

Group Polarization in Virtual Communities: The Case of Stock Message Boards

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Abstract

This study examines group polarization, the phenomenon that group members tend to become more extreme in their decisions after group discussions, in the setting of virtual communities, specifically on stock message boards. In this paper, I propose two factors – group size and discussion thread length – to introduce the group polarization theories, social comparison theory (SCT) and persuasive arguments theory (PAT), respectively, to virtual communities. I examined the effects that group size and thread length have on group polarization, which is measured by forum participants' sentiments. The findings suggest that group size has a significant effect on group polarization. The result of thread length, however, is mixed: the effect of thread length depends on the degree of posting activity on the message board. The analysis and findings echo prior literature, in which SCT and PAT are claimed to serve as two key mechanisms that drive group polarization.

Keywords: virtual communities, group polarization, social comparison, persuasive arguments

Introduction

There has been a long interest in studying the phenomenon of group polarization in psychology and social science literature. Group polarization refers to the phenomenon that group members have a tendency to become more extreme in their thinking (positions, decisions, or choices) after group discussions (Isenberg 1986; Myers and Lamm 1976). For instance, group polarization has been widely adopted to explain the jury decision-making process: jury members usually decided on punitive damage awards that were larger or smaller than the amount any individual juror had preferred prior to deliberation after group discussions. Group polarization, therefore, presents the effects of extreme inclinations of people after deliberating with each other.

Prior studies have presented group polarization in various settings, ranging from political decisions (Janis 1989) to investment decisions (Whyte 1993). The role of group polarization, however, is mixed. Group polarization could be detrimental if group members lack profound understanding of it (Brockner 1992; McCauley 1989; Whyte 1993), yet it has been proved to be beneficial as well in many circumstances, such as shown in participation in social support systems (Festinger et al. 1956). Therefore, understanding what factors affect group polarization and its underlying formation process has become an important issue, helping people and decision makers to benefit most from group polarization.

As the progress of information technologies, the use of computer-mediated communication has shown to be able to make a difference in group polarization (El-Shinnawy and Vinze 1998). With computer-mediated communication, people engage in a group discussion with less social presence, compared with traditional face-to-face communications (Rice 1993). Seigel et al. (1986) present that dispersed group communications in an electronic form, which is with reduced social presence, have greater group polarization than face-to-face group communications. One explanation is given by Valacich et al. (1994): when people work together via computer-mediated communication in dispersed settings, more unique and high-quality ideas are generated, leading to greater group polarization. Sia et al. (2002), furthermore, investigates the effects of communication cues, social presence, and anonymity on group

polarization in computer-mediated communication. In particular, their studies have shown that when group members are in a distributed or anonymous environment, group discussions can lead to even higher levels of group polarization compared to traditional face-to-face meetings. This is attributed to two reasons. First, greater numbers of novel arguments are generated in computer-mediated communications, and second, there is higher incidence of one-upmanship behaviors.

While fruitful research has been conducted to investigate group polarization in both traditional face-to-face or computer-mediated communications in various settings, less is relatively known how group polarization works in one burgeoning form of computer-mediated communication, that is, communication in virtual communities, including online forum/message board communications. The innovation of the Internet technologies has encouraged more and more online forum and message board communications nowadays, changing how information is presented to people and the ways in which people can respond to that information. Take stock message board for example. Stock message boards, or stock forums, provide an unprecedented opportunity for investors to invest, debate, and exchange stock information and personal opinions with reduced or even no previous social connections. Statistics show that the level of forum activity keeps growing: during the year 1999 to 2001, more than 35 millions messages about public American firms were posted and discussed on Yahoo! Finance (Antweiler and Frank 2002). Stock message boards, in addition, are proven to have great impacts on the market. For example, Wysocki (1999) reports that message postings will forecast next day trading volume and next day abnormal stock returns. Although there is a noticeable importance and growing of stock message boards, the challenges and difficulties of examining communications happening in online forums are essentially rooted in three aspects. First, message board postings are known to have significant noise, contradictory opinions, rumors, and manipulations. The interactions among forum participants and online messages hence result in even more complicated communications. Second, the activity and scope of online forum communication are free of time and space constraints, leading to an enormous volume of information that can overwhelm forum participants. This also leads to the difficulty of identifying the form and boundary of communications among people. Third, the dynamic and complicated natures of online forums make it more difficult to identify factors and to develop measures for group discussions and communications, compared with other types of traditional or computer-mediated communications in prior work, where experiments can be more controlled.

