (0)
3. Data Analytics	Market	0.4 (0) (1)	0.6 (1) (1)		0.2 (1) (0)
4. Human Resource	HR	0.1 (0) (0)	0.1 (0) (0)	0.2 (1) (0)	

Table 31. Hypothetical names and values for four communities to serve the purpose of illustrating how the measures are calculated

Qualitative analysis method

To supplement our quantitative analysis, talked with members of the communities we were analyzing to understand if our conclusions were accurate and to contribute detailed descriptions of the mechanisms studied. We interviewed 10 members about their experience participating in communities with high and low topic overlap, managing their time between multiple communities, and their practices around sharing information between communities. We referred to a list of 5 communities they had contributed to when

we asked questions about these topics, in order to keep the discussion grounded in actual communities and experiences.

We randomly sampled from a pool of members who had contributed to at least 5 of the communities in our dataset of 9495 communities (described above), where at least one of those communities had low topic overlap (bottom 20% of our dataset) and one had high topic overlap with other communities (top 20%). These criteria selected members who were at least moderately active in communities with a variety of job roles, an average of 19 years of experience (ranging from 1 to 33 years) from across the organization. We followed a grounded theory approach of adding participants and analyzing data as we went, stopping when we reached a point of information saturation (Seidman 1998). Three researchers attended each interview, one to ask questions and the others to take detailed notes. Interviews were semi-structured, lasted 30-45 minutes, were conducted via phone and audio recorded. We analyzed the detailed notes using open coding, and then analyzed the concepts and categories from our initial coding for themes. Below we include those themes that are relevant to our quantitative findings.

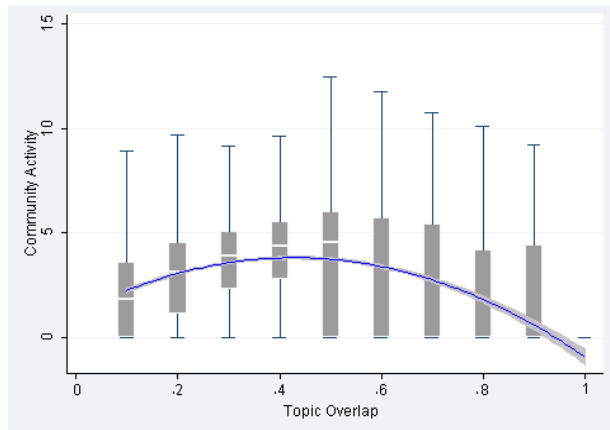| Variable Name	N	Mean	S.D.
Age of the community	9495	15.5	14.5
Number of members	9495	14.9	54.0
Activity level (logged)	9495	3.23	2.51
Topic overlap	9495	0.31	0.18
Topic overlap with shared members	9495	0.02	0.04
Topic overlap with linked community	9495	0.01	0.04
Topic overlap in the same offline org. affiliation	9495	0.10	0.19

Table 32. Descriptive statistic

Figure 13. Relationship between topic overlap and activity.

The Figure shows the quadratic prediction plots with 95% confident interval as well as the box plots.
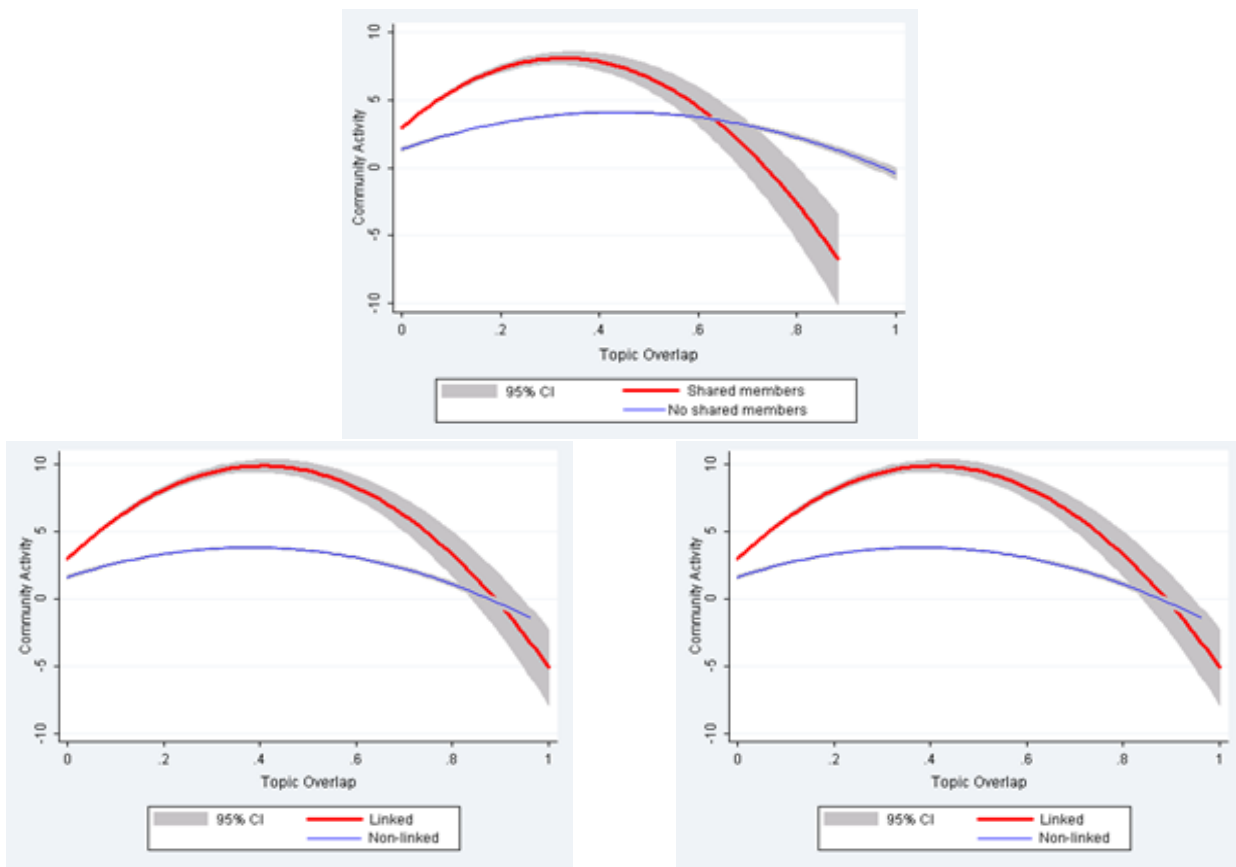

Figure 14. (Upper) Moderating effects of shared members. (Bottom Left) Moderating effects of content linking. (Bottom Right) Moderating effects of offline organizational affiliation.

Results

The effects of topic overlap

We hypothesized that for a given community, there is a curvilinear relationship between its topic overlap with other communities and its activity level (Table 30, row 1). As shown in Figure 13, low levels of topic and high topic overlap led to low activity levels. Moderate levels of topic overlap led to the highest activity levels. Model 1 in Table 33 shows that the curvilinear relationship is statistically significant. The linear term of topic overlap is significantly positive (coef.=3.30, $p<0.01$), while the quadratic term is significantly negative (coef.= -14.2, $p<0.01$). These results confirm hypothesis 13.

