Does Money Talk?

—The Impact of Monetary Incentive on UGC Contribution

Abstract

Monetary incentive is often used to encourage user-generated content (UGC) contribution in many UGC platforms. Empirical studies, however, reported contradictory results with regard to the impact of monetary incentive. We build a theoretical model to study the impact of monetary incentive on UGC contribution, where four types of contributors (classified by whether they are intrinsically-motivated and whether they produce efficiently) compete for audience attention, and the introduction of monetary incentive either positively or negatively modifies contributors' intrinsic reward. We identify two types of crowding in/out effect—the motivation crowd in/out, and the competition crowd in/out. Under the influence of these two types of crowd in/out effects, an increase in the monetary incentive has a non-monotonic impact on the market structure, total content volume as well as the overall quality of content contributed. As a result, different market equilibrium outcomes emerge with an increase in the monetary incentive. Our findings offer guidelines in designing monetary incentive schemes to achieve different market outcomes.

Keywords:

User Generated Content, Monetary incentive, Motivation Crowding Out, Competition Crowding Out

1 Introduction

In recent years, online community becomes more and more essential in people's daily life (such as Wikipedia, YouTube, Facebook, Instagram and various online forums or review sites) as well as business practice (such as the knowledge sharing systems, co-creation forums, open-source software communities.) An increasing number of companies,

including Apple, Oracle, SAP, and SUN, adopt online user forums, to offer platforms for users to contribute solutions to other users' questions (Jabr et al. 2013), or to collect user-generated creative ideas and product designs. These online communities heavily rely on users to contribute contents (such as product reviews, blogs, music, pictures, videos, answers, knowledge, etc.) Therefore, it becomes a critical issue for these businesses to encourage users to contribute.

Monetary incentives are often introduced to encourage contribution. For example, YouTube, About.com, Break, and Epinions pay users for their contributions in the form of advertising-revenue sharing schemes (Tang et al. 2012a); 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 example, Infosys (NASDAQ: INFY), a global software services company, offers KCUs (knowledge currency units, 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 co-creation forums, such as Lego's Cuusoo platform (Antorini et al. 2012), Siemens' ShareNet (Voelpel et al. 2005) etc. The objectives of using monetary incentives include attracting more contributors, generating more content, and improving content quality.

However, the empirical results on the impact of monetary incentives on UGC contribution are mixed. On one hand, based on standard economic theory, monetary incentives induce more effort and higher performance (Gneezy et al. 2011; Kreps 1997), which is a "standard price effect" or even "law of behavior" (Gneezy et al. 2011). Some empirical evidences on the impact of monetary incentives on UGC contribution show that monetary incentives may (1) attracting more contributors (Garud and Kumaraswamy 2005; Ogawa 2014); (2) improving the contribution volume (Garud and Kumaraswamy 2005; Roberts et al. 2006; Tang et al. 2012b); and (3) improving the contribution quality (Sun and Zhu 2013). On the other hand, researchers also find that introducing monetary incentive does not always guarantee improved outcomes (see Frey and Jegen 2001; Gneezy et al. 2011, for surveys). Monetary incentive may sometimes "backfire" (Fehr

and Falk 2002; Lepper et al. 1973). Empirical evidences also show that monetary incentive (1) crowding out some contributors (Ma et al. 2009; Sun et al. 2013); (2) reducing the total contribution, (e.g., Ariely et al. 2009; Gneezy and Rustichini 2000; Titmuss 1970); (3) reducing the contribution quality (e.g., Garud and Kumaraswamy 2005; Mason and Watts 2010; Zhang et al. 2006).

Due to the complex relationship between monetary incentive and UGC contribution, it is suggested to build models to examine "when and why" incentives work (e.g., Kreps 1997). Unfortunately, little research has been done to address this research problem. On one hand, the limited number of theoretical models on UGC contribution (Ghosh and McAfee 2011; Ma et al. 2009; Zhang and Sarvary 2014) do not focus on the effect of monetary incentives on UGC contribution. On the other, it is not appropriate to adopt traditional models which study the impact of monetary incentive on prosocial behavior (e.g., the salient model developed by Bénabou and Tirole (2006)) to the UGC contribution context. UGC contribution is fundamentally different from prosocial behavior: UGC contributor's intrinsic reward is correlated with the audience's attention (e.g., viewing, reading) and even interaction (e.g., "like", comment). So, there exists competition among contributors for limited audience attention. Such competition is absent in prosocial behavior.

In this paper, we build a model to examine the impact of monetary incentive on UGC contribution and to offer explanations to the contradictory findings in the literature. We not only consider the interaction between intrinsic reward of content contribution and monetary incentive, but also incorporate the competition among contributors for audience attention. We consider four types of contributors—classified by whether they are intrinsically-motivated to contribute, and whether they are efficient in producing content. These four types of contributors respond to monetary incentive differently. We identify two types of crowding in/out effects associated with monetary incentives. More specifically, when monetary incentives are introduced (from zero to positive), it affects contributors' intrinsic motivation dramatically. Contributors may be crowded in or out, or their contribution volume may change dramatically. We refer this as the "Motivation

Crowd In/Out." When there already exists monetary incentive, an increase in the monetary incentive may attract in contributors with higher quality or efficiency, while driving out contributors with lower quality or efficiency. We call this "Competition Crowd In/Out." Under the influence of these two types of Crowd In/Out effects, an increase in the monetary incentive has a non-monotonic impact on the market structure, total contribution volume as well as the overall quality of content contributed. As a result, different market equilibria emerge, depending on parameter values such as the difference between the contributors, as well as the quality control associated with the monetary incentive. Our findings offers guidelines in designing an appropriate monetary incentive scheme to achieve different market outcomes. We also discuss practical implications of our research results.

