

Unraveling the dark side of Danmaku: The effects of aggressive Danmaku and original work's attributes on condensed clips' performance

Bingqing Xiong^a, Fangfang Hou^{b,*}, Chee-Wee Tan^c, Hao Liu^a

^a Deakin Business School, Deakin University, 221 Burwood Hwy, Burwood, VIC 3125, Australia

^b International Business School Suzhou, Xi'an Jiaotong-Liverpool University, 111 Ren'ai Road, Suzhou Industrial Park, Suzhou, Jiangsu, China

^c Department of Management and Marketing, Faculty of Business, The Hong Kong Polytechnic University, M1016, Li Ka Shing Tower, Hong Kong, 999077, China

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ABSTRACT

Condensed clips have emerged as a novel form of user-generated content (UGC), offering a compelling and concise alternative to traditional full-length movies. While *Danmaku* in condensed clips enrich the co-viewing experience, they also induce moral disengagement due to anonymity, leading to aggressive behaviors in the likes of insults, obscenity, and profanity in the comments. Grounded in Cognitive Dissonance Theory (CDT), this study investigates the detrimental effects of aggressive *Danmaku* on the performance of condensed clips and explores the moderating role of the original work's attributes. Through an empirical analysis of a large-scale dataset, we demonstrate that a high proportion or intense concentration of aggressive *Danmaku* can negatively impact video performance. Furthermore, the reputation of the original work amplifies the negative effects of the proportion of aggressive *Danmaku* while reducing the impact of its concentration. In contrast, the nostalgic appeal of the original work intensifies the detrimental effects of both the proportion and concentration of aggressive *Danmaku* on video performance. Additionally, we conducted two post-hoc analyses: one to explore the existence of potential nonlinear relationships, and another to capture the diverse forms of aggressive *Danmaku* based on content and style. This study contributes to extant literature on cyber aggression and viewer behavior in consuming condensed clips, highlighting the dark side of *Danmaku* on video performance as well as yielding practical insights for UGC platforms and content creators.

1. Introduction

Condensed clips, also known as recap videos, have rapidly emerged as a novel form of user-generated content (UGC), offering a compelling, time-efficient alternative to traditional full-length media content [1]. For instance, prominent recap channels on YouTube have amassed millions of subscribers and generated hundreds of millions of views [2]. As derivative works, condensed clips are crafted by content creators who distill the core essence of the original work (e.g., a movie) into a shorter, more digestible format. These clips typically extract and present central storylines, key moments, and/or memorable scenes from the original work in a concise fashion that captures viewer attention. Beyond summarization, it is also common for creators to embed commentary, humor, and/or personal insights that aids in offering fresh interpretation of the original work [3]. This emerging genre of UGC introduces a creative and refreshing approach to content consumption, enabling

audiences to engage with media content in a focused and time-sensitive manner. Condensed clips of popular classics, in particular, provide even familiar audiences with a renewed viewing experience, making them a distinctive and impactful form of media consumption in today's digital landscape.

With the growing popularity of condensed clips, studies have sought to elucidate their impact on demand for original works [1,3]. Yet, the complex dynamics of viewer interaction in condensed clips remain relatively underexplored with audiences desiring an interactive co-viewing experience that promotes conversation and shared interpretation. The integration of *Danmaku* supports this purpose by allowing simultaneous content consumption and social engagement [4]. *Danmaku*, also known as bullet comments, is an interactive feature that facilitates dynamic viewer engagement by enabling instantaneous commentary that appears as overlay text, culminating in an environment where participants can seamlessly share reactions. It thereby

* Corresponding author

E-mail addresses: b.xiong@deakin.edu.au (B. Xiong), Fangfang.Hou@xjtlu.edu.cn (F. Hou), chee-wee.tan@polyu.edu.hk (C.-W. Tan), hao.liu@deakin.edu.au (H. Liu).

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transforms traditionally passive content consumption into an engaging co-viewing experience [4,5]. However, *Danmaku*'s content-synchronous and fast-scrolling format limits one's ability to prevent, trace, or respond to harmful comment. In turn, the *Danmaku* format may inadvertently foster a heightened propensity for cyber aggression compared to conventional forms of online communication, where interactions are often content-asynchronous and more preventable [6]. The emergence of *Danmaku* hence presents a paradox: while it bolsters viewer engagement, it simultaneously introduces new avenues for aggression.

Although contemporary research has alluded to the positive effects of *Danmaku*, including advertising effectiveness and increased engagement [4,5,7], its negative consequences remain far less explored in comparison. Studies on cyber aggression have mainly examined its causes [6,8–10] and their impact on individuals, such as social withdrawal [6]. Nevertheless, despite the widespread usage of *Danmaku* to boost viewer engagement, little is known about how aggressive messages conveyed through *Danmaku* (hereafter referred to as aggressive *Danmaku*) affect collective audience responses. To this end, this study delves into the adverse impact of aggressive *Danmaku* on the performance of condensed clips based on Cognitive Dissonance Theory (CDT). According to CDT, individuals experiencing conflicting cognitions often exhibit behavioral changes to alleviate the dissonance [11]. In the context of condensed clips, the integration of *Danmaku* enables viewers to engage with viewed content while concurrently participating in dynamic commentary, fostering expectations of enriching and meaningful co-viewing experience [2]; but at the same time, the presence of aggressive *Danmaku* may generate dissonance between viewers' anticipated and actual experiences. This leads to our first research question: **How does aggressive *Danmaku* affect the performance of condensed clips?**

Additionally, because condensed clips are derived inherently from original works [1,3], their appeal often stems from viewers' emotional and informational attachment to those originals [12,13]. For example, it is not uncommon to find viewer comments on condensed clips stating that “*I am immersed in wonderful memories while watching*”, “*I enjoy revisiting old movies and always gain new insights*”, and “*This movie is so famous*”. This in turn exemplifies the nostalgia and recognition associated with original works. Conceivably, the original work serves as a backdrop to condensed clips, which may act as contextual factors that can further shape viewers' expectations of their co-viewing experience. This indicates that the extent to which viewers experience cognitive dissonance when exposed to aggressive commentary may vary depending on their emotional and informational attachment to the original work. Accordingly, we take into account the role of nostalgic appeal and the reputation of original works to capture both emotional and informational dimensions of content consumption associated with the original works. Particularly, viewers, who are drawn to condensed clips due to the nostalgic appeal of the original work, are likely to expect an emotionally resonant atmosphere imbued with nostalgic feelings, reflected in a warmer and more reflective co-viewing experience [14–16]. Conversely, viewers attracted by the original work's reputation may expect an atmosphere with greater informational value, anticipating a more insightful and meaningful co-viewing experience [17,18]. Hence, when the original work possesses these two attributes, viewers' elevated expectations may increase their sensitivity to commentary that deviates from these expectations. This leads us to our second research question: **How do nostalgic appeal and the reputation of original works influence the effects of aggressive *Danmaku* on the performance of condensed clips?**

To answer the preceding research questions, we analyze a large-scale dataset, including 20,030 condensed clips, 10.4 million associated *Danmaku* comments, and corresponding information about the original works. We specifically focus on two focal dimensions of aggressive *Danmaku*: its proportion relative to the total volume and its concentration within the distribution. Proportion denotes the overall prevalence of aggressive content, offering insights into the general tone of the

viewing environment. In contrast, concentration captures the extent to which aggressive *Danmaku* are clustered, distinguishing between dispersed instances and concentrated bursts of aggression. Empirical findings reveal that both a high proportion and intense concentration of aggressive *Danmaku* negatively affect video performance. In turn, these relationships are moderated by the nostalgic appeal and reputation of the original work: whereas nostalgic appeal amplifies the negative effects of both proportion and concentration, reputation intensifies the impact of proportion but mitigates that of concentration. Additionally, we conducted two post-hoc analyses. Whereas the first elucidates how the effects of aggressive *Danmaku* differ across varying proportion and concentration, revealing nonlinear dynamics, the second sheds light on the impact of diverse forms of aggressive *Danmaku* by delineating it along two novel dimensions: content (cathartic vs. directed) and style (memetic vs. non-memetic).

Findings from this study contribute to extant literature on several fronts. First, it advances research on cyber aggression by capturing its manifestation through *Danmaku* along the dimensions of proportion and concentration, delineating when and how it undermines outcomes in co-viewing environments through bounded, non-linear dynamics. Second, it extends *Danmaku* research by offering a nuanced understanding of aggressive *Danmaku*, differentiating it by content and style. Third, it advances our knowledge of the boundary conditions of cyber aggression in condensed clip consumption by showcasing how attributes of the original work (i.e., nostalgic appeal and reputation) shape viewer responses. Finally, we extend CDT beyond individual cognition to collective responses, highlighting the role of contextual conditions in further shaping dissonance.

2. Theoretical background and hypotheses development

2.1. Cyber aggression

The anonymous and open nature of online environments facilitates moral disengagement, potentially leading to increased cyber aggression, defined as harmful behavior conducted via technology that recipients perceive as distressing, offensive, or threatening [6,19]. Unlike cyberbullying, which involves prolonged targeting of a victim with a power imbalance, cyber aggression encompasses a broader range of online harm and is more prevalent in digital contexts [20,21].

Past studies have explored the causes of cyber aggression, focusing on contextual and individual factors, such as one's exposure to antisocial media content [9], internet addiction [10], online disinhibition [6], and relationships with loved ones [8]. While a handful of studies have explored its consequences, such as acceptance of platform bans [22] and social withdrawal [6], they largely center on individuals. Yet, little attention has been paid to its broader impact, especially with regards to how aggressive communication drives collective reactions. Furthermore, cyber aggression has traditionally been transmitted through channels such as email and chat rooms [23], but with the advent of new communication environments like *Danmaku*, it can now be conveyed with greater immediacy, scale, and visibility, thereby warranting renewed theoretical inquiry.

