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Does Money Talk? The Impact of Monetary Incentives on User-Generated Content Contributions

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Abstract. Many platforms use monetary incentives to encourage user-generated content (UGC) contributions. However, empirical studies report contradictory findings: monetary incentives may either increase or decrease contribution. To understand the underlying mechanisms, we build a theoretical model where four types of contributors (classified by whether they contribute without monetary incentive and whether they are effective in attracting audience) compete for the audience. We identify two crowding out effects: (1) *motivation crowding out*, where the introduction of a monetary incentive reduces the non–money-driven contributors' motivation to contribute (e.g., contributors may worry that they would be viewed as greedy), so they reduce their effort or even stop contributing; and (2) *competition crowding out*, where the low-effectiveness contributors reduce their effort or even stop contributing because of intensified competition when the monetary incentive increases. Under the influence of these two crowding-out effects, the impact of a monetary incentive on the contributors' participation and on their total content volume is not monotonic. As a result, different equilibrium outcomes emerge as the monetary incentive increases. We also extend our model to the case where the number of contributors in each type could be different and identify more complicated crowding-out phenomena. Our findings offer guidelines for designing monetary incentive schemes for online UGC platforms.

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Keywords: user-generated content • monetary incentive • motivation crowding out • competition crowding out

1. Introduction

In recent years, online communities have become increasingly essential to people's daily lives (e.g., Wikipedia, YouTube, Facebook, Instagram, and various online forums or review sites), as well as business practices (e.g., knowledge sharing systems, cocreation forums, open-source software communities). An increasing number of companies, including Apple, Oracle, SAP, and SUN, adopt online forums to enable users to contribute solutions to other users' questions or to collect creative user-generated ideas and product designs (Jabr et al. 2013). These online communities rely heavily on users to contribute content, such as product reviews, blogs, music, pictures, videos, answers, codes, or knowledge. Therefore, how to encourage users to contribute has become a critical issue for these businesses.

Monetary incentives are often introduced to encourage contributions (Li et al. 2016, Fang and Liu 2018). For example, YouTube, About.com, Break, and Epinions.com pay users for their contributions through advertising-revenue-sharing schemes (Tang et al. 2012b). Moreover, many companies use cash awards to encourage employees to contribute knowledge to their electronic knowledge repositories (Garud and Kumaraswamy 2005, Kankanhalli et al. 2005). For instance, Infosys (NASDAQ: INFY), a global software services company, offers Knowledge Currency Units (KCUs), which can be exchanged for cash, to its employees for contributing knowledge to its knowledge portal (Garud and Kumaraswamy 2005). Some companies also use monetary rewards to compensate their consumers for contributing in cocreation forums, such as Lego's Cuusoo platform and Siemens's ShareNet (Voelpel et al. 2005, Antorini et al. 2012).

However, empirical findings are mixed on the impact of monetary incentives on user-generated content (UGC) contributions. On one hand, evidence shows that monetary incentives attract more contributors and

improve contributions (Tang et al. 2012a, Aoki and Ogawa 2014, Chen et al. 2017). For example, Tang et al. (2012a) study the content contributing behavior on YouTube using field data. They find that revenue sharing on YouTube is the major incentive for content contributions. On the other hand, it is also reported that monetary incentives crowd out certain contributors and reduce total contributions (Sun et al. 2017, Khern-amnuai et al. 2018). For example, Sun et al. (2017) find that the total contributions of an online review community had an unexpected reduction after introducing monetary rewards to the community. Possible reasons for the mixed findings include the interaction between monetary incentives and nonmonetary motivations, the amount of monetary incentives, and the competition among contributors (Alexy and Leitner 2011, Shen et al. 2015, Sun et al. 2017).

Because of the complicated relationship between monetary incentives and UGC contributions, it is necessary to examine *when and why* monetary incentives work (Alexy and Leitner 2011). Unfortunately, the existing theoretical models either do not focus on UGC contributions or do not focus on the effects of monetary incentives (Bénabou and Tirole 2006, Ma et al. 2009, Ghosh and McAfee 2011, Zhang and Sarvary 2014); thus, these models cannot be comprehensively investigate the impact of monetary incentives on UGC contributions. Moreover, monetary rewards are usually related to the audience size. Audience, however, is a scarce resource on the internet, and UGC contributors need to compete for it (Hansen and Haas 2001). The competition among contributors is rarely studied in the literature.

To fulfill the research gap, we build a theoretical model to examine the impact of monetary incentives on UGC contributions. Our model offers explanations for the contradictory findings in the previous literature, and more importantly, examines the consequences of competition among UGC contributors. Based on both practical observations and previous literature, we categorize the contributors by two dimensions: whether they contribute when there is no monetary incentive and whether they are effective in attracting the audience. The first dimension is inspired by the vast number of newcomers after a monetary incentive is introduced in a UGC platform, and the second dimension is inspired by the observation that contributors in UGC platforms are usually composed of many nameless grassroots contributors and a limited number of popular Internet celebrities. In our model, we assume that the *high-effectiveness* contributors attract more audience with the same effort than the *low-effectiveness* contributors do.

We identify two types of crowding out effects associated with monetary incentives, specifically, (1) the *motivation crowding out* effect and (2) the *competition crowding out* effect. Under the motivation crowding out effect, the introduction of a monetary incentive may undermine contributors' nonmonetary motivations, because the monetary incentive may dilute the signaling effect of contribution behavior on prosocial preferences and increase that on greediness (Bénabou and Tirole 2006, Ariely et al. 2009); thus, the non–money-driven contributors may reduce their contributions or even stop contributing. Under the competition crowding out effect, when the monetary incentive increases, the competition for the scarce audience resource among the contributors is intensified; thus, the low-effectiveness contributors may reduce their contributions or even stop contributing. This competition crowding out effect is unique to UGC contribution but has received little academic attention. Under the influence of these two crowding out effects, the impact of monetary incentives is nonmonotonic on contributor participation and on the total content volume. Consequently, different equilibria emerge, depending on parameters such as the difference in contributors' effectiveness in attracting the audience and how non–money-driven contributors' rewards from contributions are affected by the monetary incentive. We also extend our model to have different number of contributors within each type. We identify more complicated crowding-out phenomena. For example, as the monetary incentive increases, contributors either continue contributing, or are crowded out or restart contributing depending on the magnitude of the monetary incentive.

To the best of our knowledge, this study makes the first attempt to model the impact of monetary incentives on UGC contributions by incorporating competition among different types of contributors. It enriches our understanding of the crowding out phenomenon. Specifically, crowding out can occur for different reasons: (1) when the monetary incentive is low, the non–money-driven contributors are negatively affected by the introduction of monetary incentive, and thus they reduce contribution or stop contributing (the *motivation crowding out*); and (2) when the monetary incentive increases, the high-effectiveness contributors start contributing and crowd out the low-effectiveness contributors (the *competition crowding out*). Our study is the first to identify the competition crowding out effect and finds that both contributor participation and total content volume can drop with an increase in the monetary incentive. We also provide guidelines to practitioners for designing appropriate monetary incentive mechanisms.

The remainder of this paper is organized as follows. We review related literature in Section 2. We introduce a benchmark model in Section 3 and conduct comparative statics analyses in Section 4. We extend the model in Section 5 by considering different number of

contributors within each type. We discuss the practical implications of the theoretical findings and present the conclusions in Section 6.

2. Literature Review

2.1. UGC

UGC is commonly known as "any form of content, such as blogs, wikis, discussion forums, posts, chats, tweets, podcasting, pins, digital images, video, audio files, and other forms of media, that was created by users of an online system or service, often made available via social media websites" (Moens et al. 2014, p. 1). UGC has several characteristics including (1) the content is digital rather than material; (2) it is usually free to access; and (3) contributors need to compete for audience (Huang et al. 2015, Shen et al. 2015). Because of the characteristics of UGC, the *free ride* phenomenon is frequently observed. The well-known *1% rule* or *90-9-1 principle* indicates that only 1% of users actively contribute, 9% sparingly contribute, and the other 90% just *lurk* within Internet communities (van Mierlo 2014). The contributors are commonly driven by motivations such as reputation, interpersonal ties, direct reciprocity, and enjoyment (Wasko and Faraj 2005, Zhang and Zhu 2010, Xu and Li 2015).

2.2. Mixed Empirical Findings on the Impact of Monetary Incentives

Monetary incentives are often introduced to encourage UGC contributions (Li et al. 2016, Fang and Liu 2018). However, the empirical results on the impact of monetary incentives on UGC contributions are mixed.

On one hand, empirical studies find that monetary incentives could attract more contributors and increase contributions. For example, Garud and Kumaraswamy (2005) find that the monetary incentives of the knowledge-sharing system in InfoSys attract nearly 20% of employees to contribute knowledge. Using both survey and archival data from the Apache open-source-software developers, Roberts et al. (2006) find that paid participation leads to above-average contribution levels. Tang et al. (2012a), using data from YouTube, show that revenue-sharing programs can motivate content contributions. Burtch et al. (2015) conduct a large-scale randomized field experiment in an online clothing retailing platform and find that monetary payments attract a larger volume of reviews. Chen et al. (2017) study the effects of providing monetary incentives to amateur analysts for stock recommendation on social media. They find that monetary incentives can effectively increase the amount of content output. Aoki and Ogawa (2014) surveys 1,000 contributors of two UGC recipe sites and finds that monetary incentives have significant positive impact on the quantity of ideas and contributions.