To the best of our knowledge, this paper makes the first effort to model the impact of monetary incentive on UGC contribution. We consider not only the interaction between monetary incentive and contributors' intrinsic incentive, but also the competition among contributors, which is not covered in the studies of prosocial behavior. In addition, besides the total market contribution, we also examine other market performance measures such as market structure and quality level in the market.

This remainder of this paper is organized as follows: Section 2 reviews the related literature; Section 3 describes the model setup; Section 4 describes the benchmark model with monetary incentive without quality control; Section 5 extends the model by adding quality control. Section 6 discusses the practical implications of the theoretical findings. Finally, Section 7 discusses the results, limitations, and further research directions.

2 Related Literature

2.1 UGC

A common definition of UGC is "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). According to the related

literature (e.g., Ghose et al. 2012; Goes et al. 2014; Goh et al. 2013; Levina and Arriaga 2014; Lukyanenko et al. 2014; Susarla et al. 2012; Zhang and Sarvary 2014), UGC has several characteristics: (1) the content is digital content, rather than material content; (2) UGC is in general free to access, thus is one type of "public goods" (Zhang and Zhu 2010); and (3) the contributors need to compete for audience (Huang et al. 2015).

According to the "public goods" theory, the UGC users are able to "take free ride": The famous "1% rule" indicates that only 1% of the users actively contribute, while the other 99% of the users just "lurk" (van Mierlo 2014). But why do the contributors contribute UGC? It is found that both intrinsic motivation and extrinsic incentive can influence UGC contribution (Gneezy et al. 2011; Kreps 1997; McKenzie et al. 2012). For example, Lee et al. (2013) find that the users of a pay-for-answer Q&A service contribute answers by financial incentives and intrinsic motives. There is no consistent classification of intrinsic motivations and extrinsic incentives (McKenzie et al. 2012). The intrinsic reward may include reputation, interpersonal ties, direct reciprocity, and enjoyment (Wasko and Faraj 2005; Zhang and Zhu 2010). The common practice of extrinsic incentive is usually monetary incentive which is correlated to the audience attracted or the ratings received (e.g., Antorini et al. 2012; Mason and Watts 2010; Tang et al. 2012b; Voelpel et al. 2005).

2.2 Mixed Findings of the Impact of Monetary incentive

The empirical results on the impact of monetary incentives on UGC contribution is mixed. Gibson (2012) claims that monetary compensation is not the best way to enhance the overall output within an online co-creation community. Aguinis et al. (2013) also claim that "monetary rewards do not always lead to these desirable outcomes." In detail, researchers find the mixed findings of the impact of monetary incentives in three perspectives: the contributors, the volume of contribution, and the quality of contribution.

- **Contributors**

Empirical studies find monetary incentive could both attract more contributors or crowd out contributors (Gneezy et al. 2011). For example, Garud and Kumaraswamy (2005)

find that the monetary incentive of the knowledge sharing system in InfoSys attracted nearly 20 percent of employees to contribute knowledge. Sun et al. (2013) utilize a natural experiment and find that monetary incentive moderately increase the contributions of the some contributors, but decreases the contributions of some other contributors. Ma et al. (2009) study the impact of monetary incentive and find that higher monetary incentive may attract some contributors to an UGC platform while drive away some other contributors.

- **Volume of Contribution**

The findings on the impact of monetary incentive on contribution volume is also mixed. On one hand, there are a lot of well-documented cases which show that "monetary incentive works" (Kreps 1997). For example, Becker et al. (2010) find that monetary incentive can increase the adoption of online communities. Roberts et al. (2006) find that paid participation lead to above-average contribution levels. Using data collected from YouTube, Tang et al. (2012b) show that revenue sharing program can motivate content contribution. On the other hand, there are also a lot of "opponents" who believe that monetary incentive may "backfire" (McKenzie et al. 2012). A lot of evidences were found that monetary incentive negatively affect the contribution (see Deci et al. 1999; Frey and Jegen 2001; Gneezy et al. 2011 for surveys), which show a "crowding-out effect": the phenomena that "raising monetary incentive reduces, rather than increases, supply" (p.590, Frey and Jegen 2001). Monetary incentive may lead to lessened levels of quality-weighted effort and lower net profits (Kreps 1997). Lin and Huang (2013) compared two Q&A online forums Google Answers and Yahoo! Kimo Knowledge+, and conclude that Google Answers failed with its monetary incentive but Knowledge+ success with its virtual rewarding mechanism.

- **Contribution Quality**

Contribution quality is another major concern of UGC platforms (Chen et al. 2011; Ma et al. 2009). Some researchers find a positive effect of monetary incentive on contribution quality. For example, Sun and Zhu (2013) find that the blog content quality of a Chinese

portal site significantly increased after the contributors join the ad-revenue-sharing program. However, more researchers find non-significant or even negative effects. Wang et al. (2012) find that there are no significant quality differences between paid and unpaid reviews. Moon and Park (2002) find that the contributions motivated by the reward systems are not guaranteed to be of good quality. Mason and Watts (2010) find that increased financial incentives increase the quantity but not the quality of the work performed by participants. Ogawa (2014) compares two similar recipe websites Rakuten Recipe (offering monetary incentive) and CookPad (offers no monetary incentive), and finds a relatively lower content quality of the Rakuten Recipe.