The qualitative interviews confirmed these quantitative results, suggesting that competition and complementarity were key mechanisms behind them. Five out of 10 participants discussed themes related to the importance of complementarity regarding topic overlap. Specifically, participants discussed how topically related communities in the ecosystem shared the same content to mutual benefit, as described by participant H1:

> *"I'm in [my division's sales community] and [the sub-division's sales community]. I know they have a lot of the same information... for example, if [my division's sales community] post [sales] about [our sub-division's product], it'll probably show up in [our sub-division's sales community]. But something like [my division's sales community] is much more broad, so it's going to have a lot more information."*

Competition was particularly salient for participants, as 7 out of 10 discussed its importance. About communities that shared topics, participants discussed the importance of finding information, and how fewer communities on a topic made this easier and, conversely, too many competed for their attention and made it difficult. W1 describes:

> *"I find it very difficult to find the information I need in communities… There's a [Product] Program Team Community, there's a [Product] Development Community, and I think there's at least a couple of others… The fact that there are a lot of different [Product] communities… I don't know which one to look at."*

Participants also described how they determined which community to join or visit when such competition occurred. Commonly cited factors were a large community size (4 participants), frequent updates (3),

125

high quality content (3), and that key people for the community's topic were members (e.g., known subject matter experts) (2), e.g.:

"If you looking for an industry one, you'll come up with about a hundred different ones. Some created by three people in Finland. So for me, the criteria is, which is the biggest, which has the people that I recognize as being the subject matter experts in that area... finding the ones that looked like they covered the most ground and probably were the most active and had the most information." (A1)

Moderating effects of shared members

Shared members are medium to transfer the knowledge and, as well as a valuable resource communities compete for. We therefore hypothesized that topic overlap should have a stronger curvilinear effect in communities that shared members than in communities that do not share members. As shown in Figure 14 (Upper) and Model 2 of Table 33, for communities with shared members, topic overlap's effects are of higher magnitude (linear coef. = 26.6, quadratic coef. = -36.9), while for communities without shared members the effects are of much lower magnitude (linear coef. = 2.25, quadratic coef. = -13.4). These results indicate that there are stronger competition and stronger complementarity effects between communities that share both topics and members, confirming hypothesis 14.

The qualitative interviews provided further insights on the role of shared members. For complementarity, 8 members described specific instances when they shared content between two topically-similar communities, e.g., participant H1:

"The Consulting by Degrees Community is actually the... parent community of the U.S. Philadelphia [Community]... So sometimes if we see something in the Consulting by Degrees Community that we want to specifically share with our group of Philadelphia folks we might post it again in our group, just to bring more attention."

Several of the 7 out of 10 participants noted above who discussed competition, emphasized that competing for a shared member base between topically-similar communities harmed those communities, e.g.:

"Your user base is spread or is divided into these various communities... People just go and create communities without paying attention if there is something already out there... They keep

creating communities with content that is already out there. And then those communities start dying out and their activity is pretty low." (S1)

Moderating effects of content linking

We predicted that content linking makes knowledge sharing easier, while also intensifying competition by making members more aware of related communities. As shown in Figure 14 (Bottom Left) and in Model 3 of Table 33, for linked communities, topic overlap's effects are of higher magnitude (linear coef. = 24.8, quadratic coef. = -28.4), while for unlinked communities the effects are of much lower magnitude (linear coef. = 2.36, quadratic coef. = -16.4). These results confirm hypothesis 15.

Moderating effects of shared offline affiliation

We predicted that sharing offline organizational affiliation intensifies competition and reduces complementarity. Indeed, while in all other conditions topic overlap's linear effect is positive, when communities share the same offline affiliation, the linear effect turned negative (coef = -2.73), as shown in Figure 14 (Bottom Right) and Model 4 in Table 33. This result indicates that the shared affiliation has indeed intensified the detrimental effects of topic overlap and reduced its benefits, confirming H16.

Explanatory variables	Model 1 Coef.	Model 2 Coef.	Model 3 Coef.	Model 4 Coef.
Topic Overlap (v1)	3.30**			
Quadratic term of v1	-14.2**			
Topic overlap with shared members (v2)		26.6**		
Quadratic term of v2		-36.9**		
Topic overlap without shared members (v3)		2.25**		
Quadratic term of v3		-13.4**		
Topic overlap with linked communities (v4)			24.8**	
Quadratic term of v4			-28.4**	
Topic overlap with non-linked communities (v5)			2.36**	
Quadratic term of v5			-16.4**	
Topic overlap in the same offline org affiliation (v6)				-2.73**
Quadratic term of v6				-2.13**
Topic overlap in different offline org affiliation (v7)				8.42**
Quadratic term of v7				-8.42**
Number of members	8.95e-4**	3.33e-3**	5.02e-3**	6.30e-3**
Community age	9.29e-4**	-3.48e-3	3.90e-3*	-4.17e-3*
R-square	0.13	0.21	0.21	0.31

** p<0.01,   *p<0.05

Table 33. The effects of topic overlap (model 1) and the moderating effects of shared members (model 2), content linking (model 3), and offline organization affiliation (model 4) on the community activity.

Discussion

Theoretical contributions

Our study investigated organizational ecology theories in an online enterprise setting, a condition that prior work has not studied. Our results largely confirmed prior theory in this new condition: Communities that overlap in niche within the same ecosystem both complement and compete with each other. The benefits of complementarity dominate when overlap is low, while the drawbacks of competition dominate when the overlap is high. These effects lead to a sweet-spot, where communities with a moderate overlap achieve the highest activity levels.

By studying niche through four different dimensions—topic, members, content, and offline affiliation—we also uncovered new nuanced insights. For instance, we have found that sharing members and linking content intensifies the effect of topic overlap, making complementarity and competition stronger, and making the sweet-spot sweeter. We also found that sharing offline organization affiliation makes topic overlap more harmful, making more specialized communities more desirable. On the other hand, not sharing offline affiliations makes topically-similar communities more likely to flourish. This latter insight might explain the huge success of Facebook copies in other countries, such as Chinese RenRen. (Chinese RenRen is a clone of Facebook launched in 2005), despite their similarity to Facebook in almost all other aspects.

Practical implication

We believe the theoretical findings of this work have direct value to leaders and managers of online communities. When creating a new community, leaders often have a topic in mind but are concerned if the new community will gain support from similar communities in the ecosystem, or if it will die from fierce competition.

Our results suggest that these concerns are not misplaced, and our models suggest that the responses of the ecosystem can be partially predicted beforehand. For instance, if a proposed community has a high topic overlap with many existing communities, and many of these communities share the same offline affiliation with the proposed community, it may be better to not start the new community but instead join an existing one. On the other hand, if a proposed community is only moderately overlapped with other communities' topic, has already gained support from these communities' members, and does not share offline affiliation with these communities, the community should be created as-is because it will likely

succeed. For situations in between these two examples, various strategies might be taken, such as specializing the niche to avoid competition, changing the niche so as to leverage members and contents in related communities, or making the community independent of existing offline organizations.