On the other hand, there is opposite empirical evidence that shows monetary incentives may *backfire* (i.e., crowd out contributors and reduce contributions; McKenzie et al. 2012). For example, Sun et al. (2017) find that, after introducing monetary rewards for posting reviews to an online review community, the less-connected members increase, whereas the more-connected members decrease their contributions, and total contributions unexpectedly decrease. Lin and Huang (2013) compare two Q&A online forums: Google Answers (with monetary incentives) and Yahoo! Kimo Knowledge+ (without monetary incentives). They conclude that Google Answers fails with its monetary incentives, but Knowledge+ succeeds with its virtual rewarding mechanism. Khern-am-nuai et al. (2018), in a natural experiment, study the impact of monetary incentive on writing online reviews. They find that when the review platform offers monetary incentives, the number of new reviewers increases, but the participation level of existing reviewers decreases. Bründl and Hess (2016), in a web survey of 543 broadcasters on social live streaming platforms, also find that monetary incentives have a negative influence on contribution intentions.

2.3. Possible Reasons for Mixed Empirical Findings

The literature offers several possible explanations for the mixed findings about the impact of monetary incentives on UGC contributions.

2.3.1. The Interaction Between Two Effects of Monetary Incentives. A monetary incentive may induce two effects: a direct standard price effect and an indirect psychological effect (Frey and Jegen 2001, Heyman and Ariely 2004). The direct standard price effect (i.e., a higher monetary incentive leads to more effort and better performance) is widely acknowledged in the economics literature (Gneezy et al. 2011). Aside from the direct standard price effect, monetary incentives also have an indirect psychological effect. Monetary incentives may crowd out nonmonetary motivations; this is known as the *motivation crowding out effect* (Lepper et al. 1973). For example, Alexy and Leitner (2011) conduct a scenario experiment with open-source-software developers and find that monetary incentives decrease intrinsic motivations for some contributors. Ariely et al. (2009) review the literature and find that monetary incentives negatively interact with contributors' image concerns by diluting the signaling value of contribution behavior. Combining both direct price effect and indirect psychological effect, the ultimate effect of monetary incentives becomes a *puzzle*.

2.3.2. The Amount of Monetary Incentives. Empirical studies show that the amount of monetary incentives

may play a key role. First, introducing a small monetary incentive may cause a sharp reduction in contributions. For example, Sun et al. (2017) suggest that the *token size* of monetary rewards is a possible reason why monetary rewards undermine contribution rates in their experiments. Even when the monetary reward is token size, contributors still worry that they would be viewed as greedy (Bénabou and Tirole 2006). Second, a sufficiently large monetary incentive is found to have a positive impact (Gneezy and Rustichini 2000, Gneezy et al. 2011). Wolfe and Loraas (2008) perform two laboratory experiments of knowledge sharing. Their results also indicate that the monetary incentive must be sufficient to promote substantial knowledge sharing. Consequently, researchers suggest that *zero is special* (i.e., the impact of monetary incentives on contributions is discontinuous around the zero point) (Bénabou and Tirole 2006, Gneezy et al. 2011).

2.3.3. The Competition Among Contributors. The audience is arguably the most valuable and scarce resource on the Internet (Davenport and Beck 2001). Contributors need to compete for the audience, especially when the rewards are related to audience size (Hansen and Haas 2001). There is scant literature on the competition among contributors in the UGC setting. Shen et al. (2015) study the online book reviewers of Amazon and Barnes&Noble. They find that book reviewers are sensitive to the competition among existing reviews and try to avoid crowded review segments. Huang et al. (2015) show that there is intense competition among employees to attract the audience for their posts on an enterprise blog platform, and when the competition increases by 10%, the posts decrease by around 15%.

2.4. Related Theoretical Models

In summary, the empirical findings concerning the impact of monetary incentives on UGC contributions are mixed. After reviewing previous literature, Ariely et al. (2009, p. 545) indicate that "less is known, however, about the mechanisms by which this unintended consequence occurs." Therefore, it is necessary to develop theoretical models to understand when and why monetary incentives work on UGC contributions. However, the existing theoretical models either do not focus on UGC contributions or do not focus on the effects of monetary incentives.

On one hand, there are few theoretical models that study the effects of monetary incentives on the traditional prosocial behavior (Bénabou and Tirole 2006). Prosocial behavior is a type of behavior that benefits other people or the society as a whole, such as "helping, sharing, donating, cooperation and volunteering" (Brief and Motowidlo 1986, p. 710). UGC contribution is distinct from traditional prosocial behaviors in that (1) UGC is digital and nonexcludable, where one's consumption does not reduce the others' consumption of the same content, and (2) the UGC audience is a scarce resource on the Internet, such that UGC contributors compete for this limited audience (Davenport and Beck 2001). Therefore, the existing *prosocial behavior* models do not apply to the UGC contribution context.

On the other hand, the existing theoretical models developed for UGC contributions do not focus on the impact of monetary incentives. For example, Ghosh and McAfee (2011) provide a game-theoretical model to study the problem of incentivizing high-quality content using a rating mechanism. Zhang and Sarvary (2014) build a hoteling-style model to study the UGC market segmentation. Ma et al. (2009) model the competition between two UGC platforms and analyze the impact of a UGC platform's quality control decision. These models do not focus on the effect of monetary incentives on UGC contributions; thus, they cannot offer a comprehensive explanation for the mixed findings in the literature.

3. Benchmark Model

3.1. Contributors

Our model mainly focuses on the impact of monetary incentives on UGC contributions. When there is no monetary incentive, some contributors contribute, whereas others do not (Garud and Kumaraswamy 2005). When there is monetary incentive, the monetary incentive is usually awarded according to the size of the audience attracted by the contributors, often measured by or related to the number of page views or unique visitors, such as the cases of YouTube's advertisement-sharing plan, Seeking Alpha's premium partnership program, and Amazon's contributor rewards (Tang et al. 2012a, Chen et al. 2017). The audience size information is usually displayed on the websites. However, UGC contributors differ in their abilities to attract audience. In the context of UGC contribution, many are nameless *grassroots*, whereas some become famous or even Internet celebrities like Michelle Phan, who became Lancôme's first video makeup artist (Tang et al. 2012a). The effectiveness of the contributors in attracting the audience significantly impacts the monetary rewards they receive (Tang et al. 2012a). Following these observations and the reviewed literature, we categorize the contributors along the following two dimensions:

1. Whether a contributor contributes when there is no monetary incentive: We denote the contributors who contribute without a monetary incentive as *Non–money-driven* ($\bar{M}$) and those contributors who contribute only when there is monetary incentive as *Money-driven* (M).

2. Whether a contributor is effective in attracting the audience: For simplicity, we assume that with the same amount of effort, the contributors generate the same amount of content, but a *Low-effectiveness* contributor ($\bar{E}$) attracts α percent ($0<\alpha<1$) less audience than a *High-effectiveness* contributor (E) does. As such, if the effective effort of E is 1, the effective effort of $\bar{E}$ is $1-\alpha$.

Consequently, a contributor can be classified into one of the four types as illustrated in Figure 1.

Let c_i denote contributor i's effort, $i \in \{\bar{M}E, \overline{ME}, ME, M\bar{E}\}$. Then each contributor's effective effort, denoted by $Q_i(c_i)$, will be $c_{\bar{M}E}$, $(1-\alpha)c_{\overline{ME}}$, c_{ME}, and $(1-\alpha)c_{M\bar{E}}$, respectively.

3.2. Competition for Audience

On a UGC platform, contributors must compete for the audience (Huang et al. 2015, Shen et al. 2015). Following the logic of the Lanchester model[1] (Erickson 1985, Wang and Wu 2001), we assume that the size of the audience attracted by a contributor is positively correlated to the contributor's own effective effort (with a diminishing rate) but negatively correlated to the total effective effort in the UGC platform. More specifically, the share of the audience that contributor i attracts can be expressed as $S_i = Q_i(c_i)/\sum Q_i(c_i)$, where $\sum Q_i(c_i) = c_{\bar{M}E} + (1-\alpha)c_{\overline{ME}} + c_{ME} + (1-\alpha)c_{M\bar{E}}$, representing the total effective effort. We assume that, in the short term, the total audience size is fixed. For simplicity, let it be 1; then S_i also represents the audience size of contributor i.

In this model, each contributor maximizes his/her net utility by choosing the optimal effort level $c_i \geq 0$, given the other contributors' optimal levels of effort. We will discuss the equilibrium outcomes under two scenarios: without monetary incentives and with positive monetary incentives.

3.3. No Monetary Incentive

When there is no monetary incentive, the money-driven contributors ME and $M\bar{E}$ will not contribute. The non–money-driven contributors $\bar{M}E$ and $\overline{ME}$ obtain a nonmonetary incentive that is positively correlated with their audience size (Andreoni 2007, Zhang and Zhu 2010). Following the literature, we assume that this reward is βS_i, where S_i is the audience size of contributor i ($i \in \{\bar{M}E, \overline{ME}\}$) and $\beta > 0$.