I therefore attempt to unravel the understanding of group polarization in virtual communities through the study of one particular type of online forum: stock message boards. In this study, group polarization is recorded by comparing decisions at the group level and in online stock forum settings. Based on social comparison theory (SCT, Sanders and Baron 1997) and persuasive arguments theory (PAT, Kaplan 1977), which are considered two significant determinants of driving group polarization, I propose two factors, the group size (number of participants in one thread) and thread length (number of messages in one thread) to apply SCT and PAT to online communities setting. On message boards, although people do not necessarily know each other's true identity, they do recognize other users' virtual IDs, and as time goes by they take it more seriously their trust in other users when reading and responding messages from other participants they "virtually" know. In this way, forum participants build up a social connection to familiar others. The group size will therefore affect group decisions in the way that it decides how many people an individual can compare with, thereby recognizing whom they know and who they don't know, assessing and adjusting his/her decisions, and leading to different beliefs and in turn choices. This explains how SCT is examined on stock message boards. Thread length, on the other hand, was intentionally to account of information novelty on message boards, which in part determines the persuasiveness of online messages. The idea is rooted in the fact that the longer the thread length, the more likely a novel message can be found, increasing the persuasiveness of a discussion thread and thus impacting group decisions. This relates to the PAT arguments.

To conduct the analysis, I examine the effects that group size and thread length have on group polarization. I first propose to use the "discussion thread" on stock message boards to represent a single discussion session. On stock message boards, a thread is a sequence of messages posted by a group of members, responding to one another. Each thread usually pertains to a single topic. During the interactions among people in a thread, a group discussion is considered to occur. Following Das and Chen (2001) and Gu et al. (2007), I then apply text mining approach to each message in one discussion thread to extract online investors' sentiments, revealing online investors' investment tendency pertaining to a particular stock. In other words, these sentiments represent online investor's choices (decisions or positions) through communications, and thus are adopted as the index leading to group polarization. The

findings suggest two interesting results. First, group size affects group polarization on stock message boards, as suggested in SCT. Second, the effect of thread length depends on the posting activity of the message board: thread length has a significant effect on message boards with lower posting volume (lower level of activity) but does not have significant impacts on message boards with higher posting volume (higher level of activity). This explains how PAT works in online communities.

This study contributes to academics in two ways. First, telling choices or decisions from online forum users has always been considered a difficult task, given the dynamics and noisy contents on message boards. I shed some light on how to investigate group discussions and communications in online settings. More specifically, by proposing group size and thread length pertaining to discussion threads as two key factors that might impact online investors' sentiments, I apply SCT and PAT for group polarization to the setting of virtual communities. Second, I adopt text mining approach for user sentiment extraction to represent forum participants' choices. The results contribute to practitioners as well. Group polarization on online message boards refers to the situation that message board participants tend hold extreme opinions pertaining to an issue after participating on the message boards. This, if on stock message boards, can impact online investors' decisions and in turn their trading behaviors and moreover future investments. Therefore, by understanding the factors that will or will not affect group polarization, decision makers such as message board providers can have a better understanding of the process of group polarization and if necessary, have control over it to gain more advantages.

The rest of the paper is organized as follows. In the next section, I provide a literature review on group polarization and computer-mediated communication. Specifically I will discuss two primary theories for group polarization, the social comparison theory and the persuasive argument theory. In the section of Methodologies and Hypotheses, I present the hypotheses and how the analysis of group polarization is conducted. In Data section, I describe the stock message board postings collected for the study. The model and results are given in Hypotheses Tests and Results section, followed by the discussions of limitations and implications of this study. I conclude the paper with conclusions and future work in the last section.