2.3 Possible Reasons of the Mixed Findings

To understand mixed findings about the impact of monetary incentive on UGC contribution, several possible explanations are mentioned in the literature.

- **The Interaction between Intrinsic Motivation and Monetary Incentive**

A lot of researchers find that monetary incentive interacts with intrinsic motivations (e.g., Fehr and Falk 2002; Frey and Jegen 2001; McKenzie et al. 2012; Roberts et al. 2006). On the one hand, monetary incentive may crowd out intrinsic motivations which are important to producing desired behavior (Gneezy et al. 2011). This is known as the “motivation crowding out effect”, or “over-justification effect” (Lepper et al. 1973). For example, Kreps (1997) asserts that providing monetary incentive could be counter-productive, because it may destroy workers' intrinsic motivation. Bénabou and Tirole (2006) indicate that providing rewards to foster prosocial behavior may have a perverse effect and reduce the total contribution. A lot of empirical studies also show that monetary incentive have negative impacts on prosocial behavior (e.g., Ariely et al. 2009; Frey and Oberholzer-Gee 1997; Gneezy and Rustichini 2000; Mellström and Johannesson 2008).

On the other hand, monetary incentive may positively impact the intrinsic motivation, thus the marginal benefit of performance further increases beyond the standard price effect. This is known as the “motivation crowding in effect”. In the context of UGC

contribution, contributors may be proud of the ability of earning money through contributing. For example, Michelle Phan was a no‐name YouTuber in 2008. She posted hundreds of makeup videos, attracted a lot of viewers and earned advertising revenue. Now she is Lancôme's first video makeup artist, and an idol of successful contributor on YouTube (Tang et al. 2012b). Therefore, when study the impact of monetary incentive on UGC contribution, both crowding in and out effect should be considered.

- **The Amount of Monetary Incentive**

Empirical studies show that the amount of monetary incentive may play a key role. First, introducing a small monetary incentive is found to be sufficient to cause a sharp reduction of contribution (Bénabou and Tirole 2006). This is because when a small monetary incentive is introduced, the contributors switch from "unprofitable" to "profitable", which may be interpreted as "greedy", so they reduce their contribution (Bénabou and Tirole 2006). Mathematically, it is suggested that "zero is special", i.e., the impact of monetary incentive on contribution is discontinuous at zero point (Bénabou and Tirole 2006; Gneezy et al. 2011).

Second, a sufficiently large monetary incentive is found to have a positive impact. For example, Gneezy et al. (2011) speculate that if monetary incentive are large enough, the "positive standard price effect" will be larger than the potential negative crowding out effect, thus show an overall positive effect. Gneezy and Rustichini (2000) conduct a field experiment which require high school students to collect donations. They find that the students who receive a small compensation perform worse than the students who are not compensated; however, the students who receive a relatively big compensation perform better than the students who receive a small compensation.

Following this line of literature, the impact of the monetary incentive should be studied in two steps: (1) the introduction of a small monetary incentive, i.e., "from zero to small"; (2) the increasing of monetary incentive, i.e., "from small to large".

- **Contributors React to Monetary Incentive Differently**

Some empirical studies find that contributors have different reactions to monetary

incentives, so that monetary incentive may work for some people, but may not for the others (Gneezy et al. 2011). In the InfoSys case (Garud and Kumaraswamy 2005), introducing a monetary incentive attracted the contributors who "just to secure monetary rewards". Kreps (1997) argues that the crowding out effect applies only to the employees who have high initial levels of intrinsic motivation. Sun et al. (2013) find that monetary incentive moderately increase the contributions of the loners (those who have no connections with other contributors), but decreases the contributions of the socialites (those who have many connections with other contributors).

- **Different Quality Control**

The quality of UGC varies "drastically from excellent to abuse and spam", thus quality control is vital for UGC platforms (McKenzie et al. 2012). Interestingly, quality control will not only influence the contribution quality, but also the contribution volume (Mason and Watts 2010). For example, Ghosh and McAfee (2011) build a game-theoretic model to study the effect of exposure as incentive on UGC contribution. They find that when exposure is independent with quality, there will be a lot of low quality contributions in the equilibrium.

2.4 Related Models

In summary, the impact of monetary incentive on UGC contribution is still confusing due to the mixed findings. Ariely et al. (2009) indicate that "less is known, however, about the mechanisms by which this unintended consequence occurs." Kreps (1997) indicates that there is a need to develop theoretical models to understand when and why monetary incentive works.

To the best of our knowledge, little theoretical research has been done to study the impact of monetary incentive on UGC contribution. The most related model is the prosocial behavior model developed by Bénabou and Tirole (2006), which shows that extrinsic incentives could interact with a contributor's image concern, thus may negatively correlated with the contribution of prosocial behavior. However, since it focuses on the prosocial behavior, without considering the competition between the contributors, thus is

not proper to be directly adopted into the UGC contribution context.