Let π_i denote contributor i's net utility in contributing the content. Therefore, the decision problems for contributors $\bar{M}E$ and $\overline{ME}$ can be represented by

$$\max. \begin{cases} \pi_{\bar{M}E} = \beta S_{\bar{M}E} - c_{\bar{M}E}, \\ \pi_{\overline{ME}} = \beta S_{\overline{ME}} - c_{\overline{ME}}, \end{cases}$$

$$\text{s.t. } \pi_i \geq 0 \text{ and } c_i \geq 0, \text{ where } i \in \{\bar{M}E, \overline{ME}\},$$

$$S_{\bar{M}E} = \frac{c_{\bar{M}E}}{c_{\bar{M}E} + (1-\alpha)c_{\overline{ME}}} \text{ and } S_{\overline{ME}} = \frac{(1-\alpha)c_{\overline{ME}}}{c_{\bar{M}E} + (1-\alpha)c_{\overline{ME}}}.$$

Solving these equations, we obtain that the two contributors' effort levels are $c_{\bar{M}E} = c_{\overline{ME}} = (1-\alpha)\beta/(2-\alpha)^2$, with associated audience sizes $S_{\bar{M}E} = 1/(2-\alpha)$ and $S_{\overline{ME}} = (1-\alpha)/(2-\alpha)$, respectively. In other words, when there is no monetary incentive, the non–money-driven contributors $\bar{M}E$ and $\overline{ME}$ expend the same effort, but the high-effectiveness contributor $\bar{M}E$ attracts more audience than the low-effectiveness contributor $\overline{ME}$.

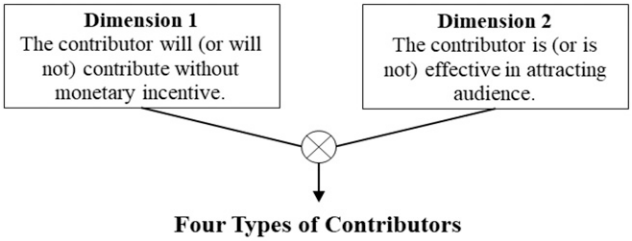
3.4. When a Positive Monetary Incentive Is Introduced

In practice, a monetary incentive is usually given based on the size of the audience attracted by the content (Tang et al. 2012a). For examples, YouTube's advertisement-sharing plan pays based on the number of views that a video attracts; Seeking Alpha's premium partnership program pays premium contributors $10 per 1,000 page views; and Amazon's contributor reward is based on the number of votes from customers, which is also correlated to the number of views (Tang et al. 2012a, Chen et al. 2017). We consider the simplest case where the monetary incentive is proportional to the audience S_i, or simply γS_i where $\gamma > 0$ represents the monetary incentive.

In addition, monetary incentives may induce an indirect psychological effect, which negatively modifies the non–money-driven contributors' nonmonetary reward (Gneezy et al. 2011). To understand, the monetary incentives may conflict with a contributor's other motivations by changing others' perceptions of the contribution behavior (decreasing the signal of prosocial preferences while increasing the signal of greediness) (Bénabou and Tirole 2006, Gneezy et al. 2011). We denote this *modified nonmonetary reward* as $\beta' = \beta + \delta$, where $\delta < 0$ represents the negative modification induced by the monetary incentive.

When a monetary incentive is introduced, the non–money-driven contributors $\bar{M}E$ and $\overline{ME}$ obtain both the modified nonmonetary reward and the monetary

Figure 1. Four Types of Contributors



	High-effectiveness (E)	Low-effectiveness ($\bar{E}$)
Non-money-driven($\bar{M}$)	$\bar{M}E$	$\overline{ME}$
Money-driven (M)	ME	$M\bar{E}$

reward, so $\pi_i = (\beta' + \gamma)S_i - c_i$, $i \in \{\bar{M}E, \overline{ME}\}$; the money-driven contributors ME and $M\bar{E}$ obtain only the monetary incentives, so $\pi_i = \gamma S_i - c_i$, $i \in \{\bar{M}E, \overline{ME}\}$. Therefore, the decision problems for the contributors are

$$\max. \begin{cases} \pi_{\bar{M}E} = (\beta' + \gamma)S_{\bar{M}E} - c_{\bar{M}E} \\ \pi_{\overline{ME}} = (\beta' + \gamma)S_{\overline{ME}} - c_{\overline{ME}} \\ \pi_{ME} = \gamma S_{ME} - c_{ME} \\ \pi_{M\bar{E}} = \gamma S_{M\bar{E}} - c_{M\bar{E}} \end{cases}$$

$$\text{s.t. } \pi_i \geq 0 \text{ and } c_i \geq 0, \text{where } i \in \left\{\bar{M}E, \overline{ME}, ME, M\bar{E}\right\},$$

$$S_{\bar{M}E} = \frac{c_{\bar{M}E}}{\sum Q_i(c_i)}, S_{\overline{ME}} = \frac{(1-\alpha)c_{\overline{ME}}}{\sum Q_i(c_i)}, S_{ME} = \frac{c_{ME}}{\sum Q_i(c_i)},$$

$$S_{\overline{IP}} = \frac{(1-\alpha)c_{M\bar{E}}}{\sum Q_i(c_i)},$$

and $\sum Q_i(c_i) = c_{\bar{M}E} + (1-\alpha)c_{\overline{ME}} + c_{ME} + (1-\alpha)c_{M\bar{E}}$.

In equilibrium, each contributor i decides his/her optimal effort level given the other contributors' optimal effort levels. Note that $\partial \pi_i / \partial c_i = \mu_i(\sum Q_i(c_i) - Q_i(c_i))/(\sum Q_i(c_i))^2 - 1$, where $\mu_{\bar{M}E} = \beta' + \gamma$, $\mu_{\overline{ME}} = (1-\alpha)\beta' + (1-\alpha)\gamma$, $\mu_{ME} = \gamma$ and $\mu_{M\bar{E}} = (1-\alpha)\gamma$. According to the Karush-Kuhn-Tucker (KKT) conditions, a contributor i makes a positive contribution (interior solution) if μ_i is sufficiently large: that is, $\mu_i > (\sum Q_i(c_i))^2 / (\sum Q_i(c_i) - Q_i(c_i))$. Otherwise, the contributor i will not contribute (corner solution). Here, μ_i can be interpreted as the maximum benefit that contributor i can get. It is straightforward to see that contributor i would contribute if, and only if his/her maximum benefit (μ_i) is sufficiently high. Given that each contributor's equilibrium solution may either be interior ($c_i > 0$) or at boundary ($c_i = 0$), Lemma 1 presents the equilibrium outcomes based on which contributors contribute (all the proofs are given in the online appendix).

Lemma 1 (Equilibrium Cases). *Depending on the magnitude of the monetary incentive, there are six possible equilibrium cases. In equilibrium, the total effective effort* $\sum Q_i(c_i^*) = (|\mathcal{B}| - 1)/\sum_{i \in \mathcal{B}} 1/\mu_i$, *where* $\mathcal{B}$ *denotes the set of contributors that contribute. Each contributor receives an audience of size* $S_i = 1 - \sum Q_i(c_i^*)/\mu_i$. *Table 1 summarizes the conditions for each equilibrium case.*

Lemma 1 shows that each equilibrium case is characterized by different types of contributors, corresponding to different levels of monetary incentive γ and parameters α and β'. For example, the *all contributors participate* equilibrium case (case 1, see Online Appendix A1 for the numbering of the equilibrium cases) includes all four types of contributor (largest variety), which may be desired by a UGC platform that values participant varieties (Du and Qi 2013). The *non–money-driven* equilibrium case (case 2) includes only non–money-driven contributors. This equilibrium may be desired by a UGC platform who likes to maintain an objective, nonprofit image. For example, Douban.com, a famous UGC platform in China, aims to provide authentic online reviews for movies, TV shows, and books and refuses to be commercialized (Song et al. 2019). Another example is about the Infosys's internal knowledge management system (Garud and Kumaraswamy 2005). After introducing a monetary incentive, the Infosys's internal knowledge management system attracts a lot of *money-driven* contributors and the content volume grows explosively. However, it becomes even harder for Infosys employees to find relevant information from the system. Then the company has to adjust its monetary incentive scheme to reduce the contributions from the money-driven employees (Garud and Kumaraswamy 2005).

4. Comparative Statics Analyses When the Monetary Incentive Changes

Lemma 1 shows that there are six possible equilibria. When the monetary incentive increases, the equilibrium may shift from one to the other; that is, certain contributors may stop or start contributing, and the total content volume ($\sum c_i^*$) changes accordingly. Does a higher monetary incentive induce more content volume?

Table 1. Equilibrium Cases and Conditions

Equilibrium cases	Set of contributors	Conditions
Case 1: All	$\bar{M}E$ $\overline{ME}$ ME $M\bar{E}$	$\beta' \geq 0$, $(1-2\alpha)\gamma > (1+\alpha)\beta'$ or $\beta' < 0$, $(2\alpha-1)\gamma < (2-\alpha)\beta'$
Case 2: Without $M\bar{E}$	$\bar{M}E$ $\overline{ME}$ ME	$\beta' \geq 0$, $\gamma > (1-\alpha)\beta'$, $(2\alpha-1)\gamma < (1-\alpha)\beta'$ and $(1-2\alpha)\gamma \leq (1+\alpha)\beta'$
Case 4: Non-money-driven	$\bar{M}E$ $\overline{ME}$	$\beta' \geq 0$, $\gamma \leq (1-\alpha)\beta'$
Case 5: Without $\overline{ME}$	$\bar{M}E$ ME $M\bar{E}$	$\beta' < 0$, $(1-2\alpha)\gamma > \alpha\beta'$, $(2\alpha-1)\gamma \geq (2-\alpha)\beta'$ and $\gamma > -(2-\alpha)\beta'$
Case 6: High-effectiveness	$\bar{M}E$ ME	$\beta' \geq 0$, $(2\alpha-1)\gamma \geq (1-\alpha)\beta'$ or $\beta' < 0$, $(2\alpha-1)\gamma \geq -\alpha\beta'$
Case 13: Money-driven	ME $M\bar{E}$	$\beta' < 0$, $\gamma \leq -(2-\alpha)\beta'$

Note. The details of the case numbers are provided in Online Appendix A1.

