Multiple Pathways and Key Factors for Enhancing Debunking Information Dissemination Effectiveness: A Configurational Perspective

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Abstract

[Objective] To explore the configurational pathways and key influencing factors that enable rumor-refutation information to achieve high dissemination effectiveness in social media environments. [Method] Based on a configurational perspective, this study obtains rumor-refutation data from Sina Weibo and employs fuzzy-set Qualitative Comparative Analysis (fsQCA) to explore the formation pathways of high dissemination effectiveness and further analyze key factors. [Results] The results indicate that there are four configurational pathways capable of generating high dissemination effectiveness, with an overall coverage of approximately 46.1% across all pathways. The raw coverage of each pathway exceeds its unique coverage, and the consistency level of the overall solution is above 0.8. [Limitations] First, there are numerous factors influencing the dissemination effectiveness of rumor-refutation information, yet this study only considers a subset of these factors. Second, all data in this research are sourced from Sina Weibo, making it uncertain whether the conclusions are applicable to other social media platforms. [Conclusion] The study finds that pathways generating high dissemination effectiveness can be primarily summarized into three patterns (information-driven pattern, actor-driven pattern, and synergy-driven pattern). Information originality and richness are key factors in producing high dissemination effectiveness and play an indispensable role. Additionally, the equifinality among configurations can provide a theoretical explanation for inconsistent research findings in existing literature.

Full Text

Research on Multiple Paths and Key Factors for Promoting the Dissemination Effect of Rumor-Refuting Information from a Configuration Perspective

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Abstract

[**Objective**] This study explores the combination paths and key influencing factors that generate high dissemination effects for rumor-refuting information in social media environments.

[**Methods**] Based on a configuration perspective, this paper obtains rumor-refuting data from Sina Weibo and employs fuzzy-set qualitative comparative analysis (fsQCA) to investigate the formation paths of high dissemination effects and further analyze key factors.

[**Results**] The results show that four combined paths can produce high dissemination effects, with an overall coverage of approximately 46.1% across all paths. The raw coverage of all paths exceeds their unique coverage, and the consistency level of the overall solution surpasses 0.8.

[**Limitations**] First, numerous factors affect rumor-refuting information dissemination effects, but this paper only considers some of them. Second, since all data originate from Sina Weibo, the generalizability of these conclusions to other social media platforms remains uncertain.

[**Conclusions**] The study finds that paths producing high dissemination effects can be summarized into three modes (information-driven mode, agent-driven mode, and collaborative-driven mode). Information originality and richness are key factors indispensable to achieving high dissemination effects. Additionally, equivalence between configurations can provide theoretical explanations for inconsistent research conclusions in existing literature.

Keywords: Rumor-refuting information, High dissemination effect, Influencing factors, Fuzzy-set qualitative comparative analysis

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In recent years, when major man-made accidents or natural disasters and other emergencies occur, accompanying online rumors have emerged endlessly and spread rampantly, seriously disrupting normal social order. As an important tool for information exchange, social media has further accelerated the spread of rumors due to its low access threshold, imperfect review mechanisms, and strong network externalities [1]. Although governments and mass media, as the

main actors in online rumor refutation [2], release refuting information through various channels, the dissemination effect of such information on social media is often inferior to that of rumors themselves, leading to the phenomenon that "a rumor spreads with a single mouth, but refuting it takes legs running off." This makes it difficult to achieve the desired refutation effect. Therefore, improving the dissemination effect of rumor-refuting information in the "competition" with rumor spread is of great significance for public sectors such as governments and mass media to prevent and govern online rumors, and clarifying the key factors influencing the dissemination effect of rumor-refuting information constitutes an important step in this process.