There are several game-theoretic models which study the UGC-related problems. For example, Ghosh and McAfee (2011) develop a model to study whether the contributors will contribute high quality content when they are motivated by exposure. However, their model did not consider monetary incentive. Ma et al. (2009) study the impact of quality control on UGC contribution. In their model, two UGC platforms (one control quality while the other not) compete with each other for users. Zhang and Sarvary (2014) develop a model which discusses competition between UGC platforms. These models do not focus on the effect of monetary incentive on UGC contribution, thus cannot offer a comprehensive explanation on the mixed findings.

3 The Benchmark Model without Monetary Incentive

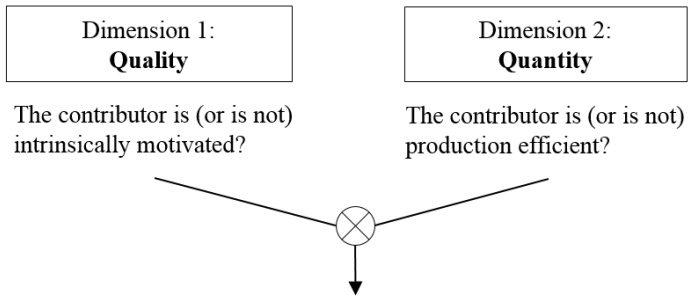
3.1 The Contributors

We classify the contributors by two dimensions: (1) the quality dimension: contributors can be either *Intrinsically-motivated* (I) or *Non-intrinsically-motivated* ($\bar{I}$). The intrinsically-motivated contributors contribute higher quality content than the non-intrinsically-motivated contributors do (Garud and Kumaraswamy 2005; Lou et al. 2013); (2) the quantity dimension: Contributors can be either *Production-efficient* (P) or *Non-production-efficient* ($\bar{P}$). The production-efficient contributors contribute more content with one unit of effort than the non-production-efficient contributors (Lee et al. 2013; Pal et al. 2012). A production-efficient contributor may not produce high-quality content. For example, a contributor can simply produce (such as copy and paste) many contents in popular topics (such as stock market, salacious content, and celebrities gossip) and attracts a lot of attention, while those contents are not necessarily of high-quality (Sun and Zhu 2013).

Let C_H represent the effort of the intrinsically-motivated contributors to contribute one unit of UGC, and C_L represent that of the non-intrinsically-motivated contributors, where $C_H > C_L$. Given the same effort c ($c \geq 0$), the intrinsically-motivated contributors contribute less content than the non-intrinsically-motivated contributors $\left(\frac{c}{C_H} < \frac{c}{C_L}\right)$. This

is consistent with the empirical findings that the intrinsically-motivated contributors contribute higher quality content but with lower quantity than the non-intrinsically motivated contributors, (Garud and Kumaraswamy 2005; Lou et al. 2013). Assume that the non-production-efficient contributors produces α $(0 < \alpha < 1)$ less content than the production-efficient contributor does, so that if the production-efficient contributor contributes 1 unit of content, the non-production-efficient contributor contribute $(1 - \alpha)$ unit of content with the same effort.

Therefore, we classify the contributors into 4 types. Figure 1 demonstrates the conceptual model of these four types of contributors.



	Production-efficient (P)	Non-production-efficient ($\bar{P}$)
Intrinsically-motivated (I)	IP	$I\bar{P}$
Non-intrinsically-motivated ($\bar{I}$)	$\bar{I}P$	$\overline{IP}$

Figure 1, the Four Types of Contributors

Then we are able to calculate the quantity of contents of these four types of contributors. Let N_i denote contributor type i's content volume, then we have $N_{IP} = \frac{c_{IP}}{C_H}$, $N_{I\bar{P}} = \frac{(1-\alpha)c_{I\bar{P}}}{C_H}$, $N_{\bar{I}P} = \frac{c_{\bar{I}P}}{C_L}$, and $N_{\overline{IP}} = \frac{(1-\alpha)c_{\overline{IP}}}{C_L}$. Note that non-production-efficient contributors cost more effort to contribute one unit of content than the production-efficient contributors do.

3.2 Competition of Attention

Note that the audience attention is always limited. Specifically, in a short term, the total number of views can be treated as a fixed value. Then the contributors have to compete for the views (in other words, when the effort of all the contributors increases, the number

of views each unit of effort receives reduces.) Huang et al. (2015) also find evidence of competition to attract readership for their blog posts among employees within a Fortune 1000 IT services and consulting firm. Without loss of generality, let the total number of views to be 1, then the number of views each contributor receives represent its market share.

We assume that (1) a piece of high-quality content attracts more audience than a piece of low-quality content does. More specifically, let the proportion of the audience attracted by a piece of high-quality content comparing to that of a piece of low-quality content to be $\frac{C_H}{C_L}$; (2) keep everything else constant, the more content produced, the more audience attracted. Let Q_i represent the attention that contributor i receives, the total content volume in the market can be represented as: $Q = \sum_i Q_i$, and contributor i's market share can be calculated by $\frac{Q_i}{Q}$.

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

3.3 Benchmark: No Monetary Incentive

When there is no monetary incentive, the contributors can only get intrinsic reward. It is found that the intrinsic reward is positively correlated with the audience size (Andreoni 2007; Zhang and Zhu 2010). Following the literature, we assume that the intrinsic reward is proportional to this contributor's market share (volume of audience) $\frac{Q_i}{Q}$. Simply, we let the intrinsic reward to be $\beta \frac{Q_i}{Q}$, where $\beta > 0$ and $i \in \{IP, I\bar{P}\}$.