To understand the impact of monetary incentives on contributions, we conduct comparative statics analyses.

The impact of monetary incentive can be noncontinuous at zero; thus, following the literature (Bénabou and Tirole 2006, Gneezy et al. 2011), we study the impact of the monetary incentive under two scenarios: (1) the introduction of a small monetary incentive (i.e., from zero to a small amount) and (2) the increase of monetary incentive (i.e., from a small amount to a large one).

4.1. When the Monetary Incentive Changes from Zero to Positive

When a small monetary incentive γ is introduced, the rewards of the non–money-driven contributors change from β to $\beta' + \gamma$, where $\beta' = \beta + \delta$ and $\delta < 0$. Because γ is small, according to Lemma 1, either the conditions of case 4 ($\beta' \geq 0$, purely non–money-driven contributors) or the conditions of case 13 ($\beta' < 0$, purely money-driven contributors) will be satisfied. In case 4, if $\beta' + \gamma < \beta$ or simply $\gamma < -\delta$, the non–money-driven contributors' rewards decrease; thus, they will reduce their contributions, so the total content volume in the platform also decreases. In case 13, δ is too negative that the non–money-driven contributors stop contributing. Although the money-driven contributors start contributing because of the positive monetary incentive, the total content volume in the platform decreases if $\gamma < \beta$. Therefore, we have the following proposition.

Proposition 1 (Motivation Crowding Out). *When a small amount of monetary incentive γ is introduced ($\gamma < \min\{-\delta, \beta\}$), the total content volume in the platform decreases, and* (1) *if the modified nonmonetary reward $\beta' \geq 0$, the non–money-driven contributors reduce their contributions, whereas the money-driven contributors will not contribute; and* (2) *if the modified nonmonetary reward $\beta' < 0$, the non–money-driven contributors stop contributing, but the money-driven contributors start contributing.*

This result is consistent with the motivation crowding out effect that is observed when the monetary incentive breaks certain established social norms or damages social reputation (Bénabou and Tirole 2006).

4.2. When the Monetary Incentive Increases

We find that the impact of increasing the monetary incentive largely depends on the magnitude of the monetary incentive (γ), along with other parametric values (α and β'). When the monetary incentive increases, the equilibrium can either remain the same or shift from one case to another as caused by different contributors starting to contribute or stopping contribution. This finally leads to changes in the total content volume.

Figures 2 and 3 illustrate the equilibrium shifts when $\beta' \geq 0$ and $\beta' < 0$, respectively. Panel (1) shows the equilibrium shifts when the monetary incentive increases. The paths of equilibrium shifts are different when $\alpha < 1/2$ and $\alpha \geq 1/2$. When the monetary incentive is sufficiently large, the equilibrium remains at case 1 (when $\alpha < 1/2$) or case 6 (when $\alpha \geq 1/2$), and a further increase in monetary incentives will not cause equilibrium shifts, as indicated by the self-loops in panel (1). Panels (2) and (3) show the changes of the audience attracted by the contributors who make positive contributions, when $\alpha < 1/2$ and $\alpha \geq 1/2$, respectively.

Combining the scenarios when $\beta' \geq 0$ and $\beta' < 0$ leads us to Proposition 2.

Proposition 2 (Equilibrium Shifts). *As the monetary incentive increases,*

(1) *if the modified nonmonetary reward is nonnegative ($\beta' \geq 0$), the equilibrium shifts as follows: case 4 →2→1 or 6; and*

(2) *if the modified nonmonetary reward is negative ($\beta' < 0$), the equilibrium shifts as follows: case 13→5→1 or 6.*

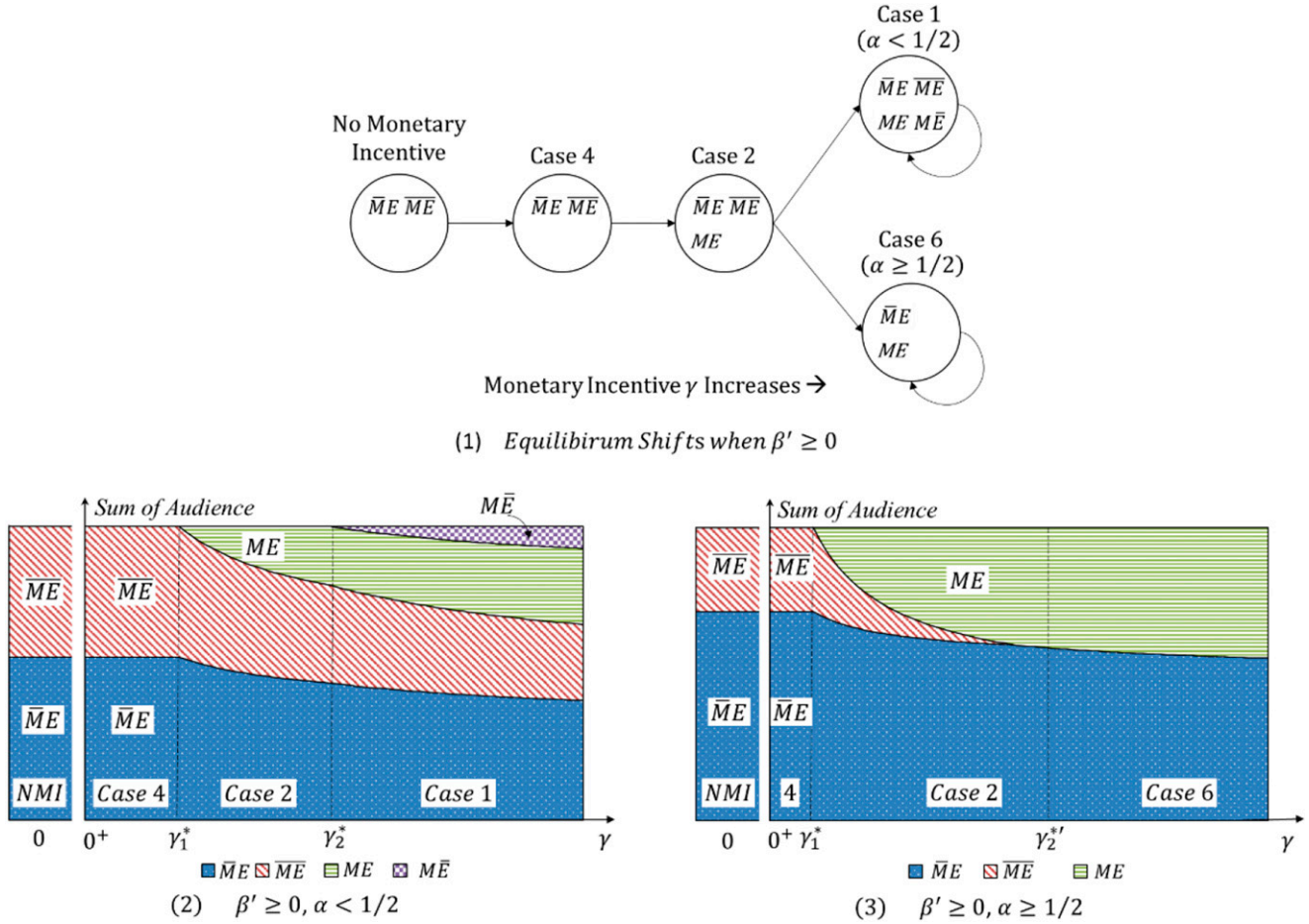
Proposition 2 shows the comparative statics with respect to the changes in the monetary incentive, that is, how does the equilibrium shift when the monetary incentive increases. This is mostly overlooked in previous literature, especially in empirical studies. We also summarize the following findings with regards to the equilibrium shift.

1. With a sufficiently large monetary incentive, the equilibrium either involves all four contributors (case 1) or only the high-effectiveness contributors (case 6). A further higher monetary incentive will not change this composition of contributors in the platform. Specifically, if the high-effectiveness contributors are significantly more effective in attracting audience than the low-effectiveness contributors ($\alpha \geq 1/2$), the low-effectiveness ones stop contributing when the monetary incentive is sufficiently large, as represented by case 6. Otherwise, all contributors will contribute (case 1).

2. Among all these cases, $\bar{M}E$ (the non–money-driven high-effectiveness contributor) is the most active contributor (absent only in case 13). This is because $\bar{M}E$ is the dominant contributor: $\bar{M}E$ contributes when there is no monetary incentives and is effective in attracting audience attention. The only reason for $\bar{M}E$ to stop contributing is when he/she suffers badly from the introduction of a monetary incentive (case 13). However, when the monetary incentive is large enough, contributor $\bar{M}E$ restarts contributing.

3. Among all these cases, $M\bar{E}$ (the money-driven low-effectiveness contributor) appears the least often. This is because $M\bar{E}$ is the weakest contributor. $M\bar{E}$ does not contribute when there is no monetary incentive and is not effective in attracting the audience. Contributor $M\bar{E}$ starts contributing either when the UGC platform welcomes all contributors (case 1) or

Figure 2. (Color online) Equilibrium Shifts and Audience when $\beta' \geq 0$



Notes. (1) Equilibrium shifts when the modified nonmonetary reward is nonnegative. The self-loops mean that a further increase in monetary incentives will not cause equilibrium shifts. (2) and (3) Changes of the audience attracted by the contributors corresponding to (1) when $\alpha < 1/2$ and $\alpha \geq 1/2$, respectively.

when non–money-driven contributors suffer when a monetary incentive is introduced (cases 13 and 5).