2.2. Research on *Danmaku*

Danmaku, which displays scrolling comments synchronized with video playback, creates a dynamic co-viewing experience that fosters greater viewer engagement than traditional online discussions [4,5]. Early research on *Danmaku* primarily centered on user motivations, highlighting entertainment, information seeking, and social connectedness as key drivers [24]. More recent studies have shifted to its effects in live streaming and video consumption, illustrating that features such as message length and positive valence can stimulate favorable audience responses, including likes, recommendations, gifting, and sales performance [4,5,7,25–27]. Despite these documented benefits, limited

attention has been paid to the potential negative effects of *Danmaku*. Particularly, *Danmaku's* anonymity enables users to express themselves with minimal inhibition, yet the rapid flow of comments hinders sender identification and timely responses, heightening the risk of cyber aggression.

Aggressive *Danmaku* differs from generally negative *Danmaku* with the latter including dismal emotional expressions that are not inherently aggressive. On UGC platforms, such negative *Danmaku* may stem from emotional reactions to content—for example, sadness over a tragic plot, as reflected in the *Danmaku* “It is so heartbreaking, Tommy”. Though negative in tone, these messages are not typically intended to provoke viewers and can, at times, even foster engagement through shared emotional resonance [26]. In contrast, aggressive *Danmaku* embodies hostility, insults, or personal attacks, contributing to a toxic co-viewing environment [28,29].

Despite the potential for *Danmaku* to convey aggression, the nuanced effects of aggressive *Danmaku* remain largely unexplored. Specifically, the rapid and dynamic flow of *Danmaku* may prevent viewers from noticing every aggressive expression, so much so that these comments, when not excessive, may still foster social presence by signaling audience engagement and boosting the vibrancy of the viewing environment [5]. Consequently, we contend that aggressive *Danmaku* may significantly compromise viewing experience only when it draws substantial viewer attention through a high proportion or concentration. Additionally, aggressive *Danmaku* may manifest in distinct formats rather than adhering to a single uniform pattern [30]. Certain expressions may be overt, such as “You are disgusting,” while others may be sarcastic, such as “You think you are funny?” This indicates the potential heterogeneity of aggressive content, which has received limited attention. Furthermore, contextual factors linked to the way videos are constructed may further shape viewers' expectations during co-viewing [1,3], potentially influencing their responses to aggressive *Danmaku*. This hints that the effects of aggressive *Danmaku* may be contingent on boundary conditions shaped by the broader viewing environment. Therefore, further inquiries into the dark side of *Danmaku* are needed.

2.3. Cognitive dissonance theory

According to CDT, cognitive dissonance is the psychological discomfort arising from holding contradictory beliefs, attitudes, or knowledge, which motivates efforts to restore consistency [11]. Strategies for reducing dissonance may entail adjusting attitudes to align with conflicting cognitions, altering behaviors to avoid inconsistency, or seeking confirmatory information [31,32]. CDT has been widely applied in marketing research to explain how negative consumer experiences, which, conflict with a priori beliefs, can drive behavioral change [33,34]. For example, exposure to negative word-of-mouth can reduce

consumers' intentions to make repeat purchases [35]. Recently, CDT has been increasingly applied to investigate user engagement with digital technologies. Studies discover that dissonance from unmet expectations can trigger negative emotions, leading to discontinued system usage [36]. Likewise, exposure to discomforting social media content can induce dissonance-reducing behaviors, such as engaging with counter-attitudinal information [37,38]. These insights highlight CDT's relevance in deciphering user behavior in response to negative online experiences.

This study embraces CDT to shed light on viewer behavior in response to aggressive *Danmaku*. When engaging with condensed clips, viewers often go beyond passive content consumption to seek out emotional resonance, interpretive engagement, and communal discussion centered on the original work through *Danmaku* interactions [2,5,39] (see Fig. 1). This fosters an expectation for an enriching, harmonious, and meaningful co-viewing environment, where audiences can engage with both the content and peer viewers. For this reason, when viewers encounter aggressive *Danmaku*, they may feel alienated, discomfort, or even offended [6], causing inconsistency to emerge between their expectations and the hostile reality [40]. This inconsistency can trigger cognitive dissonance, prompting viewers to modify their behavior to restore psychological consistency [41].

2.3.1. Impact of aggressive *Danmaku* in condensed clips

This study focuses on aggressive *Danmaku* within condensed clips, reflected in its proportion and concentration (see Fig. 2). A higher proportion of aggressive *Danmaku* increases the likelihood that viewers perceive hostility within the environment. When such comments constitute a larger share of the total messages in *Danmaku*, they are less likely to be seen as isolated anomalies and more likely reflect the overall tone of the co-viewing experience [29]. This pervasive presence of hostility contrasts with viewers' expectations of a generally harmonious atmosphere [42], potentially generating a persistent sense of dissonance that erodes their ability to relate to both the content and fellow viewers.

In contrast, a higher concentration of aggressive *Danmaku* within select segments may give rise to localized ‘hotspots’ of hostility. These dense clusters of aggression can sharply amplify antagonist perceptions. Confronted with a sudden surge in aggression, viewers may find it difficult to reconcile the abrupt shift in tone with their expectations of a cohesive co-viewing experience [34].

Conceivably, when condensed clips contain a higher proportion or concentration of aggressive *Danmaku*, viewers may experience heightened cognitive dissonance. In an effort to alleviate this discomfort and restore cognitive balance, they may alter their behavior by disengaging from the content and turning to alternative viewing experiences that better align with their preferences [37]. This in turn may negatively affect the performance of the condensed clips. We therefore hypothesize

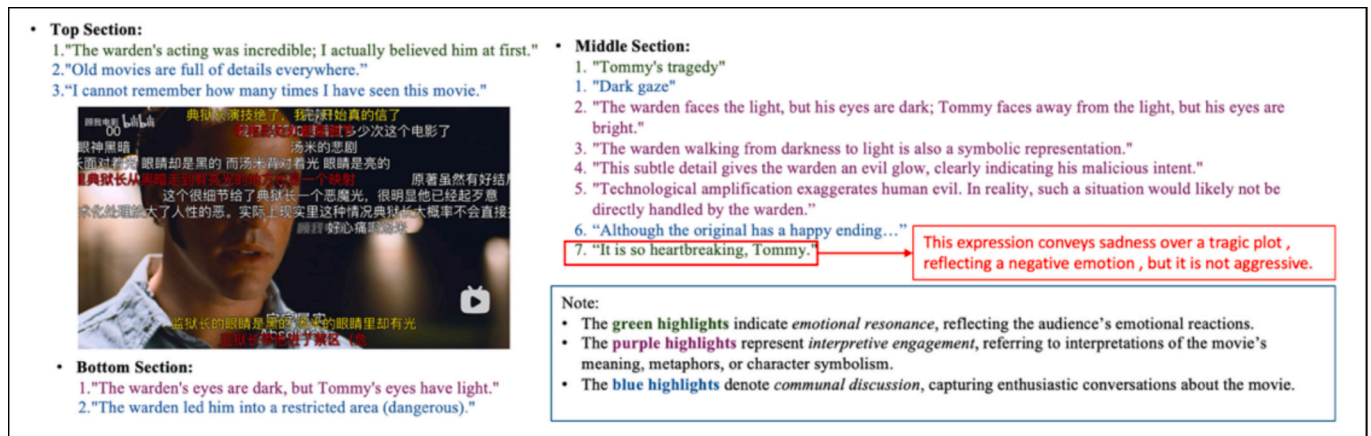


Fig. 1. Examples of *Danmaku* in Condensed Clips.

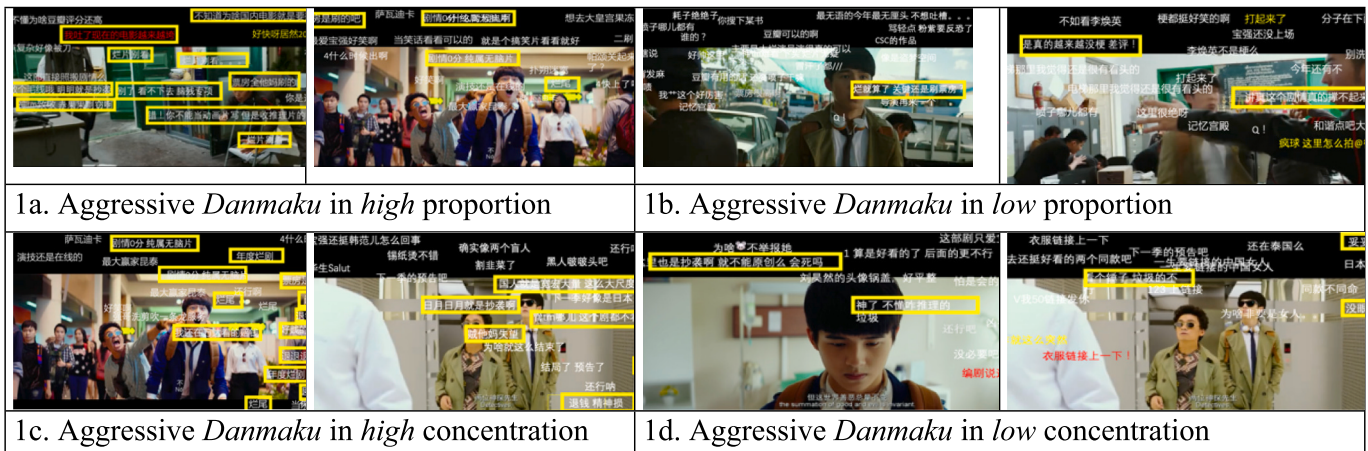


Fig. 2. Examples of Aggressive Danmaku.
Note: Aggressive Danmaku is indicated by a square marker.

that:

Hypothesis 1. *The presence of a higher (H1a) proportion and (H1b) concentration of aggressive Danmaku is negatively associated with the performance of condensed clips.*

2.3.2. Moderating influence of original work's attributes

Given the derivative nature of condensed clips, viewers rarely engage with them without prior reference, instead drawing on emotional ties and knowledge formed through the original work [1,3]. As a result, the original work serves as a contextual backdrop that shapes viewers' expectations of the co-viewing experience when watching condensed clips. The emotional and informational appeals embedded in the original work may work as affective and cognitive anchors that influence the degree of dissonance viewers experience when confronted with aggressive Danmaku during the viewing of condensed clips. Particularly, this study designates nostalgic appeal as a reflection of its emotional appeal, while the reputation of the original work is considered as an indicator of its informational appeal. The nostalgic appeal of the original work may elicit emotional responses by fostering a sense of connection to the past [14,15], shaping their expectations of an emotionally engaging co-viewing experience. In contrast, reputation acts as an informational signal [17,18], prompting viewers to anticipate a cognitively engaging and more insightful co-viewing environment. These expectations, shaped by the attributes of the original work, may heighten viewers' sensitivity to aggressive commentary. Accordingly, this study aims to showcase how these two attributes of the original work interact with aggressive Danmaku in condensed clips, ultimately leading to further behavioral changes.