Existing research identifies two categories of key factors affecting rumor-refuting information dissemination effects: source characteristics and information characteristics [3-5]. However, inconsistent conclusions exist regarding the effects of these key factors. For example, some studies suggest that source authority promotes the dissemination of rumor-refuting information [4,6-7], while others find that the relationship between authority and dissemination effect is not significant [8] or even produces negative effects [9]. Moreover, existing research primarily uses variance-based models to explore the "net effects" of key factors on rumor-refuting information dissemination effects, ignoring the interdependent relationships among factors and limiting overall explanatory power. Therefore, based on source characteristics (including influence and authority) and information characteristics (including vividness, originality, richness, and elaborateness) proposed in existing research, this paper adopts a configuration perspective and employs fuzzy-set qualitative comparative analysis (fsQCA) to explore the impact of multi-factor combinations on high dissemination effects of rumor-refuting information, thereby determining the combination paths that influence rumor-refuting dissemination effects. This method helps explain inconsistent findings in existing literature and, by examining the "mixed effects" of factor combinations rather than individual "net effects," addresses complex causal problems with multiple concurrent factors [30].

2.1 Related Research on the Dissemination Effects of Rumor-Refuting Information

Rumor-refuting information refers to information that, after a rumor has spread, aims to reduce the harm caused by the rumor by citing solid evidence to refute and correct it [10]. Whether the release of rumor-refuting information can achieve the purpose of clarifying the truth and blocking the spread of rumors depends on its dissemination effect. The dissemination effect of rumor-refuting information refers to the scope and breadth of its spread, without involving impacts on audience psychology, emotions, or attitudes, and is generally measured through the number of comments, forwards, and likes [11-14]. Current research on the dissemination effects of rumor-refuting information primarily categorizes influencing factors into two aspects: source characteristics and information characteristics.

Source characteristics primarily involve two dimensions: source influence and authority. Source influence refers to the scope and degree of impact that information published by an information 主体 can exert, and its magnitude is mainly measured through indicators such as number of followers, posts, and followings [5,15]. Some scholars have pointed out that source influence is an important factor affecting the dissemination of rumor-refuting information [16]. For example, Wang et al. studied the dissemination effect of Weibo rumor-refuting information during the COVID-19 pandemic based on the ELM model and found that source influence had a significant positive effect [9]. Li et al. constructed a Social Media Rumor-Refuting Information Effectiveness Index (REI), in which user influence played a very important promotional role [17]. Source authority refers to a social status obtained by individuals through educational background, personal experience, professional knowledge, talent, and other characteristics [18], and its magnitude is mainly determined by the identity characteristics of the 主体 [19]. Some studies have pointed out that government health departments, social media platforms, and expert sources are generally considered to have high authority, which can promote the dissemination of health-related rumor-refuting information and achieve the purpose of correcting health information rumors [20]. However, other studies have indicated that the relationship between source authority and dissemination effect is not significant [8], or even produces negative effects [9].

Information characteristics mainly refer to the vividness, originality, richness, and elaborateness of information content. Vividness refers to whether the presentation method of information content is lively. Some scholars have pointed out that rumor-refuting information containing images or videos has better dissemination effects compared to pure text information [21-23]. Originality refers to whether the Weibo content is created by the user themselves. Chen Juan et al., taking the top ten government Weibo accounts as research subjects, found that whether content is original has a significant impact on both the forwarding and comment numbers of rumor-refuting information [24]. However, some studies have shown that whether information is original does not significantly affect dissemination effect [25-26]. Richness refers to whether information content contains multiple text organization methods. On social media, people often use #, @, and other symbols to increase the richness of text content organization forms. Shi et al. studied the influencing factors of Twitter users' forwarding behavior using the number of URLs and # symbols as measurement indicators for information text richness [27]. Xie Nan, based on the ELM model, found that whether containing @ symbols has a significant impact on the emotional level of dissemination effect, but no obvious impact on cognitive and behavioral levels [28]. Elaborateness refers to the text length of information content. Yi Ming et al., based on the three elements of popularity theory, studied the impact of Weibo text characteristics on dissemination effect and found that text length significantly affected the comment and forwarding numbers of rumor-refuting information [29]. However, longer texts also mean that audiences need to invest more time costs and cognitive resources, which can easily cause reading annoy-

ance and fatigue, thus being detrimental to information dissemination [15,25].

