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Understanding the Impact of Opinion Leaders' Characteristics on Online Group Knowledge-Sharing Engagement from In-Group and Out-Group Perspectives: Evidence from a Chinese Online Knowledge-Sharing Community

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Abstract: Opinion leaders often play key roles in online knowledge-sharing communities, which has intrigued a lot of researchers and practitioners worldwide. However, it is not clear how various characteristics of opinion leaders may affect different online groups' knowledge-sharing engagement. This paper aims to answer this question by building upon social capital theory to examine the differential influences of opinion leaders' characteristics (interactivity, authority, and activity) on online groups. In-groups and out-groups were distinguished, and the study used the context of an investment-oriented online knowledge-sharing community. By leveraging a unique aggregated group-level secondhand dataset collected from Snowball.com, we conducted log-linear and Poisson regression models. The results revealed that the intensity of online group knowledge-sharing engagement was heavily contingent upon the types of characteristics of opinion leaders. We found that in-group knowledge-sharing engagement (generating new knowledge) was driven by an opinion leader's interactivity and authority, whereas out-group knowledge-sharing engagement (developing new members) could not be facilitated by these types of characteristics. Instead, the opinion leader's activity hindered out-group users from joining in-groups. The study also identified a "mutual promotion" issue, which was generated from the association between in-group and out-group knowledge-sharing engagement.

Keywords: opinion leader; social capital theory; knowledge-sharing; online community; in–out perspective

1. Introduction

In the current digital era, more and more people tend to spend a lot of time in online knowledge-sharing communities of interest, such as investment-oriented online knowledge-sharing communities or online knowledge-sharing communities oriented to some other fields. For example,

Snowball.com (https://xueqiu.com) is one of the most popular investment-oriented online knowledge-sharing communities in China. It brings together a tremendous amount of high-quality investment-related professional knowledge (i.e., information, skills, strategies, or expertise) and highly qualified investors. Notably, unlike other types of online communities, such as communities of transaction, communities of fantasy, and communities of relationship, such communities of interest consist of multiple groups of people interacting, sharing, and working [1]. Online groups are usually unstable entities that are characterized by high membership fluidity [2]. With the abandonment of the conventional method of knowledge organization and classification mainly designed by community architects and managers, online knowledge-sharing communities are increasingly adopting a user-led knowledge-sharing mode. Members of online groups rally around specific topics (e.g., a stock, an investment-grade bond, or private equity), share knowledge, or act as mentors [3]. Each online user is free to attach labels, create investment-related topics, and join groups of interest as an in-group member to share their knowledge. At the same time, out-group users can also browse in-group knowledge as well as interact with in-group members.

In such online knowledge-sharing communities, community managers and users work toward a common goal: sustainable development [4]. Sustainable development means "meeting the online community development needs of present without compromising the ability of future generations to meet their needs" [5]. It creates and pursues a vision of a community that respects and makes prudent use of all its resources in online knowledge-sharing communities, including members, member-created knowledge, etc. For online knowledge-sharing communities to move toward a more desired, sustainable future, one of the key indicators is active group knowledge-sharing engagement [6,7]. Specifically, there are two feasible ways regarding knowledge-sharing engagement to get competitive advantages. First, the constant generation of knowledge offers the potential, if used appropriately, to enable a more sustainable future [2]. Specifically, knowledge, which is regarded as a renewable factor of production in a network society, represents unboundedness, shareability, and sustainability, which can make up for the scarcity of natural resources. In other words, knowledge can be used and reused by many people in different physical spaces. Once this type of factor of production is created, it would not only remain unexhausted by development and utilization but also intensify and accumulate through knowledge-sharing [8]. Thus, knowledge generation provides a foundation for the sustainable development of online communities. Second, in addition to encouraging current members to generate more new knowledge, developing more new in-group members from out-groups is also a valid measure of sustainability. On the one hand, by increasing the input of labor, the online group's overall productivity is likely to increase and thus create more knowledge, which facilitates sustainable development [9]. On the other hand, a larger and wider collection of online members could enable new forms of interaction in terms of speed, scope, and scale [10]. There is the potential to build a positive knowledge-sharing social network when an online community embraces the multitude of members' dynamic actions and interactions. Flourishing members and vibrant social networks produce a rich stock of social trust, norms of reciprocity, and conditions that are conducive to long-term cooperation and sharing, which also meet the requirements of sustainability [11]. Therefore, sustainable development entails a growing group of members who animate the online community and work to create knowledge. These two knowledge-sharing engagement aspects (i.e., generating new knowledge and developing new members) help online community managers set clear, quantifiable targets to be achieved to ensure sustainable development. Correspondingly, the amount of new knowledge generated by in-group members and the number of new members coming from out-groups are key quantifiable indicators that are measured by practitioners to assess the effectiveness of sustainable development strategies [12].

Notably, opinion leaders can be conceived of as an efficient basic tool to maintain sustainable development through an online knowledge-sharing community, as a result of consensus from many managers [13]. Although the members of a group enjoy equal rights, those who possess superior online status, education, and social prestige are often deemed opinion leaders. They are generally considered

to be the most influential and have the expertise to exert a positive influence on other ordinary users in many aspects such as thoughts, attitudes, and behaviors concerning knowledge-sharing [14,15]. In fact, user-led online knowledge-sharing communities need opinion leaders in two ways. First, there is evidence that they generate almost all of the content (90%–91%) on such professional knowledge-sharing networking sites [16]. That is, opinion leaders can sustain the intervitality of online knowledge-sharing groups. Second, if outside members see an active group that can be mobilized by opinion leaders, they may be more motivated to participate because of the bandwagon effect. In other words, opinion leaders can stimulate the outward development of online groups. Thus, managers seek to understand the mechanism of opinion leaders exerting influence and use what is online community-provided in an appropriate and wise manner, so that the undertaking for them is more lighthearted.

In sum, in the context of online knowledge-sharing communities, building a sustainable community is the ultimate goal of managers. Online community success is critically dependent on two specific knowledge-sharing engagement behaviors at the online group level: active knowledge generation by in-group members and new members being developed from outside the group. Whether increasing sharable knowledge or increasing the number of members engaged in knowledge-sharing, both of these knowledge-sharing mechanisms are tied to opinion leaders, who can encourage in-group members to generate knowledge and mobilize out-group users to join the group. Ultimately, opinion leaders are considered to be non-negligible facilitators of the success of developing sustainable online communities [2]. Their contribution may explain why many well-known knowledge-sharing companies in the world spend billions every year on opinion leader practices [15]. A recent report also predicted a further sharp increase in investments devoted to influencer marketing of key opinion leaders in 2019 [17]. With such a massive amount of money to invest in opinion leaders in the context of knowledge-sharing, practitioners are constantly deepening the understanding of opinion leaders and seeking out better solutions to strengthen their influence. As a result, more in-group members will produce knowledge and more out-group users will join the group, thus furthering the efforts toward the sustainable development of online communities.

Theoretically, researchers have come to a consensus that "suitable" opinion leaders serve as major gateways to enhance users' positive attitudes and knowledge-sharing intentions and continuously play crucial roles. For instance, Smith pinpointed that opinion leaders can be catalysts or inhibitors of intermittent or ongoing knowledge-sharing efforts, which depends on their personal factors and influence [18]. De Bernardi, Bertello, and Venuti highlighted the far-reaching significance of combining the culture of special social characters who are in key positions (e.g., opinion leaders of groups) and knowledge-sharing to achieve sustainability and high social impact [19]. Witt suggested that opinion leaders' intense communication with ordinary users might directly translate into certain positive cognitive commonalities and socially shared tacit knowledge, such as knowledge about social models of behavior [20]. Although studies give us a sense of the importance of opinion leaders, the common characteristic among them is that opinion leaders are often assessed in an aggregate manner (e.g., in terms of numbers or categories).

Meanwhile, recent research on leader–member exchange and interpersonal relationships has shown that personal characteristics would be a promising research direction. As Li et al. have stated, some distinguishing characteristics of opinion leaders (e.g., expertise and activity) are conducive to promoting research paradigms in the online community setting [5]. Zhao et al. found an association between opinion leaders' characteristics (e.g., credibility) and their influence on the evolution of opinions of online in-group members [21]. Most studies on the area of opinion leaders' characteristics have merely investigated narrow personality constructs in a limited fashion, shying away from diverse personal characteristics [22]. Thus, subtle distinctions or unique characteristics of opinion leaders and the consequent influence on online groups could potentially be overlooked throughout this process. Furthermore, the measurements of personal characteristics and their subsequent effect on group behaviors have been mainly conducted through firsthand survey data by qualitative methods so far (e.g., questionnaire) [23–26]. Analysis based on secondhand data is still scarce. Given that online

knowledge-sharing communities have a large volume of real user interaction data in the digital age, finding objective evidence and depicting the potential mechanisms between opinion leaders and online groups show a clear prospect [27].