When there is no monetary incentive, the intrinsically-motivated contributors IP and $I\bar{P}$ get positive intrinsic reward, so they will contribute; the non-intrinsically-motivated contributors $\bar{I}P$ and $\overline{IP}$, however, get no intrinsic reward, so they will not contribute. This result is consistent with the literature (Wendelken et al. 2014). Let π_i denote contributor i's net benefit when making effort c_i in contributing content. Each

contributor maximizes his/her net utility (benefit minus effort) by choosing the optimal effort level c_i, given the other contributors' action. Therefore, the decision problem is:

$$max. \begin{cases} \pi_{IP} = \beta \frac{c_{IP}}{Q} - c_{IP} \\ \pi_{I\bar{P}} = \beta \frac{(1-\alpha)c_{I\bar{P}}}{Q} - c_{I\bar{P}} \end{cases}$$

$$\text{s.t. } \pi_i \geq 0 \; and \;\; c_i \geq 0, where \; i \in \{IP, I\bar{P}\}$$

Accordingly, the total market contribution is $Q = \frac{\beta(1-\alpha)}{(2-\alpha)}$.The two contributors' effort levels are $c_{IP} = c_{I\bar{P}} = \frac{\beta(1-\alpha)}{(2-\alpha)^2}$ and their market shares are $\frac{Q_{Ip}}{Q} = \frac{1}{(2-\alpha)}$, and $\frac{Q_{I\bar{p}}}{Q} = \frac{(1-\alpha)c_{I\bar{p}}}{Q} = \frac{(1-\alpha)}{(2-\alpha)}$. So we have

Lemma 1 (No Monetary Incentive Case):

When there is no monetary incentive, only the intrinsically-motivated contributors IP *and* $I\bar{P}$ *contribute. They generate the same effort. The productive contributor* IP *generates more output and obtains a larger market share.*

4 The Model with Monetary Incentive

4.1 Monetary Incentive

When a monetary incentive is introduced, it may induce two effects: a direct standard price effect and an indirect psychological effect (Frey and Jegen 2001; Gneezy et al. 2011; Heyman and Ariely 2004). The direct standard price effect is widely acknowledged in the economics literature. It is recognized as a basic "law of behavior" that higher monetary incentive will lead to higher marginal benefit or lower marginal cost, thus will lead to more effort and better performance (Frey and Jegen 2001; Gneezy et al. 2011). In practice, a monetary reward can be given based on the market share that the content generates. For example, YouTube's "Advertisement Sharing Plan" pays monetary rewards according to the number of views that the video attracts. It can be also based on the quality of the content being contributed. For example, the more "likes" or "helpful comments" or the higher rating attracted, the higher the payment. We first consider the

simplest case that the monetary incentive is proportional to the market share $\frac{Q_i}{Q}$. Simply, let the monetary incentive to be $\gamma\frac{Q_i}{Q}$ where $\gamma > 0$. We extend this assumption in section 5 by incorporating quality based incentive.

Besides the direct standard price effect, monetary incentive may also have an indirect psychological effect (Gneezy et al. 2011). The indirect psychological effect could be either positive or negative (e.g., Alexy and Leitner 2011; Roberts et al. 2006), i.e., the monetary incentive may modify the intrinsic motivations of contribution. Denote the *modified intrinsic reward* as $\beta' = \beta + \delta$, where δ can be either positive, 0 or negative, indicating the modification of intrinsic reward by the monetary incentive.

When a monetary incentive is introduced, the intrinsically-motivated contributors IP and $I\bar{P}$ obtain both the modified intrinsic reward and monetary reward, thus $\pi_i = (\beta' + \gamma)\frac{Q_i}{Q} - c_i$, where $i \in \{IP, I\bar{P}\}$ and $c_i \geq 0$; the non-intrinsically-motivated contributors $\bar{I}P$ and $\overline{IP}$ obtain only monetary incentive, thus $\pi_i = \gamma\frac{Q_i}{Q} - c_i$, where $i \in \{\bar{I}P, \overline{IP}\}$ and $c_i \geq 0$. Therefore, the decision problem for each contributor is:

$$max. \begin{cases} \pi_{IP} = (\beta' + \gamma)\dfrac{c_{IP}}{Q} - c_{IP} \\ \pi_{I\bar{P}} = (\beta' + \gamma)\dfrac{(1-\alpha)c_{I\bar{P}}}{Q} - c_{I\bar{P}} \\ \pi_{\bar{I}P} = \gamma\dfrac{c_{\bar{I}P}}{Q} - c_{\bar{I}P} \\ \pi_{\overline{IP}} = \gamma\dfrac{(1-\alpha)c_{\overline{IP}}}{Q} - c_{\overline{IP}} \end{cases}$$

$$\text{s.t. } \pi_i \geq 0 \; and \; c_i \geq 0, where \; i \in \{IP, I\bar{P}, \bar{I}P, \overline{IP}\}$$

In equilibrium, each contributor i decides his/her optimal contribution level given other contributors' contribution. The contributions can be either positive ($c_i > 0, \pi_i > 0 \; and \; \frac{\partial \pi_i}{\partial c_i} = 0$) or zero (which means no contribution: $c_i = 0, \pi_i = 0 \; and \; \frac{\partial \pi_i}{\partial c_i} \leq 0$). We present in Table 1 the conditions for each contributor to contribute. The proof is in the Appendix A-1.