2.2 Research Review

Existing research on the influencing factors of rumor-refuting information dissemination effects provides a good reference for this paper, but still has certain limitations. First, existing studies have inconsistent conclusions regarding the effect of the same factor. For example, factors such as authority, originality, and elaborateness have been found to promote the dissemination effect of rumor-refuting information in some studies, while other studies have found they have no effect or even a negative effect on dissemination. However, existing research lacks reasonable explanations for this.

Second, existing literature either only studies the impact of a single factor, resulting in insufficient overall explanatory power [12], or uses traditional variance-based models such as mathematical statistics and regression models to study the "net effects" of multiple factors on rumor-refuting information dissemination effects, ignoring the interdependent relationships between variables and possible "chemical reactions" [30], and thus cannot solve complex causal problems with multiple concurrent factors.

2.3 Research Questions

Based on the review of existing literature, this paper proposes the following three research questions: (1) What are the combination paths that lead to high dissemination effects of rumor-refuting information? (2) What are the key factors influencing high dissemination effects of rumor-refuting information? (3) How can we understand and explain the phenomenon that some factors have inconsistent effects on rumor-refuting information dissemination effects in existing literature?

To answer these research questions, this paper constructs an analytical framework for the influencing factors of rumor-refuting information dissemination effects from two aspects—source and information characteristics—based on a configuration perspective (as shown in Figure 1 [Figure 1: see original paper]). Using rumor-refuting information on the Weibo platform as the data source, this study employs the fuzzy-set qualitative comparative analysis (fsQCA) method to explore the impact of multi-factor combinations on high dissemination effects of rumor-refuting information, thereby determining the combination paths that influence rumor-refuting dissemination effects. This method helps understand inconsistent results in existing literature by identifying different combination paths that achieve high dissemination effects. Simultaneously, based on a holistic analytical perspective, this method treats research objects as configurations of different combinations of conditional variables. Instead of studying the "net effect" of individual influencing factors, it examines the "mixed effect" of all factor combinations, thus helping to answer complex causal problems with multiple concurrent factors [30].

3.1 Research Method

Qualitative Comparative Analysis (QCA) is a method first proposed and developed by sociologist Charles C. Ragin in 1987 [31]. Based on holism, this method combines set theory and Boolean algebra, adopting a configuration perspective to analyze cases. It views cases as wholes composed of causal conditions and thus focuses on the complex causal relationships between condition configurations and outcomes [30]. QCA based on a configuration perspective can fundamentally avoid many endogeneity shortcomings of traditional regression research methods when solving complex problems such as multiple concurrent causes, multiple equivalent solutions, and causal asymmetry [32]. First, because QCA is based on causal asymmetry—that is, the reasons for the occurrence and non-occurrence of a result are different and need to be analyzed separately—it can avoid reverse causality problems. Second, because QCA is based on Boolean algebra and studies set relationships rather than correlation relationships, there is no omitted variable bias problem [33-34], thus avoiding omitted variable bias. Finally, QCA' s abductive reasoning and set analysis do not rely on random sampling techniques, thus avoiding sample selection bias problems caused by random sampling [32].

Currently, QCA mainly includes four analytical methods: crisp-set QCA (csQCA), multi-value QCA (mvQCA), fuzzy-set QCA (fsQCA), and time-series QCA (TQCA) [35]. This study adopts fuzzy-set qualitative comparative analysis (fsQCA) based on the following three considerations. First, the quality of information dissemination effects is often not determined by a single factor but by the combined effect of multiple factors. Second, existing research has inconsistent or contradictory findings regarding the effects of factors, and the QCA method has good explanatory power for this [36]. Third, the paths to achieving high dissemination effects are not unique, and there may be multiple equivalent causal chains in the process of producing high dissemination effects. Finally, since most causal variables involved in this study are continuous variables with degree changes and partial membership problems, fsQCA is suitable for adoption.

3.2 Data Collection

This paper uses the Sina Weibo platform as the data source, searching with the keywords "Weibo rumor refutation" and "rumor refutation," and then collects relevant data through web crawling. The data collection period was set from January 1, 2022, to May 21, 2022, with data obtained on May 26, 2022. The collected content mainly includes two parts: publisher personal information and published content-related information. The former includes user nickname, ID, number of followers, verification type, membership verification, etc., while the latter includes information content, publication time, image address, number of forwards, number of comments (excluding comment content), and number of likes, etc., with a total of 236 data items collected. After data cleaning and preprocessing, removing invalid, duplicate, blank, and other data, 156 data

items were used for the final analysis.