With regard to the inter-relationships between opinion leaders, in-groups, and out-groups, a branch of studies has deemed opinion leaders to be major transfer nodes in the process of information dissemination: opinion leaders not only share information and knowledge with in-group members, but also may influence outside users [4]. However, although there are abundant works on the influence of opinion leaders on users within the same topic group, people still cannot find a clear link between opinion leaders and outside users beyond the group. Moreover, since group differentiation has been proven to be related to online knowledge-sharing behaviors, the link between distinct online groups' knowledge-sharing engagement behaviors has also intrigued people [28]. Even though group externalities have been empirically verified, which can strengthen the power of an inner crowd, how in-group behaviors in turn influence out-group behaviors has not yet been fully explored [29]. Furthermore, how to simultaneously gauge the influences of in-groups and out-groups from the perspective of knowledge-sharing engagement also deserves more attention from both practitioners and researchers. Addressing these issues regarding the internal connection between in and out group aspects helps to profoundly comprehend two types of knowledge-sharing engagement behaviors at the group level and enhance competitive advantages of online knowledge-sharing community sustainable development.

Therefore, this paper is an attempt to explore the interactions between opinion leaders' characteristics, in-group knowledge-sharing engagement (i.e., generating new knowledge), and out-group knowledge-sharing engagement (i.e., developing new members) in an online knowledge-sharing community scenario and reveal the antecedents of different types of knowledge-sharing engagement at the group level. Specifically, our study also aims to fill the aforementioned research gaps by addressing the following questions:

Q1. Do various aspects of opinion leaders' characteristics (i.e., interactivity, authority, and activity) affect different types of online group knowledge-sharing engagement (i.e., in-group and out-group knowledge-sharing engagement)?

Q2. Is there an interplay between different types of online group knowledge-sharing engagement (i.e., in-group and out-group knowledge-sharing engagement)?

Building primarily on evolving social capital theory, we propose a conceptual framework that encompasses two components of group social capital (i.e., bonding and bridging social capital), presented separately by in-group and out-group knowledge-sharing engagement. The framework also depicts individual social capital from the dimensions of social network, social trust, and shared goals, and we exploit opinion leaders' characteristics (i.e., interactivity, authority, and activity) to assess the intensity of diverse types of individual social capital. We examine the relationships between opinion leaders' characteristics and in-group and out-group knowledge-sharing engagement by using a unique group-aggregated dataset collected from a leading investment-oriented online knowledge-sharing community, Snowball.com, through log-linear and Poisson regression analyses.

The remainder of this paper is organized as follows: In Section 2, we review some related literature regarding social capital theory, knowledge sharing, opinion leaders, and online groups (successively). Then, in Section 3, we propose a conceptual framework based on social capital theory that can capture the association between opinion leaders' characteristics and online group knowledge-sharing engagement. In Section 4, we present the dataset, variable construction, model specification, and analytic techniques. Section 5 details an empirical study that was conducted by establishing econometric analysis models (i.e., log-linear and Poisson regression models) to evaluate our proposed models. The results of a robustness analysis are also reported to validate our estimates through additional regression models. Lastly, Section 6 contains the conclusions drawn from the empirical findings, future research directions, and theoretical and managerial implications.

2. Literature Review

2.1. Social Capital Theory

In the knowledge-sharing domain, social capital theory is one of the most influential conceptual paradigms for understanding this type of interpersonal interaction behavior. It underlines that individual actions are influenced by society [30]. Specifically, in a network society, individuals cannot exist and develop independently: they must rely on cooperation and resource-sharing and exchange with stakeholders [31]. Social capital is an invisible, potential resource embedded in network structures among social actors, which provides the necessary conditions for social exchange [32,33]. The theory states that the existence of a group is the result of individuals becoming members in order to obtain the resources of the group. Social capital is diverse, generally presenting as personal, community, national, organizational, or network capital at a horizontal level or as internal or external social capital at a focal level [34]. Leana and Pil pointed out that internal social capital lies in the relationships among members of a community or enterprise [35], while Zahra suggested that external social capital exists in the form of network connections among external individuals, organizations, or communities [36].

Social capital theory provides generalizable insights into processes that influence the maintenance of interpersonal relationships and is often applied to analyze user behavior, especially in the knowledge-sharing setting. Nahapiet and Ghoshal discovered that social capital in the domain of communities highlights the central importance of strong interpersonal networks, which offer a basis for trust over time [32]. Maizza et al. proposed an integrated model of sustainable development and offered an innovative perspective to interpret social capital as the actors' ability to understand the relevance of the advantages derived from participating in the exchange of knowledge [37]. The structure, relationships, and cognitive dimensions of social capital have also been confirmed to positively affect knowledge acquisition and sharing intention [38]. However, most current studies have typically focused on the influence of network resources embedded in various external communities on organizational value. Research concerning the internal association between individuals and organizations is still scarce compared to research on organization–government and organization–organization relationships. Furthermore, there are also few studies that have comparatively examined the influence of individuals' social capital on internal groups' social capital and external groups' social capital concurrently.

It is noteworthy that the mechanism of out-group users joining in-groups in online knowledge-sharing communities forms unique two-way network structures between individuals and groups. Quantifiable user knowledge-sharing behavior also offers an opportunity to measure intangible resources in network structures. Thus, social capital theory seems to be a hopeful way to dissect the resource-exchange process at the group level and explain the influence of opinion leaders on online groups under the situation of knowledge-sharing.

2.2. Opinion Leader

An emerging body of research on knowledge-sharing has highlighted the importance of opinion leaders within groups. Deliberately distinguishing opinion leaders from ordinary members (e.g., supporters and amplifiers), researchers have assumed that leaders are seen as unique in various attributes [39–41]. In particular, opinion leaders are expected to have extraordinary leadership traits, such as eloquence, persuasiveness, patience, persistence, the capacity to gain sympathy, and confidence, that help them earn the esteem of ordinary users within groups through informal communication [20]. Moreover, the opinion leader–member relationship has been a longstanding interest of many scholars. In line with the leader–member exchange theory school of thought, a high-quality leader–member relationship is intrinsically built on social exchange, meaning that the leader and the individual members of a group must contribute resources valued by the other parties [22]. If the judgment of an opinion leader's contribution is positive, the leader will assign better tasks to members, and members will experience more support. Drawing on social exchange theory, Wu and Lee conducted a multilevel analysis and argued that a group leader's positive leadership can help group members develop positive

psychological social capital, which can enhance their knowledge-sharing [27]. Although leaders'
behaviors will likely differ depending on the followers and the context, their common purpose is to
build a broad network with more people in their own circles, which is beneficial to the realization
of group goals and the development of individual members. Meanwhile, opinion leaders do not
have time to give all members equal attention and thus tend to establish close relationships with key
members, who become the in-group. The use of online platforms further enables interdependence
between different roles. Ordinary users engaging in online behaviors greatly rely on the intensity and
types of interactions with opinion leaders [39].

With regard to the entire online group, the primary influence of opinion leaders on a group has
long been discussed in many contexts, such as in public management (e.g., studies on the key role of
opinion leaders in controlling public opinion and improving government–public relationships) [42–44],
marketing (e.g., studies on opinion leaders and word-of-mouth marketing) [18,45–47], the media, and
information dissemination (e.g., studies on opinion leader identification and classification) [48–51].
Switching to the knowledge-sharing domain, however, only a few scholars (e.g., Smith [18]) have
recognized that opinion leaders have a remarkable capability to reflect the requirements of users or
promote the development of organizations [52]. For instance, Erkut conducted a qualitative case study
using publicly available blogs. He contended that strong leadership behaviors in flat hierarchies can
be effective in developing organizational capabilities and managing innovation, in which knowledge
generation is central to a competitive advantage [53]. Witt suggested that core economic actors
(e.g., opinion leaders) are offered unique advantages to successfully organize resources into envisioned
businesses [24]. Resource owners (e.g., knowledge-sharers) must be coordinated with the opinion
leaders' conception and be motivated to perform properly. Witt also proposed individual socially
shaped cognitive frames to explain that opinion leaders who possess remarkable leadership skills help
to effectively transmit individual concepts, boost cognitive commonalities, promote socially shared tacit
knowledge, and ultimately shape the market [20]. Within the framework of evolutionary economics,
Erkut put forward a four-dimensional (nano–micro–meso–macro) integrated framework and positively
associated the capabilities of economic actors, especially opinion leaders, in the mesodimension
with the transformation of knowledge in the microdimension [53]. Following this theoretical stream,
by absorbing knowledge and concepts from opinion leaders, groups can not only be more innovative
but can also reduce potential divergence among users. Besides, when knowledge to be shared is
congruent with the beliefs of the opinion leaders in a group, sharing can be accelerated. Obviously,
investigations on what opinion leaders can do to improve online knowledge-sharing communities are
mostly conducted from the perspective of overall organizations, rather than distinct types of subgroups
(e.g., in-groups and out-groups).