Original Work's Nostalgic Appeal: Nostalgia refers to a sentimental yearning for the past, characterized by a desire to relive the emotions associated with earlier time [16,43]. The nostalgic appeal of a product lies in its ability to evoke emotional memories of familiar entities or environments, providing psychological comfort [44]. Consumers are often drawn to nostalgic products to reconnect with their personal past and foster a sense of social belonging [47,49]. Prior research further shows that nostalgic consumption can buffer negative experiences by alleviating discomfort and perceived threats [45]. Condensed clips curated from original works with nostalgic appeal can efficiently preserve emotionally resonant elements in a more time-efficient format, thereby fostering anticipation of an emotionally engaging and sentimental co-viewing experience. For viewers who are familiar with or have previously watched the original work, nostalgia can heighten psychological involvement by evoking memories and emotional recall [16]. When such viewers encounter a high proportion of aggressive Danmaku during the viewing of condensed clips, nostalgic engagement

may help anchor them in meaningful prior experiences, reinforcing their connection to past memories and alleviating the discomfort caused by a mismatch between expectations and actual experience [46,47]. Consequently, the nostalgic appeal of the original work may mitigate the negative effect stemming from a higher proportion of aggressive Danmaku on the performance of condensed clips.

However, when viewers with this nostalgic connection are abruptly exposed to a concentrated stream of aggressive Danmaku, the clustered and rapid influx of hostile comments introduces an intense burst of antagonistic affect within a short time frame. This sudden spike leaves these viewers with little opportunity to effectively reconcile the conflicting emotional cues present at that moment, which may, in turn, hinder the evocation of personally meaningful associations necessary to sustain emotional resonance [48]. Consequently, the high density of aggressive Danmaku may exacerbate the difficulty these viewers experience in reconciling their expectations with the actual experience, thereby further undermining the video's performance. We therefore hypothesize that:

Hypothesis 2. *The nostalgic appeal of the original work has a moderating influence on the performance of condensed clips, (H2a) attenuating the negative impact of aggressive Danmaku proportion and (H2b) amplifying the negative impact of aggressive Danmaku concentration.*

Original Work's Reputation: Original works with a strong reputation, often associated with high-quality content, tend to attract a dedicated viewer base that possesses a deep passion and extensive knowledge of the material [49]. When condensed clips are derived from such works, viewers may approach them with pre-existing expectations grounded in admiration, familiarity, and shared values. These expectations often extend to the co-viewing environment, which is presumed to be insightful and grounded in mutual appreciation of the original work [50]. On one hand, a high proportion of aggressive Danmaku introduces a broadly antagonistic tone that may sharply contradict these expectations. This discrepancy intensifies their cognitive dissonance, as viewers struggle to reconcile their positive associations with the original work and its fan community with the broad hostility expressed in Danmaku. Consequently, the viewing experience may become more jarring.

On the other hand, renowned works often invite diverse interpretations, prompting viewers to cognitively engage with multiple, sometimes conflicting, aspects of the content [51,52]. When the original work boasts of a strong reputation, viewers may approach the co-viewing of condensed clips with an expectation that the fellow viewers would engage in critical reflection and deliberation. For example, layered meanings, narrative ambiguities, and symbolic richness of renowned works may generate interpretive complexity and

promote critical debate among divergent interpretive positions. In this case, viewers may be prepared for the potential occurrence of a concentrated influx of aggressive commentary at certain points [53]. Hence, the sudden cluster of aggressive *Danmaku* is less likely to trigger significant cognitive dissonance. Rather, the perceived prestige of the original work may facilitate viewers in reconciling the tension between the concentration of antagonistic commentary and their expectations, thereby buffering the negative impact. We therefore hypothesize that:

Hypothesis 3. *The reputation of the original work has a moderating effect on the performance of condensed clips, (H3a) amplifying the negative impact of aggressive Danmaku proportion and (H3b) attenuating the negative impact of aggressive Danmaku concentration.*

Fig. 3 depicts the research model for this study.

3. Methodology

3.1. Empirical setting and data collection

The hypotheses were tested using condensed clips from Bilibili (<https://www.bilibili.com>), a leading Chinese video-sharing platform with over 326 million monthly active users [54]. As a pioneer of the *Danmaku* system in China and a major hub for UGC, Bilibili is widely regarded as representative of *Danmaku* usage across video-sharing platforms [55,56], making it an appropriate context for data collection. The condensed clips analyzed in this study were released on Bilibili between December 2015 and February 2022. To ensure sample consistency, only clips derived from movies were included. Comprehensive data were collected, encompassing all associated *Danmaku* and video comments, as well as descriptive information and performance metrics. Supplementary information on original movies was sourced from Douban (<https://www.douban.com>), China's largest third-party movie and TV review platform. In total, the dataset comprises 20,030 condensed clips and 10,416,222 *Danmaku* entries. Fig. 4 showcases examples of our data sources.

3.2. Operationalization of focal variables

Dependent Variable: Performance of condensed clips was assessed by the number of coins they received. Coins are Bilibili's platform-specific digital currency, distributed daily to users based on activity (e.g., check-ins), and used primarily to tip content creators. Coins are non-refundable and influence both the video's visibility and the creator's revenue potential. While coins are not convertible to cash, they hold quasi-monetary value due to their limited supply and platform utility (e.g., nickname changes and event participation) [57].

Aggressive Danmaku: We identified aggressive comments from *Danmaku* through a robust multi-pattern search, utilizing an extensive lexicon comprising 1973 Chinese abusive words. To efficiently detect aggressive words within *Danmaku*, we employed the Aho-Corasick algorithm to measure the frequency of abusive words in each comment. Particularly, we built a trie (prefix tree) with all aggressive words from the lexicon, where each node resembles a character of an aggressive word. This organizes the aggressive words in a structured manner for quick lookup. After constructing the trie, failure links are built for each node to handle mismatches and ensure efficient transitions during the search. Additionally, output links were created for nodes corresponding to the end of aggressive words, indicating which aggressive words are matched when that node is reached. With the trie and links in place, each bullet comment was processed character by character. The algorithm follows edges in the trie if they exist and uses failure links to find the next match if there is no direct edge. Matches are recorded using the output links when a node is reached. The Aho-Corasick algorithm possesses two advantages for this task. It operates in linear time, making it highly efficient for processing large-scale datasets. Moreover, the algorithm can search for all aggressive words simultaneously, eliminating

the need for separate searches for each word and significantly improving performance.

The aggressive *Danmaku* identified were aggregated at the video level using proportion and concentration metrics. Whereas proportion reflects the share of aggressive *Danmaku* relative to the total comment volume, concentration captures how these *Danmaku* are distributed: lower values indicate a more even spread, while higher values point to clustering at specific moments.

Moderators: Reputation of the original work was operationalized as the overall rating received by the original movie on the Douban platform. Product rating serves as a prominent indicator of product reputation [58]. This rating reflects reviewers' subjective evaluations of the original movie's quality and serves as a proxy for its public perception. Higher ratings typically reflect a stronger reputation.

Nostalgic appeal was operationalized as the number of years since the original movie's release, calculated by subtracting the release year from 2023. This measure captures the extent to which the passage of time may enhance the movie's nostalgic resonance for viewers, reflecting the impression that older movies often carry greater nostalgic significance [44].

Control Variables: We incorporated a set of control variables to address potential confounding effects. At the video level, we controlled for launch timing, duration, the total number of *Danmaku*, title length, dynamic descriptions, video type, and technical specifications such as High-Definition (HD) availability and video resolution. We additionally controlled for viewer comment indicators that may reflect their post-viewing reactions. To account for the influence of perceived video quality, we included the number of comments related to video quality that express positive or negative sentiments. Other comment-related variables included the average length of comments, the proportion of comments mentioning "*Danmaku*", the frequency of question-like expressions, the reply rate, the number of viewers who posted comments, and the proportion of VIP viewers among commenters. Furthermore, we also incorporated the production country of the original movie to capture broader cultural and production-related heterogeneity. Descriptive statistics and a correlation matrix of the main variables are presented in Tables 1 and 2 respectively.