Will a higher monetary incentive attract more contributors to contribute and induce a larger total content volume?

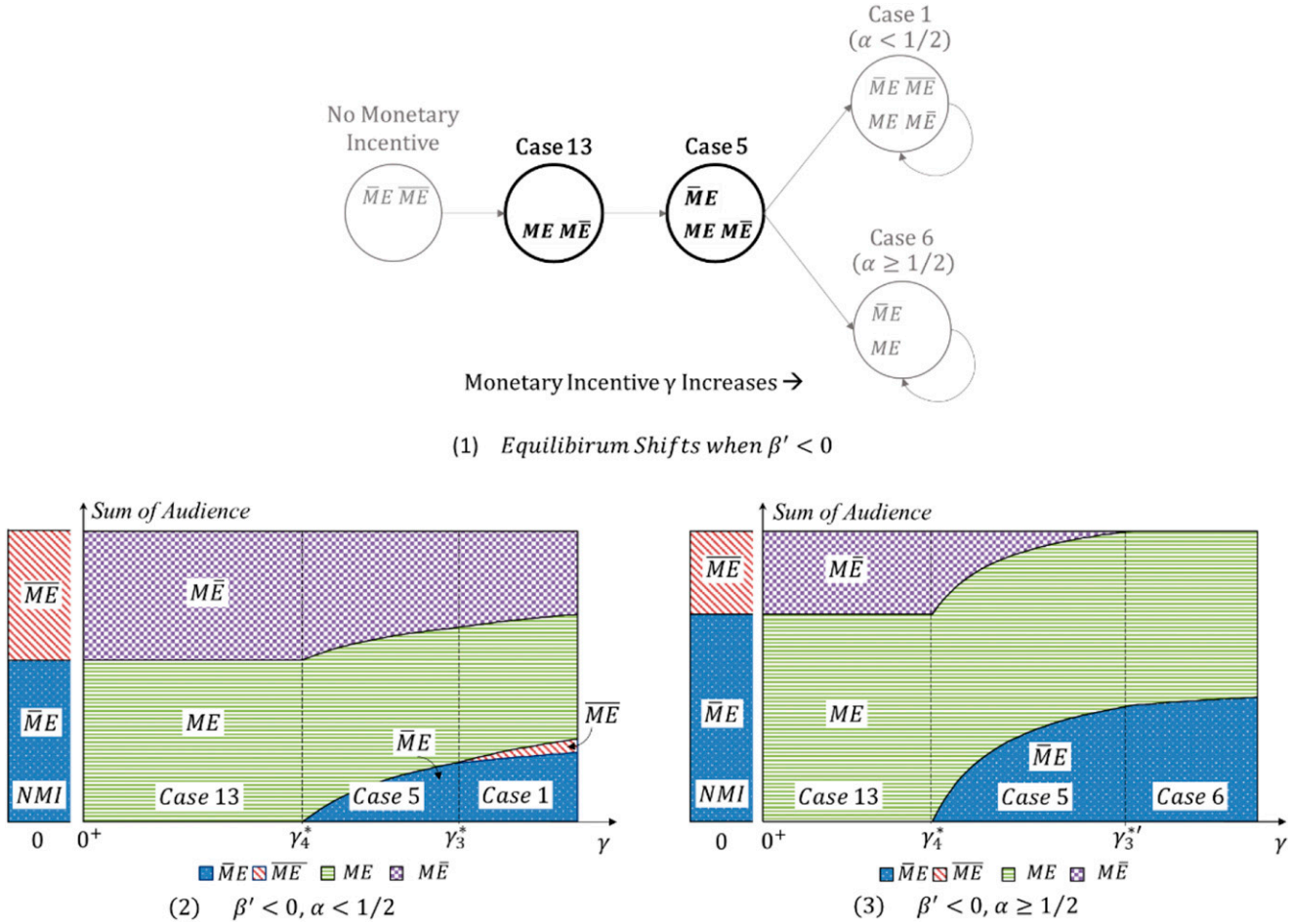
Proposition 3 (Competition Crowding Out). *Increasing the monetary incentive from a positive amount may reduce the number of contributors (when $\alpha > 1/2$) and the total content volume (when $\alpha > \sqrt{3} - 1$) because of the competition among the contributors.*

The relationship between the monetary incentive and number of contributors is illustrated by Figure 2, panel (1) and Figure 3, panel (1), where the low-effectiveness contributors ($\overline{ME}$ and $M\bar{E}$) stop contributing (when $\alpha > 1/2$) as the monetary incentive increases (as illustrated by the equilibrium shift follow 2→6 or 5→6.) The relationship between the monetary incentive and the total content volume is illustrated in Figure 4. Panels (1) and (2) show two examples wherein an increase in the monetary incentive increases the total content volume, whereas panels (3) and (4) show that an increase in the monetary incentive sometimes reduces the total content volume (in cases 2 and 5 when $\alpha > \sqrt{3} - 1$.)

Contrary to conventional wisdom that a higher monetary compensation attracts more contributors or elicits higher total content volume (standard price effect), Proposition 3 shows that, surprisingly, raising the monetary incentive can crowd out certain types of contributors and reduce the total content volume in the platform. Different from the motivation crowding out effect, this crowding out effect is caused by the competition for audience among contributors—the competition crowding out. This is a unique feature of UGC contributions, where there exists competition among contributors.

When the monetary incentive increases, it is intuitive that more contributors will be attracted. Why do certain contributors stop contributing under this scenario? This is because when high-effectiveness contributors start contributing because of the high monetary

Figure 3. (Color online) Equilibrium Shifts and Audience when $\beta' < 0$



Notes. (1) Equilibrium shifts when the modified nonmonetary reward is negative. The self-loops mean that a further increase in monetary incentives will not cause equilibrium shifts. We highlight the differences between (1) and Figure 2, panel (1) in bold lines and characters. (2) and (3) Changes of audience attracted by the contributors.

incentive, the audience of the low-effectiveness contributors is taken away in the competition. Once the audience of a low-effectiveness contributor drops to zero, this contributor stops contributing. Moreover, the high-effectiveness contributors need relatively less effort to attract the audience compared with the low-effectiveness contributors. If the difference in the effectiveness (α) between contributors is large enough ($\alpha > \sqrt{3} - 1$), the crowding out of the low-effectiveness contributors results in a drop in the total content volume. However, this drop is temporary and lasts only until the low-effectiveness contributors are completely crowded out. Thereafter, the equilibrium shifts to another case, and the competition crowding out effect stops.

Thus, the impact of monetary incentives is nonmonotonic on the number of contributors and on the total content volume. Shall a monetary incentive be introduced if the platform's objective is to generate more content? To answer this question, we present the following proposition.

Proposition 4 (Pay Nothing or Pay Enough)**.** *The introduction of a monetary incentive increases the total content volume only when the monetary incentive is sufficiently large ($\gamma > \gamma^*$).*

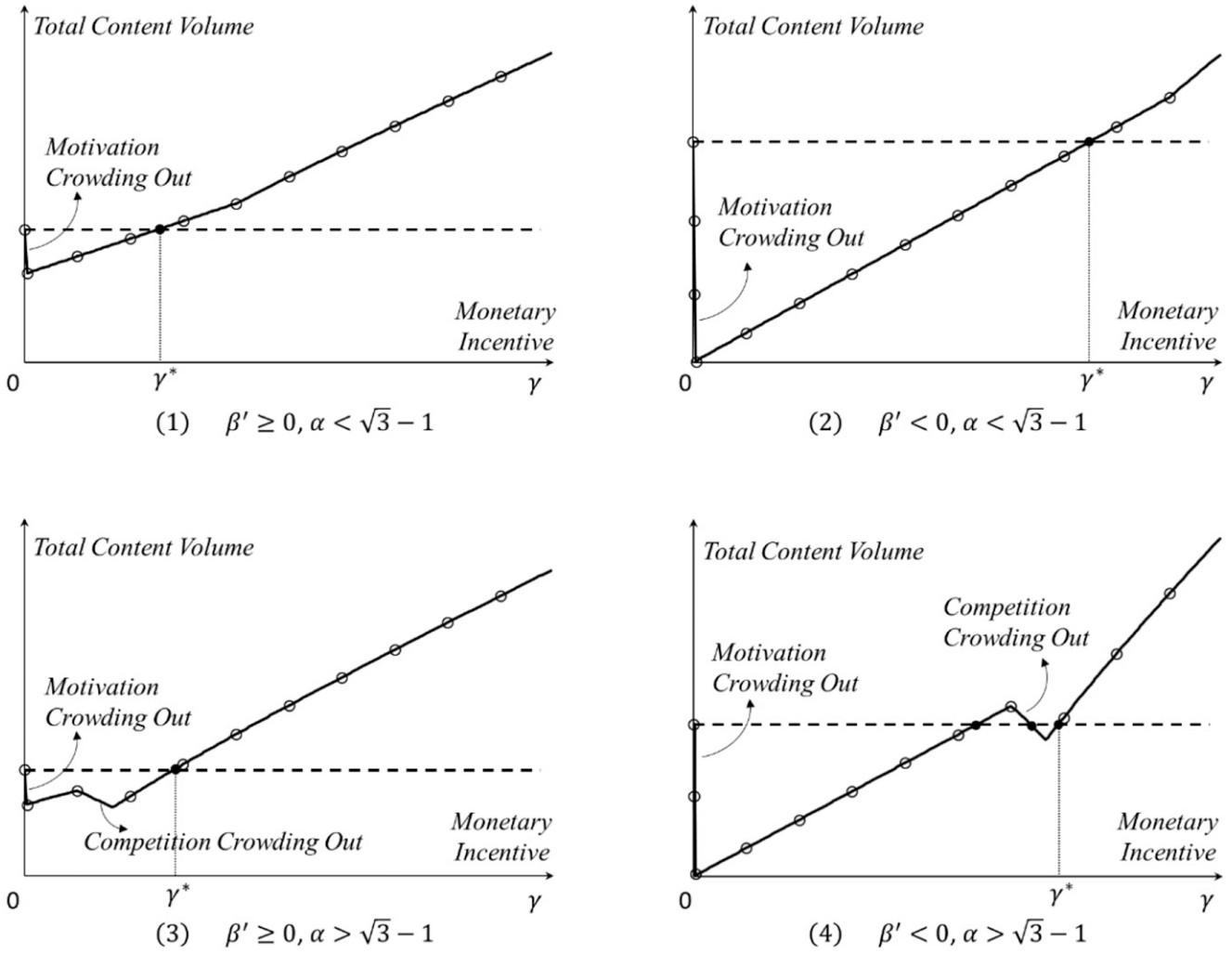
Proposition 4 offers an interesting guideline. If the objective of the platform in introducing a monetary incentive is to increases the total content volume, the incentive should be large enough; otherwise, the total content volume can be even lower than the level when no monetary incentive is offered, as illustrated in Figure 4. Therefore, as economists often emphasize, *incentives matter* (Gneezy et al. 2011); the incentives should be large enough. The threshold γ^* may not be unique because of the nonmonotonic impact of monetary incentive on the total content volume, as shown in Figure 4, panel 4.