Moreover, the traditional knowledge-sharing literature has pointed out that knowledge-sharing
cannot happen automatically, in that some factors such as personal factors, organizational characteristics,
knowledge features, and environmental context play important roles [54–58]. Among the factors,
personal factors are deemed to be the most important [59]. Many researchers have tried to apply
conventional knowledge-sharing theories and frameworks to online knowledge-sharing behavior.
They have attempted to utilize classical theories of psychology, sociology, and economics to explain users'
knowledge-sharing motivations, such as altruism, self-efficacy, entertainment value, emotional value,
and informative value [3,60–62]. In addition to various motivations, they have also addressed the effects
of different personal incentive mechanisms (e.g., reciprocity, common vision, community attachment)
on knowledge-sharing intention and behaviors [63–65]. Notably, by summarizing motivators, barriers,
and enablers of knowledge-sharing in online communities, Ardichvili demonstrated that most prior
studies have been conducted by means of questionnaires [66]. More investigations using practical
datasets are urgently needed. Furthermore, although several existing studies have focused on user
characteristics of opinion leaders when designing algorithms to identify them [15,67,68], opinion
leaders are often considered to be a global concept. Given their diverse characteristics, the relationship
between opinion leaders and their influence on groups is worth in-depth exploration on a subtler level.

2.3. Online Groups: In-Groups and Out-Groups

On online platforms, groups are made up of users who have similar interests, hobbies, and tastes [45]. Groups are often differentiated as strangers and friends [69], crowds and friends [70], and in-groups and out-groups [71,72]. Each categorization has subtle differences, but they all highlight the dependence of one's decisions on the decisions of others. The strength of group relationships is an important factor in distinguishing group categories. As a result of strong ties, people categorize themselves into certain groups and out of others, which can sometimes be an automatic process [73]. Within an in-group, there is frequently a pro-in-group bias driven by a heightened desire to connect with "home", which prompts members to expand their stretchable in-group boundaries to include the related out-group users [74]. In addition, when interacting with leaders, members of the in-group are characterized by a high negotiating latitude, whereas the out-group is characterized by a low negotiating latitude, according to leader–member exchange theory. Group memberships develop fairly quickly and remain stable over time [75].

The influences of online groups (also called online group influence) have been associated with a variety of constructs, such as social influence [76], crowd wisdom [77], brand identification [78], consumption communities [79], and reference groups [80]. Marketers and investors are particularly interested in online group influence because of its ability to rapidly disseminate experience and professional knowledge and influence users' choices [77,81]. In sociology, researchers have suggested that group influence occurs when people adapt their behaviors, attitudes, or beliefs to the behaviors, attitudes, or beliefs of others in the social system [82]. They emphasize a sense of identity and belonging [83,84].

Focusing on the influences of in-groups and out-groups, we found that early research used some network structure metrics (e.g., number of sharing neighbors, edge betweenness, and transfer frequency) to measure group influence [40,48,49]. Because network indicators may overlook the interactions between users, some frameworks with a series of considerations, such as topics and individual network metrics (e.g., centrality, in-degree, out-degree), have been successively proposed to evaluate the influence of in-group information creators or transmitters [41,85–87]. Moreover, from the perspective of information diffusion, the intensity of group influence on outside users is usually assessed through the number of infected nodes, the probability of infection, and infected targets [88,89]. Few existing studies have conducted simultaneous measurement of the influences of in-groups and out-groups.

Besides, while the literature on the background of knowledge-sharing has been continuously growing since 2000, the results of studies are becoming more complex and cross-disciplinary, especially in works done on the motivators of online knowledge-sharing at the individual level [54–56] and the impact of knowledge-sharing on resource- or capability-based competitive advantages at the firm level [90,91]. Prior research has stressed investigations of the relationships between knowledge-sharers within a group (e.g., opinion leaders) and their influence on other online group users (e.g., in-group members) in the context of online communities; however, opinion leaders' cross-group influence on knowledge-sharing engagement at the group level has rarely been studied thoroughly [92].

3. Conceptual Model and Hypotheses

In this section, we discuss the conceptual framework and hypotheses. Our conceptual framework was developed on the basis of social capital theory, as depicted in Figure 1.
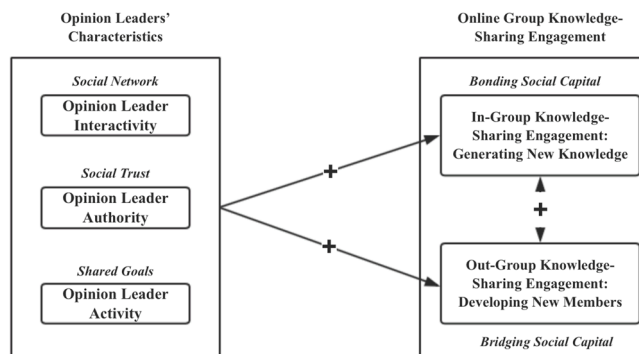
Figure 1. Research framework.

3.1. Relationship between In-Group and Out-Group Knowledge-Sharing Engagement

In online knowledge-sharing communities, as the understanding of a group or a topic deepens, out-group users may decide to join the group because they are driven by their emerging sense of identity and belonging. Grissa argued that opinion leaders create the most of knowledge shared among online groups [16]. In other words, crossing structural holes embedded in open networks, opinion leaders manage to connect users coming from outside the group with their online group. In the process of knowledge exchange and transformation, the influence exerted by opinion leaders on the out-group, e.g., developing new members, acts as a bridge between internal and external groups: hence, this can be looked at as bridging social capital. Relying strongly on bridging social capital, groups are able to absorb out-group users, expand the size of the group, enrich available resources, and thus increase the aggregate social capital at the group level.

Shifting to the inner groups, opinion leaders continually and actively create new posts to foster interactions with in-group members, which can induce a variety of desirable online behaviors and attitudes, such as elevating group awareness or increasing positive feedback [82]. By evoking a strong sense of group identity and belonging, the in-group influence exerted by opinion leaders leads in-group members to generate new knowledge, which can be viewed as bonding social capital. Enhanced group interconnection and cohesion are crucial benefits that group members expect to acquire from their bonding social capital. This type of social capital is also propitious for reinforcing group self-centered networks and boosting group popularity and influence.

In the current context, developing new members (out-group knowledge-sharing engagement), as bridging social capital, may help a group to bring external resources into the internal group, thereby creating more opportunities to enrich in-group knowledge and behaviors [93]. In turn, generating new knowledge (in-group knowledge-sharing engagement), as bonding social capital, is conducive to uniting in-group members to deepen their understanding of common topics and accomplish the common objective of being a sustainable online group, thus attracting more out-group users [94]. With both aspects combined, we specify the first hypothesis.

Hypothesis 1. *There is a positive association between in-group and out-group knowledge-sharing engagement.*

3.2. Effect of Opinion Leaders' Characteristics on Online Group Knowledge-Sharing Engagement

The overall existing and potential resources generated by individuals in social groups through personal or social connections with others in their online and offline social networks are referred to as social capital [95]. Knowledge-sharing is typically regarded as an exchange process of social capital, whereby members of a group exchange their knowledge and create new knowledge [96]. Opinion leaders in vital roles in groups are perceived as possessing many social resources and network relations. In line with the thought of leadership for sustainability, in the current user-led context, opinion leaders act as "transactional leaderships" rather than "administrative leaderships" who drive sustainable development forward with a clear vision in mind [97]. Besides the rule of

reciprocity, group gain is also a "guideline" for opinion leaders in their knowledge-exchange processes in online communities [98]. In balanced high-exchange opinion leader–member dyads, the followers demonstrate better performance and stronger satisfaction than in low-exchange dyads [99]. That is, what matters for social capital at the group level is the opinion leaders' personal transactional social capital.