Model Specification: Our baseline model is given as follows: $PC_i = \beta_0 + \beta_1 PA_i + \beta_2 CA_i + \beta_3 NO_i + \beta_4 RO_i + \beta_5 PA_i \times NO_i + \beta_6 CA_i \times NO_i + \beta_7 PA_i \times RO_i + \beta_8 CA_i \times RO_i + \gamma X_i + \epsilon_i$ where PC_i denotes the performance of condensed video i , and X_i is a set of control variables. PA_i denotes the proportion of aggressive *Danmaku* in video i , while CA_i captures the concentration. NO_i represents original work's nostalgic appeal, and RO_i indicates its reputation. The model also includes interaction terms between aggressive *Danmaku* and the original work's nostalgic appeal and reputation. The error term ϵ_i captures unobserved factors affecting the outcome.

4. Data analysis and results

4.1. Regression analysis

Multicollinearity was assessed using variance inflation factors (VIFs), with all values below 6, indicating no serious multicollinearity concerns. Table 3 presents analytical results. Model 1 includes only control variables. Model 2 introduces the main effects of aggressive *Danmaku*, showing that both its proportion ($p < 0.001$) and concentration ($p < 0.001$) have a significant negative impact on performance, supporting H1a and H1b. Further analyses (Models 3–5) were conducted to scrutinize the moderating effects. Model 3 serves as the baseline. Model 4 shows that the original work's nostalgic appeal intensifies the negative impacts of both aggressive *Danmaku* proportion ($p < 0.001$) and concentration ($p < 0.01$) on performance. H2b is thus supported, while H2a is not. Model 5 introduces the moderating effect of original work reputation, revealing that reputation strengthens the negative impact of aggressive *Danmaku* proportion ($p < 0.01$), while marginally reducing

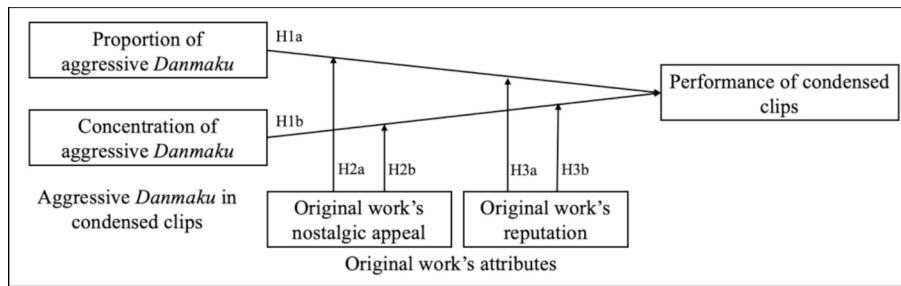


Fig. 3. Research Model.



Fig. 4. Examples of Data Sources.

the effect of concentration ($p < 0.1$). Therefore, H3a is supported, while H3b receives marginal support.

4.2. Robustness checks

Robustness checks using alternative measures, along with tests for selection bias and endogeneity, confirm the consistency of our findings.

Alternative Measures: First, we re-calculated the dependent variable as the conversion rate from views to coin behaviors to assess how effectively views translate into digital support (Table 4, Model A). Second, we introduced alternative measures for the two moderators (Table 4, Model B). Particularly, the original work's nostalgic appeal was gauged using the proportion of nostalgia-related comments in the movie's Douban reviews, identified via a Large Language Model (LLM)

prompted with a refined lexicon of linguistic markers for nostalgia^{1,2}. Original work's reputation was reassessed through Bayesian estimation of Douban ratings, combining average scores with review volume to mitigate bias from outliers and sparse data.

Selection Bias: We refined our sample by including condensed clips only longer than 180 s, as shorter videos may limit viewer engagement (Table 4, Model C). We further excluded videos longer than 3600 s to reduce undue influence from unusually long content (Table 4, Model D). We also restricted the sample to landscape-oriented videos, as this format better reflects the original cinematic presentation (Table 4, Model E). These robustness checks affirm that our findings are not driven by specific model specifications or sample criteria.

¹ We employed a LLM (Google Gemini) to identify movie reviews containing explicit references to personal or cultural longing for the past. This process was guided by a refined dictionary of nostalgia-related linguistic markers, developed through an iterative review of both the literature and sample data. It was prompted to classify each review as nostalgic or non-nostalgic based on the presence and intensity of these expressions. To ensure reliability, three researchers independently cross-validated a random sample of the classifications. This approach yields a contextually grounded, data-driven measure of nostalgic appeal, operationalized in the proportion of reviews identified as nostalgic.

² We also examined the time gap between the condensed video's release year and the original movie's release year as an alternative measure of nostalgic appeal, and the results remained consistent.

Table 1
Descriptive Statistics.

Variable	Operationalization	Mean	Std Dev	Min	Max
Dependent Variable					
Performance of Condensed Clips (PC)	Total number of B coins received since its launch on the platform. The value was logarithmic transformed	5.034	2.069	0	12.579
Independent Variables					
Proportion of Aggressive <i>Danmaku</i> (PA)	Ratio of the number of aggressive <i>Danmaku</i> to the total number of <i>Danmaku</i>	0.097	0.118	0	1
Concentration of Aggressive <i>Danmaku</i> (CA)	Herfindahl-Hirschman Index (HHI) was adapted to measure the concentration of aggressive <i>Danmaku</i> across different time segments of a video. The calculation involved squaring the proportion of aggressive <i>Danmaku</i> in each time segment and aggregating these squared values	0.309	0.356	0	1
Moderators					
Reputation of Original Work (RO)	Average reviewer rating received on the Douban platform	7.157	1.314	2.1	9.7
Nostalgic Appeal of Original Work (NO)	Number of years since the movie's original release, calculated by subtracting the release year from 2023	15.724	14.664	1	120
Control Variables					
Video Launch (VL)	Number of days elapsed since the video was launched	2005.543	555.282	1165	3397
Video Duration (VD)	Total runtime of the video, measured in seconds	601.921	916.498	10	79,028
Video Total <i>Danmaku</i> (VTD)	Total number of <i>Danmaku</i> received by the video	490.725	1354.99	1	33,125
Video Title Length (VTL)	Total number of characters in the video title	31.623	8.612	6	94
Video Dynamic Description Length (VDL)	Number of characters in the dynamic description of the video	46.025	70.475	0	699
Video Resolution (VDWH)	Width and height in pixels, indicating the horizontal and vertical dimensions of a video frame	1,513,526	863,065.4	0	9,830,400
HD Availability (VHD)	Availability of high-definition or enhanced video rights. The variable was measured by whether the video was available in HD5 quality	0.407	0.491	0	1
Video Type (VT)	Content category of the condensed clip, including Humanities and History, Anime Commentary, Entertainment Commentary, Video Editing, Film and TV Commentary, General Animation, Celebrity Compilation and Trailers and News	6	0.089	1	8
Comment Length (CL)	Average number of characters per comment posted on the video	25.030	13.483	1	434
Quality Positive Comments (QPC)	Number of comments mentioning "quality" that express positive sentiments	4.801	13.671	0	1037
Quality Negative Comments (QNC)	Number of comments mentioning "quality" that express negative sentiments	3.661	10.714	0	574
<i>Danmaku</i> Mention Ratio (DMR)	Proportion of comments that explicitly mention " <i>Danmaku</i> " relative to the total number of comments	0.003	0.009	0	0.5
Comment Reply Rate (CRR)	Proportion of comments that received replies	0.727	0.656	0	9.917
Commenting User Count (CUC)	Number of distinct users who posted comments on the video, regardless of the number of comments made	196.516	472.506	1	21,514
Question Comment Ratio (QCR)	Proportion of comments that include question-like expressions, relative to the total number of comments	0.104	0.073	0	1
VIP Comment Ratio (VR)	Proportion of comments made by VIP (paying) users among all comments	0.791	0.122	0	1
Country of Production of Original Work (OCP)	Whether the movie was a domestic production or not, indicating its origin of production	0.32	0.46	0	1

Endogeneity Tests: To address potential endogeneity concerns, we employ three complementary strategies: (i) instrumental variable (IV) estimation, (ii) multiple matching approaches, and (iii) placebo tests based on video attributes unaffected by *Danmaku*. For IV estimation, we constructed two IVs to capture factors associated with the generation of aggressive *Danmaku* but are unlikely to directly influence outcome metrics such as tipping, likes, or viewership. The first IV is the average timestamp lag of *Danmaku* postings, which reflects the typical delay between comments. Shorter lags are more likely to be associated with immediate, emotionally charged reactions, increasing the likelihood of aggressive content. However, this temporal attribute primarily reflects audience responsiveness and is unlikely to directly influence video performance. The second IV measures comment section intensity via the highly liked ratio, defined as the number of comments with over 10 likes divided by the total number of comments. This ratio indicates the emotional resonance and engagement within the viewer community, correlating with the likelihood of aggressive *Danmaku* but not directly influencing performance metrics. To address potential endogeneity in interaction terms, we include interactions between IVs and key moderators, i.e., the original work's nostalgic appeal and reputation. Two-Stage Least Squares (2SLS) results are presented (Table 4, Model F). This specification incorporates both the primary IVs and their interactions with moderators, offering a more comprehensive instrument set to account for cross-variable influences.

The Angrist–Pischke first-stage *F*-tests reject the null of weak instruments, with *F*-statistics of 3472.84 (proportion) and 2708.83

(concentration), both far above the 10 threshold and significant at 1%. Likewise, the Cragg–Donald Wald *F*-statistics (351.02 for proportion and 379.74 for concentration) exceed the critical value of 16.38, confirming instrument strength [59]. The second-stage estimates align closely with the baseline results, supporting the robustness of our findings.

Furthermore, we estimated the treatment effects using multiple matching methods, including kernel Propensity Score Matching (PSM), nearest-neighbor matching (Mahalanobis; $k = 1-10$), and Coarsened Exact Matching (CEM). Across all specifications, treatment effects of both the proportion and concentration of aggressive *Danmaku* remain statistically significant ($p < 0.01$), exhibiting consistent direction and magnitude.³ Placebo tests based on technical attributes (e.g., video resolution and HD availability⁴) show no effects. Overall, analytical results validate the strength and relevance of our instruments, affirming that they effectively capture exogenous variation in *Danmaku* aggression without directly affecting performance outcomes, thereby mitigating

³ We further re-estimated the outcome regressions on the matched samples, restricted to the region of common support and applying the corresponding matching weights (e.g., kernel PSM weights and CEM weights). The estimated treatment coefficients remained consistent in both sign and magnitude, with inference yielding similar results under either bootstrap or clustered standard errors. Detailed results are available upon request.