Because many ecosystems are very large, with 100K communities or more, it may be impossible for community leaders to understand them. Our work informs tools, such as visualization or analytic systems, aimed to solve this problem. These tools should enable leaders to get an overview of a community ecosystem to understand its topic distributions, how many members gravitate toward different topics, and how communities relate to offline affiliations. The tools could assess a proposed niche and suggest modifications to improve the chance of success. These tools could also point designers to relevant content to bootstrap their community. Our interviews suggest that members also suffered when too many communities covered a topic. Other tools could help them identify the right set of communities to join to best fit their topic interests.

Limitation and future research

First, while we proposed the underlying mechanisms that drive the observable variables, our quantitative data analysis by itself cannot directly prove the existence of these mechanisms. Nonetheless, our use of both quantitative and qualitative methods, results which strongly agreed with each other, helps alleviate this concern.

Secondly, our study used whether the community has activity or not as a proxy for community success, while in reality success can be measured in many aspects such as quality of deliverables (in Wikipedia) and progress towards particular goals (in enterprise). Nonetheless, as activity level is indeed a widely-used measure of community success (Iriberri and Leroy 2009, Preece & Maloney-Krichmar 2003), we believe our results are still valuable. Future research could extend this work, by incorporating more nuanced success measures as appropriate.

Lastly, the importance of a community's topic might be a confounding factor, because it could be argued that a more important topic may result in more members and more activities. We however believe such proposed effects do not necessarily happen, because while more people will be interested in important topics, they will also likely have more communities to choose from, in the end balancing out the success of each individual community. As a result, we believe competition and complementarity are indeed the mechanisms driving our findings, and suggest future work to measure topic importance separately and study its effects.

Conclusion

We take an ecological view to understand the impact of a given community's position in a larger population of communities on its activity level. These findings provide new insight into an important mechanism underlying successful online communities, and may provide valuable guidance for the hosts and creators of online communities.

REFERENCE:

Abrams, D., Wetherell, M. S., Cochrane, S., Hogg,M. A., & Turner, J. C. (1990). Knowing what to think by knowing who you are: Self-categorization and the nature of norm formation, conformity, and group polarization. British Journal of Social Psychology, 29, 97–119.

Alexa Internet (2013). Five-year Traffic Statistics for Wikipedia.org. http://www.alexa.com/siteinfo/wikipedia.org?range=5y&size=large&y=t Retrieved Sept. 27th, 2013

Amburgey, T. L., D. Kelley, W. P. Barnett. 1993. Resetting the clock: The dynamics of organizational change and failure. Admin. Sci. Quart. 38(1) 51–73.

Angrist, J.D., Krueger, A.V. (1999) Empirical strategies in labor economics. Handbook of Labor Economics.

Argote, L. (1999). Organizational learning: Creating, retaining, and transferring knowledge. Norwell, MA: Kluwer.

Argote, L., & Ingram, P. (2000). Knowledge Transfer: A Basis for Competitive Advantage in Firms. Organizational Behavior and Human Decision Processes, 82(1), 150–169.

Argote, L., & Miron-spektor, E. (2011). Organizational Learning : From Experience to Knowledge Organizational Learning : From Experience to Knowledge. Organization Science, 22(April 2015), 1123–1137.

Ariely, D., Bracha, A., & Meier, S. (2009). Doing good or doing well? Image motivation and monetary incentives in behaving prosocially. The American economic review, 99(1), 544-555.

Arrow K. J.(1974). The Limits of Organization (1974) (W. W. Norton, New York)

Ashforth, B.E., and Saks, A. M. (1996) Socialization Tactics: Longitudinal Effects on Newcomer Adjustment. The Academy of Management Journal , Vol. 39, No. 1 (Feb., 1996), pp. 149-178.

Ashforth, B.E., Harrison,S.H., and Corley, K.G (2008) Identification in Organizations: An Examination of Four Fundamental Questions. Journal of Management.

Baldwin, T. T.,& Ford, J. K. (1988). Transfer of training:Areview and direction for future research. Personnel Psychology, 41, 63–105.

Barker, J. (1993). Tightening the iron cage: Concertive control in self-managing teams. Administrative Science Quarterly, 38(3), 408-437.

Bartel, C. A. 2001. Social comparisons in boundary-spanning work: Effects of community outreach on members' organizational identity and identification. Administrative Science Quarterly, 46: 379-413.

Bass, B. M. (1990) Bass & Stogdill's handbook of leadership: Theory, research, and managerial applications (3rd ed.). New York, NY, US: Free Press.

Batson, D., (1998) "Altruism and Prosocial Behavior." In Handbook of Social Psychology. Vol 2, ed. Daniel T. Gilbert, Susan Fiske, and Gardner Lindzey, 282-316. New York: McGraw Hill.

Baum, J. A. C.,& Ingram, P. (1998). Survival-enhancing learning in the Manhattan hotel industry, 1898–1980, Management Science, 44, 996–1016.

Baum, J. A., & Shipilov, A. V. (2006). 1.2 Ecological Approaches to Organizations. The SAGE Handbook of Organization Studies, 55.

Baumeister, R.F.; Cairns, K.J. (1992) Repression and self-presentation: When audiences interfere with self-deceptive strategies. Journal of Personality and Social Psychology, Vol 62(5), May 1992, 851-862.

Beenen, G., Ling, K., Wang, X., Chang, K., Frankowski, D., Resnick, P., and Kraut, R. E. (2004). Using social psychology to motivate contributions to online communities. In CSCW 2004

Bénabou, R., Tirole, J.,(2006) Incentives and Prosocial Behavior. The American Economic Review, Volume 96, Number 5, December 2006 , pp. 1652-1678(27)

Benkler, Y. (2002). Coase's Penguin, or Linux and the Nature of the Firm. Yale Law Journal, Vol. 112.

Benkler, Y. (2006). The wealth of networks: How social production transforms markets and freedom. Yale University Press.

Benkler, Y.(forthcoming). Law, Policy, and Cooperation, in Balleisen, Edward, and David Moss, eds. Government and Markets: Toward a New Theory of Regulation, Cambridge University Press.

Benkler, Y. (forthcoming) Peer Production and Cooperation, forthcoming in JM Bauer & M. Latzer (eds.), Handbook on the Economics of the Internet, Cheltenham and Northampton,

Edward Elgar. Peer Production and Cooperation.

Bowles S (2006)Group competition, reproductive leveling, and the evolution of human altruism. Science 314:1569–1572.

Brehm, J.W. (1966) A Theory of Psychological Reactance. Oxford, England: Academic Press. (1966). x 135 pp.

Brooks, F.P. (1975). The mythical man month. Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA.

Brown, J.S., and Duguid, P., Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation, Organization Science , Vol. 2, No. 1.

Brown, S. L., Eisenhardt, K. M. 1998. Competing on the Edge: Strategy as Structured Chaos. Harvard Business School Press, Boston.

Bryant, S. L., Forte, A., & Bruckman, A. (2005). Becoming Wikipedian: transformation of participation in a collaborative online encyclopedia. In Proc. SIGGROUP'2005. ACM Press.

Burke, C., Stagl, K., Klein, C., Goodwin, G., Salas, E., and Halpin, S. (2006) What type of leadership behaviors are functional in teams? A meta-analysis. The Leadership Quarterly, 17(3).

Burke, M., & Kraut, R. (2008). Mopping up: modeling wikipedia promotion decisions. In Proc. CSCW'2008. ACM Press.

Burke, M., & Kraut, R. E. (2008). Mopping up: Modeling Wikipedia Promotion Processes. In CSCW 2008.