3.3 Variable Measurement

(1) Outcome Variable

Dissemination Effect

This paper takes the dissemination effect of rumor-refuting information as the outcome variable. Dissemination effect mainly reflects the scope and breadth of rumor-refuting information after its release. This paper measures it primarily through indicator data such as user forwards, comments, and likes. Considering that different indicators contribute differently, this study borrows the comprehensive influence formula obtained through the entropy weight method [12] for calculation. The specific formula is as follows:

$$\text{辟谣信息综合效果} = 0.299513 \times \text{转发数} + 0.308966 \times \text{评论数} + 0.391522 \times$$

(2) Conditional Variables

Influence

Influence mainly reflects the attention received by the source and its own activity level. The influence of a dissemination 主体 is generally measured by the number of followers and posts, where the number of followers reflects the publisher' s attention level on the platform, and the number of posts reflects the publisher' s activity level [15]. Therefore, this paper uses the number of followers and posts as measurement indicators for the influence of rumor-refuting 主体, with indicator weights referenced from existing literature [15]. The specific formula is as follows:

$$\text{辟谣主体影响力} = 0.763 \times \text{粉丝数} + 0.237 \text{力发博数}$$

Authority

Authority mainly reflects the professionalism and reliability of the source, generally assessed through the identity characteristics of the 主体 [19]. Based on previous research [9], this paper divides source authority into five different levels and assigns values according to the level height, uniformly taking the right endpoint of the interval. For example, all cases belonging to the interval [1,1.5] are assigned a value of 1.5, and all cases belonging to the interval [1.5,2] are assigned a value of 2. The specific scoring criteria are shown in Table 1 .

Elaborateness

Elaborateness mainly reflects the comprehensiveness and detailed degree of information content. Generally, text length is positively correlated with the amount of information it can convey. The longer the rumor-refuting information, the richer its content, which helps users comprehensively and thoroughly understand the truth and triggers their commenting and forwarding behaviors [12,29]. Therefore, this paper uses Weibo text length as the indicator to measure the elaborateness of rumor-refuting information.

Vividness

Vividness mainly refers to the presentation method of information content. Compared with pure text information, adding images to Weibo content or directly using video formats to publish information can enrich the dimensions of information expression, increase the possibility of audience participation and interaction, and help improve information dissemination effects [15]. Therefore, this paper assigns pure text information a value of 0.33, information containing images a value of 0.67, and information containing videos a value of 1.

Richness

Richness mainly reflects the diversification degree of text content organization methods. On social platforms such as Weibo, WeChat, and short videos, people often use # tags to organize text content and establish topics related to the published content. Through the @ symbol, Weibo users can form effective linkages with other accounts, thereby expanding the scope of information dissemination. Therefore, this paper assigns information containing neither # nor @ symbols a value of 0.33, information containing either symbol a value of 0.67, and information containing both # and @ symbols a value of 1.

Originality

Originality mainly refers to whether information content is created by the user themselves. Since creating original Weibo posts requires users to invest certain time and effort, it can to some extent represent the authenticity and reliability of the content. Compared with directly forwarding others' Weibo posts, original Weibo posts express the blogger's own viewpoints and attitudes, making it easier to trigger user commenting, forwarding, and liking behaviors [24]. Therefore, this paper assigns original rumor-refuting information a value of 1 and non-original information a value of 0.

3.4 Data Calibration

Data calibration is a very important step in fuzzy-set qualitative comparative analysis, as it can transform variable data into membership scores between [0,1] for the target set. Membership scores represent the degree to which different samples belong to a certain set, typically including three states: full membership, partial membership, and full non-membership. The closer the membership score is to 1, the stronger the membership relationship; the closer to 0, the weaker the membership relationship, with 0.5 being the maximum fuzzy point.