⁴ These outcomes are hardware/encoding attributes that are determined prior to user interactions and are not plausibly affected by aggressive *Danmaku* exposure; hence they serve as negative-control (placebo) outcomes.

Table 2
Inter-Variable Correlations.

Variable	PC	CA	PA	RO	NO	VL	VD	VTD	VTL	VDL
CA	-0.658***	1.000								
PA	-0.435***	0.320***	1.000							
RO	0.124***	-0.001	-0.037***	1.000						
NO	0.076***	-0.043***	-0.053***	0.270***	1.000					
VL	0.026***	-0.102***	-0.058***	0.004	-0.034***	1.000				
VD	0.204***	-0.111***	-0.071***	0.090***	0.047***	-0.142***	1.000			
VTD	0.526***	-0.275***	-0.094***	0.015*	0.042***	0.006	0.133***	1.000		
VTL	0.012 ⁺	-0.002	-0.032***	0.006	0.016*	-0.148***	0.027***	-0.019***	1.000	
VDL	0.162***	-0.082***	-0.058***	0.018**	-0.028***	-0.050***	0.028***	0.082***	0.134***	1.000
VDWH	-0.025***	0.095***	0.039***	-0.026***	-0.005	-0.653***	0.076***	-0.020**	0.124***	0.113***
CL	0.147***	-0.164***	-0.091***	0.069***	-0.055***	-0.099***	0.074***	0.136***	-0.047***	0.067***
QPC	0.414***	-0.230***	-0.092***	0.040***	-0.006	0.025***	0.087***	0.611***	-0.034***	0.081***
QNC	0.388***	-0.229***	-0.080***	0.001	-0.030***	0.031***	0.060***	0.653***	-0.045***	0.074***
DMR	0.170***	-0.137***	-0.072***	0.045***	0.010	0.072***	0.039***	0.145***	0.001	0.011 ⁺
CRR	0.027***	-0.126***	-0.112***	0.024***	-0.036***	-0.120***	-0.014 ⁺	0.037***	-0.001	0.018**
CUC	0.488***	-0.279***	-0.095***	0.007	-0.005	0.045***	0.057***	0.783***	-0.060***	0.077***
QCR	-0.047***	-0.055***	0.018*	-0.060***	-0.073***	0.046***	-0.063***	0.031***	-0.031***	-0.005
VR	0.220***	-0.160***	-0.118***	-0.010	-0.082***	0.194***	-0.046***	0.097***	-0.026***	0.072***
OCPC	-0.046***	0.010	0.000	-0.187***	-0.015*	-0.059***	0.014 ⁺	0.056***	-0.080***	0.002

Variables	VDWH	CL	QPC	QNC	DMR	CRR	CUC	QCR	VR
VDWH	1.000								
CL	0.085***	1.000							
QPC	-0.019***	0.172***	1.000						
QNC	-0.023***	0.192***	0.872***	1.000					
DMR	-0.061***	0.060***	0.123***	0.149***	1.000				
CRR	0.091***	0.421***	0.088***	0.118***	-0.005	1.000			
CUC	-0.036***	0.184***	0.739***	0.825***	0.114***	0.119***	1.000		
QCR	-0.024***	0.249***	0.042***	0.089***	0.029***	0.232***	0.081***	1.000	
VR	-0.100***	0.066***	0.096***	0.105***	0.056***	0.068***	0.127***	0.066***	1.000
OCPC	0.059***	0.175***	0.053***	0.064***	-0.019**	0.128***	0.081***	0.053***	-0.033***

Note: ⁺p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001.

endogeneity concerns.

4.3. Insights from primary study

Empirical findings highlight the dark aspects of the *Danmaku* system by attesting to the adverse effects of aggressive *Danmaku* on collective viewer behavior. Specifically, consistent with prior research documenting the negative impact of aggressive online interactions [6,60], we discover that video performance is negatively associated with exposure to aggressive *Danmaku* characterized by its proportion and concentration during condensed-clip viewing. At the same time, to strengthen the validity of our empirical findings, it is imperative to eliminate the possibility that the mere presence of aggressive *Danmaku* is adequate to trigger pronounced disengagement. Otherwise, one may counterargue that the presence of aggressive *Danmaku*, as opposed to its proportion and concentration, acts as the primary impetus for viewers to disengage. Particularly, we contend that at low levels, the adverse effects of aggressive *Danmaku* may be diluted, as such comments may receive limited attention within the fast-moving stream of comments. Only when the proportion and concentration of aggressive *Danmaku* reaches a tipping point will its negative impact become discernible. To this end, we conducted a post-hoc study to explore potential curvilinear patterns in the relationship between aggressive *Danmaku* and video performance across varying levels of proportion and concentration.

Furthermore, empirical findings highlight that the attributes of the original work moderate the impact of aggressive *Danmaku* on condensed-clip performance. Consistent with past studies [17], our findings reveal that the reputation of the original work amplifies the negative impact of a high proportion of aggressive *Danmaku*. As theorized, when viewers hold elevated expectations for the co-viewing experience of condensed clips from reputable original works, excessive aggressive *Danmaku* may heighten cognitive dissonance, further

reducing engagement with the content. Empirical findings also indicate that the reputation of the original work can buffer the negative effects of concentrated aggressive *Danmaku* on performance. This suggests that when certain aspects of a condensed clip provoke aggression, a strong original-work reputation can mitigate its impact, consistent with prior evidence of greater audience tolerance for conflicting opinions in highly rated movies [51].

Unexpectedly, our findings reveal that the nostalgic appeal of the original work intensifies the negative effects of both the proportion and concentration of aggressive *Danmaku* on performance. One plausible reason for the contradiction could be attributed to our conception of aggressive *Danmaku* as being homogeneous in nature when in fact, such comments could assume different forms in the way aggression is perpetrated. For example, one comment on the condensed clips of classic movies noted: “*What’s going on with these Danmaku? Making bad jokes during such serious videos is really off-putting. Please do not turn the Danmaku section into another battleground... At least take the time to appreciate these classic films*”. Another viewer remarked: “*The Danmaku just erupted into conflict... This is a truly classic film... I was ironically amused by the wave of criticism that followed*”. These reactions point to the possibility that aggressive *Danmaku* may manifest in diverse forms, such as overt hostility or sarcastic humor. Accordingly, the heterogeneity of aggression types may affect viewers’ nostalgic engagement in distinct ways. We hence conducted a second post-hoc analysis to capture the complexity of aggressive communication in co-viewing environments.

5. Post-hoc study 1: Test of nonlinear relationships

To highlight the importance of proportion and concentration, rather than the mere presence of aggressive *Danmaku*, in triggering pronounced disengagement, we examine whether its effects vary across these dimensions. We estimated quadratic models and conducted U-

Table 3
Analytical Results.

Dependent Variable: Performance of Condensed Clips					
Focal Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Proportion of Aggressive <i>Danmaku</i>		-3.939*** (0.077)	-3.895*** (0.076)	-3.949*** (0.077)	-3.949*** (0.077)
Concentration of Aggressive <i>Danmaku</i>		-2.62*** (0.027)	-2.642*** (0.027)	-2.644*** (0.027)	-2.644*** (0.027)
Nostalgic Appeal of Original Work			0 (0.001)	0 (0.001)	0 (0.001)
Reputation of Original Work			0.139*** (0.007)	0.139*** (0.007)	0.139*** (0.007)
Proportion of Aggressive <i>Danmaku</i> * Nostalgic Appeal of Original Work				-0.022*** (0.006)	-0.018** (0.006)
Concentration of Aggressive <i>Danmaku</i> * Nostalgic Appeal of Original Work				-0.004** (0.002)	-0.005** (0.002)
Proportion of Aggressive <i>Danmaku</i> * Reputation of Original Work					-0.16** (0.062)
Concentration of Aggressive <i>Danmaku</i> * Reputation of Original Work					0.038+ (0.02)
Control Variables					
Video Launch	0+ (0)	0*** (0)	0*** (0)	0*** (0)	0*** (0)
Video Duration	0*** (0)	0*** (0)	0*** (0)	0*** (0)	0*** (0)
Video Total <i>Danmaku</i>	0*** (0)	0*** (0)	0*** (0)	0*** (0)	0*** (0)
Video Title Length	0.001 (0.001)	-0.002 (0.001)	-0.002 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Video Dynamic Description Length	0.003*** (0)	0.002*** (0)	0.002*** (0)	0.002*** (0)	0.002*** (0)
Video Resolution	0*** (0)	0 (0)	0 (0)	0 (0)	0 (0)
HD Availability	0.129*** (0.028)	0.084*** (0.021)	0.077*** (0.021)	0.076*** (0.021)	0.076*** (0.021)
Comment Length	0.013*** (0.001)	0.006*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
Quality Positive Comments	0.032*** (0.002)	0.024*** (0.001)	0.022*** (0.001)	0.022*** (0.001)	0.022*** (0.001)
Quality Negative Comments	-0.045*** (0.003)	-0.033*** (0.002)	-0.03*** (0.002)	-0.03*** (0.002)	-0.03*** (0.002)
<i>Danmaku</i> Mention Ratio	19.922*** (1.26)	9.296*** (0.951)	8.482*** (0.941)	8.458*** (0.941)	8.507*** (0.941)
Comment Reply Rate	-0.076*** (0.02)	-0.273*** (0.015)	-0.284*** (0.015)	-0.284*** (0.015)	-0.283*** (0.015)
Commenting User Count	0.001*** (0)	0.001*** (0)	0.001*** (0)	0.001*** (0)	0.001*** (0)
Question Comment Ratio	-2.292*** (0.164)	-1.886*** (0.123)	-1.707*** (0.122)	-1.696*** (0.122)	-1.702*** (0.122)
VIP Comment Ratio	2.601*** (0.097)	1.527*** (0.073)	1.562*** (0.073)	1.558*** (0.073)	1.562*** (0.073)
Country of Production of Original Work	-0.399*** (0.025)	-0.3*** (0.019)	-0.223*** (0.019)	-0.224*** (0.019)	-0.225*** (0.019)
Video Type	Fixed	Fixed	Fixed	Fixed	Fixed
Constant	2.29* (1.148)	4.208*** (0.863)	4.197*** (0.853)	4.219*** (0.853)	4.208*** (0.853)
Observations	20,030	20,030	20,030	20,030	20,030
R ²	0.392	0.657	0.664	0.665	0.665