5. Model Extensions

5.1. Different Number of Contributors in Each Type

The benchmark model considers four contributors, each represents one type of contributor. Now we consider an

Figure 4. Total Content Volume



Notes. The dashed line in each panel is the reference line that indicates the total content volume when there is no monetary incentive. The γ^* is the threshold of monetary incentive in Proposition 4.

extension in which the number of contributors in each type could be different. We denote the number of contributors in each type as m_i, $i \in \{\bar{M}E, \overline{ME}, ME, M\bar{E}\}$. Furthermore, we assume that $m_i > 1$ (i.e., there is more than one contributor for each type). The contributors' effort should have an upper bound; otherwise, the extended model would be qualitatively the same as the benchmark model.

We denote each contributor's upper bound effort as $\bar{c}_i$, $i \in \{\bar{M}E, \overline{ME}, ME, M\bar{E}\}$. Then the decision problem for the contributors is

$$\max. \begin{cases} \pi_{\bar{M}E} = (\beta' + \gamma) S_{\bar{M}E} - c_{\bar{M}E} \\ \pi_{\overline{ME}} = (\beta' + \gamma) S_{\overline{ME}} - c_{\overline{ME}} \\ \pi_{ME} = \gamma S_{ME} - c_{ME} \\ \pi_{M\bar{E}} = \gamma S_{M\bar{E}} - c_{M\bar{E}} \end{cases}$$

$$\text{s.t.}\ \pi_i \geq 0 \text{ and } 0 \leq c_i \leq \bar{c}_i, \text{where } i \in \{\bar{M}E, \overline{ME}, ME, M\bar{E}\},$$

$$S_{\bar{M}E} = \frac{c_{\bar{M}E}}{\sum_i m_i Q_i(c_i)}, S_{\overline{ME}} = \frac{(1-\alpha) c_{\overline{ME}}}{\sum_i m_i Q_i(c_i)},$$

$$S_{ME} = \frac{c_{ME}}{\sum_i m_i Q_i(c_i)}, S_{\overline{IP}} = \frac{(1-\alpha) c_{M\bar{E}}}{\sum_i m_i Q_i(c_i)}, \text{ and}$$

$$\sum_i m_i Q_i(c_i) = m_{\bar{M}E} c_{\bar{M}E} + m_{\overline{ME}} (1-\alpha) c_{\overline{ME}} + m_{ME} c_{ME} + m_{M\bar{E}} (1-\alpha) c_{M\bar{E}}.$$

In this extended model, each contributor has three possible actions: (1) not to contribute (corner solution), (2) to contribute c_i^* $(0 < c_i^* < \bar{c}_i)$ (interior solution), or (3) to contribute the upper bound $\bar{c}_i$ (corner solution). In equilibrium, each contributor i decides his/her optimal effort level, given the other contributors' optimal effort levels.

According to the KKT conditions, a contributor i will not contribute when $\mu_i \leq \sum_i m_i Q_i(c_i)$, will contribute c_i^*

$(0 < c_i^* < \bar{c}_i)$ when $\sum_i m_i Q_i(c_i) < \mu_i < (\sum_i m_i Q_i(c_i))^2/(\sum_i m_i Q_i(c_i) - Q_i(\bar{c}_i))$, and will contribute $\bar{c}_i$ when $\mu_i \geq (\sum_i m_i Q_i(c_i))^2/(\sum_i m_i Q_i(c_i) - Q_i(\bar{c}_i))$. As in the benchmark model, μ_i represents the maximum benefit a contributor i can get. In other words, if the benefit from contributing is sufficiently low, a contributor will not contribute; if the benefit is sufficiently high, a contributor will contribute his/her upper-bound effort level; otherwise, the interior solution persists.

The equilibrium in the extended model include two more possible equilibrium cases: the equilibrium case with only $\bar{M}E$ contribute (case 8, see Online Appendix A1 for the details of the case number) and the equilibrium case with only ME contribute (case 14). This is because a contributor needs to compete not only with other types of contributors, but also with other contributors of the same type.

5.2. Equilibrium Shifts

When there is no monetary incentive in the benchmark model, both $\bar{M}E$ and $\overline{ME}$ contribute. However, in the extended model, there are two possible equilibria: only $\bar{M}E$ contribute or both $\bar{M}E$ and $\overline{ME}$ contribute. The intuition for the additional equilibrium is that an $\bar{M}E$ contributor not only has to compete with those $\overline{ME}$ contributors but also the other $\bar{M}E$ contributors.

When there is a monetary incentive, the equilibrium shifts in this extended model are much more complex than that in the benchmark model. However, with a sufficiently large monetary incentive, all the contributors in the extended model will expend their maximum effort to contribute (case 1). Recall that in the benchmark model, with a sufficiently large monetary incentive, the equilibrium case could be either case 1 or case 6. In the extended model, case 6 will further shift to case 1 as the monetary incentive increases. In summary, we have the following proposition.

Proposition 5 (Equilibrium Shifts)**.** *When the number of contributors are different within each type, there are new equilibrium shift paths compared with the benchmark model: as the monetary incentive increases, a contributor could start to contribute at a relatively low level of monetary incentive, be crowded out at a moderate level of monetary incentive, and restart to contribute at a relatively high level of monetary incentive. This contribute-stop-restart equilibrium shift path is only possible for the low-effectiveness contributors.*