Burke, M., Marlow, C., & Lento, T. (2010). Social network activity and social well-being. In Proc. CHI'2010. ACM Press.

Burns, J. M. (1978) Leadership. New York: Harper & Row.

Burns, T. E., & Stalker, G. M. (1961). The management of innovation. University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.

Burt, R.S. (1987) Social contagion and innovation: Cohesion versus structural equivalence, American Journal of Sociology, 92, 1287-1335.

Butler, B. S. (2001). Membership size, communication activity, and sustainability: A resource-based model of online social structures. Information systems research, 12(4), 346-362.

Butler, B., Joyce, E., & Pike, J. (2008, April). Don't look now, but we've created a bureaucracy: the nature and roles of policies and rules in wikipedia. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 1101-1110). ACM.

Campbell, D.T., Stanley, J.C. (1963) Experimental and Quasi-experimental Designs for Research, Houghton Mifflin Company, Boston.

Carli, L. L., & Eagly, A. H. (1999). Gender effects on social influence and emergent leadership.

Cassell, J., Huffaker, D., Tversky, D. (2006) The Language of Online Leadership: Gender and Youth Engagement on the Internet. Developmental Psychology.

Castells M (2007) Communication, power and counter-power in the network society. International Journal of Communication1: 238–66.

Chen, J., Ren, Y., & Riedl, J. (2010). The effects of diversity on group productivity and member withdrawal in online volunteer groups. In Proc. CHI'2010.ACM Press.

Cheney, G. 1983a. On the various and changing meanings of organizational membership: A field study of organizational identification. Communication Monographs, 50: 342-362.

Cheney, G., & Tompkins, P. (1987). Coming to terms with organizational identification and commitment. Communication Studies, 38(1), 1-15.

Choi, B. R., Alexander, K., Kraut, R. E., & Levine, J. M. (2010). Socialization Tactics in Wikipedia and Their Effects CSCW'10: Proceedings of the ACM Conference on Computer-Supported Cooperative Work (pp. 107-116). New York: ACM Press.

Choi, B., Alexander, K., Kraut, R. E., & Levine, J. M. (2010, February). Socialization tactics in Wikipedia and their effects. In Proc. CSCW'2010. ACM Press.

Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and Conformity. Annual Review of Psychology, 55(1), 591-621.

Ciborra, C. U. 1996. The platform organization: Recombining strategies, structures, and surprises. Organ. Sci. 7(2) 103–118.

Clary, E. G., and Snyder, M. (1991) A Functional Analysis of Altruism and Prosocial Behavior. Review of Personality and Social Psychology, 1991, 12 (1), 119–148.

Corporation for National and Community Service. "Research Brief: Volunteering in America Research Highlights" (2011).

Cosley D., Frankowski D., Terveen L., and Riedl J. (2007) SuggestBot: using intelligent task routing to help people find work in wikipedia. In Proceedings of the 12th international conference on Intelligent user interfaces (IUI '07). ACM, New York, NY, USA, 32-41.

Cosley, D., Frankowski, D., Terveen, L., and Riedl, J., 2006. Using intelligent task routing and contribution review to help communities build artifacts of lasting value. In Proceedings of the SIGCHI conference on Human Factors in computing systems (CHI '06)

Cothrel, J.P. Measuring the success of an online community. Strategy & Leadership 28, 2 (2000), 17–21.

Cox, J. F. (1994). The effects of superleadership training on leader behavior, subordinate self-leadership behavior and subordinate citizenship. Unpublished doctoral dissertation, University of Maryland, College Park.

Cummings, J. L., & Teng, B.-S. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. Journal of Engineering and Technology Management, 20(1-2), 39–68.

D'Agostino, R.B., Jr. (1998). Tutorial in biostatistics: Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Statistics in Medicine, 17, 2265-2281.

D'Aveni, R. A. 1994. Hypercompetition: Managing the Dynamics of Strategic Maneuvering. Free Press, New York.

Daft, R., & Lengel, R. (1984). Information richness: A new approach to managerial behavior and organizational design. Research in Organizational Behavior, 6, 191-233.

Daniel, J. (2012). Making sense of MOOCs: Musings in a maze of myth, paradox and possibility. Journal of Interactive Media in Education, 3.

Darley, J. M., & Latane, B. (1968). Bystander Intervention in Emergencies: Diffusion of Responsibility. Journal of Personality & Social Psychology, 8(4, PT. 1), 377-383.

Darr, E. D., Argote, L., & Epple, D. (1995). The of Acquisition , Knowledge in Transfer , Service and Depreciation Organizations : Franchises Productivity in. Management Science, 41(11), 1750–1762.

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. Psychological Inquiry: An International Journal for the Advancement of Psychological Theory. Volume 11, Issue 4, 2000.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychological Bulletin, 125(6), 627-668.

DeNisi, A. S., Hitt, M. A., & Jackson, S. E. (2003). The knowledge-based approach to sustainable competitive advantage. Managing knowledge for sustained competitive advantage: Designing strategies for effective human resource management, 3-33.

Dobrev, S. D., T.-Y. Kim, M. T. Hannan. 2001. Dynamics of niche width and resource partitioning. Amer. J. Sociol. 106(5) 1299–1338.

Dowell, G., A. Swaminathan. 2000. Racing and back-pedalling into the future: New product introduction and organizational mortal- ity in the U.S. bicycle industry, 1880–1918. Organ. Stud. 21(2) 405–431.

Druskat, V. U., & Wheeler, J. V. (2004). Self-Managing Team. MIT Sloan Management Review.

Evans, M.G.(1970) The effects of supervisory behavior on the path-goal relationship, Organizational Behavior and Human Performance, Volume 5, Issue 3, May 1970, Pages 277-298

Farmer, S. M. Fedor, D. B. (1999) Volunteer Participation and Withdrawal: A Psychological Contract Perspective on the Role of Expectations and Organizational Support, Nonprofit Management and Leadership, 1999, VOL 9; NUMBER 4, pages 349-368.

Feather N.T.; Rauter K.A., (2004) Organizational citizenship behaviours in relation to job status, job insecurity, organizational commitment and identification, job satisfaction and work values. Journal of Occupational and Organizational Psychology, 77(1), 81-94.

Feldman, M. S., & Pentland, B. T. (2003). Reconceptualizing Routines Organizational. Science, 48, 94–118.

Festinger, L., (1954) A Theory of Social Comparison Processes, Human Relations.

Fleishman, E. A. (1953) The description of supervisory behavior. Journal of applied psychology

Flint, D. J. 2002. Compressing new product success-to-success cycle time: Deep customer value understanding and idea generation. Indust. Marketing Management 31(4) 305–315.

Forsythe R,Horowitz JL, SavinNE, SeftonM(1994) Fairness in simple bargaining games. Games Econ Behav 6:347–369.

Forte, A., & Bruckman, A. (2008). Scaling Consensus: Increasing Decentralization in Wikipedia Governance. Hawaii International Conference on System Sciences, Proceedings of the 41st Annual, 157-157.

Fowler JH, Kam CD (2007) Beyond the Self: Social Identity, Altruism, and Political Participation. J Politics 69:813–827.