Literature Review

In the study of group communications and decisions, a group usually needs to reach a common decision even when the opinions of group members are in fact heterogeneous. For instance, Ackoff (1967) argues that in an organization, production and sales conclude a common strategy despite different respective goals. When group decisions are different from the original individual opinions, or when a group decision is enhanced after a group discussion, group polarization occurs. It refers to the situation that individuals tend to take more extreme opinions (Isenberg 1986; Myers and Lamm 1976). This phenomenon was first discovered by Stoner (1961) by finding out that group decisions are riskier than private decisions of individuals within the group.

Group polarization mechanisms could be investigated based on two primary theories, social comparison theory (SCT) (Sanders and Baron 1997) and persuasive arguments theory (PAT) (Kaplan 1977). SCT refers to the idea that individuals tend to assess themselves by comparing with other people. Furthermore, it is suggested by SCT that individuals will learn about and adjust their opinions toward the direction valued by other people as they continue the comparison process. The concept of SCT applies to group polarization in a way that by comparing with other people continuously, individuals tend to present themselves toward the socially desirable value after group discussions (Brown 1965). More specifically, Isenberg (1986) argues that one-upmanship and pluralistic balance are the two key characteristics that drive group polarization through social comparisons. First, one-upmanship, by definition, is the practice of trying to one-up, or outdo, an opponent. In a group setting, one-upmanship refers to the situation that when two individuals hold mutual positions during a group discussion, one tends to outdo another by moving his/her thinking toward the more socially desirable value. Pluralistic balance, on the other hand, refers to the "compromise" that people attempt to achieve, taking into account the tradeoff, or balance, between self-preference and preferences of other people. Therefore, during a group discussion, if an individual finds out that his/her position is not in accordance with the group value, which is called collective decision, he/she tends to move toward the collective decision, balancing between his/her own preference and the group's. One-upmanship and pluralistic balance are found to be two important mechanisms that form the group polarization (Fromkin 1970; Pruitt 1971). In online communities, social comparisons keep occurring when forum participants interact with each other by reading and posting messages, and by arguing and

compromising through the interactions.

The second major theory, the persuasive arguments theory (PAT), is considered an informational influence (Kaplan 1977). According to PAT, individual decisions are determined based on how he/she weighs the pro and con arguments. During group discussions, when each group member presents his/her pro and con arguments, he/she shifts the *weight* of these arguments, giving each other new arguments. Group polarization is then formed in the manner that people tend to pro the arguments that group discussions favor, and con those arguments against by the group discussions. This leads to the idea of to what degree each argument is considered to be “persuasive”. Novelty and validity are two proposed determinants of the persuasiveness. First, the novelty of an argument depends on how an individual regard it as interesting, original, and new. During the group discussion, when an individual is exposed to a novel argument, he/she tends to change the decisions. The second factor, validity, makes an argument to be more heavily weighted than a not-so-valid argument. During the group discussion, people will judge the correctness of each argument and change decisions accordingly. Prior studies have shown that both novelty and validity account of group polarization (Burnstein 1982; Butler and Crino 1992; Vinokur and Burnstein 1978). In the setting of online communities, it is considered harder to measure the persuasiveness of arguments. This is due to the common noisy contents and the alias mechanism used in online communities.

The approach to measuring group polarization is proposed from two different perspectives, at individual level as a preference change (Hinsz and Davis 1984) and at group level as a choice shift (Zuber et al. 1992). Choice shift refers to the difference between the individual’s average “pre-meeting” choice and the final collective choice. When the final group decision is more extreme compared with the average pre-meeting decisions, group polarization occurs. In measuring choice shift, group polarization is considered at a group level. Preference change, which is measured for group polarization at an individual level, takes into account the average difference between an individual’s pre- and post-meeting choices. After group discussions, if an individual’s post-meeting choice moves toward the group choice, then group polarization is claimed to have happened. In the setting of online forum communications, the preference change is considered more difficult to capture. This is attributed to two reasons. First, in a virtual community, online participants come and leave arbitrarily, which means in a group discussion a member could appear and join a discussion but leave in the next second, without waiting till after the discussion. Second, the use of aliases in online forums makes it harder to position each different individual, leading to the challenge of identifying individual decisions. Therefore in this study, group polarization is measured at the group level, the group’s choice shift, based on Whyte (1993) as well, which shows that the magnitude of choice shift is generally stronger than that of preference change.