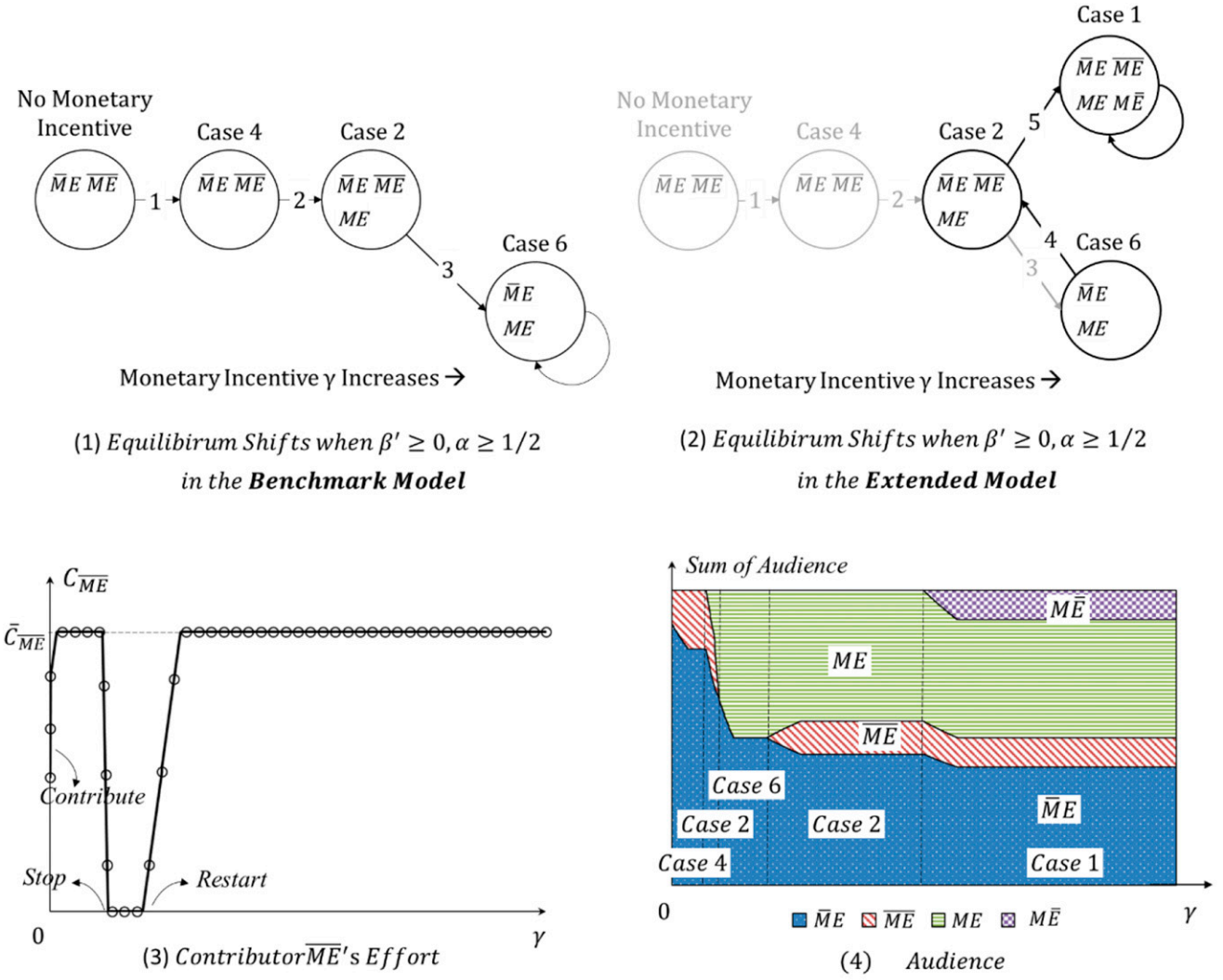
The rationale of the contribute-stop-restart equilibrium shift process is as follows. The low-effectiveness contributors are initially attracted to contribute by either a nonmonetary reward (e.g., $\overline{ME}$ in case 4) or a monetary incentive (e.g., $M\bar{E}$ in case 13). However, when the monetary incentive increases, the high-effectiveness contributors start contributing content, and the low-effectiveness contributors could be crowded out by the competition from the high-effectiveness contributors; however, if the monetary incentive keeps increasing, these low-effectiveness contributors are able to restart contributing when the high-effectiveness contributors reach the upper bound of their effort.

For the low-effectiveness contributors $\overline{ME}$, the contribute-stop-restart equilibrium shift path exists when $1 - (m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})/((m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})^2/(m_{\bar{M}E}\bar{c}_{\bar{M}E} + (m_{ME} - 1)\bar{c}_{ME}) + \beta') < \alpha < \beta'/(\beta' + m_{\bar{M}E}\bar{c}_{\bar{M}E})$ and $\beta' > m_{\bar{M}E}\bar{c}_{\bar{M}E}(m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})/m_{ME}(m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME} - \bar{c}_{ME})$, whereas for the low-effectiveness contributors $M\bar{E}$, the contribute-stop-restart equilibrium shift path exists when $1 - (m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})/((m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})^2/(m_{\bar{M}E} - 1)\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME}) - \beta') < \alpha < \beta'/(\beta' - m_{ME}\bar{c}_{ME})$ and $\beta' < -m_{ME}\bar{c}_{ME}(m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME})/m_{\bar{M}E}(m_{\bar{M}E}\bar{c}_{\bar{M}E} + m_{ME}\bar{c}_{ME} - \bar{c}_{\bar{M}E})$. To interpret, this start-stop-restart equilibrium shift path exists only when the difference between the contributors' effectiveness (α) in attracting the audience lies within a moderate range. If the gap is too big, the low-effectiveness contributors will not get a chance to start contributing before the high-effectiveness contributors reach the upper bound of their effort. Meanwhile, if the gap is too small, the low-effectiveness contributors will not be crowded out at all. The conditions of β' ensure the ranges of α are not empty.

Figure 5 demonstrates one numerical example of the *contribute-stop-restart* equilibrium shifts when $\beta' \geq 0$. To show the difference from the benchmark model, we demonstrate the equilibrium shifts of the benchmark model in panel (1) and that of the extended model in panel (2). Although the equilibrium shift in the benchmark model is NMI (no monetary incentive case)→4→2→6, the equilibrium shift in the extended model is NMI→4→2→6→2→1. Figure 5, panel (3) shows that when the monetary incentive increases, the effort of contributors $\overline{ME}$ first increases, then drops to zero, and then re-increases until the upper-bound effort is reached, as we described in Proposition 5. Figure 5, panel (4) shows the audience attracted by each type of contributor when the monetary incentive increases: the contributors $\overline{ME}$ contribute at a relatively low monetary incentive level, be crowded out at a relatively moderate monetary incentive level, and then restart contributing at a relatively high monetary incentive level.

Similarly, Figure 6 demonstrates one numerical example of the contribute-stop-restart equilibrium shifts when $\beta' < 0$. The equilibrium shift in the benchmark model is NMI→13→5→6, whereas in the extended model, it is NMI→13→5→6→5→1. The contributors $M\bar{E}$ contribute content at a relatively low level of monetary incentive, get crowded out when the monetary incentive increases, and restart contributing at a relatively high level of monetary incentive.

Figure 5. (Color online) Example of Contribute-Stop-Restart Equilibrium Shifts when $\beta' \geq 0$ and $\alpha \geq 1/2$



5.3. Impact of the Number of Contributors

It is also interesting to examine the comparative statics of the number of a certain type of contributors. Increasing the number of a certain type of contributors may intensify the competition while causing some types of contributors to stop contributing. In other words, the increase in the number of a certain type of contributors may crowd out the other types of contributors; thus, the composition of the participating contributors may change. We then have the following proposition.

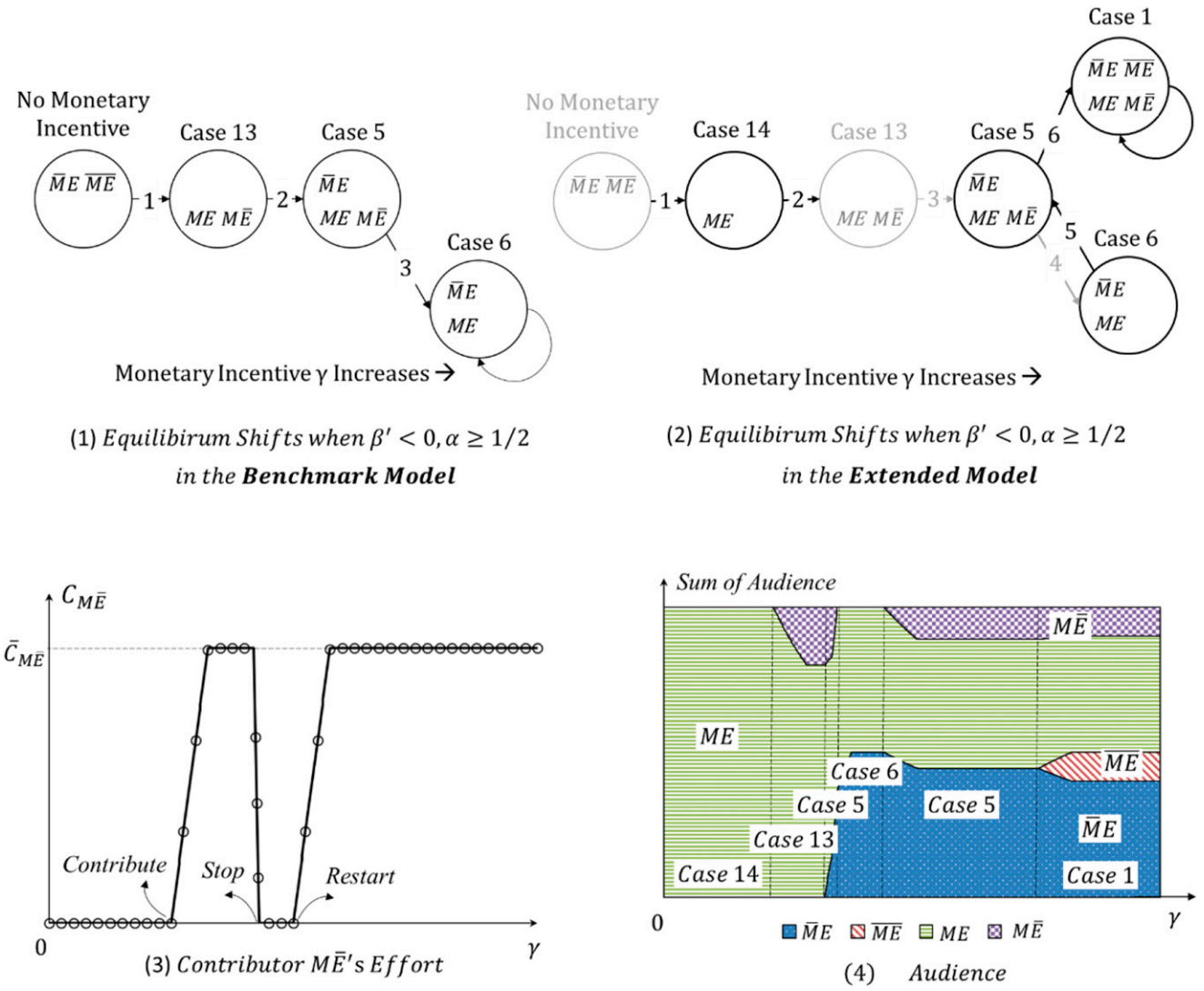
Proposition 6 (Impact of the Number of Contributors). *Keeping other conditions fixed, an increase in the number of type i contributors will*

(1) *not crowd out contributors with* $\mu_j \geq \mu_i$*: their audience will shrink but remain positive; and*

(2) *reduce the audience of those contributors with* $\mu_j < \mu_i$ *or even crowd them out; more specifically, the lower the* μ_j*, the earlier that type j contributors will be crowded out.*

Here μ_i refers to the maximum possible benefit that a certain type of contributor can obtain. Figure 7 shows a numerical example where $\mu_{\bar{M}E} > \mu_{ME} > \mu_{\overline{ME}} > \mu_{M\bar{E}}$. It is easy to observe that contributors with higher μ_i can crowd out contributors with lower μ_i. For example, in Figure 7, panel (2), as the number of contributors $\overline{ME}$ increases, contributors $M\bar{E}$ are crowded out ($\mu_{M\bar{E}} < \mu_{\overline{ME}}$), but the contributors $\bar{M}E$ and ME still contribute ($\mu_{\bar{M}E} > \mu_{ME} > \mu_{\overline{ME}}$). Moreover, we can also see from Figure 7, panel (4) that as the number of contributors $M\bar{E}$ increases, the audience attracted by each of the other types of contributors is reduced but remains positive. The distribution of audience across each type of contributor approaches a stable point even when the number of contributors $M\bar{E}$ increases beyond m_1.