Note: +p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001. Standard errors are in parentheses.

shape tests for proportion and concentration, incorporating the same controls as in the main analyses to evaluate potential non-linear effects [61]. Analytical results are visualized in Fig. 5. Specifically, the linear term for proportion is negative and significant ($\beta = -8.87, p < 0.001$), while the squared term is positive and significant ($\beta = 7.96, p < 0.001$). The estimated turning point falls outside the observed range and does not meet U-shape test criteria, indicating diminishing marginal effects. As depicted in Fig. 5A, performance declines sharply as the proportion increases from low to moderate levels, and the negative effect attenuates at higher levels. At low proportions, aggressive *Danmaku* is diluted in the fast-moving stream, whereas at moderate proportions it becomes salient and strongly harms performance. At higher proportions, additional aggression conveys little new information once an unfavorable impression of the co-viewing environment has formed. This pattern indicates

that disillusioned viewers exit early, leaving a remaining audience less responsive to further increases in aggression [62].

For the concentration of aggressive *Danmaku*, the linear term is negative and significant ($\beta = -4.94, p < 0.001$) and the squared term is positive and significant ($\beta = 5.39, p < 0.001$). The implied turning point lies well within the empirical range at the 95% confidence level. Fig. 5B indicates a steep drop in performance as aggressive *Danmaku* becomes more concentrated at low to moderate levels, followed by a flattening of the decline at higher concentrations. Analytical results indicate that clustered aggression is particularly harmful when it becomes salient. Once such surges occur, further increases in concentration add little to viewers' evaluations. This is because more sensitive viewers tend to exit earlier, leaving a remaining audience that is less responsive to additional clustering. At extremely high levels of concentration, Fig. 5B shows a

Table 4
Robustness Checks.

Focal Variable	Model A	Model B	Model C	Model D	Model E	Model F
Proportion of Aggressive <i>Danmaku</i>	-0.005*** (0.001)	-3.733*** (0.115)	-4.138*** (0.084)	-3.772*** (0.075)	-3.961*** (0.078)	-11.869*** (1.652)
Concentration of Aggressive <i>Danmaku</i>	-0.001** (0)	-2.567*** (0.039)	-2.61*** (0.027)	-2.483*** (0.027)	-2.648*** (0.027)	-1.007* (0.414)
Nostalgic Appeal of Original Work	0*** (0)	-0.356*** (0.072)	0 (0.001)	-0 (0.001)	0 (0.001)	0 (0.001)
Reputation of Original Work	0.001*** (0)	0.164*** (0.008)	0.145*** (0.007)	0.103*** (0.007)	0.141*** (0.006)	0.103*** (0.012)
Proportion of Aggressive <i>Danmaku</i> *	0	-1.43* (0.628)	-0.029*** (0.007)	-0.017** (0.006)	-0.019** (0.006)	-0.006 (0.02)
Nostalgic Appeal of Original Work	-0.0001*** (0)	-0.579** (0.195)	-0.004* (0.002)	-0.004* (0.002)	-0.005** (0.002)	-0.004* (0.002)
Concentration of Aggressive <i>Danmaku</i> *	-0.003*** (0.001)	-0.13 ⁺ (0.069)	-0.128 ⁺ (0.07)	-0.107 ⁺ (0.06)	-0.177** (0.062)	-0.527* (0.21)
Nostalgic Appeal of Original Work	0.001*** (0)	0.044* (0.022)	0.049* (0.02)	0.049* (0.019)	0.041* (0.02)	0.044 ⁺ (0.024)
Reputation of Original Work						
Control Variables	Consistent with main analysis					
Constant	0 (0.007)	4.287*** (0.85)	4.13*** (1.152)	3.24*** (0.088)	4.25*** (0.851)	2.74*** (0.351)
Observations	20,030					
R ²	0.158					
	0.668					
	0.671					
	0.682					
	0.665					
	0.58					

Note: ⁺p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001. Standard errors are in parentheses.

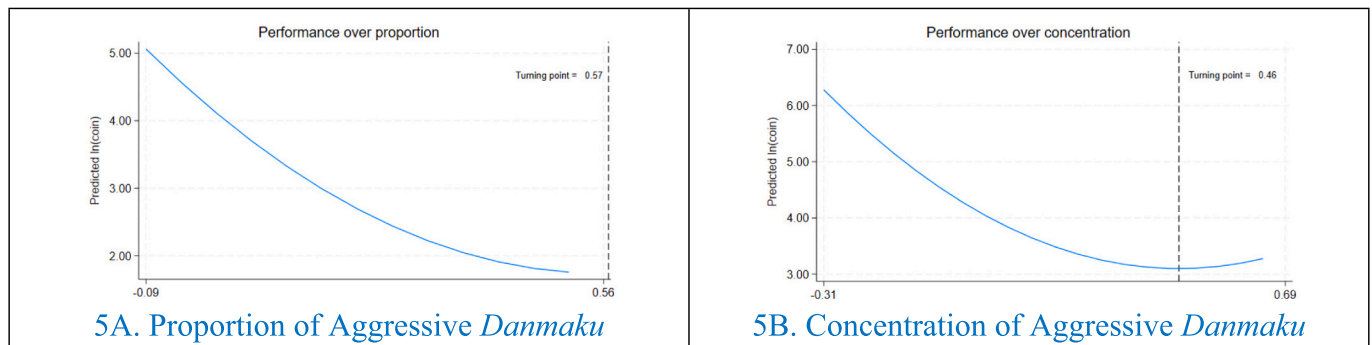


Fig. 5. Test of Nonlinear Effects for Proportion and Concentration of Aggressive *Danmaku*.

slight localized reversal. This indicates that extremely concentrated aggression at certain points may attract a self-selected, more tolerant subgroup, partially restoring engagement. This is consistent with evidence that provocative content can elicit increased interaction from audiences predisposed to such stimuli [63]. Importantly, this recovery is confined to the extreme tail and does not overturn the dominant negative pattern.

Taken together, these nonlinear analyses demonstrate that the negative impact of aggressive *Danmaku* becomes more pronounced as it becomes salient in proportion or concentration, but their marginal effects diminish with increasing proportion and concentration.

6. Post-hoc study 2: Test of effects of distinct aggression types

Although online aggression is often treated as a monolithic construct, it varies in both what is being expressed and how it is conveyed, reflecting heterogeneity [28,30,64,65]. Accordingly, we classify aggression along two dimensions, content and style, to capture this complexity.

Aggression Types by Content: An individual's aggressive disposition typically involves both affective and cognitive aspects [30]. As online expressions reflect the psychological states of their creators, online aggressive content may embody the underlying affective and cognitive mechanisms that drive aggression. Affectively driven aggression arises from spontaneous emotional states such as anger, which, when expressed through online content, often appears as reactive

outbursts marked by intensity and confrontation [66,67]. Such expressions have the potential to elicit psychological distress in recipients, thereby causing harm [28]. This type of aggressive content is termed *cathartic aggression* in this study, characterized by emotionally charged expressions rooted in intense and uncontrollable negative emotions such as anger, dissatisfaction, or irritation. Such messages are primarily affective in nature and may lack a specific target. In contrast, cognitively driven aggression may stem from antagonistic thoughts and, when articulated in online content, is often expressed through deliberate attempts to damage, humiliate, or retaliate against others [28,30,40]. This type of aggressive content is termed *directed aggression* in this study, characterized by purposeful and targeted expressions of hostility, such as animosity, devaluation, or malevolence, directed at a specific entity.

Aggression Types by Style: While aggressive content reveals what is communicated, the manner of its expression—its stylistic form—is also important, particularly in digital contexts where aggression frequently takes the form of culturally encoded or humorous expressions rather than overt or literal statements [65]. Memes—discrete units of cultural information that proliferate rapidly across platforms—have emerged as a prominent mode of expression in digital discourse [68]. Notably, memes are increasingly leveraged as a way for expressing aggression in subtle or indirect ways [69]. Their reliance on irony, metaphor, and mockery enables them to present as playful or humorous on the surface, while simultaneously conveying hostile undertones [64]. To account for the distinction in expressive style, this study classifies aggression into two categories: *memetic aggression* and *non-memetic*

aggression. Memetic aggression refers to a form of aggression expressed through meme-driven discourse, labels, or metaphors, often presented through humor, satire, or mockery. In contrast, non-memetic aggression involves explicit expressions of hostility that do not rely on meme formats.

To categorize distinct types of aggressive *Danmaku*, we utilized a LLM capable of identifying both the content and stylistic features of aggressive expression.⁵ We then replicated the core regression model from the main analysis to analyze the effects of different types of aggression—cathartic, directed, memetic, and non-memetic—on performance outcomes. Analytical results depicted in Table 5 indicate that all types of aggression—measured by both their proportion and concentration—consistently exert direct negative effects on performance. However, their interaction effects with the attributes of the original work vary, as further elaborated in Tables 6 and 7.