Computer-mediated communication is shown to impact group polarization (El-Shinnawy and Vinze 1998) with reduced social presence (Rice 1993). Siegel et al. (1986) show that in computer-mediated communications, where groups might communicate in a more dispersed environment, group polarization is intensified compared with the traditional face-to-face communications. Two explanations are given in prior work. First, when a group of members work together via computer-mediated communications, it is more likely that high-quality and interesting thoughts could be produced (Valacich et al. 1994). Moreover, in computer-mediated communications people are able to communicate in an anonymous way, which leads to a stronger group polarization because the exchange of social cues is restricted (Connolly et al. 1990) and social presence is again reduced. Sia et al. (2002) further presents the precise impact of features offered by computer-mediated communications, including communication cues, social presence, and anonymity, on group polarization and the underlying process. While there has been a growing interest in studying computer-mediated communications and group polarization, little is investigated about how one particular type of computer-mediated communication, online forums or message boards, affects group polarization. In the following sections, I will present an approach to understanding group polarization in online forums, specifically on the Internet stock message boards, extending prior work in computer-mediated communications and group polarization to a more dynamic and large-scale online setting.

Methodologies and Hypotheses

I conduct the study on group polarization analysis in the online settings of stock message boards. In contrast to the experimental designs suggested in prior work, for instance Sia et al. (2002), defining the scope of group discussions and communications in online forums has several challenges resulted from the

dynamics and complications on the Internet. Therefore, in my study, I first identify a *discussion thread* on stock message boards as a session of group discussion. A discussion thread consists of a sequence of messages posted by forum participants, responding to each other pertaining to a single topic. Figure 1 is an example showing what a discussion thread looks like.

Messages in Topic Minimum rating: [What's this?](#)

Subject	Author	Rating	Time of Post (ET)
ABI Says Linux Will Dominate Mobile Market	wottowwottow	★★★★★	8-Apr-07 01:05 pm
↳ Re: ABI Says Linux Will Dominate Mobile Market	creepy_word_game	Rate it	8-Apr-07 02:18 pm
↳ Re: ABI Says Linux Will Dominate Mobile Market	intentosajusto	Rate it	8-Apr-07 02:28 pm
↳ Re: ABI Says Linux Will Dominate Mobile Market	creepy_word_game	Rate it	8-Apr-07 02:33 pm
↳ Re: ABI Says Linux Will Dominate Mobile Market	intentosajusto	Rate it	8-Apr-07 02:36 pm

Figure 1. An example of a discussion thread (© 2007 Yahoo! Finance stock message board: MSFT).

In a discussion thread, forum participants read and post messages, responding to the arguments made by other people. This is analogous to the traditional group discussion settings: during a session of group discussion presented by a discussion thread, the posted messages are the arguments that people get involved, and by repeatedly interacting with one another, individual and group decisions are made.

As presented earlier, social comparison theory (SCT) and persuasive arguments theory (PAT) are the two major mechanisms that drive group polarization. Based on SCT and PAT, I propose two key factors that might affect group polarization in the stock message board settings: group size, the number of online participants in one discussion thread, and thread length, the number of messages comprising one discussion thread.