Chow and Chan further segmented exchangeable individual social capital into three dimensions—social network, social trust, and shared goals—and suggested that these elements have a significant positive impact on the overall intention to share knowledge [100]. In an online community context, social network users establish many direct contacts with others if the organizational structure is flat and decentralized. The social network provides a slew of opportunities for actual interpersonal contact. Social relationships and friendship judgments have been shown to be emphasized by users who form groups and develop knowledge-sharing collaborations [101]. People typically have more positive feelings about sharing ideas and resources with members with whom they have developed close relationships [100]. In line with leader–member exchange theory, it has also been shown that those leaders who develop higher-quality links with their members produce greater resources than those who develop lower-quality links [102]. Opinion leaders who have more extensive real social networks (e.g., actually interact with users) rather than only a large number of zombie fans have more group social capital, including bridging and bonding social capital, because good relationships result in high expectations and the favorable actions of other users (e.g., behaviors conducive to the sustainable development of online communities).

In our study, we employed the interactivity of opinion leaders to measure their actual contact with others through online knowledge-sharing communities. Interactivity is characterized by the degree to which two or more parties in communication can act on each other [103], and it embodies the salient features of an online community that is based on social media and social networks. This indicator is often used to estimate the intimacy and size of online social networks in the social network analysis domain [104]. Many researchers (e.g., Xu, Chin, and Cosley) have held that, for individuals, interacting and communicating with others is an important way to make new friends and establish social networks in the word [105]. Opinion leaders utilize their communication and interaction talent for building close and extensive social relations. With such interactivity, the social network can be assessed as going beyond some friends with a "mere virtual presence" [106]. For example, an opinion leader's knowledge-sharing post with only descriptive text, no comments, no reposts, and even no likes is not at all interactive, while a question or guessing contest is more interactive, since group members can offer personal insights on that knowledge to the opinion leader and thus develop a more widely connected social network. Therefore, we hypothesized that opinion leaders who are highly interactive and build extensive, effective social networks may improve group knowledge-sharing engagement at the group level, regardless of the mechanism (generating new knowledge and developing new members). This is articulated as Hypotheses 2a and 2b:

Hypothesis 2a. *An online opinion leader's interactivity is positively associated with in-group knowledge-sharing engagement.*

Hypothesis 2b. *An online opinion leader's interactivity is positively associated with out-group knowledge-sharing engagement.*

Many studies have suggested that social trust or mutual trust between members is one of many factors that are critical to the success of knowledge-sharing activities [47]. Social trust in an online group advances interaction between users: people want to learn from each other and share their knowledge. Members are more likely to respond positively, share their knowledge, and provide resources to those who are trustworthy. The level of social trust influences the expectations of members' intentions and behaviors. Moreover, overall social capital can be raised with increasing social trust, particularly the trust of key members (e.g., opinion leaders). Some scholars have attempted to explain

this situation, and they have deemed that trustworthy people, especially trustworthy opinion leaders, already do the "right" thing to promote the sustainable development of online knowledge-sharing communities. This degree of trust motivates people to comply and more readily continue with such behaviors through mere imitation [107]. Perceived trust, especially in a virtual online community, reduces the perceived uncertainty and risk in the exchange process and initiates more exchange from a social exchange theory point of view [108].

Notably, an observable characteristic, namely authority, can be regarded as a simple criterion for making a judgment regarding trustworthy under complex social conditions [109]. In prior studies, authority has usually been used to assess people's reliability [110]. For instance, Qureshi, Min, and Kouvatsos proposed a lightweight trust model framework for identifying trustworthy users and creating online communities of trusted users. In terms of assessing trust, they underlined the importance of referring to opinions and indicators of a third party, such as with user authority, user reputation, and online authentication. In a noncentralized decision-making scenario, Richters and Tiago also found that nodes with high authority, which is measured by the out-/in-degree of the nodes, are more efficient and lead to higher average trust transitivity [111]. From the aspects of social identity and deference, Tyler believed that the close link between authority relations of groups and deference and social identity shows predictability in creating and maintaining the social conditions under which trust can occur [112]. Besides, Sutliff conducted an investigation to evaluate the public's attitudes and trust of authority figures: no significant difference was found with regard to the public's relatively high trust in authority based on region of the country or type of community [113]. Moreover, based on trust in authoritative people, many scholars in the field of marketing and advertising have usually deemed that endorsements by highly authoritative figures have a star effect and can effectively promote product sales and advertising clicks [114–116]. Furthermore, according to leader–member exchange theory, leaders are granted the authority to negotiate with members to back up their cultivation of a trusting atmosphere [117]. Put differently, leaders can exchange their authority for more social trust.

On the basis of previous studies, we also evaluated the characteristics of authority using the ratio of fans and followings and believe that opinion leaders with strong authority are deemed trustworthy [21,111,118]. For instance, imagine the following scenario: an authenticated opinion leader has 10 followings and 100,000 fans, while another authenticated opinion leader has 10 followings and only 10 fans. Between the two different types of opinion leaders, who is more likely to be trusted and whose shared knowledge is more acceptable to the public? Most people may think that highly authoritative opinion leaders are more credible, trustworthy, and influential. Thus, it is reasonable to speculate that both types of group knowledge-sharing engagement can be substantially enhanced when it comes to highly authoritative opinion leaders. This is specified in Hypotheses 3a and 3b:

Hypothesis 3a. *An online opinion leader's authority is positively associated with in-group knowledge-sharing engagement.*

Hypothesis 3b. *An online opinion leader's authority is positively associated with out-group knowledge-sharing engagement.*

Shared goals promote a mutual understanding and exchange of ideas. Shared goals can be considered the force that aggregates people who have identical or similar values and a sense of honor, and they can then share what they know to better contribute to community development and expand social capital [100]. Within an online group network, an opinion leader is the core node in a key position who can control the flow of knowledge and resources in the whole network. Shared goals can be adopted and achieved by users through the opinion leader's active guidance and practice. This is because opinion leaders, who engage in personalized expression of opinion as well as share knowledge at high frequencies, are likely to be identified as the advocates of group action. The enactment of this role involves shaping what the goal of the knowledge-sharing action is about as well as prominently contributing, thus bringing broader and deeper interest to group engagement [39]. Specifically, opinion

leaders can expertly lead in-group members to accept goals and arouse and gather them to accomplish shared goals, which boosts internal bonding social capital [119]. Meanwhile, with the growing activity of opinion leaders, more knowledge and group goals can be outwardly shared directly, offering more opportunities to entice out-group users. Ultimately, external bridging social capital is enhanced accordingly. With these aspects combined, we deduce that active opinion leaders who are stimulated by shared goals are more likely to engage other users in establishing connections and sharing knowledge, thus enriching various resources and social capital for the group. Notably, in contrast to interactivity, activity promotes the unilateral introduction of knowledge, declaration of shared group goals, and removal of members' perceived uncertainty, rather than bilateral ties between opinion leaders and members. For example, an opinion leader who only generates one knowledge-sharing post or shares group goals once is typically deemed to have a lower level of activity, whereas an opinion leader who generates 100 knowledge-sharing posts or shares group goals 100 times is deemed to have a higher level of activity. In terms of social exchange theory, it can also be seen that active opinion leaders exchange actions for people's deeper understanding and acceptance of common goals, which can ultimately translate into people's actual favorable behavior for the sustainable development of online communities. This is further elaborated in Hypotheses 4a and 4b:

Hypothesis 4a. *An online opinion leader's activity is positively associated with in-group knowledge-sharing engagement.*

Hypothesis 4b. *An online opinion leader's activity is positively associated with out-group knowledge-sharing engagement.*

4. Methods and Variables

4.1. Data and Sample

Erkut and Witt pointed out the unique importance of opinion leaders in developing collective capabilities and sought out the exact association between them using qualitative methods, but it is still necessary to further quantify that relationship through specific data [23,24]. Considering the means of quantification, the extant analytical literature provides some guidance. For example, Zhao et al. utilized a numerical simulation algorithm to understand the key role of opinion leaders' characteristics (e.g., credibility) on group formation [21]. However, the selection of approaches left a lot to be desired, since numerical simulation experiments merely look into regular structures and are generally based on idealized assumptions [21]. Some quantitative empirical analytic techniques with real-world evidence could compensate for these weaknesses and reveal the actual relationship. Following this thread, using an online music listening dataset from a music sharing and promotion community, Mu et al. distinguished different levels of in-groups (i.e., superordinate and subordinate in-groups) and examined the differential effects of online group influence on digital product consumption by building an econometric model (i.e., Poisson quasi-maximum likelihood estimation) [46]. Kim et al. conducted a longitudinal survey of 221 women with breast cancer and discovered that opinion leaders in computer-mediated social support (CMSS) groups, which offer viable online space to share knowledge and experiences in facing illness, can help group members to obtain psychosocial health benefits, such as higher levels of competence in cancer information, breast cancer knowledge, and better problem-focused coping strategies [26]. Weeks et al. collected two-wave panel questionnaires online and found that opinion leaders in social media groups can be influential in changing their peers' political attitudes and behaviors both directly and indirectly [25]. Obviously, although extensive empirical work using subjective firsthand survey data has shed light on the importance of opinion leaders within online groups and communities, analysis based on secondhand data is still comparatively rare. Moreover, in the digital age, the application and analysis of massive objective data shows some promise, which may be presented as evidence to objectively depict the potential mechanisms operating

between opinion leaders and online groups [76]. Stated thus, we attempted to apply secondhand data from a real online community to clarify the actually existing relationship.