In fsQCA, there are generally two methods for data calibration: direct calibration and indirect calibration. Direct calibration requires setting three anchors in the data calibration process: full membership point, crossover point, and full non-membership point. Indirect calibration, also called the assignment method, refers to researchers achieving calibration by assigning values to variables. This paper comprehensively adopts both direct and indirect methods for data calibration, where "vividness," "richness," and "originality" are calibrated using the indirect method, while the remaining variables are continuous variables cal-

ibrated using the direct method. Based on previous research results and combined with the actual situation of this study, this paper sets the three anchors at 0.95, 0.5, and 0.05, respectively. The calibration methods and anchor points for each variable are shown in Table 2 .

4.1 Necessity Analysis of Individual Antecedent Conditions

Before conducting configuration analysis, fuzzy-set qualitative comparative analysis (fsQCA) requires a necessity test of antecedent variables to analyze whether each conditional variable can individually serve as a necessary condition for the occurrence of an event. If a variable is a necessary condition, it must be included in the combination path. The judgment of necessary conditions is mainly obtained through the consistency of antecedent variables on the outcome variable. A consistency higher than 0.8 can be considered a sufficient condition for the event occurrence, and higher than 0.9 can be considered a necessary condition [37]. As shown in Table 3 , the consistency of all antecedent variables is less than 0.9, indicating that no single conditional variable can independently lead to the occurrence of the outcome variable. Therefore, this shows that the dissemination effect of rumor-refuting information is jointly affected by multiple factors, and it is necessary to further analyze different configurations of antecedent variables to determine which configurations can lead to higher dissemination effects.

4.2 Sufficiency Analysis of Condition Combinations

Based on data calibration, this study uses fs/QCA 3.0 software to construct a truth table and analyze different combination paths for rumor-refuting information dissemination effects. fsQCA analysis can typically yield three types of solutions: complex solution, intermediate solution, and parsimonious solution. The complex solution does not incorporate any logical remainders, does not simplify configurations, and yields relatively complex results. The parsimonious solution incorporates all logical remainders, has relatively loose conditions, and easily produces results that contradict theory and reality. The intermediate solution only incorporates logical remainders consistent with expectations, has moderate complexity, and is generally considered the best choice for reporting and interpretation in QCA research [38]. Therefore, this paper selects the intermediate solution for combination path analysis, sets the raw consistency threshold at 0.75, the case frequency threshold at 1 (typically retaining at least 75% of all cases after thresholding [38]), and the PRI threshold at 0.5 [39-40] (Greckhamer et al. point out that configurations with PRI scores below 0.5 show obvious inconsistency [41]). Core conditions are identified through nested comparison of intermediate and parsimonious solutions: conditions appearing in both intermediate and parsimonious solutions are core conditions, while conditions appearing only in the intermediate solution are peripheral conditions [30]. The analysis results are shown in Table 4 .

In the analysis results, raw coverage represents the proportion of cases among

all cases that can be explained by a given path, typically used as an indicator to measure the explanatory power of conditional paths on the outcome. Unique coverage represents the proportion of cases among all cases that can only be explained by a given path, which can also be understood as net explanatory power [42]. Consistency represents the degree to which all cases included in the analysis share a given condition (or combination of conditions) that leads to the outcome [43]. According to the data in the table, there are four combination paths that can produce high dissemination effects. The overall coverage of all paths is about 46.1%, indicating that they can explain approximately 46.1% of cases. The raw coverage of all paths is higher than the unique coverage, indicating that multiple causal relationships indeed exist among cases. The consistency level of each path exceeds 0.8, indicating that each condition combination can be considered a sufficient condition for high dissemination effects of rumor-refuting information. Moreover, the consistency level of the overall solution is also higher than 0.8 [44], further satisfying the sufficient consistency level.

4.3 Combination Path Analysis

Further analysis of the combination paths in the table reveals that they can be summarized into three modes: content-driven mode (paths H1 and H2), subject-driven mode (path H3), and collaborative-driven mode (path H4).