Contribute?	IP	$I\bar{P}$	$\bar{I}P$	$\overline{IP}$

Yes	$Q < (\beta' + \gamma)$	$Q < (1-\alpha)(\beta' + \gamma)$	$Q < \gamma$	$Q < (1-\alpha)\gamma$
No	$Q \geq (\beta' + \gamma)$	$Q \geq (1-\alpha)(\beta' + \gamma)$	$Q \geq \gamma$	$Q \geq (1-\alpha)\gamma$

Table 1, Conditions for Each Contributor to Contribute

Since each of the four contributors has two options, there are altogether $2^4 = 16$ "possible cases", illustrated in Table 2. Fortunately, most of these cases can be eliminated in equilibrium. For example, condition $Q < (1-\alpha)(\beta' + \gamma)$ implies $Q < (\beta' + \gamma)$, that is, if contributor $I\bar{P}$ is in the market, contributor IP is also in the market. According to this logic, cases 9~12 can be excluded. Similarly, we can exclude 6 other impossible cases (see Appendix A-2). The remaining 6 possible cases, including Case 1 (all in), 2 (all except $\overline{IP}$), 4 (purely intrinsically-motivated), 5 (all except $I\bar{P}$), 6 (purely production-efficient), and 13 (purely non-intrinsically-motivated) are highlighted in Table 2.

1	$\boldsymbol{IP}$	$\boldsymbol{I\bar{P}}$	$\boldsymbol{\bar{I}P}$	$\boldsymbol{\overline{IP}}$	9		$I\bar{P}$	$\bar{I}P$	$\overline{IP}$
2	$\boldsymbol{IP}$	$\boldsymbol{I\bar{P}}$	$\boldsymbol{\bar{I}P}$		10		$I\bar{P}$	$\bar{I}P$	
3	IP	$I\bar{P}$		$\overline{IP}$	11		$I\bar{P}$		$\overline{IP}$
4	$\boldsymbol{IP}$	$\boldsymbol{I\bar{P}}$			12		$I\bar{P}$		
5	$\boldsymbol{IP}$		$\boldsymbol{\bar{I}P}$	$\boldsymbol{\overline{IP}}$	**13**			$\boldsymbol{\bar{I}P}$	$\boldsymbol{\overline{IP}}$
6	$\boldsymbol{IP}$		$\boldsymbol{\bar{I}P}$		14			$\bar{I}P$	
7	IP			$\overline{IP}$	15				$\overline{IP}$
8	IP				16				

Note: The cases highlighted in bold are the remained cases.

Table 2, Possible Cases

We now solve the model for the remaining 6 cases (the details are presented in the Appendix A-3.) Then we have the following proposition:

Proposition 1 (Possible Equilibrium):

When there is a monetary incentive, there are 6 possible equilibria; the conditions for each case, and the total market contribution Q *are summarized in Table 3; each contributor's market share is* $\frac{Q_{IP}}{Q} = 1 - \frac{Q}{(\beta'+\gamma)}$, $\frac{Q_{I\bar{P}}}{Q} = 1 - \frac{Q}{(1-\alpha)(\beta'+\gamma)}$, $\frac{Q_{\bar{I}P}}{Q} = 1 - \frac{Q}{\gamma}$, *and* $\frac{Q_{\overline{Ip}}}{Q} = 1 - \frac{Q}{(1-\alpha)\gamma}$, *respectively.*

Case No.	*Contributors*				*Conditions*	Q
NMI: No Monetary Incentive	IP	$I\bar{P}$			*N/A*	$\frac{(1-\alpha)\beta}{(2-\alpha)}$
1: All	IP				$\beta' \geq 0,\ (1-2\alpha)\gamma > (1+\alpha)\beta'$	

		$I\bar{P}$	$\bar{I}P$	$\overline{IP}$	$\beta' < 0,\ (2\alpha - 1)\gamma < (2 - \alpha)\beta'$	$\frac{3(1-\alpha)\varphi\gamma}{(2-\alpha)(\varphi+\gamma)}$
2: Without $\overline{IP}$	IP	$I\bar{P}$	$\bar{I}P$		$\beta' \geq 0,\ \gamma > (1-\alpha)\beta',\ (2\alpha-1)\gamma < (1-\alpha)\beta'$ and $(1-2\alpha)\gamma \leq (1+\alpha)\beta'$	$\frac{2(1-\alpha)\varphi\gamma}{\omega}$
4: Intrinsically-motivated	IP	$I\bar{P}$			$\beta' \geq 0,\ \gamma \leq (1-\alpha)\beta'$	$\frac{(1-\alpha)\varphi}{(2-\alpha)}$
5: Without $I\bar{P}$	IP		$\bar{I}P$	$\overline{IP}$	$\beta' < 0,\ (1-2\alpha)\gamma > \alpha\beta',\ (2\alpha-1)\gamma \geq (2-\alpha)\beta'$ and $\gamma > -(2-\alpha)\beta'$	$\frac{2(1-\alpha)\varphi\gamma}{\beta'+\omega}$
6: Production-efficient	IP		$\bar{I}P$		$\beta' \geq 0,\ (2\alpha-1)\gamma \geq (1-\alpha)\beta'$ $\beta' < 0,\ (2\alpha-1)\gamma \geq -\alpha\beta'$	$\frac{\varphi\gamma}{(\varphi+\gamma)}$
13: Non-Interested			$\bar{I}P$	$\overline{IP}$	$\beta' < 0,\ \gamma \leq -(2-\alpha)\beta'$	$\frac{(1-\alpha)\gamma}{(2-\alpha)}$