French, J., & Raven, B.H. (1959). The bases of social power. In D. Cartwright(Ed.), Studies of social power. Ann Arbor, MI: Institute for Social Research, pp. 150-167.

Galbraith, C. S. (1990). Transferring core manufacturing technologies in high technology firms. California Management Review, 32(4), 56–70.

Garud, R., A. Kumaraswamy, R. N. Langlois, eds. 2002. Managing in the Modular Age: Architectures, Networks, and Organizations. Blackwell Publishers, Malden, MA.

Georgopoulos, Basil S.; Mahoney, Gerald M.; Jones, Nyle W., Jr. (1957) A path-goal approach to productivity. Journal of Applied Psychology, Vol 41(6), Dec 1957, 345-353.

Gillmor D (2004) We the media: Grassroots journalism, by the people, for the people. URL: http://www.authorama.com/we-the-media-1.html

Goette L, Huffman D,Meier S (2006) The impact of groupmembership on cooperation and norm enforcement: Evidence from random assignment to real social groups. Am Econ Rev 96:212–216.

Granovetter, M. S. (1973). The strength of weak ties.   American journal of sociology, 78(6), 1360.

Grice, T. A., Gallois, C., Jones, E., Paulsen, N., & Callan, V. J. 2006. "We do it, but they don't": Multiple categorizations and work team communication. Journal of Applied Communication Research, 34: 331-348.

Groom, P. (1965). Hiring Practices for Longshoremen. Monthly Lab. Rev., 88, 1289.

Gruenfeld, D. H., Martorana, P. V., & Fan, E. T. (2000). What Do Groups Learn from Their Worldliest Members? Direct and Indirect Influence in Dynamic Teams. Organizational Behavior and Human Decision Processes, 82(1), 45–59.

Hager, M., & Brudney, J. (2004). Volunteer management practices and retention of volunteers. The Urban Institute

Halfaker, A., Kittur A., and Riedl J. (2011) Don't bite the newbies: how reverts affect the quantity and quality of Wikipedia work. In Proceedings of the 7th International Symposium on Wikis and Open Collaboration (WikiSym '11).

Hall, D. B. (2004). Zero‑inflated Poisson and binomial regression with random effects: a case study. Biometrics, 56(4), 1030-1039.

Hall, M., Frank E., Holmes G., Pfahringer B., Reutemann P., and Witten I.H. The WEKA Data Mining Software: An Update; SIGKDD Explorations, 11(1) (2009).

Hannan, M. T., & Freeman, J. (1977). The population ecology of organizations. American journal of sociology, 929-964.

Hansen, M. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. Administrative Science Quarterly, 44(1), 82–111.

Hansen, M. (2002). Knowledge networks: Explaining effective knowledge sharing in multiunit companies. Organization Science, 232–248.

Harrison P.M., 1960. Weber's categories of authority and voluntary association. American Sociological Review, 25:232-237.

Haslam, S.A. (2004) The psychology of organizations: A social identity approach. London & Newbury Park, CA:Sage.

Hattie and Timperley (2007) The power of feedback.

Heath, C., Larrick, R. P., & Wu, G. (1999). Goals as reference points. Cognitive Psychology, 38(1), 79-109.

Heinicke, C., & Bales, R. F. (1953). Developmental trends in the structure of small groups. Sociometry, 7-38.

Hill, B. M. and Shaw, A. (Forthcoming) "Is volunteer labor a "fixed and finite" resource? Evidence from peer production." Working Paper.

Hinsz, V.B. (1995). Goal setting by groups performing and additive task: A comparison with individual goal setting. Journal of Applied Social Psychology, 25, 965-990.

Hogan, R., Curphy, G. J., & Hogan, J. (1994). What We Know About Leadership. American Psychologist, 49(6), 493-504.

Hogg, M. A., & Reid, S. A. (2006). Social Identity, Self‐Categorization, and the Communication of Group Norms. Communication Theory, 16(1), 7-30.

Hogg, M. A., & Terry, D. J. (2000). Social identity and self-categorization processes in organizational contexts. The Academy of Management Review, 25(1), 121-14.

Hogg, M. A., and J. C. Turner (1985). 'Interpersonal attraction, social identification and psychological group formation'. European Jour of Social Psychology 15: 51–66.

Hogg, M.A. (2001) A social identity theory of leadership, Personality and social psychology review, 2001 vol. 5 no. 3 184-200.

Hogg, M.A., Abrams, D., (1988) Social identifications: a social psychology of intergroup relations and group processes. Psychology Press.

Hogg, M.A., Turner, J.C., (1987) Social identity and conformity: A theory of referent informational influence, Cambridge University Pres.

House, R. J. (1971) A Path Goal Theory of Leader Effectiveness Administrative Science Quarterly Vol. 16, No. 3.

Howe, J. (2006). The rise of crowdsourcing. Wired magazine, 14(6), 176-183.

http://en.wikipedia.org/wiki/Wikipedia:Bots/Requests_for_approval/BetacommandBot_Task_5 Retrieved July 11th , 2013.

Ilgen D.R., Fisher, C.D., & Taylor, M.S.(1979) Consequences of individual feedback on behavior in organization. Journal of Applied Psychology, 64, 349-371.

Ingram, P. and Baum, J.A.C. (1997) 'Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries', Strategic Management Journal, 18: 75–98.

Ingram, P. and Baum, J.A.C. (1997) 'Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries', Strategic Management Journal, 18: 75–98.

International Telecommunications Union (2013) Key ICT indicators for developed and developing countries and the world, 04 Sept 2013.

Iriberri, A. and Leroy, G. A life-cycle perspective on online community success. ACM Comput. Surv. 41, 2 (2009), 1–29.

Jenkins H (2006) Convergence Culture. New York: New York University Press.

Jenkins, S. P. (2005). Survival analysis. Unpublished manuscript, Institute for Social and Economic Research, University of Essex, Colchester, UK.

Jensen, R. J., & Szulanski, G. (2007). Template Use and the Effectiveness of Knowledge Transfer. Management Science, 53(April 2015), 1716–1730.

Kairam, S. R., Wang, D. J., & Leskovec, J. (2012). The life and death of online groups: predicting group growth and longevity. In Proc. WSDM'2012. ACM Press.

Kannan, D., HOW MCDONALD'S CONQUERED INDIA, BBC News, Delhi. 19 November 2014. http://www.bbc.com/news/business-30115555.

Kane, A. A., Argote, L., & Levine, J. M. (2005). Knowledge trans- fer between groups via personnel rotation: Effects of social identity and knowledge quality. Organizational Behavior and Human Decision Processes, 96, 56-71.

Kärreman, D., & Alvesson, M. (2004). Cages in tandem: Management control, social identity, and identification in a knowledge-intensive firm. Organization, 11(1), 149-175.

Katz, Daniel; Maccoby, Nathan; Morse, Nancy C. (1950). Productivity, supervision, and morale in an office situation. Part I. Oxford, England: Institute for Social Research.

Kennedy, P. (2001). A guide to econometrics (4th ed.). Cambridge, MA: MIT Press.

Kernis, M., Zuckerman, M., Cohen, A., & Spadafora, S. (1982). Persistence following failure: The interactive role of self-awareness and the attributional basis for negative expectancies. Journal of Personality and Social Psychology, 43(6), 1184-1191.