We collected a unique dataset from a leading Chinese investment-oriented online knowledge-sharing community, Snowball.net. As described in Section 1, groups on Snowball.net are aggregated by common topics of certain investment products. Users can interact with one another through designed social features, such as following, commenting, posting, sharing, etc. Additionally, we paid close attention to stock investments, since, as the earliest and most important section of Snowball.net, it has drawn the attention of many investors and has established a fairly perfect discussion mechanism. This naturally offered a good opportunity to observe opinion leaders and their interactions with ordinary members.

Figure 2 illustrates a typical online group interface regarding a stock (Industrial and Commercial Bank of China, No. 601398) posted in Chinese. Three key pieces of information are included. Part A shows the total number of online group members, which is updated in real time. Part B shows individual characteristics of the in-group members, including nickname, brief introductions, number of in-group knowledge-sharing posts, number of followings, and number of fans. Part C shows the latest knowledge-sharing posts generated by in-group members.

Figure 2. Snowball.net screenshot (typical online group page).

To observe online groups whose knowledge-sharing behavior at the group level was influenced by opinion leaders (i.e., more knowledge posts shared by in-group members, or more new members from outside the group), groups that had at least one new post or one new member were selected as the targets. A crawling program was developed to unobtrusively collect data. Initially, we selected a random sample of 15 online groups, i.e., Teda Manulife Quantificatio (No. 001733), the China State Construction Engineering Corporation (No. 601668), Phoenix Optical (No. 600071), the China Railway Construction Corporation (No. 601186), Sinopec Group (No. 600028), Ping An Insurance (No. 601318), Kweichou Moutai (No. 600519), Zhongmin Energy (No. 600163), Guizhou Space Appliance (No. 002025), Ningbo David Medical Device (No. 300314), Shanghai Haixin Group (No. 600851), the Industrial and Commercial Bank of China (No. 601398), Poly Real Estate Group (No. 600048), Midea Group (No. 000333), and the Agricultural Bank of China (No. 601288). We randomly tracked 5000 users (including opinion leaders and ordinary users) from 2 March to 2 April 2015. During the one-month data collection period, no major special events occurred that affected user behavior. The thousand-level observation users were consistent with prior research on the influence of online groups in other industries (e.g., Reference [45]). After content relevance checking, a total of 33,190 knowledge-sharing posts and corresponding user online responses (e.g., sharing, commenting, liking) were collected. *T*-tests showed that there was no difference between the sample users and the overall population in terms of gender.

4.2. Variables

We developed a set of variables using specific calculation formulas inspired by previous research through a calculator program to test the proposed conceptual framework. The variables reflected the abovementioned theoretical concepts developed on the basis of social capital literature.

4.2.1. Dependent Variable: Knowledge-Sharing Engagement

We classified knowledge-sharing engagement behaviors into two types: in-group knowledge-sharing engagement (in-group members generating new knowledge) and out-group knowledge-sharing engagement (developing new members from out-groups). To establish our measurement scheme, we referenced the work of Kempe, Kleinberg, and Tardos for a quantitative methodology to evaluate these two dependent variables [120]. We used the number of newly infected nodes outside the group to investigate the bridging influence on out-group users. In the online knowledge-sharing scenario, the number of new members joining a group on each statistical day was used as a proxy for developing new members (out-group knowledge-sharing engagement). In addition, given that posting is a primary mode of knowledge-sharing, we considered the number of new knowledge-sharing posts generated by in-group members on each statistical day as a proxy for generating new knowledge (in-group knowledge-sharing engagement).

4.2.2. Independent Variables: Opinion Leaders' Characteristics

Opinion leaders' characteristics were measured by community metrics, including interactivity, authority, and activity. Following Yang and Leskovec's work, we identified the opinion leader of an online group as the member who had the most fans [51]. To assess the actual connections between an opinion leader and other users, we used the number of comments, reposts, and likes on his/her knowledge posts as an indicator of interactivity level [103]. The opinion leader's authority means the individual prestige among knowledge-sharers. The ratio of an opinion leader's fans and followings could represent the degree of popularity, and we used it as a proxy to measure authority [21,118]. A higher ratio suggests a greater degree of authority of the opinion leader. In addition, opinion leader activity reflects the enthusiasm for exchanging knowledge and ideas, and it could be measured by the number of knowledge posts shared by a leader during our observation period [121].

4.2.3. Control Variables

To reduce potential confounding effects and support the robustness of the empirical results, we developed an array of control variables that captured two major aspects: (1) the overall characteristics of ordinary knowledge-sharers in addition to opinion leaders, and (2) the overall characteristics of a knowledge-sharing group.

First, with regard to the characteristics of ordinary in-group knowledge-sharers other than the opinion leader, the control variables included ordinary sharer interactivity, authority, and activity [122]. Second, we also created a few variables to control for the intrinsic effects generated by online groups: network average path length [123], network scale [124], network density [50], and group maturity [125].

The variables and their descriptions are summarized in Table 1. Table 2 includes fundamental descriptive statistics. The correlations of all variables were examined, as shown in Table 3. No correlation coefficients were greater than 0.7, which indicated there was no potential multicollinearity issue.

Table 1. List of variables and measurements.

Variable	Abbreviation	Explanation	Supporting Literature
Dependent Variables			
In-group knowledge-sharing engagement	$New\_Knowledge_{i,t}$	The number of new knowledge posts generated in group i on statistical day t	[51,118,120]
Out-group knowledge-sharing engagement	$New\_Members_{i,t}$	The number of new members engaging in knowledge generation in group i on statistical day t	[51,118,120]
Independent Variables			
Opinion leader interactivity	$OL\_Interactivity_{i,t}$	The total number of comments, reposts, and likes on new knowledge posts generated by the opinion leader in group i on statistical day t	[103]
Opinion leader authority	$OL\_Authority_{i,t}$	The ratio of fans and followings of the opinion leader in group i on day t	[21,118]
Opinion leader activity	$OL\_Activity_{i,t}$	The number of new knowledge posts shared by the opinion leader in group i on statistical day t	[121]
Control Variables			
Ordinary Knowledge-Sharer			
Ordinary sharer interactivity	$OS\_Interactivity_{i,t}$	The average number of comments, reposts, and likes on new knowledge posts generated by all ordinary sharers in group i on statistical day t	[122]
Ordinary sharer authority	$OS\_Authority_{i,t}$	The average ratio of fans and followings of all ordinary sharers in group i on statistical day t	[122]
Ordinary sharer activity	$OS\_Activity_{i,t}$	The average number of new knowledge posts shared by all ordinary sharers in group i on statistical day t	[122]
Knowledge-Sharing Group			
Network average path length	$Length_{i,t}$	The average shortest distance between any two members in group i on statistical day t	[49,123]
Network scale	$Scale_{i,t}$	The total number of members in group i on statistical day t	[124]
Network density	$Density_{i,t}$	The weighted degree distribution of the network of group i on statistical day t	[50]
Group maturity	$Maturity_{i,t}$	The relative length of time from the establishment of group i to statistical day t	[125]

Notes: The measurement of variables was conducted using Gephi 0.9.2 software.

Table 2. Fundamental descriptive statistics.