Figure 6. (Color online) Example of Contribute-Stop-Restart Equilibrium Shifts when $\beta' < 0$ and $\alpha \geq 1/2$



Based on Proposition 6, we have the following findings:

1. *No matter how large the number of low-effectiveness contributors is, the UGC platform will never be taken over by these contributors.*

2. *If type $\bar{M}E$ contributors are already contributing in the UGC platform, they will always contribute even when the number of other types of contributors increases.*

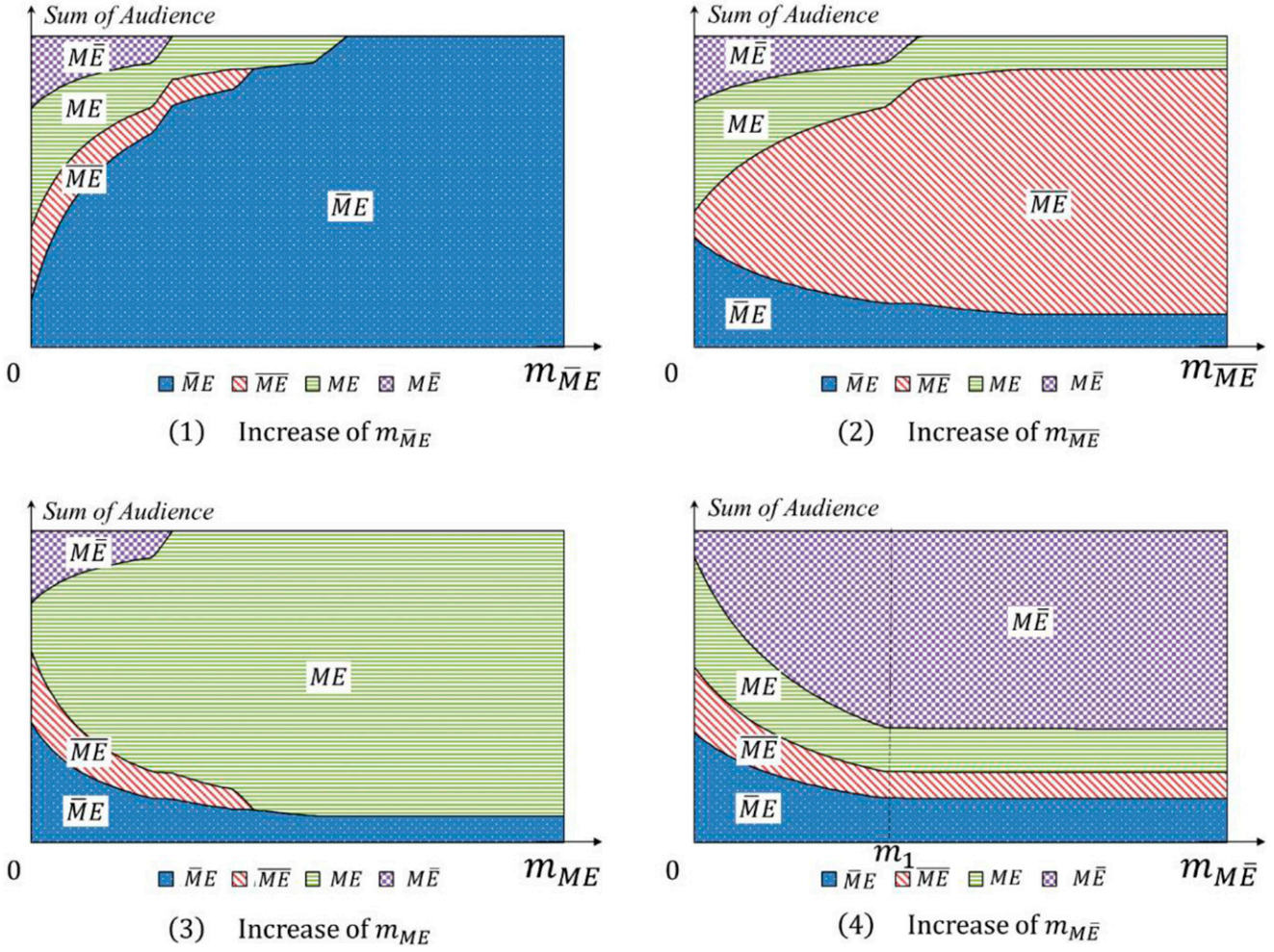
3. *The marginal impact of increasing one type of contributor beyond a certain level approaches to zero but remains positive. This implies that the distribution of audience across different types of contributors approaches a stable point.*

6. Conclusions

Gneezy et al. (2011, p. 206) state that "incentives do matter, but in various and sometimes unexpected ways." It is reported that introducing a monetary incentive helps in attracting more contributors and generating more contributions (Garud and Kumaraswamy 2005, Chen et al. 2017); however, other literature finds the opposite—monetary incentives crowd out contributors and cause unexpected decrease in total contributions (Khern-am-nuai et al. 2018, Sun et al. 2017). Motivated by such contradictory empirical findings, this study makes the first attempt to build a unified theoretical model to understand the complex nature of the impact of monetary incentives. By considering different types of contributors, as well as the competition among contributors, our model reconciles the seemingly contradictory findings in the literature with regard to the impact of monetary incentives. Specifically, we find that an increase in monetary incentives can either increase or reduce contributors' contributions depending on different parametric values, corresponding to the different cases of equilibrium in our model.

More specifically, UGC contributions can decrease in the presence of a monetary incentive, for two different

Figure 7. (Color online) Increase of m_i when $\mu_{\bar{M}E} > \mu_{ME} > \mu_{\overline{M\bar{E}}} > \mu_{M\bar{E}}$



reasons: (1) when a small amount of monetary incentive is introduced, the non–money-driven contributors may be too negatively affected that they reduce or even stop contributing (*motivation crowding out*); and (2) when the monetary incentive is relatively large, the high-effectiveness contributors start contributing and crowd out the low-effectiveness ones (*competition crowding out*). As a result, the impact of monetary incentives is nonmonotonic on contributor participation and on the total content volume.

Our results offer guidelines for different UGC platforms on designing monetary incentive mechanisms. Our model shows that by changing the level of monetary incentives, different equilibrium outcomes may emerge. This implies that in practice, firms can achieve different equilibrium outcomes by changing the monetary incentive. For example, InfoSys, by adjusting the monetary incentive scheme, has experienced a surge followed by a drop in the contributed content in its internal knowledge management system (Garud and Kumaraswamy 2005). To attract certain types of contributors or maintain a certain level of total contributions, the platform should set appropriate levels of monetary incentives—too high or too low level of incentives will lead to a different equilibrium outcome. For example, if the monetary incentive is set sufficiently high, the high-effectiveness contributors may crowd out the low-effectiveness ones. Correspondingly, after YouTube introduced its revenue-sharing plan in 2007, high-effectiveness producers such as ABC, NBC, and CBS entered the market. Gradually the "dominance of professional-generated content (PGC) marginalize[d] UGC (Kim 2012, p. 61)." In 2009, the Video option became the only UGC clip category (Kim 2012), whereas the other three categories (movies, music, and shows) are dominated by PGC.

This study is not without limitations. First, for tractability, we assume that the audience size is fixed in the short term, and contributors' effort has a diminishing marginal return on the attracted audience. We also assume that a contributor's reward is a linear function of the audience attracted. The real world is more complex than our model: the total audience size could increase, and the reward function can be either

convex or concave. It would be worthwhile to relax these assumptions. Second, different types of contributors may contribute content of different quality levels. By considering content quality and the objective functions of the UGC platforms, one can discuss the significance of each equilibrium and the associated social welfare. In the future, an extended model with content quality should be studied to examine the impact of monetary incentives on content quality, the payoff of the UGC platform, and even the social welfare. Finally, it would be valuable to collect field data or conduct field experiments to verify our research findings.

Endnote

[1] The classic Lanchester model is a model used in conflict economics. The model was originally developed in the study of combats (Deitchman 1962). In recent years, the Lanchester model has been used in advertising competition (Erickson 1985, Wang and Wu 2001, Jarrar et al. 2004).

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