Kickul, J., & Neuman, G. (2000). Emergent leadership behaviors: The function of personality and cognitive ability in determining teamwork performance and KSAs. Journal of Business and Psychology, 15(1), 27-51.

Kim, A.J. (2000) Community building on the web : Secret strategies for successful online communities. Peachpit Press.

Kim, L., & Nelson, R.R., 2000. Technology, Learning, and Innovation: Experiences of Newly Industrializing Economies. Cambridge University Press, Cambridge, UK.

Kittur, A., & Kraut, R. E. (2008). Harnessing the wisdom of crowds in Wikipedia: Quality through coordination. In CSCW'08: Proceedings of the ACM conference on computer-supported cooperative work. New York: ACM Press.

Kittur, A., Chi, E., Pendleton, B. A., Suh, B., & Mytkowicz, T. (2008). Power of the Few vs. Wisdom of the Crowd: Wikipedia and the Rise of the Bourgeoisie CHI 2008: Proceeding of the ACM Conference on Human Factors in Computing Systems. New York: AMC Press.

Kittur, A., Pendleton, B., & Kraut, R. (2009). Herding the cats: The influence of groups in coordinating peer production In WikiSym 2009.

Kiyonari T, Tanida S, Yamagishi T (2000) Social exchange and reciprocity: Confusion or a heuristic? Evolution and Human Behavior 21:411–427.

Kluger, A. N., DeNisi, A. (1996) The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. Psychological Bulletin, Vol 119(2), Mar 1996, 254-284.

Kogut, B., & Zander, U. (1993). Knowledge of the firm and the evolutionary theory of the multinational corporation. Journal of international business studies, 625-645.

Kogut, B., & Zander, U. 1996. What firms do? Coordination, identity, and learning. Organization Science, 7: 502-518.

Kramer, R. M. 2006. Social capital and cooperative behavior in the workplace: A social identity perspective. Advances in Group Processes, 23: 1-30

Kraut R.E. & Fiore A. T.(2014) The role of founders in building online groups. In Proc. of CSCW.

Kraut, R. E. & Resnick, P. (2012). Evidence-based social design: Mining the social sciences to build online communities. Cambridge, MA: MIT Press.

Kriplean, T., Beschastnikh, I., and McDonald, D.W.(2008). Articulations of wikiwork: uncovering valued work in wikipedia through barnstars. In Proceedings of the 2008 ACM conference on Computer supported cooperative work (CSCW '08).

Lakhani, K., and Wolf, R. "Why hackers do what they do: Understanding motivation and effort in free/open source software projects." (2003).

Lawler, E. E., Mohrman, S. A., & Benson, G. (2001). Organizing for high performance: Employee involvement, TQM, reengineering, and knowledge management in the Fortune 1000: The CEO report. San Francisco: Jossey-Bass.

Lazar, J. and Preece, J. (1998) Classification schema for online communities. Proc. of AISAC, 84–86.

Lee, S., Rittiner, F., & Szulanski, G. (2015). The Past, Present, and Future of Organizational Learning Research: A Conversation With Professor Linda Argote. Journal of Management Inquiry.

Lessig L (2004) Free Culture. New York: Penguin Press.

Lepper, M.R., Greene D.,, and Nisbett, R. 1973. "Undermining Children's Interest   with Extrinsic Rewards: A Test of the 'Overjustification Hypothesis'." Journal of Personality   and Social   Psychology, 28(1): 129-37.

Lerner, Josh, and Jean Tirole. (2005). The economics of technology sharing: Open source and beyond. Journal of Economic Perspectives. 19 (2): 99-120.

Levitt, B., & March, J. (1988). Organizational learning. Annual Review of Sociology, 14(1988), 319–340.

Ling, K., Beenen, G., Ludford, P. J., Wang, X., Chang, K., Li, X., et al. (2005). Using Social Psychology to Motivate Contributions to Online Communities. Journal of Computer Mediated Communication, 10(4)

Lippman, S. A., & Rumelt, R. P. (1982). Uncertain imitability: An analysis of interfirm differences in efficiency under competition. The Bell Journal of Economics, 418-438.

Locke, E. A., & Bryan, J. (1969). The directing function of goals in task performance.   Organizational Behavior and Human Performance, 4, 35– 42.

Locke, E. A., & Latham, G. P. (1990). A theory of goal setting and task performance. Englewood Cliffes, NJ: Prentice-Hall.

Locke, E. A., & Latham, G. P. (2002) Building a Practically Useful Theory of Goal Setting and Task Motivation American Psychologist, Vol. 57, No. 9, 705–717.

Lu, M., Wynn, E., Chudoba., K., & Watson-Manheim, M. B. 2003. Understanding Virtuality in a Global Organization: Toward a Virtuality Index. In S. T. March, A. Massey, & J. I.DeGross (Eds.), Proceedings of the International Conference on Information Systems: 1-7. Seattle, WA.

Luther, K and Bruckman, A. (2008). Leadership in online creative collaboration. In Proceedings of the 2008 ACM conference on Computer supported cooperative work (CSCW '08).

Luther, K, Caine, K, Ziegler, K, and Bruckman, A. (2010). Why it works (when it works): success factors in online creative collaboration. In Proceedings of the 16th ACM international conference on Supporting group work (GROUP '10). ACM, New York, NY, USA, 1-10.

Malone, T.W., Yates, J., and Benjamin, R.I., 1987. Electronic markets and electronic hierarchies. Commun. ACM 30, 6 (June 1987), 484-497.

Martin, A., & Bal, V. 2006. The State of Teams. Greensboro, NC: Center for Creative Leadership.

McGarty C., Turner, J.C, Hogg, M.A., David B., Wetherell M.S.(1992) Group polarization as conformity to the prototypical group member. British Journal of Social Psychology. Volume 31, Issue 1, pages 1–19, March 1992.

Mellstr?m, C., & Johannesson, M. (2008). Crowding out in blood donation: was Titmuss right? Journal of the European Economic Association, 6(4), 845-863.

Misiolek, N. L., & Heckman, R. (2005, January 3 - 6, 2005). Patterns of emergent leadership in virtual teams. Paper presented at the 2005 Hawaii International Conference on System Sciences (HICSS-38).

Mitchell,W., K. Singh. 1993. Death of the lethargic: Effects of expan- sion into new technical subfields on performance in a firm's base business. Organ. Sci. 4(2) 152–180.

Mockus, A., Fielding, R. T., & Herbsleb, J. D. (2002). Two Case Studies of Open Source Software Development: Apache and Mozilla. ACM Transactions on Software Engineering and Methodology, 11(3), 309-346.

Mugny, G; Papastamou, S (1982) Minority influence and psycho-social identity. European Journal of Social Psychology, Vol 12(4), Oct-Dec 1982, 379-394

Muller, M., Ehrlich, K., Matthews, T., Perer, A., Ronen, I., and Guy, I. (2012) Diversity among enterprise online communities: collaborating, teaming, and innovating through social media. Proc. of CHI, 2815–2824.

Nielsen, J. (1993). Iterative user-interface design. Computer, 26, 32–41.

Nov, O. (2007). What motivates wikipedians?. Communications of the ACM, 50(11), 60-64.