(1) Information-Driven Mode
This mode is primarily driven by information characteristic factors. That is, in this type of mode, the core conditions that exist are mainly related to information characteristics, while source-related characteristics are not necessary conditions. In other words, audiences mainly make judgments and provide corresponding feedback based on information characteristics. This mode mainly includes paths H1 and H2. Path H1 has core conditions of elaborateness and vividness, with auxiliary conditions of richness and originality. Path H2 has a core condition of originality, with an auxiliary condition of richness.

The information-driven mode indicates that when rumor-refuting information content is elaborate and vivid or original, high dissemination effects can still be achieved even if the information publisher has relatively small influence and insufficient authority. Some scholars have found that although Sina Weibo has a strong "celebrity effect," ordinary users can still gain attention through other means [45]. Specifically, users can increase the exposure and attention of rumor-refuting information by publishing content in the form of images or videos, using # and @ symbols to expand information dissemination scope, elaborating on event details to help audiences learn more, creating original content instead of forwarding others' Weibo posts, and other methods, thereby enhancing information dissemination effects. For example, in sample cases such as "Dr. Li Qing," "Xi Zhengze," and "Laiqu Zhijian," although user influence and authority were relatively small (ordinary users with fewer than 800,000 followers), by publishing original videos with detailed explanatory text and @ other influential users, they similarly attracted large amounts of attention and discussion from

netizens, with popularity even far exceeding many official accounts with millions of followers, producing high dissemination effects.

(2) Subject-Driven Mode

This mode is primarily driven by factors related to rumor-refuting information publishers. That is, in this type of mode, the core conditions that exist are mainly source-related attribute characteristics (such as source influence), while information-related characteristics only play auxiliary roles. This type of mode includes path H3, whose core condition is source influence, with auxiliary conditions of content vividness, richness, and originality.

The subject-driven mode indicates that when the rumor-refuting information publisher has sufficiently large influence and the content possesses certain vividness, richness, and originality, high dissemination effects can still be achieved even if their own authority is relatively low and the content is relatively brief. As the first person to release information, the rumor-refuting subject's own influence has a very important impact on the dissemination of information content. Generally, the greater the influence of the subject, the wider the dissemination scope of the information they release, and the more they can attract attention, forwards, and comments about the event from more people. We generally call such Weibo accounts with relatively large influence "opinion leaders" —individuals or groups that can guide the development direction of events to a certain extent by virtue of their powerful influence [46]. For example, Global Times, Observer Network, and other online influencers with tens of millions of followers can cause large numbers of netizens to watch and discuss any message they release, generating high public opinion heat. Compared with some specialized Weibo rumor-refuting accounts, rumor-refuting information released by such influential subjects can obviously attract more public attention and thus achieve better dissemination effects.

(3) Collaborative-Driven Mode

This mode results from the joint action of both information characteristics and source characteristics. That is, in this type of mode, the core conditions that exist include both information-related features and source-related features, with the synergistic effect of both jointly enhancing the dissemination effect of rumor-refuting information. This type of mode mainly includes path H4, in which all antecedent conditions affecting the dissemination effect of rumor-refuting information are core conditions.

The collaborative-driven mode indicates that when user influence and authority are relatively high, and the content has good vividness, richness, originality, and elaborateness, high dissemination effects can be produced. In addition, the raw coverage and unique coverage of this path are also the largest among all paths, indicating that when all antecedent conditions are satisfied, the dissemination effect of rumor-refuting information can undoubtedly be maximized. In fact, the processes through which information characteristics and source characteristics exert influence are not isolated from each other. In addition to playing their respective roles and functions, the superposition effect between them further

amplifies information dissemination effects. For example, in research cases such as "Torch of Thought," "Orient Network," and "Weibo Rumor Refutation," the information publishers themselves are official authoritative accounts with relatively large influence, and the content is mostly presented in image/video formats with detailed text descriptions, includes one or more # tags, and uses @ symbols to interact with other Weibo influencers, forming a linkage effect that can disseminate rumor-refuting information on a larger scale.