	Min	Max	M	SD
$New\_Knowledge_{i,t}$	2.00	807.00	284.46	219.37
$New\_Members_{i,t}$	1.00	317.00	70.10	71.70
$OL\_Interactivity_{i,t}$	3.00	173.00	35.51	42.86
$OL\_Authority_{i,t}$	1.47	3.87	2.50	0.62
$OL\_Activity_{i,t}$	0.00	55.00	18.36	14.66
$OS\_Interactivity_{i,t}$	0.00	0.39	0.19	0.17
$OS\_Authority_{i,t}$	0.16	0.58	0.27	0.14
$OS\_Activity_{i,t}$	0.00	0.52	0.20	0.18
$Length_{i,t}$	1.12	4.20	2.57	1.01
$Scale_{i,t}$	3860.00	30,899.00	10,069.47	4452.04
$Density_{i,t}$	2.23	5.38	3.59	0.81
$Maturity_{i,t}$	0.00	1.00	0.52	0.35

Notes: Data analysis was conducted using Stata 14.0 software.

Table 3. Correlations between all variables.

No.		1	2	3	4	5	6	7	8	9	10
1	$OL\_Interactivity_{i,t}$	1.00									
2	$OL\_Authority_{i,t}$	0.01	1.00								
3	$OL\_Activity_{i,t}$	0.30 *	0.31 *	1.00							
4	$OS\_Interactivity_{i,t}$	−0.17	0.35 *	0.63 ***	1.00						
5	$OS\_Authority_{i,t}$	0.08	0.04	0.19	0.03	1.00					
6	$OS\_Activity_{i,t}$	0.02	−0.10	−0.09	−0.05	0.13	1.00				
7	$Length_{i,t}$	−0.08	0.14	0.29	0.25	−0.06	−0.01	1.00			
8	$Scale_{i,t}$	0.36 *	−0.37 **	−0.51 ***	−0.32 *	−0.05	−0.07	−0.23	1.00		
9	$Density_{i,t}$	−0.20	0.20	0.35 *	0.06	−0.04	−0.42 **	0.09	−0.38 *	1.00	
10	$Maturity_{i,t}$	−0.16	−0.01	0.02	0.00	−0.16	−0.22	−0.04	−0.11	0.04	1.00

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Data analysis was conducted using Stata 14.0 software.

4.3. Model Specification and Analytic Techniques

In this section, we discuss the model framework used to examine (1) the interrelationship between in-group and out-group knowledge-sharing engagement; (2) the main impact of opinion leader interactivity, authority, and activity on in-group knowledge-sharing engagement (generating new knowledge); and (3) the main impact of opinion leader interactivity, authority, and activity on out-group knowledge-sharing engagement (developing new members).

With regard to analytic technique, given the actual dataset, econometric modeling was more suitable than other techniques. Although structural equation modeling is considered to be a powerful technique that can combine complex path models with latent variables often indirectly measured by multidimensional manifest variables [126], it seemed inappropriate to apply this method to our study for two reasons. On the one hand, based on the secondhand data we collected, all constructs were one-dimensionally measured by statistical manifest variables through calculation formulas inspired by previous literature, instead of multidimensional measurement by self-developed scales. On the other hand, in order to separate online in-group and out-group knowledge-sharing engagement simultaneously in the analysis, we tended to isolate the influence of each characteristic of opinion leaders on distinct online groups. Unlike structural equation modeling, econometric modeling can significantly avoid potential confounding effects among multiple dependent variables and account for the direction of causality. As a result, econometric modeling was considered to be a better fit in the current situation.

More specifically, we applied two separate econometric modeling methodologies to study these relationships. First, we employed a log-linear regression model to examine the interrelationship between online in-group and out-group knowledge-sharing engagement. We used the numbers of new knowledge-sharing posts of in-group members and new members developed on each statistical day t as dependent variables. We applied a log-transformation such that the transformed variables followed a normal distribution. There were likely lags between our major independent variables and the resulting online influence. To explicitly account for the direction of causality, following the approach recommended by Hsiao and Wooldridge, we used the main independent variables in the prior period to predict the dependent variables in the current period [127–129]. More specifically, to test H1, we used the following (Model 1) in Equations (1) and (2), where ε is the error term:

$$Ln(New\_Knowledge_{i,t}) = \gamma_0 + \gamma_1 New\_Members_{i,t-1} + \varepsilon_1, \tag{1}$$

$$Ln(New\_Members_{i,t}) = \theta_0 + \theta_1 New\_Knowledge_{i,t-1} + \varepsilon_2. \tag{2}$$

Second, we employed a Poisson regression model to examine the impact of opinion leader interactivity, authority, and activity on in-group and out-group knowledge-sharing engagement. We used this approach because our dependent variables $New\_knowledge_t$ and $New\_members_t$ were discrete count variables. In Table 2, there is an underdispersion issue in our dataset whereby the mean value of each variable (i.e., in-group and out-group knowledge-sharing engagement) is greater than

the corresponding variance. Poisson quasi-maximum likelihood (PQML) estimators have been shown to be particularly robust and to effectively contend with over- and underdispersion in dependent variables and the prevalence of zero values [129]. PQML estimation also can circumvent the incidental parameters bias problem by modeling the unconditional likelihood function instead of conditioning based on the initial observations. In addition, in PQML estimation, panel data make it possible to both control for unobserved confounders and allow for lagged, reciprocal causation [45]. As a result, we considered PQML analysis to be a better fit to portray the relationship between opinion leader characteristics and online group knowledge-sharing engagement [129]. A series of control variables was used in the model estimation. To control potential endogenous problems, we allowed for the possibility that the characteristics in the online knowledge-sharing community context on prior day $t-1$ could affect group knowledge-sharing engagement in the following day t [130–132]. Therefore, estimation Model 2 could be elaborated in the form of Equations (3) and (4), where ε is the error term:

$$
\begin{aligned}
New\_Knowledge_{i,t} = \alpha_0 + \alpha_1 OL\_Interactivity_{i,t-1} + \alpha_2 OL\_Authority_{i,t-1} + \\
\alpha_3 OL\_Activity_{i,t-1} + \alpha_4 OS\_Interactivity_{i,t-1} + \alpha_5 OS\_Authority_{i,t-1} + \alpha_6 OS\_Activity_{i,t-1} + \\
\alpha_7 Length_{i,t-1} + \alpha_8 Scale_{i,t-1} + \alpha_9 Density_{i,t-1} + \alpha_{10} Maturity_{i,t-1} + \varepsilon_3,
\end{aligned}
\tag{3}
$$

$$
\begin{aligned}
New\_Members_{i,t} = \beta_0 + \beta_1 OL\_Interactivity_{i,t-1} + \beta_2 OL\_Authority_{i,t-1} + \\
\beta_3 OL\_Activity_{i,t-1} + \beta_4 OS\_Interactivity_{i,t-1} + \beta_5 OS\_Authority_{i,t-1} + \\
\beta_6 OS\_Activity_{i,t-1} + \beta_7 Length_{i,t-1} + \beta_8 Scale_{i,t-1} + \beta_9 Density_{i,t-1} + \\
\beta_{10} Maturity_{i,t-1} + \varepsilon_4.
\end{aligned}
\tag{4}
$$

5. Data Analysis and Results

In this section, we discuss the empirical results from the two models. Table 4 presents the results estimated by log-linear regressions, and the adjusted R-squared (more than 0.25) and p-values (0.000) were reasonable and significant. Hypothesis H1 predicted that in-group members generating new knowledge would affect developing new members from out-groups and vice versa. This hypothesis was supported because the coefficients of out-group knowledge-sharing engagement in Model 1a (0.629, $p < 0.001$) and in-group knowledge-sharing engagement in Model 1b (0.856, $p < 0.001$) were positive and statistically significant. The results suggest that a one-unit increase in in-group members generating new knowledge was associated with about a 62.9% increase in developing new members from out-groups. Meanwhile, a one-unit increase in developing new members from out-groups also led to about an 85.6% increase in in-group members generating new knowledge.

Table 4. List of parameter estimations of log-linear regression models from Model 1.

Parameter	Model 1a	Model 1b
	$New\_Knowledge_{i,t}$	$New\_Members_{i,t}$
$New\_Knowledge_{i,t-1}$	—	0.856 *** (0.078)
$New\_Members_{i,t-1}$	0.629 *** (0.057)	—
(Intercept)	3.39 *** (0.204)	−2.24 *** (0.437)
R-sq	0.738	0.738
Adjusted R-sq	0.732	0.732
F	121.052	121.052
p	0.000	0.000

Notes: Columns contain estimated coefficients and their associated robust standard errors (in parentheses). *** $p < 0.001$. Data analysis was done with Stata 14.0 software.