In summary, our post-hoc analysis yields rich insights by disaggregating the effects of distinct aggression types. For original works with nostalgic appeal, aggression type that interferes with the expected emotional tone during co-viewing, such as cathartic aggression, tends to have a stronger negative effect. For original works with a strong reputation, aggression type that interferes with the expected informational value during co-viewing, such as directed aggression or memetic aggression, is more likely to further shape viewers' responses.

Table 5
Post-Hoc Analysis.

Focal Variable	Cathartic	Directed	Memetic	Non-memetic
Proportion of Aggressive <i>Danmaku</i>	-3.19*** (0.107)	-4.643*** (0.162)	-3.297*** (0.13)	-3.952*** (0.126)
Concentration of Aggressive <i>Danmaku</i>	-1.778*** (0.031)	-0.454*** (0.032)	-1.19*** (0.032)	-1.211*** (0.031)
Nostalgic Appeal of Original Work	0.006*** (0.001)	0.007*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
Reputation of Original Work	0.122*** (0.011)	0.08*** (0.012)	0.09*** (0.012)	0.115*** (0.011)
Proportion of Aggressive <i>Danmaku</i> * Nostalgic Appeal of Original Work	-0.017* (0.008)	-0.014 (0.013)	-0.005 (0.01)	-0.031** (0.01)
Concentration of Aggressive <i>Danmaku</i> * Nostalgic Appeal of Original Work	-0.004* (0.002)	-0.004+ (0.002)	-0.003 (0.002)	-0.003 (0.002)
Proportion of Aggressive <i>Danmaku</i> * Reputation of Original Work	-0.123 (0.089)	-0.557*** (0.12)	-0.38*** (0.108)	-0.13 (0.097)
Concentration of Aggressive <i>Danmaku</i> * Reputation of Original Work	0.02 (0.023)	0.113*** (0.025)	0.108*** (0.024)	0.018 (0.024)
Control Variables	Consistent with the main analysis			
Constant	4.092*** (1.007)	2.665* (1.104)	3.288** (1.068)	2.914** (1.054)
Observations	20,030	20,030	20,030	20,030
R ²	0.533	0.438	0.475	0.488

Note: +p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001. Standard errors are in parentheses.

⁵ We employed a LLM (Google Gemini) to systematically categorize terms from the original lexicon into specific types of aggression, based on the presence of indicative lexical features. To ensure consistency and reliability, three researchers independently cross-validated the classification results. The procedure followed the same preprocessing and matching pipeline used in our earlier analysis, thereby maintaining methodological consistency and ensuring scalability of the approach.

Table 6
Aggression Types and Nostalgic Appeal^a.

Aggression	Proportion	Concentration
Cathartic aggression	<i>Negative effects amplified</i> This type of aggression can interfere with emotional continuity. When such comments are frequent or highly concentrated, they introduce abrupt emotional fluctuations that challenge viewers' ability to maintain a nostalgic state. This misalignment between expected affective tone and the confrontational nature of the comments can heighten psychological discomfort, as viewers face a stronger conflict between their desire for emotional resonance and emotionally charged aggression in the <i>Danmaku</i> .	<i>Negative effects amplified</i> When directed aggression is temporally concentrated, it commands focused attention through intense and hostile exchanges that sharply diverge from the anticipated tone of warmth and reflection. This sudden shift creates a jarring viewing experience, making it more difficult for audiences to sustain the affective coherence typically associated with nostalgic engagement.
	<i>Interaction insignificant</i>	<i>Interaction insignificant</i>
Content	Dispersed instances of directed aggression tend to be perceived as peripheral, especially when targeted at specific individuals with limited relevance to the wider audience, allowing viewers to maintain their emotional immersion.	<i>Interaction insignificant</i> Memetic aggression is rooted in contemporary digital culture and functions primarily as a form of present-day social commentary. In contrast, nostalgic appeal draws on personal memory and emotional resonance associated with the past. Consequently, the affective engagement prompted by nostalgia and the cultural critique embodied in memetic aggression operate along separate dimensions, resulting in relatively independent effects on audience response.
	<i>Interaction insignificant</i>	<i>Interaction insignificant</i>
Directed aggression	<i>Negative effects amplified</i> When non-memetic aggression is persistently present in the <i>Danmaku</i> environment, it gradually depletes viewers' emotional resources, eroding their capacity to remain immersed and emotionally consistent with the nostalgic atmosphere.	<i>Interaction insignificant</i> When non-memetic aggression occurs in brief, isolated episodes, its momentary salience is insufficient to override the prevailing nostalgic frame, allowing viewers to maintain affective coherence with the overall viewing atmosphere.
	<i>Interaction insignificant</i>	<i>Interaction insignificant</i>
Style	<i>Negative effects amplified</i> When non-memetic aggression is persistently present in the <i>Danmaku</i> environment, it gradually depletes viewers' emotional resources, eroding their capacity to remain immersed and emotionally consistent with the nostalgic atmosphere.	<i>Interaction insignificant</i> When non-memetic aggression occurs in brief, isolated episodes, its momentary salience is insufficient to override the prevailing nostalgic frame, allowing viewers to maintain affective coherence with the overall viewing atmosphere.
	<i>Interaction insignificant</i>	<i>Interaction insignificant</i>

^a **Nostalgic Appeal:** Promotes an emotionally immersive atmosphere in which viewers expect a warm and reflective co-viewing experience.

7. Discussion

7.1. Implications for theory

This study contributes to extant literature on several fronts. First, this study contributes to research on cyber aggression by illuminating the adverse effects of aggressive comments delivered through a novel technological medium that facilitates co-viewing experiences. Departing from past studies which have primarily focused on individual and contextual causes of cyber aggression [6,8,9], this study investigates the collective-level effects of aggressive messages transmitted via *Danmaku*. Capturing the manifestation of cyber aggression along two dimensions, proportion and concentration, we show that the detrimental effects of aggressive *Danmaku* differ across varying levels of proportion and concentration. In so doing, we elucidate when and how aggression undermines outcomes in co-viewing environments through bounded, non-linear dynamics. It underscores the importance of assessing aggressive

Table 7
Aggression Types and Reputation^a.

Aggression	Proportion	Concentration
Cathartic aggression	<i>Interaction insignificant</i> Cathartic aggression primarily manifests at the emotional level, serving as a means of affective release, whereas the reputation of the original work shapes audience expectations around cognitive engagement and informational value. Given the relative independence of these dimensions, the presence of emotionally charged comments does not significantly influence audience expectations for insightful or high-quality commentary. <i>Negative effects amplified</i>	<i>Interaction insignificant</i> Manifests at the emotional level, serving as a means of affective release, whereas the reputation of the original work shapes audience expectations around cognitive engagement and informational value. Given the relative independence of these dimensions, the presence of emotionally charged comments does not significantly influence audience expectations for insightful or high-quality commentary. <i>Negative effects alleviated</i>
Content	When directed aggression becomes widespread, it undermines the overall discursive quality of the environment. The <i>Danmaku</i> section then devolves into conflict rather than dialogue, further diminishing the co-viewing experience.	When directed aggressive comments are concentrated around specific plot points, they are often perceived as part of an engaged, albeit intense discussion. In such cases, audiences may be more tolerant, as the aggression remains contextually anchored and may still contribute to the exchange of viewpoints, thus diminishing its negative impact.
Directed aggression	<i>Negative effects amplified</i> When memetic aggression becomes excessive and pervasive, it can overshadow substantive commentary, making it difficult for meaningful insights to gain attention or traction. This saturation degrades the overall quality of interaction, shifting the environment from informed exchange to hostile banter, further diminishing the audience's experience.	<i>Negative effects alleviated</i> When memetic aggression is concentrated around specific plot points, it often reflects a shared situational understanding among viewers and is more likely to be perceived as a form of communal engagement. In such cases, its negative effects are mitigated.
Memetic aggression	<i>Interaction insignificant</i> There is no significant interaction between non-memetic aggression and the reputation of the original work. Non-memetic aggressive comments—characterized by direct expressions of hostility—tend to mainly influence the emotional tone of the viewing environment rather than its cognitive substance. Since viewer expectations for highly reputed works are primarily focused on the quality and depth of information conveyed in commentary, such emotionally driven expressions do not substantially affect the anticipation of informative engagement.	<i>Interaction insignificant</i>
Style		
Non-memetic aggression		

^a **Reputation:** Cultivates a cognitively engaged environment in which viewers anticipate insightful, high-quality commentary and informed interaction in their co-viewing experience.

behavior in emerging communication technologies with attention to both the general tone of the viewing environment and the occurrence of sudden, intense surges of aggression. Recognizing these dual manifestations is essential for advancing future research on the dynamics of cyber aggression and for informing strategies that support healthier online environments.

Second, this study extends extant literature on *Danmaku* by scrutinizing its dark side, focusing on aggressive *Danmaku* and their heterogeneity. Past studies have predominantly focused on the positive outcomes of *Danmaku* [4,25,26], while its potential negative effects have largely been neglected. As an emerging communication channel, *Danmaku* can also function as a medium for conveying aggression. This study advances our understanding of the adverse consequences

associated with this distinctive form of user-generated commentary. Furthermore, we have further categorized aggressive *Danmaku* along two key dimensions—content and style—to better capture the complexity of aggression expressed through *Danmaku*. Our empirical findings attest to the importance of moving beyond a monolithic view of aggressive content and of attending to both what is expressed and how it is communicated when analyzing aggressive behavior in online communication.