4.4 Robustness Check

Common robustness test methods for QCA mainly include adjusting calibration thresholds, changing consistency threshold values, and case frequency [47]. This paper first adjusts the consistency threshold from 0.75 to 0.80 while keeping case frequency unchanged for re-analysis, and the test results are consistent with the original results. Then, adjusting case frequency from 1 to 2 changes the number of combination paths from 4 to 3, but the results have a clear subset relationship with the previous paths, with consistent internal explanatory mechanisms, only showing slight differences in coverage and consistency (coverage decreases from 46.1% to 44.9%, consistency decreases from 82.2% to 82%, see Table 5). The robustness test results show basically consistent findings.

5.1 Configuration Patterns for High Dissemination Effect of Rumor-Refuting Information

The configuration patterns for rumor-refuting information to produce high dissemination effects mainly include three types: information-driven mode, subject-driven mode, and collaborative-driven mode. The information-driven mode takes information characteristics as the core existing conditions, with source characteristics not being necessary conditions. This mode mainly emphasizes the decisive impact of vividness in information presentation, elaborateness of information content, richness of text organization methods, and whether the post is original on producing high dissemination effects. The subject-driven mode takes source characteristics as the core existing conditions, with information characteristics playing auxiliary roles. This mode mainly relies on the source' s own powerful influence to achieve high dissemination effects, with information presentation form, content detail level, text organization method, and originality only playing auxiliary functions. The collaborative-driven mode simultaneously takes both information characteristics and source characteristics as core existing conditions, requiring both that information content has vividness, elaborateness, richness, and originality, and that the source possesses powerful influence and high authority. This mode can fully exert the influence of both information and source aspects, producing synergistic effects, and thus has higher coverage and consistency than the other two modes.

5.2 Analysis of Key Factors Affecting Dissemination Effect

For the combination paths that produce high dissemination effects, originality and richness are very important constituent elements, while source authority shows relatively low necessity for existence. In all combination paths, originality and richness either exist as core conditions or as peripheral conditions, obviously playing an indispensable role in producing high dissemination effects. However, except for path H4, authority either appears as a missing core condition or a missing peripheral condition in the remaining paths, generally having little influence or even a certain negative effect. The possible reasons for the above results are as follows.

First, as a means of actively clarifying facts and eliminating misunderstandings to the public, online rumor refutation is mostly released by local government Weibo accounts and mass media targeting rumors circulating locally, with only a few specialized rumor-refuting Weibo accounts forwarding others' refuting information. Therefore, most rumor-refuting information is original. Second, # and @ symbols, as one of the most popular text organization methods on current social media, can expand content dissemination scope and accelerate information dissemination speed. Therefore, most people include # or @ symbols when editing content to expand influence scope. Finally, due to the influence of "psychological reactance," people hold skeptical attitudes or even serious resistance toward some government departments or authoritative experts [48], thus affecting the wide dissemination of rumor-refuting information to a certain extent. Therefore, authority appears as missing in most paths.

5.3 Explanation Mechanism for Inconsistent Conclusions in Existing Research

The formation paths for rumor-refuting information to produce high dissemination effects are not unique, and different paths have equivalence. Equivalence means that multiple paths exist to achieve the same result [36], that is, "all roads lead to Rome." Equivalence between configurations helps people understand phenomena where certain influencing factors have inconsistent effects [36]. Combined with real-world observations, we can find that rumor-refuting information dissemination effects do not depend on a single factor but are simultaneously affected by the joint influence of multiple factors. In some situations, a certain factor can play a leading role, while in other situations, it no longer plays a leading role but can only play an auxiliary role, or even does not need to exist at all. For example, richness exists as a core condition in path H4, but as a peripheral condition in paths H1, H2, and H3. Vividness exists as a core condition in H1 and H4, as a peripheral condition in path H3, but as a missing core condition in path H2. Authority exists as a core condition in path H4, as a missing peripheral condition in path H2, and as missing core conditions in paths H1 and H3. That is to say, the combination paths that can produce high dissemination effects are diverse, and the role and function played by a cer-

tain factor differ across different paths or are unnecessary. Therefore, although multiple different paths can produce high dissemination effects, the same factor plays different roles and functions in different paths, even contradictory ones. It is precisely these differences or contradictions that lead to inconsistent research conclusions in existing literature.