O'Leary-Kelly, A., Martocchio, J., & Frink, D. (1994). A review of the influence of group goals on group performance. Academy of Management Journal, 37(5), 1285-1301

O'leary, M. B., Mortensen, M., & Woolley, A. W. (2011). Multiple team membership: A theoretical model of its effects on productivity and learning for individuals and teams. Academy of Management Review, 36(3), 461-478.

O'Mahony, & Ferraro, F. (2007). The Emergence of Governance in an Open Source Community. Academy of Management Journal, 50(5), 1079-1106.

Organ, D. W. (1988). Organizational citizenship behavior: The good soldier syndrome. Lexington, MA: Lexington Books.

Organ, D. W., & Ryan, K. (1995). A meta-analytic review of attitudinal and dispositional predictors of organizational citizenship behavior. Personnel Psychology, 48(4), 775-802.

Orlikowski, W. (1993). Learning from notes: Organizational issues in groupware implementation. In CSCW (Vol. 9, pp. 237–250).

Orlikowski, W. J. (1996). Improvising Over Time: Transformation Organizational A Situated Change Perspective. Information Systems Research, 7(1), 63–92.

Pearce, C.L., and Conger,J. A. (2003) Shared leadership: Reframing the hows and whys of leadership, Sage, Thousand Oaks.

Pearce, C.L., and Sims H.P. (2002) Vertical Versus Shared Leadership as Predictors of the Effectiveness of Change Management Teams: An Examination of Aversive, Directive, Transactional, Transformational, and Empowering Leader Behaviors, Group Dynamics, 6(2) (2002).

Pearce, J.P., (1993) Volunteers: the organizational behavior of unpaid workers, Published by Routledge, 11 New Fetter Lane, London

Powell, W., (1990) Neither market nor hierarchy: Network forms of organization. Research In Organizational Behavior, 1990

Preece, J. and B. Shneiderman (2009) "The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation," AIS Transactions on Human-Computer Interaction, (1) 1, pp. 13-32

Preece, J., & Maloney-Krichmar, D. (2003). Online communities. In J. Jacko & A. A. Sears (Eds.), Handbook of human-computer interaction (596-620).

Quintela, Y., & Donovan, J. (2008). A model of motivational spillover. In K. H. Kiefer (Ed.), Applied Psychology Research Trends. New York: Nova Science, 141-160.

Raymond, E.(1999) The cathedral and the bazaar. Knowledge, Technology & Policy. Volume 12, Issue 3, pages 23-49.

Ren, Y., Kraut, R., & Kiesler, S. (2007). Applying common identity and bond theory to design of online communities. Organization Studies, 28(3), 377-408.

Resnick, P., Konstan, J., Chen, Y., & Kraut, R. E. (2012). 6 Starting New Online Communities. Building successful online communities: Evidence-based social design, Cambridge, MA: MIT Press.

Silvertown, J. (2009). A new dawn for citizen science. Trends in ecology & evolution, 24(9),467-471.

Roberts, J. A., Hann, I.-H., & Slaughter, S. A. (2006). Understanding the Motivations, Participation, and Performance of Open Source Software Developers: A Longitudinal Study of the Apache Projects. Management Science, 52(7), 984-999.

Rose, C. P., Wang, Y.C., Cui, Y., Arguello, J., Stegmann, K., Weinberger, A., and Fischer, F. International Journal of Computer Supported Collaborative Learning. 3(3) (2008).

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. Biometrika, 70, 41-55.

Rothkopf, E., & Billington, M. (1979). Goal-guided learning from text: Inferring a descriptive processing model from inspection times and eye movements. Journal of Educational Psychology, 71, 310 –327.

Rousseau, D. M. (1998). Why workers still identify with organizations. Journal of Organizational Behavior 19, 217-233.

Rousseau, D.M., (1989) Psychological and implied contracts in organizations, Employee responsibilities and rights journal, 1989。

Ryan, R. M.; Deci, E. L.(2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, Vol 55(1), Jan 2000, 68-78.

Salton G, Buckley C (1988). Term-weighting approaches in automatic text retrieval. Information Processing and Management 24 (5): 513–523.

Sebastiani, F. (2002). Machine learning in automated text categorization. ACM computing surveys (CSUR), 34(1), 1-47.

Seidman, I. (1998) Interviewing as Qualitative Research: A Guide for Researchers in Education And the Social Sciences. Teachers College Press, New York.

Shamir, B., House, R. J., & Arthur, M. B. (1993). The motivational effects of charismatic leadership: A self-concept based theory. Organization science, 577-594.

Shneiderman, B. (1992). Designing the user interface: strategies for effective human-computer interaction (Vol. 2). Reading, MA: Addison-Wesley.

Simon, H. A. 1976. Administrative behavior: A study of decision-making processes in administrative organization, 3rd ed. New York: Free Press

Singh, J. V., R. J. House, D. J. Tucker. 1986. Organizational change and organizational mortality. Admin. Sci. Quart. 31(4) 587–611.

Singer, J. D., & Willett, J. B. (2003). Applied longitudinal data analysis. New York: Oxford University Press.

Smith, A., (1759) The Theory of Moral Sentiments. 1759. Amherst, NY: Prometheus Books

Smith, C. A., Organ, D. W., Near, J. P. (1983) Organizational citizenship behavior: Its nature and antecedents. Journal of Applied Psychology, Vol 68(4), Nov 1983

Stemler. S. An overview of content analysis. Practical Assessment, Research & Evaluation, 7(17) (2001).

Stewart, K. J., & Gosain, S. (2006). The impact of ideology on effectiveness in open source software development teams. MIS Quarterly, 291-314.

Suh, B., Convertino, G., Chi, E. H.,and Pirolli, P. (2009). The singularity is not near: slowing growth of wikipedia. In WikiSym '09: Proceedings of the 5th International Symposium on Wikis and Open Collaboration, pages 1–10, New York, NY, USA. ACM

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. Strategic Management Journal, 17(S2), 27–43.

Szulanski, G. (2000). The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness. Organizational Behavior and Human Decision Processes, 82(1), 9–27.

Szulanski, G., & Jensen R.J. (2006). PRESUMPTIVE ADAPTATION AND THE EFFECTIVENESS OF KNOWLEDGE TRANSFER. Strategic Management Journal, 957(February), 12.

Tajfel, H. 1972. Social categorization (English translation of "La cat6gorisation sociale"). In S. Moscovici (Ed.), Introduction a la psychologie sociale, vol. 1: 272-302.   Paris: Larousse.

Tajfel, H., & Turner, J. C. 1979. An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), The social psychology of intergroup relations: 33-47. Monterey, CA: Brooks-Cole.

Tajfel, H., Billig, M. G., Bundy, R. P., Flament,C., 1971 Social categorization and intergroup behaviour, European Journal of Social Psychology, Volume 1, Issue 2.

Thompson, L., Gentner, D., & Lowenstein, J. (2000). Avoiding missed opportunities in managerial life: Analogical training more powerful than individual case training. Organizational Behavior and Human Decision Processes, 82, 60–75.

Tompkins, P. K., & Cheney, G. 1985. Communication and unobtrusive control in contemporary organizations. In R.D. McPhee & P. K. Tompkins (Eds.), Organizational communication: Traditional themes and new directions: 179-210. Beverly Hills, CA: Sage.