We then estimated Poisson regression models based on PQML in order to reflect time series correlations. Table 5 presents the estimation results. Regarding opinion leaders' characteristics (interactivity, authority, and activity) and their impact on in-group members generating new knowledge, the coefficients of interactivity and authority were both positive (0.271 and 0.207 respectively) and significant ($p < 0.05$, $p < 0.001$) in Model 2a. However, the coefficient of activity did not appear to be significant under the condition of in-group members generating new knowledge, indicating that the opinion leader's activity was not positively associated with online in-group knowledge-sharing engagement. Therefore, Hypotheses 2a and 3a were supported, but hypothesis 4a was rejected. Notably, the positive association between an opinion leader's authority and its influence on online in-groups was also verified by Zhao et al.'s work [21]. Although the methods in these two studies were inconsistent, the research results agreed, in that in order to maximize the influence power of opinion leaders on an in-group, it is crucial to enhance the degree of trust in them.

Table 5. List of parameter estimations of Poisson regression models from Model 2.

Parameter	Model 2a	Model 2b
	$New\_Knowledge_{i,t}$	$New\_Members_{i,t}$
$OL\_Interactivity_{i,t-1}$	0.271 * (0.111)	−0.026 (0.157)
$OL\_Authority_{i,t-1}$	0.207 *** (0.007)	0.006 (0.010)
$OL\_Activity_{i,t-1}$	−0.079 (0.132)	−0.146 * (0.290)
$OS\_Interactivity_{i,t-1}$	0.202 (0.314)	−0.427 (0.466)
$OS\_Authority_{i,t-1}$	−0.111 (0.063)	0.034 (0.079)
$OS\_Activity_{i,t-1}$	0.016 (0.018)	−0.002 (0.020)
$Length_{i,t-1}$	−0.002 (0.004)	−0.001 (0.006)
$Scale_{i,t-1}$	−0.000 (0.000)	0.000 * (0.000)
$Density_{i,t-1}$	0.304 *** (0.076)	0.226 * (0.101)
$Maturity_{i,t-1}$	−0.465 *** (0.060)	−2.146 *** (0.084)
(Intercept)	0.271 * (0.111)	−0.026 (0.157)
Likelihood Ratio test	153.14	88.02
Log likelihood	−256.999	−165.882
Pseudo *R*-sq	0.231	0.210
$p >$ chi2	0.000	0.000

Notes: Columns contain estimated coefficients and their associated robust standard errors (in parentheses). * $p < 0.05$, *** $p < 0.001$. Data analysis was done with Stata 14.0 software.

Concerning the impact of opinion leaders' characteristics on developing new members from out-groups, we found an opposite pattern in Model 2b, where the coefficients of interactivity and activity were both negative (−0.026 and −0.146, respectively), and the coefficient of authority was positive (0.006). Since only activity appeared to be significant ($p < 0.05$) with regard to online out-group knowledge-sharing engagement, this suggests that the opinion leader's activity was negatively associated with influence beyond the online group. External users might encounter a potential transfinite effect due to the lack of close connections with internal members. Without intense interest and emotional motivation, external users could be bothered by frequent posting and even express

aggressive and antagonistic feelings toward opinion leaders. This is not conducive to encouraging users to join the online group. Therefore, Hypotheses 2b, 3b, and 4b were rejected.

We supplemented our Poisson regression model specification with log-linear regression models to increase robustness against the misspecification of Model 2 [133]. The estimated results (see Table 6) were consistent with the results from the previous Poisson regression models (see Table 5). Therefore, the results were robust. Moreover, the economic meaning was analyzed more intuitively through log-linear regression models. Opinion leaders' interactivity showed a positive effect on in-group members generating new knowledge at the 5% significance level ($p < 0.05$), suggesting that a one-unit increase in interactivity was associated with about a 27.4% increase in in-group knowledge-sharing engagement. Similarly, the capacity for gaining the social trust of opinion leaders, with authority as a proxy, also presented a positive relationship with generating new knowledge at the 0.1% significance level ($p < 0.001$), suggesting that a one-unit increase in authority was associated with about a 20.6% increase in in-group knowledge-sharing engagement. Contrary to the influence on in-groups, the coefficient estimates of interactivity and authority were insignificant ($p > 0.05$) with regard to developing new members from out-groups. With regard to the opinion leader's activity, we found that it had a negative impact on attracting new members from out-groups at the 5% significance level ($p < 0.05$), demonstrating that a one-unit increase in activity was associated with about a 38.6% decrease in out-group knowledge-sharing engagement.

Table 6. List of parameter estimations of log-linear regression models from Model 2.

Parameter	Model 2c	Model 2d
	$New\_Knowledge_{i,t}$	$New\_Members_{i,t}$
$OL\_Interactivity_{i,t-1}$	0.274 *	−0.056
	(0.128)	(0.126)
$OL\_Authority_{i,t-1}$	0.206 ***	−0.001
	(0.008)	(0.008)
$OL\_Activity_{i,t-1}$	−0.084	−0.386 *
	(0.153)	(0.151)
$OS\_Interactivity_{i,t-1}$	0.238	−0.125
	(0.368)	(0.362)
$OS\_Authority_{i,t-1}$	−0.102	−0.008
	(0.072)	(0.071)
$OS\_Activity_{i,t-1}$	0.017	0.014
	(0.022)	(0.021)
$Length_{i,t-1}$	−0.002	−0.003
	(0.005)	(0.005)
$Scale_{i,t-1}$	−0.000	0.000
	(0.000)	(0.000)
$Density_{i,t-1}$	0.303 **	0.081
	(0.088)	(0.087)
$Maturity_{i,t-1}$	−0.449 ***	−0.686 ***
	(0.071)	(0.070)
(Intercept)	2.505 ***	2.625 ***
	(0.289)	(0.285)
R-sq	0.879	0.858
Adjusted R-sq	0.873	0.817
F	22.774	23.305
p	0.000	0.000

Notes: Columns contain estimated coefficients and their associated robust standard errors (in parentheses). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Data analysis was done with Stata 14.0 software.

6. Discussion and Conclusions

6.1. Discussion and Future Work

Opinion leaders provide many benefits to support the sustainable development of online knowledge-sharing communities. Online community managers, however, should acknowledge and resolve the challenges concerning the introduction of opinion leaders before they can add value. The process of opinion leaders showing individual characteristics entails many factors that can affect the online group's knowledge-sharing engagement. An in-depth understanding of those factors is needed in order to facilitate the appropriate choice of opinion leaders within communities and platforms.

After a detailed literature review, we proposed a new research framework inspired by social capital theory to understand the influence of various opinion leaders' characteristics on distinct online group (i.e., in-group members generating new knowledge and developing new members from out-groups). We designed three independent variables with respect to social capital: opinion leader interactivity, authority, and activity. These variables included opinion leader interactivity, opinion leader authority, and opinion leader activity. Based on a dataset from a typical Chinese investment-oriented online knowledge-sharing community, we established log-linear and Poisson regression models to conduct an empirical analysis of our proposed conceptual framework. We also found consistent results in a robustness check.

The results showed that there was a significant, mutually beneficial correlation between online in-group and out-group knowledge-sharing engagement. With regard to the distinct characteristics of opinion leaders, interactivity and authority could effectively improve online group knowledge-sharing engagement, specifically in-group members generating new knowledge. That is, an opinion leader who demonstrated a high level of interactivity and/or authority played a positive role in encouraging in-group members to share more knowledge, but these characteristics were completely worthless to out-group users. Conversely, the activity of opinion leaders could not help in driving online in-group knowledge-sharing engagement but could hurt out-group knowledge-sharing engagement. Highly active opinion leaders were shown to hinder out-group users from joining online groups.

Yielding several important contributions to actual practice, the empirical findings provide real and applied value for managers in creating unique sustainable development strategies in the context of an online knowledge-sharing community. Specifically, opinion leaders were shown to enable managers to accomplish the ultimate goals of the online community. The significant relationship between opinion leaders and online community users indicated that managers can fortify effective online campaigns toward sustainable development by leveraging opinion leaders. Meanwhile, it is worth noting that for managers, it can be a great help to classify the target user categories (online in-group members or out-group users) and distinguish them when developing strategies. As our research shows, the characteristics of opinion leaders could evoke different outcomes in different user groups. In addition, managers should try to develop a variety of personalized opinion leader strategies (e.g., fostering leaders with high-level interactivity, introducing leaders with high-level authority, avoiding leaders with high-level activity) tailored specifically to certain phased tasks (e.g., triggering new knowledge-sharing, attracting more members).