Note: $\boldsymbol{\varphi = \beta' + \gamma}$ ***and*** $\boldsymbol{\omega = \gamma + (1-\alpha)(\varphi+\gamma)}$ ***in this table.***

Table 3, Equilibrium Cases and Conditions

Proposition 1 shows that different level of monetary incentive and other parameters corresponds to different equilibrium, each corresponding to a scenario with different contributors as well as contribution volume in the market. Each of the 6 equilibria has its own advantages/weakness. For example, the "all contributors participate" equilibrium (Case 1) has the most contributors (variety), which may be desired by a UGC platform at its early stage ; the "purely intrinsically-motivated" equilibrium (Case 4) has the highest quality content, which may be preferred by an internal knowledge repository within an organization (InfoSys, for example). The "purely non-intrinsically motivated" equilibrium (Case 13) produces the lowest quality content; and the "purely production-efficient" equilibrium (Case 6) represents the highest production efficiency.

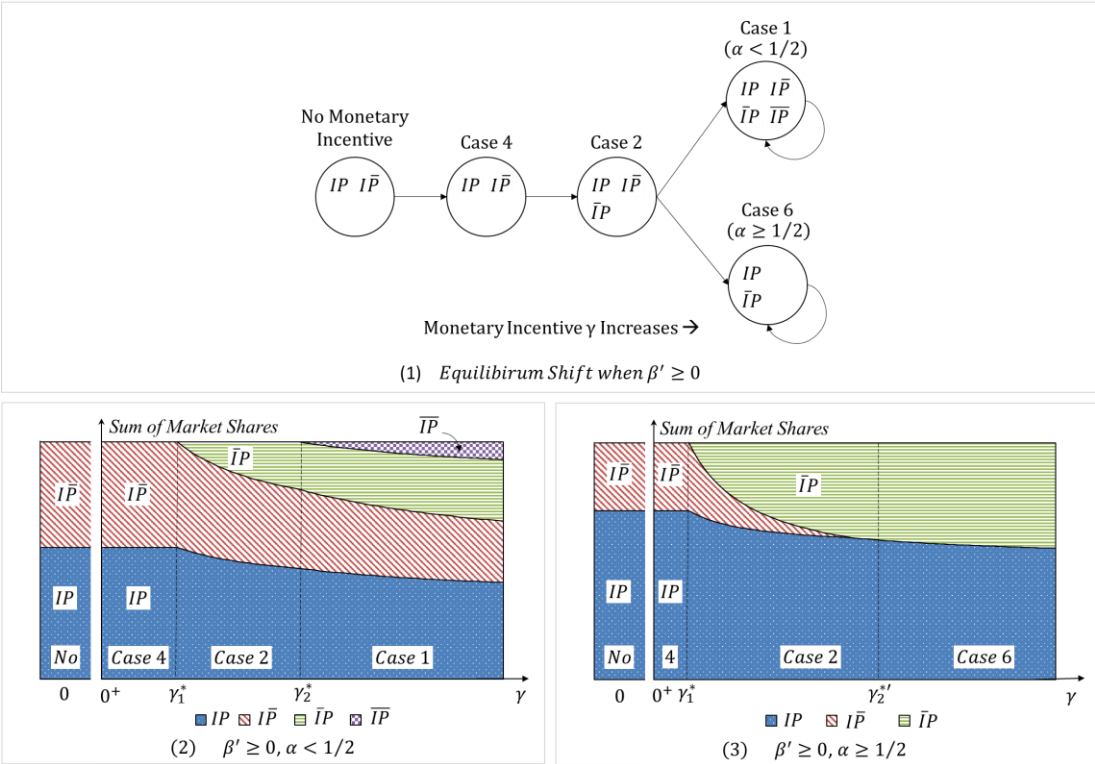
Moreover, Proposition 1 also implies that, when the level of monetary incentive changes, the equilibrium may change from one case to another, and some contributors enter into or quit from the market. This may cause the change in the market structure, total contribution volume, as well as the overall contribution quality. In the following section we discuss the shift of equilibrium when the conditions changes.

4.2 Equilibrium Shifts

Note that all the inequalities in Table 3 are related to the parameters α, β' and γ. Recall that the parameter α describes the difference of the productivities between a productive contributor and a non-productive contributor, which is assumed to be exogenous in this

model. The parameter β' represents the modified intrinsic reward from contributing contents, which is commonly assumed to be exogenous too, because it is difficult to influence or control by the sponsor (Frey and Jegen 2001). The monetary incentive γ can be easily manipulated. Therefore, we focus on the impact of γ given α and β' (the details are in Appendix A-4).

We discuss the equilibrium shift when $\beta' \geq 0$ and $\beta' < 0$ seperately. Figure 2 shows how the equilibrium change as the monetary incentive increases when the modified monetary incentive β' is no-negative. As shown in the subfigure 2(1), when the monetary incentive increases, the equilibrium shifts from the "Case NMI" (No Monetary Incentive), to "Case 4" (IP and $I\bar{P}$ contribute), then to "Case 2" ($\bar{I}P$ enters), then to "Case 1" ($\overline{IP}$ enters so that all contributors contribute, when $\alpha < 1/2$) or "Case 6" ($I\bar{P}$ is crowded out from the market so that only the production-efficient contributors contribute, when $\alpha \geq 1/2$). Note that in this scenario, there are no further cases after Case 1 and Case 6, i.e., the equilibrium sticks to these cases and does not shift when the monetary incentive further increases. We call such cases *Ultimate Case*, indicated by the semi-loops with arrows in the subfigure 2(1). The subfigure 2(2) and 2(3) show the change of market shares corresponding to the subfigure 2(1) when $\alpha < 1/2$ and $\alpha \geq 1/2$ separately.