Turner, J. C. 1985. Social categorization and the self-concept: A social cognitive theory of group behavior. In E. J. Lawler (Ed.), Advances in group processes: Theory and research, vol. 2: 77-122. Greenwich, CT: JAI Press.

Tyler, T. R. 1999. Why people cooperate with organizations: An identity-based perspective.   Research in Organizational Behavior, 21: 201-246.

Tyre, M. J., & Orlikowski, W. J. (1994). Patterns in Opportunity : Temporal Patterns of Technological Adaptation in Organizations, 5(1), 98–118.

Valenzuela Jr, A. (2000). Working on the margins: immigrant day labor characteristics and prospects for employment.

van Knippenberg, D. (2000). Work motivation and performance: A social identity perspective. Applied psychology, 49(3), 357-371.

van Knippenberg, D., & van Schie, E. C. M. 2000. Foci and correlates of organizational identification. Journal of Occupational and Organizational Psychology, 73: 137-147

Vroom, V.H. (1964) Work and motivation. Oxford, England: Wiley.

Warncke-Wang, M., Ayukaev, V. R., Hecht, B., & Terveen, L. G. (2015, February). The Success and Failure of Quality Improvement Projects in Peer Production Communities. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (pp. 743-756). ACM.

Wang, X., B. Butler, Y. Ren. (2013). The impact of membership overlap on the growth: An ecological competition view of online groups. Organization Science. 24(2), 414-431.

Web Technology Surveys (2013) Usage of web servers for websites. http://w3techs.com/technologies/overview/web_server/all Retrieved July 11th 2013.

Weber, Steven. 2004. The success of open source. Cambridge, MA: Harvard University Press.

Weinberger D (2007) Everything is Miscellaneous. New York: Henry Holt and Company.

Wegge, J. & Haslam, S. A. (2003). Group goal setting, social identity and self-categorization: Engaging the collective self to enhance group performance and organizational outcomes. In A. Haslam, D. van Knippenberg, M. Platow & N. Ellemers (Eds.), Social identity at work: Developing theory for organizational practice (pp 74-99). London: Taylor and Francis.

Wegge, J., & Haslam, S. A. (2006). When group goal setting fails: The impact of task complexity and unfair supervisors. Manuscript undergoing revision: Technical University of Dresden.

Weldon, E., & Weingart, L. R. (1993). Group goals and group performance*. British Journal of Social Psychology, 32(4), 307-334.

West S. (2010) Wikipedia's Evolving Impact, slideshow presentation at TED2010.

Wikimedia Foundation (2012) Distribution of article edits over registered editors, incl. bots. Retrieved June 11, 2012, from   http://stats.wikimedia.org/EN/TablesWikipediaEN.htm#editdistribution

Wikipedia (2012 c): WikiProject_Anime_and_manga/Collaboration_of_the_Week. Retrieved June 11, 2012, from
http://en.wikipedia.org/wiki/Wikipedia:WikiProject_Anime_and_manga/Collaboration_of_the_Week

Wikipedia (2012 d): WikiProject_Council/Guide. Retrieved June 11, 2012, from
http://en.wikipedia.org/wiki/Wikipedia:Wikiproject_Council/Guide.

Wikipedia (2012 e): WikiProject_Video_games/Collaboration_of_the_week. Retrieved June 11, 2012, from http://en.wikipedia.org/wiki/Wikipedia:WikiProject_Video_games/Collaboration_of_the_week

Wikipedia (2012 f): Vandalism. Retrieved June 11, 2012, from http://en.wikipedia.org/wiki/Wikipedia:Vandalism

Wikipedia (2013b). Research talk:Effects of Feedback on Participation in Wikipedia http://meta.wikimedia.org/wiki/Research_talk:Effects_of_Feedback_on_Participation_in_Wikipedia Retrieved July 11th , 2013.

Wikipedia (2013c). http://en.wikipedia.org/wiki/Wikipedia:Administrators. Retrieved July 11th , 2013.

Wikipedia (2013d).

Wikipedia. (2012 a). Wikipedia   Retrieved June 11, 2012, from http://en.wikipedia.org/wiki/Wikipedia

Wikipedia. (2012 b). Wikipedia Signpost/Archives/WikiProject report. Retrieved June 11, 2012, from http://en.wikipedia.org/wiki/Wikipedia:Wikipedia_Signpost/Archives/WikiProject_report

Wikipedia. (2013a). Wikipedia Statistics http://en.wikipedia.org/wiki/Wikipedia:Statistics Retrieved Sept 27th , 2013.

Wilson DS (1975) A theory of group selection. Proc Natl Acad Sci USA 72:143–146.

Wilson T., Wiebe J., and Hoffmann P. Recognizing Contextual Polarity: An Exploration of Features for Phrase-Level Sentiment Analysis, Computational Linguistics 35(3) (2009).

Winter, S. G., & Szulanski, G. (2001). Replication as Strategy. Organization Science, 12(6), 730–743.

Winter, S. G., Szulanski, G., Ringov, D., & Jensen, R. J. (2012). Reproducing knowledge: inaccurate replication and failure in franchise organizations, (April 2015). doi:10.5465/AMBPP.2007.26530073

Wolff, S. B., Pescosolido, A. T., & Druskat, V. U. (2002). Emotional intelligence as the basis of leadership emergence in self-managing teams. The Leadership Quarterly, 13(5), 505-522.

Wooldridge, J. M. (2003) Introductory econometrics, 2nd   Ed.   Mason, OH: South-Western.

Yamagishi T,MifuneN(2008)Does shared group membership promote altruism? Fear, greed, and reputation. Rationality Society 20:5–30.

Yelle, L. E. (1979). The learning curve: Historical review and comprehensive survey. Dec. Sci., 10(2), 302.

Yoo, Y., & Alavi, M. (2004). Emergent leadership in virtual teams: what do emergent leaders do? Information and Organization, 14(1), 27-58.

Yu, J., & Zaheer, S. (2010). Building a process model of local adaptation of practices: A study of Six Sigma implementation in Korean and US firms. Journal of International Business Studies, 41(3), 475–499.

Yu, L., and Nickerson, J. V. (2011) Cooks or cobblers?: crowd creativity through combination. In Proc. CHI'2011.ACM Press.

Yukl, G. (1998) Leadership in Organizations

Zhu, H., Kraut, R. E., & Kittur, A. (2012 a). Organizing without formal organization: Group Identification, Goal Setting and Social Modeling in Directing Online Production CSCW 2011: Proceedings of the ACM Conference on Computer Supported Cooperative Work. New York: ACM.

Zhu, H., Kraut, R. E., & Kittur, A. (2012 b). Effectiveness of shared leadership in online communities . CSCW 2012: Proceedings of the ACM Conference on Computer-Supported Cooperative Work. (pp. 407-416). NY: ACM Press.

Zhu, H., Kraut, R., & Kittur, A. (2014). The Impact of Membership Overlap on the Survival of Online Communities. In Proc. of CHI.

Zhu, H., Kraut, R.E., Wang, Y.C., & Kittur, A. (2011) Identifying Shared Leadership in Wikipedia. In CHI'2011.

Zika-Viktorsson, A., Sundstrom, P., & Engwall, M. 2006. Project overload: An exploratory study of work and management in multi-project settings. International Journal of Project Management, 24(5): 385-394.