First, SCT refers to that forum participants tend to assess themselves, make decisions, and adjust their opinions by comparing with other online users. To what degree an online user can compare with others depends on one factor, that is, on how many people he/she can compare with, and that leads to the proposed idea of group size. On message boards, online users post and read messages, and interact with others using a virtual ID, an alias. Although the true identities of online users are generally unknown, for users frequently and actively participate in message boards, they in fact learn gradually about other users by interacting with each other. Forum participants thus do have social links, though virtually, to one another. Group size determines how many other online participants an individual can interact with, or compare with, in one discussion thread, leading to different beliefs and in turn different choices and decisions. In addition, social impact theory (Latane 1981) states that social influence experienced by an individual partially depends on the number of people involved, which in this scenario, refers to the group size of the discussion thread. The social impact theory implies that, the more people get involved in communications, the stronger impacts SCT and PAT processes have on each individual. This thereby results in stronger group polarization.

The second factor, thread length, is generated based on PAT. According to PAT, a forum participant's decision is determined based on how he/she weighs the pro and con messages. The pros and cons of a message, furthermore, depend on the persuasiveness of the message. In particular, as discussed before, the novelty of a form posting is a significant determinant of its persuasiveness. It refers to how an online user regards a message as interesting, original, or new. The idea of thread length thus comes from the fact that having a larger number of messages will increase the possibility of including more novel arguments. This leads to the proposed factor, the thread length. Thread length determines how many messages contained in a discussion thread, and thus is considered a factor that can affect group polarization from the perspective of message novelty.

I next propose how to measure group polarization. Group polarization is widely measured using choice shift and preference change (Zuber et al. 1992). However, as discussed earlier, in online forum settings, the number and identity of forum participants are dynamically changing from time to time. Furthermore, prior study has also shown that the magnitude of choice shift is generally stronger than that of preference change (Whyte 1993). In my study, therefore, I focus on choice shift for group polarization. The choice of online investors is reflected by their "choices of stock investment," which are expressed in the stock "sentiments" that online investors reveal in their posted messages. Notice that on stock message boards, for instance the case of Yahoo! Finance, online investors are usually given an option to specify

their sentiments pertaining to a particular stock. This sentiment falls into five categories, including strong sell, strong buy, sell, buy, and hold. However, giving the sentiment is not mandatory, and very often forum participants do not specify it clearly. Therefore, in order to extract sentiments from messages posted by online participants, I follow prior work (Das and Chen 2001; Gu et al. 2007) and exploit text mining approach to mine the hidden sentiment information based on the textual message contents. In the text mining task, a training data set consisting of textual messages, each of which with a known, manually assigned sentiment class label, is first given. I then can induce a classification model from the training data to classify future messages into the pre-defined classes. For each discussion thread, posted messages are classified into one of the three categories in terms of their sentiments, shown as follows.

Category 0: sentiment is “strong sell” or “sell”.

Category 1: sentiment is “strong buy” or “buy”.

Category 2: sentiment is “hold” or “no opinion”.

Given the three classification categories of sentiments, to measure the overall group choice and decision of a discussion thread, I use the measurement of *sentiment entropy* to capture the degree of how the sentiments are mixed, or the sentiment purity over all messages in one discussion thread. The sentiment entropy is calculated as follows. Assume in thread i , the proportion of category 0 is P_0 , the proportion of category 1 is P_1 , and the proportion of category 2 is P_2 . The sentiment entropy for each thread i , is then calculated based on Shannon Entropy (Shannon 1948):

$$\text{Sentiment Entropy } (i) = -P_0 \times \log_2 P_0 - P_1 \times \log_2 P_1 - P_2 \times \log_2 P_2, \quad (1)$$

which is measure of how uncertain, or how mixed, the online participants' decisions are. Therefore, in order to measure the degree of group polarization, I use the reciprocal of sentiment entropy. In other words, for each thread i , the degree of group polarization is measured by

$$\text{Group Polarization } (i) = \frac{1}{\text{Sentiment Entropy } (i)}. \quad (2)$$

This is consistent with the idea that, the more extreme the individual decisions are, the smaller the sentiment entropy, and the greater the group polarization.

Based on the discussions above, I state the hypotheses as follows:

Hypothesis H1. *One stock message boards, group size will significantly affect group polarization.*

Hypothesis H2. *One stock message boards, thread length will significantly affect group polarization.*

Next I will present the data for the study, followed by the hypotheses tests and results to study the effects of group size and thread length on group polarization on stock message boards.