This study still had some limitations. First, although our research examined three particular characteristics (interactivity, authority, and activity) of opinion leaders, other characteristics are also common (eloquence, persuasiveness, patience, capacity for gaining confidence, etc.), as mentioned by Witt [20]. Based on our results, it is worth considering how these characteristics catalyze the influence on an online group and whether other opinion leaders' characteristics could better explain the differences between in-group and out-group knowledge-sharing engagement. Characteristics stemming from leadership offer many possibilities: for example, despite the significant relationship between an opinion leader's capacity to gain confidence and its influence on in-groups, as found by Zhao et al. [21], it would be interesting to observe whether it has similar effects on out-groups. These intriguing issues merit further examination. Second, this study was a novel attempt to measure implicit, invisible individual

social capital (i.e., social network, social trust, and shared goals) through some explicit proxy variables that were individual characteristics (i.e., interactivity, authority, and activity). The methodology strongly implies that secondhand datasets can be applied in more wide-ranging research in the social capital domain. However, despite evidence that individuals attend to and recognize the authority of opinion leaders in informal communication, members may not always accurately perceive trust in authoritative opinion leaders or associate it with actual knowledge-sharing engagement. Although this concern worked against our hypotheses (making our studies more conservative), it suggests the need for further exploration of proxy variable choosing. Thus, future research can be developed by tracking changes in opinion leaders' individual-level explicit characteristics, engaging in behavior regarding knowledge-sharing in online communities, and constructing relevant proxy variables on a more granular level. Third, the study was conducted exclusively within the professional investment industry. Although we believe that our underlying arguments could apply to other similar online knowledge-sharing communities (e.g., healthcare-oriented online knowledge-sharing communities or fitness-oriented online knowledge-sharing communities), additional factors may need to be further considered. For example, in an online healthcare community, knowledge-sharers are often identifiable in terms of expertise, reply history, professional title, demographics, etc., whereas knowledge-sharers in the investment community are generally anonymous. The availability of this information may weaken or strengthen the extent to which opinion leader characteristics affect group behaviors from an in–out perspective. Therefore, future research is needed to extend our investigation to more online knowledge-sharing community settings. Fourth, our study assumed that each group had only one prominent opinion leader and measured the opinion leader's characteristics at the group level. Considering that an opinion leader is embedded in an online group, indicating potential multilevel issues, an extra multilevel study method could be a promising extension in follow-up work to more fully understand the relationship between opinion leaders and online groups. Fifth, given that our study only focused on the catalyzing nature of opinion leaders, we did not uncover their mediating effect. There is evidence from a study using structural equation modeling that the influence of nursing knowledge on professional practice behavior is partially mediated by perceptions of online leaders [134]. This mediation seems to be important when examining the relationship between attitudes and practice, because the influence of opinion leaders can explain why some members might have more knowledge and positive attitudes toward knowledge-sharing but low levels of actual practice or the provision of knowledge. The empirical results provide an avenue for future research to understand the pivotal role of opinion leaders in influencing other members' attitudes and behaviors, and the focus should be extended to include a mediating effect. Individual psychological state, attitude, and level of knowledge should also be taken into account, which could affect the perception of opinion leaders.

6.2. Theoretical Contributions

This study contributes to the existing body of literature in the following ways.

First, to the best of our knowledge, this is among the first attempts to provide empirical evidence for why people with different statuses (in-group members or out-group users) are or are not willing to engage in knowledge-sharing within an online group. Our research design allowed us to separate the influences on online in-groups and out-groups and thereby isolate the effects of individual characteristics of opinion leaders on online group knowledge-sharing engagement. In the context of online knowledge-sharing, the findings suggest that although in-group members generating new knowledge and developing new members from out-groups can be mutually promoted, their influencing factors are quite different. For in-group members, the social network and social trust of opinion leaders drive internal influence. However, for ordinary out-group users, frequent signals or goals they receive from in-group opinion leaders with whom they have no connection tend to be useless and even counterproductive. This may be because outsiders do not have commonly shared goals with in-group members due to the lack of close association. The result also illustrates that different user categories in the knowledge-sharing setting affect how the real effectiveness of opinion leaders' characteristics is

gauged. By not disentangling the influences on in-groups and out-groups, prior studies might have presented an inaccurate picture of the impact of opinion leaders, lead users, or organizational members on online group knowledge-sharing engagement (e.g., Chow and Chan [100]).

Second, many recent studies concerning knowledge-sharing behavior in virtual communities have often paid more attention to opinion leaders' offline innovation activities and users' individual online participation motivations [135–137]. Only a few scholars (e.g., Rogers and Cartano [40]) have examined the key role of opinion leaders in group knowledge-sharing behaviors. Following this theoretical stream, we further looked into a set of distinct opinion leaders' personal characteristics. The novel finding is that the transformation of opinion leader leadership to real knowledge-sharing behaviors (e.g., sharing more knowledge or joining more knowledge groups) was highly dependent upon these personal characteristics. We confirmed that opinion leaders' individual interactivity and authority were crucial to the growth of knowledge-sharing behaviors. In another dimension, however, we discovered that activity should be carefully exploited in knowledge-sharing stimulation campaigns. For outside users, the high activity of opinion leaders may cause a transfinite effect, inducing conflicting emotions and finally leading to negative outcomes.

Third, this work expands the scope of social capital theory. By extending traditional social capital theory to the online knowledge-sharing community context, we identified and conceptualized key dependent variables (i.e., online in-group and out-group knowledge-sharing engagement) that explained bonding and bridging social capital embedded in interpersonal network structures. Additionally, our findings contribute to enriching social capital theory by combining it with social exchange theory and leader–member exchange theory. Classical social capital metrics of opinion leaders (e.g., social network, social trust, and shared goals) have seldom been observed directly in other studies. While these types of implicit metrics were previously observable only through questionnaires or experimental designs, we used explicit measures that are available in online communities (i.e., opinion leaders' interactivity, authority, and activity) to serve as proxies. The explication of implicit constructs was enlightened by social exchange theory and leader–member exchange theory, which indicated that individuals want to maximize their social capital through interpersonal exchange in the social system. For example, opinion leaders exchange interactivity talent, authority, and actions to build a wide social network, gain social trust, and enhance people's understanding of a common goal. Thus, interactivity, authority, and activity metrics were reasonable proxies for the constructs of social network, social trust, and common goals. Social exchange theory and leader–member exchange theory offer an alternative for applying social capital theory in more wide-ranging research conditions, such as secondhand datasets. Based on the social capital framework, we further validated the positive role of opinion leaders' characteristics (interactivity and authority) in enhancing social capital at the group level (bonding social capital). Furthermore, concerning the inner logic between two types of social capital from the in–out perspective, we leveraged the data available in the new scenario to confirm and clarify the existing two-way link between bonding and bridging social capital, which uncovered a new relationship in the social capital domain.

6.3. Suggestions for the Sustainable Development of Online Knowledge-Sharing Communities

Based on the main empirical findings of this study, we make the following suggestions for managers to better attain the sustainable development of online knowledge-sharing communities through understanding and enhancing online group knowledge-sharing engagement.

First, our findings regarding the significant relationship between the responses of opinion leaders and users (i.e., sharing new knowledge and joining new groups) and between online in-group and out-group knowledge-sharing engagement strongly imply the possibility that managers could internally fortify effective knowledge-sharing community campaigns rather than seek external support (e.g., pay for followers or knowledge-sharing posts).

Second, our empirical results suggest that the characteristics of opinion leaders evoke different responses in different user groups, which means that neglecting the differences in the impact of opinion

leaders on in-group and out-group users could undermine the effectiveness of enhancing online knowledge-sharing outcomes through opinion leaders. Thus, managers should distinguish distinct target user categories and understand the contrasting effects of opinion leader characteristics on diverse users. For instance, opinion leaders' interactivity and authority would have more influence on existing in-group members, whereas those characteristics seem to have no significant effect on out-group users who lack intimacy with leaders. Additionally, opinion leaders' activity would diminish the willingness of out-group users to join the group but would not affect in-group members.

Third, from a practical standpoint, given that the influences of opinion leaders on online in/out-groups are contingent upon their characteristics, this suggests that managers should not devote the same attention to all types of opinion leaders. Rather, it would be more profitable for managers to develop clear phased tasks toward sustainable development and design unique opinion leader strategies for different goals. Specifically, if managers expect to encourage more in-group members to share new knowledge as a renewable productive factor with the potential to drive a more sustainable future, they should devote more effort to shaping opinion leaders with high authority and interactivity, because those leaders can enable in-group members to generate more knowledge-sharing posts. In addition, if managers want to achieve sustainable development through the other way, i.e., attracting new members from outside the group, they could increase the workforce of the group. Under this situation, highly active opinions should not appear on out-group users' pages due to a potential transfinite effect.

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