Third, this study enhances our understanding of the boundary conditions of cyber aggression in the context of condensed clip consumption, a novel form of UGC derived from original full-length works. Though past studies have explored how condensed clips influence viewer demand for the original works [1,3], the potential influence of the original works' attributes on viewers' responses to condensed clips has largely been overlooked. Our study marks a pioneering effort in uncovering how specific attributes of the original work shape viewers' responses to different types of aggressive *Danmaku* during co-viewing of condensed clips. As shown in Table 8, certain types of aggression exhibit greater variation in impact depending on the attributes of the original work. Specifically, when the original work possesses nostalgic appeal, the effect of cathartic aggression content is more pronounced, whereas when the original work is reputed, directed aggression content and memetic aggression style demonstrate greater variability in their impact. These empirical findings highlight the importance of considering previous associations established by the original work as boundary conditions for cyber aggression. Future studies on viewer behavior in condensed clip consumption should account for the contextual influence of source material on audience responses.

Finally, while CDT traditionally addresses internal cognitive conflict at the individual level [36–38], this study extends its application to collective viewer behavior. Our findings indicate that cognitive dissonance can produce uncoordinated yet synchronous reactions across a viewing community. Moreover, viewer responses to aggressive commentary vary with contextual factors, illustrating how CDT can account for the mechanisms through which context shapes the intensity of

Table 8
Aggression Types Showing Greater Impact Variation by Original Work Attributes.

Original Work Attribute	Aggression Type	Dimension	Greater Impact Variation
Nostalgic Appeal	Cathartic aggression	Content	During co-viewing of condensed clips, the intense emotional expression of cathartic aggression may interfere with the expected affective tone elicited by the nostalgic appeal of the original work. This introduces abrupt emotional fluctuations that challenge viewers' ability to maintain a nostalgic state and heighten discomfort, leading to the amplification of its negative effects.
Reputation	Directed aggression, Memetic aggression	Content Style	During co-viewing of condensed clips, these types of aggression may interfere with the expected informational value elicited by the strong reputation of the original work. When these aggressions are pervasive, they can hinder meaningful discussion, resulting in the amplification of their negative effects; however, when concentrated around specific points, they may reflect fierce debate in the exchange of ideas or shared situational understanding, leading to the mitigation of their negative effects.

dissonance and, consequently, collective behavioral outcomes.

7.2. Implications for practice

This research yields valuable practical implications for platform managers. A strict blocking approach to aggressive *Danmaku* risks suppressing expressive diversity, thereby undermining the interactive nature of the co-viewing environment. Instead, platforms may develop mechanisms that identify and monitor situations in which aggressive *Danmaku* appear in high proportions or cluster densely. This allows for timely interventions, such as introducing AI-generated *Danmaku* to dilute aggressive content, while reserving strict blocking only for severe cases. Additionally, given the heterogeneity of aggressive *Danmaku*, AI-driven pattern-recognition algorithms can be employed to monitor distinct types of aggressive expressions. Such an approach allows platforms to mitigate their detrimental effects while preserving the convivial co-viewing experience that *Danmaku* enables.

Moreover, moderation strategies should be adapted to the characteristics of the original work. For content derived from highly reputable sources, particular attention should be given to directed and memetic aggression in order to maintain the quality of discussion. For content that evokes strong nostalgic appeal, moderation strategy should focus more on managing cathartic aggression. Creators are advised to avoid including polarizing elements that deliberately instigate disputes, thereby preserving the reflective and emotionally rich atmosphere.

7.3. Limitations and future research

This section highlights several limitations of this study and presents opportunities for future research. First, while the data from a popular UGC platform are well-suited for examining the impact of aggressive *Danmaku*, we acknowledge limitations related to the use of proxy measures and a cross-sectional dataset. These approaches may not fully capture dynamic viewer responses or unobservable factors such as cognitive dissonance. To address these concerns, we included control variables for both condensed clip and original work characteristics and further conducted endogeneity checks through synthetic control-style analyses, drawing on multiple matching methods (i.e., kernel PSM, nearest-neighbor matching, and CEM), along with supplementary robustness tests to reduce potential biases. These robustness checks consistently produce treatment effects of similar sign and magnitude, reinforcing the credibility of our analytical results. Nonetheless, future research could employ causal identification strategies, such as field experiments or longitudinal studies with panel datasets, to more directly examine the underlying mechanisms and validate the observed effects.

Second, while our study provides an initial step toward understanding how specific attributes of the original work (i.e., nostalgic appeal and reputation) interact with aggressive *Danmaku* to influence viewer response, other contextual factors may also serve as potential moderators, such as genre and thematic complexity. Additionally, this study does not consider the synchronization between specific video content and *Danmaku*. Future research could extend this study by exploring a broader range of contextual factors and the potential alignment between video content and *Danmaku*, thereby developing a more comprehensive understanding of audience reactions to condensed clips.

Third, this study draws data from a single platform with a focus on condensed video clips. While Bilibili is a leading example of *Danmaku* culture, it may not capture the full diversity of video formats or viewer behaviors across platforms. *Danmaku*-style interaction reflects an emerging global trend in digital media engagement. In China, platforms like iQIYI, Tencent Video, and Youku have adopted *Danmaku* features, with iQIYI alone recording over 10 million bullet comments during a popular 2024 series [70]. Internationally, interactive commentary is also evident on platforms such as Twitch (real-time comments), Viki (live comments), and YouTube (live chat) [71]. We are therefore

convinced that the interactive mechanisms analyzed in this study can offer insights into broader trends in digital video engagement. Additionally, recap videos—common on platforms like YouTube and TikTok—often rely on narration due to copyright constraints, yet still attract active participation [2]. A China Economic Net report notes that young audiences commonly engage with these videos through *Danmaku*, using them to interact around plot points, narration, and analysis [72]. We recognize, however, that the structure of condensed clips may shape specific patterns of *Danmaku* behavior that are not fully representative of content types. Future research could explore *Danmaku* dynamics across a wider range of platforms and video genres to assess the broader applicability of our conclusions and to capture the evolving forms of audience interaction in digital video culture.

Lastly, this study is set within China's specific cultural and regulatory context, where video platforms function under stringent content governance [73]. The findings should be considered with attention to the specific moderation practices and social norms of this setting, as patterns may differ in platforms or cultural contexts with alternative regulatory approaches. Nevertheless, the persistence of aggressive comments even under strict moderation suggests that such behaviors likely reflect broader online interaction patterns, indicating that our findings may offer insights beyond this particular context. Future research is encouraged to extend this work across platforms and cultural settings to validate these findings. Examining how varying moderation mechanisms and audience expectations impact aggressive behaviors in *Danmaku* and similar comment systems could be invaluable in formulating a more comprehensive understanding of online user interactions.

CRediT authorship contribution statement

Bingqing Xiong: Visualization, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization, Writing – review & editing, Writing – original draft. **Fangfang Hou:** Resources, Methodology, Formal analysis, Data curation, Conceptualization, Writing – review & editing, Writing – original draft. **Chee-Wee Tan:** Supervision, Resources, Methodology, Data curation, Conceptualization, Writing – review & editing. **Hao Liu:** Methodology, Formal analysis, Data curation, Writing – review & editing.

Declaration of competing interest

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Data availability

Data will be made available on request.

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Dr. Bingqing Xiong is a Senior Lecturer at Deakin Business School, Deakin University. Her research interests focus on innovation issues related to innovation diffusion, innovation portfolios, and strategic management in various contexts (e.g., open innovation, crowd-sourcing, social trading, e-commerce, and e-health). Her research has appeared in international journals such as *Journal of Management Information Systems (JMIS)*, *Journal of*

the Association for Information Science and Technology (JASIST) and Industrial Management & Data Systems (IMDS) as well as proceedings of leading management and information systems conferences such as the Americas Conference on Information Systems (AMCIS), the Annual Meeting of the Academy of Management (AOM), the Hawaii International Conference on System Sciences (HICSS), the International Conference on Information Systems (ICIS), and the Pacific Asia Conference on Information Systems (PACIS).

Dr. Fangfang Hou is currently an Assistant Professor at Department of Intelligent Operations and Marketing, International Business School Suzhou, Xi'an Jiaotong Liverpool University. Her research areas include social media, live streaming, charitable crowdfunding, and digital innovation. She has published papers in journals such as Information Systems Journal, Information Technology & People, Production Planning and Control, Internet Research, and Industrial Management and Data Systems.

Prof. Chee-Wee Tan is a Professor in the Department of Management and Marketing at the Hong Kong Polytechnic University. His research interests focus on design and innovation issues related to digital platforms. Particularly, he is interested in discovering how value can be extracted from digital platforms, exploring ways by which contemporary technological trends can contribute to the design and governance of such platforms. His work has

been published in leading journals such as Information Systems Research (ISR), Journal of Operations Management (JOM) MIS Quarterly (MISQ), Journal of Management Information Systems (JMIS), Information Systems Journal (ISJ), Journal of the Association for Information Systems (JAIS), and Journal of Information Technology (JIT) among others. Apart from his current appointment as Senior Editor for MISQ, Chee-Wee has served or is currently serving on the editorial boards of Decision Support Systems (DSS), Industrial Management & Data Systems (IMDS), Information and Management (I&M), Internet Research (IntR), JAIS, Journal of Management Analytics (JMA), and JMIS. Chee-Wee is also the Vice President of Publications for the Association for Information Systems.

Dr. Hao Liu is a Lecturer at Deakin Business School, Deakin University. His research interests include data mining, machine learning, deep learning, big data analytics, natural language processing, and their applications in talent analytics and open innovation. His research has appeared in international journals such as AIS Transactions on Replication Research (TRR), and IEEE Transactions on Knowledge and Data Engineering (TKDE) as well as proceedings of international conferences such as the Australasian Conference on Information Systems (ACIS), Hawaii International Conference on System Sciences (HICSS), and the International Joint Conference on Artificial Intelligence (IJCAI).