Data

In this study, I collected message board postings from a random sample of three stocks from Yahoo! Finance, which is widely acknowledged as one of the leading stock investment communities. The three stocks, presented by their stock tickers, include GE, MSFT, and MCD. The three stocks contain the issues that forum participants (individuals) care about and thus will have discussions over. According to the stock's risk (i.e. beta) levels, these three stocks considered to be widely held and therefore less speculative. This characteristic is desirable because in the analysis of group polarization, we will want to exclude the influences of price movements and stock markets on the posted messages or on the online investors' decisions. Based on the same reasons, for each of the three stocks, I collected data from the two weekend periods, which again aim to get rid of the stock price effects. For each stock message board during one weekend period, I collected messages from discussion threads which thread lengths are greater than or equal to 5. The following attributes were acquired for each message: thread topic, author

ID, posting date and time, message content, and sentiment (if existent) assigned along with every message. Table 1 shows the summary of descriptive statistics of the discussion threads of all 3 stocks, including weekend periods, total number of threads, total number of forum participants over all threads, and the total posting volume as an index of the degree of posting activity and the frequency of participation of online investors on that particular stock message board. Table 2 further shows the descriptive statistics summary pertaining to the analysis of group polarization.

Table 1
Descriptive Statistics of Discussion Threads

Stock Ticker	Weekend Periods	Total # of Threads	Total # of Participants	Total # of Postings (as of 05/01/2007)
GE	04/07/07 ~ 04/08/07 04/14/07 ~ 04/15/07	38	108	210,063
MSFT	04/07/07 ~ 04/08/07 04/14/07 ~ 04/15/07	54	186	341,689
MCD	03/31/07 ~ 04/01/07 04/14/07 ~ 04/15/07 04/21/07 ~ 04/22/07	8	21	21,216

Table 2
Descriptive Statistics for Group Polarization

Stock Message Board Ticker	Thread Length Mean (Std. dev.)	Group Size Mean (Std. dev.)	Group Polarization Mean (Std. dev.)
GE	16.31 (9.95)	5.54 (1.94)	0.6716 (0.0309)
MSFT	15.75 (10.30)	7 (6.27)	0.6549 (0.0120)
MCD	7.75 (2.38)	3.28 (2.45)	0.6580 (0.0155)

Hypotheses Tests and Results

To perform statistical tests of the effects group size and thread length on group polarization, I first divide each of the factors into two levels: group size large vs. group size small, and thread length long vs. thread length short. The division threshold is based on the data we have. Figure 2 shows graphically the descriptive statistics of the discussion threads on GE and MSFT message boards (due to space constraints) after dividing factors into levels.

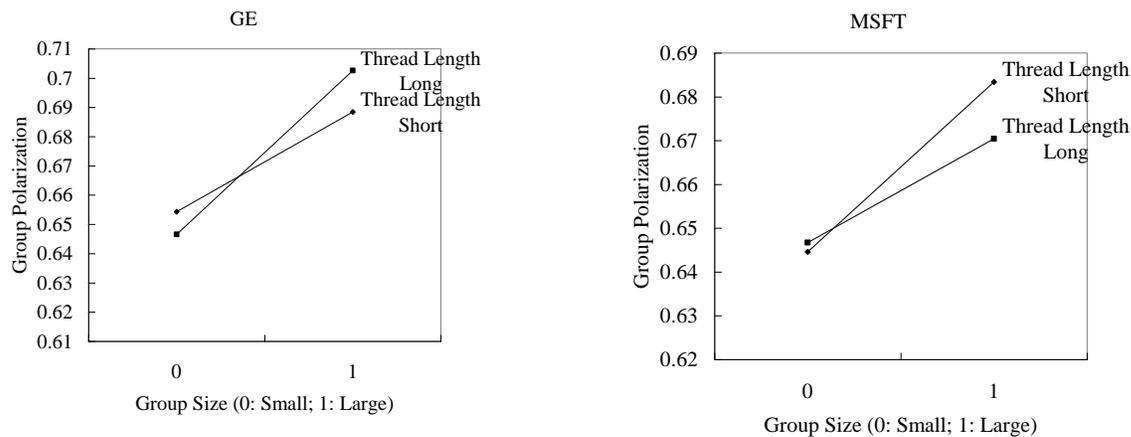


Figure 2. Graphical presentation of discussion threads for GE and MSFT.