6 Research Implications

Theoretically, first, this study systematically reviews relevant domestic and foreign literature on influencing factors of rumor-refuting information dissemination effects from two aspects—information content and source characteristics—identifies their shortcomings, and studies the combination paths leading to high dissemination effects of rumor-refuting information based on a configuration perspective, thereby expanding and supplementing related research on rumor-refuting information dissemination effects and providing a new theoretical perspective. Second, this study uses fsQCA to identify four combination paths affecting high dissemination effects of rumor-refuting information and summarizes three driving modes. Through analysis of these three driving modes, it clarifies the key factors influencing high dissemination effects of rumor-refuting information and provides certain theoretical explanations for inconsistent conclusions in existing literature.

Practically, the research results of this paper can provide certain theoretical references and guidance suggestions for public sectors such as government agencies and mass media to improve the dissemination effects of rumor-refuting information, helping to block the serious harm caused by online rumor spread. First, user influence is an important condition for rumor-refuting information to produce high dissemination effects. Therefore, government Weibo accounts should attract people's attention by publishing high-quality content, increase the number of followers, strive to enhance their own visibility, and shape powerful influence. Second, as the main channel for releasing authoritative information, government Weibo accounts should, while ensuring information authenticity and reliability, adopt colloquial language to express content, appropriately reduce the intensity of rumor refutation, and actively narrow the distance with audiences [49] to offset the negative effects of "psychological reactance." Third, with the rise of short videos, more and more people tend to rely on vivid, interesting, and effortless methods such as images/videos to obtain information. Therefore, government Weibo accounts should follow the trend of the times, adopt short videos and image-text combinations to release rumor-refuting information, and reduce users' cognitive load and time costs when receiving information. Finally, to further expand information dissemination scope, government Weibo accounts should also strengthen interaction and connections with other government Weibo accounts, mass media, and influencer users through # and @ symbols, establish an information dissemination matrix, and form a "1+1>2" superposition dissemination effect.

This paper takes two key types of factors affecting rumor-refuting information

dissemination effects (i.e., source characteristics and information characteristics) as research objects. First, it systematically reviews existing domestic and foreign literature from two aspects—source characteristics and information characteristics—identifies shortcomings in existing research, and proposes a research framework based on a configuration perspective. Then, it crawls rumor-refuting information data from the Sina Weibo platform as research samples, cleans the data, measures corresponding variables, and obtains the analysis dataset. Finally, it uses the fsQCA method for configuration analysis and obtains three driving modes that produce high dissemination effects: the information-driven mode with information characteristics as core existing conditions, the subject-driven mode with subject characteristics as core existing conditions, and the collaborative-driven mode with both information characteristics and subject characteristics as core existing conditions. Simultaneously, research results also find that information originality and richness are very important factors for rumor-refuting information to produce high dissemination effects, playing an indispensable role. This paper provides a new theoretical perspective for understanding high dissemination effects of rumor-refuting information theoretically, while also providing certain guidance suggestions for improving rumor-refuting information dissemination effects.

This paper still has certain limitations. First, there are many factors affecting rumor-refuting information dissemination effects, and this paper only selects some objective factors from two dimensions—source and information content—for analysis, without involving subjective factors such as audience psychology, emotions, and attitudes. Therefore, it does not completely explain the influencing mechanism of rumor-refuting information dissemination effects. Future research should combine specific content of user comments to analyze emotional tendencies, attitude changes, and other actual impact effects contained therein. Second, in terms of research object selection, all data in this paper comes from Sina Weibo. Therefore, it is difficult to determine whether the research conclusions are applicable to the dissemination effects of rumor-refuting information on other social media platforms (such as WeChat). Future research should sample from multiple platforms and conduct comparative analysis of combination paths of influencing factors for rumor-refuting information dissemination effects across multiple platforms.

Author Contribution Statement:

Yang Renbiao: Theoretical construction, data acquisition and analysis, initial draft writing and revision
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Note: Figure translations are in progress. See original paper for figures.