In this study, statistical tests are carried out based on 5% and 1% levels of significance. A 2 x 2 factorial ANOVA test involving the independent variable (group polarization) and two explanatory variables (group size and thread length, each containing 2 levels) is carried out. Table 3 shows the statistical results. F-test detects significant effect for group size on group polarization (GE: $F = 38.72, p < 0.01$; MSFT: $F = 38.97, p < 0.01$; MCD: $F = 11.65, p < 0.05$). Hypothesis H1 is supported. This result shows the consistency with SCT and the argument that group size significantly affects group polarization: group size determines how many other online investors an individual will be able to compare and interact with to adjust opinions and make decisions, thereby resulting in the phenomenon of group polarization.

For the effect of thread length, the results are mixed. For GE and MSFT, the F-test does not detect significant effect for thread length on group polarization (GE: $F = 0.11, p < 0.05$; MSFT: $F = 0.90, p < 0.05$). Hypothesis H2 is thus not supported: thread length does not have a significant effect on group polarization. This can be explained by the nature of online forum messages. Recall that thread length was originally taken into account from the perspective that thread length determines the number of message included, relating to the possibility that a novel, persuasive message is found to occur. However, in online forums such as stock message boards, many of the messages are in fact small talks, containing noisy or irrelevant information. This impacts the effect of thread length: whether the discussion is long or short is no longer necessarily related to the persuasiveness of messages within it. This phenomenon is verified in my statistical test. For MCD, however, the F-test does detect significant effect for thread length on group polarization (MCD: $F = 24.40, p < 0.01$). This is attributed to the fact that MCD, compared with GE and MSFT, has relatively lower posting volume and thus lower level of posting activity (see Table 1. for total number of postings). The data also show that MCD has relatively shorter average thread length compared with GE and MSFT. This leads to the observation that, although many of the forum messages contain noise and are considered not persuasive, as discussed earlier, if there is only a smaller number of messages posted online, the importance of each additional message will still become more crucial, given that the original message pool is small. In other words, stock message boards with less posting volume and generally shorter threads will weigh the factor of thread length higher for group polarization than those with more posting volume and longer discussion threads.

Table 3
Statistical Results of 2 x 2 Factorial ANOVA

Stock Message Board	Source of Variation	F	Sig. of F
GE	Group Size	38.72	0.000**
	Thread Length	0.11	0.739
Adjusted R-Squared = 0.508			
	Group Size	38.97	0.000**

MSFT	Thread Length	0.90	0.346
	Adjusted R-Squared =		0.425
MCD	Group Size	11.65	0.027*
	Thread Length	24.40	0.008**
	Adjusted R-Squared =		0.826

Significance level: * $p < .05$; ** $p < .01$

Discussions and Limitations

In this study I examine the effects of group size and thread length on group polarization, in the setting of stock message boards. The results support the argument that group size significantly affects group polarization and the effects of thread length on group polarization depends on the posting activity of a particular stock message board. This study, however, has several limitations. First, this analysis does not account of the effects that the overall stock market performance has on individual and group decisions. For instance, although the discussion threads posted during weekend periods are taken into account, aiming to exclude the price effects, some external factors such as financial news could still impact online investors' opinions pertaining to certain stocks (Tetlock 2007). The same argument exists for the limitation that in this study, only message boards of more stable stocks are investigated. For volatile stocks, even though the analysis is performed during weekend periods, measuring group polarization still requires more careful considerations regarding additional factors resulted from the stock volatility that will impact group decisions. In addition, to enforce experimental controls and to reduce the complications on the stock message boards, this study was conducted using a relatively smaller number of stock message boards across 2 to 3 weekend periods. The numbers of forum participants and threads are sufficient for a reasonable analysis, but the phenomenon across a larger set of various stocks should be investigated more. Consequently, this study and findings open up an opportunity toward understanding group polarization in virtual communities, but will require more careful manipulations in terms of generalizability.

Several related aspects of academic implications can be undertaken. The analysis of group size and thread length effects on group polarization in this study can serve as a starting point for this line of research. Future studies can investigate additional factors that might as well impact group polarization. In particular, changes in the level of social presence, the degree to which people build personal connections with each other in a communication setting (Short et al. 1976), are shown to be able to affect group communications (Walton and McKersie 1965). Moreover, the exchange of communication cues, including verbal, visual, or textual cues (McGrath 1984), can change the level of social presence and human behavior (Johansen et al. 1991; Shorter et al. 1976; Sia et al. 2002; Williams 1977). Social presence can be observed in online forum communications based on the features such as participation time and frequency of online investors, and on how they interact with each other to establish the virtually social bonds. The way to capture the communication cues, however, is not easy. For online communication settings, it is natural to assume that only textual cues are present. The text mining approach provides a thought to manipulate the textual communication cues by filtering out noisy or irrelevant information and extracting the hidden yet informative knowledge from posted messages. This suggest an interesting future direction of research to further explore the effects of social presence and communication cues on group polarization, analogous with the study of Sia et al. (2002), in virtual communities.

Second, the concepts proposed in this study can be replicated in other online scenarios, for example, group communications and polarization in globally decentralized organizations. As more and more organizations are decentralized and organizational structures are getting flattened, many group decision makings in organizations nowadays are accomplished by means of other computer-mediated communication forms, for example, via not only emails but also weblogs or intra wikis (Wagner and Majchrzak 2007). Future studies can examine the underlying process and effects of group polarization in different virtual and cultural settings.

Results of this study also provide implications for practice. Decision makers for virtual communities can benefit from better understanding the process of group polarization and the effects that impact group polarization. Literature has shown that in some situations people benefit from a larger degree of group polarization, while in some cases more group polarization can do harms (Coleman 1957; Festinger et al. 1956). For virtual communities such as stock message boards, this understanding is particularly crucial

because individual and group decisions can also lead to future investment, thereby impacting on trading volume, stock returns, revenues, etc. Online forum providers can therefore benefit from group polarization rather than being harmed by it by controlling the group polarization process.

Conclusion and Future Work

In this paper I examine the effects of 1) group size of a discussion thread and 2) discussion thread length on group polarization in virtual communities, particularly in the settings of stock message boards. The results suggest that group size has a significant impact on group polarization, while the effect of thread length depends on the degree of posting activity: thread length has a significant effect on group polarization for stock boards with lower activity level, but does not introduce a significant effect on group polarization for stock boards with higher posting activity. The findings echo SCT and PAT, which were proposed in prior literature for group polarization. In particular, SCT and PAT are applied to online communities and their effects are presented.

The increasing complexity of different forms in computer-mediated communications, such as virtual communities including online forums, message boards, weblogs, etc., has led to a growing interest in investigating the issue of group communications, decision making, and polarization, which can further impact critical organizational decisions and profits. The online communications, however, are known to be difficult to tackle with because of the dynamics and variability of the large-scale Internet platforms. This study is therefore considered as an incremental yet significant contribution towards a better understanding of how to measure group polarization in online communities, and of how group polarization has been affected.

This study also opens up several opportunities for academics and practitioners for future research directions. Some straightforward future work could be induced from the study. First, including more stock message boards and discussion threads from either stable or volatile stocks will help understanding the phenomenon of group polarization in online forums. Second, as discussed earlier, other factors such as social presence and communication cues can be examined regarding their effects on group polarization. In particular, one of the current progresses is to apply text mining approach to directly measuring the persuasiveness of online posted messages, comprising the discussion threads, and thereby affecting group polarization according to PAT.

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