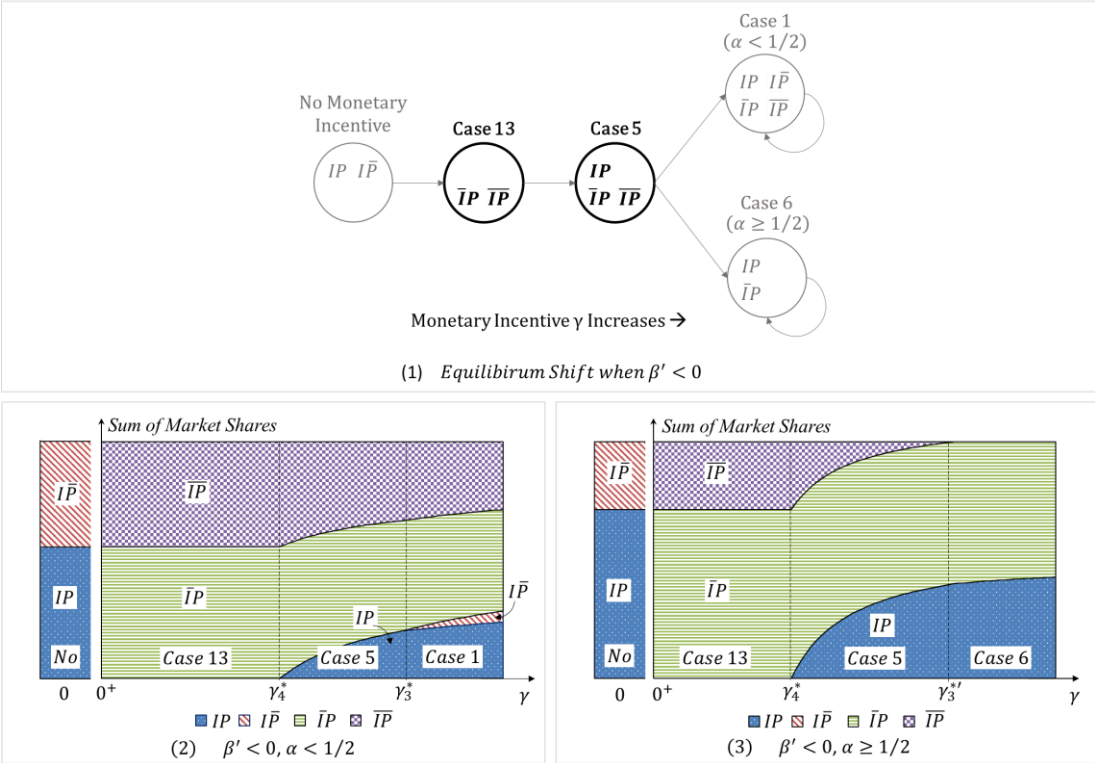
Note: The subfigure (1) shows the equilibrium shifts when the modified intrinsic reward is non-negative. The subfigures (2) and (3) show the change of market share corresponding to the subfigure (1) when α<1/2 and α⩾1/2 separately.

Figure 2, Equilibrium Shift and Market Shares when $\beta' \geq 0$

Figure 3 shows the equilibrium change as the monetary incentive increases when the modified monetary incentive β' is negative. After comparing the equilibrium shift when $\beta' < 0$ (subfigure 3(1)) and $\beta' \geq 0$ (subfigure 2(1)), we find that they both start from the No Monetary Incentive Cases (NMI) and end with Case 1 or Case 6; however, as highlighted in subfigure 3(1), the shift of equilibrium is different.

Interestingly, when a small monetary incentive is introduced (i.e., when the monetary incentive increases from 0), the change of market shares is not continuous: all the intrinsically-motivated contributors (IP and $I\bar{P}$) are crowded out from the market, and the non-intrinsically-motivated contributors ($\bar{I}P$ and $\overline{IP}$) enter the market. This illustrates a "market turnover". Intuitively, when $\beta' < 0$, intrinsically-motivated contributors incur a loss. If this loss can not be offset by the small amount of monetary incentive, the intrinsically-motivated contributors will quite the market. The non-intrinsically-motivated

contributors enjoy the positive monetary incentive while their intrinsic reward is not affected (zero), so they enter the market.



Note: The subfigure (1) shows the equilibrium shifts when the modified intrinsic reward is negative. We highlight the differences between the subfigure 3(1) and subfigure 2(1) in bolded lines and characters. The subfigures (2) and (3) show the market share shifts.

Figure 3, Equilibrium Shift and Market Shares when $\beta' < 0$.

Combining the scenarios when $\beta' \geq 0$ and $\beta' < 0$, we have the following proposition:

Proposition 2 (Equilibrium Shifts):

With an increase in the monetary incentive, contributors may be attracted to or crowded out of the contribution market, depending on the level of monetary incentive γ, modified intrinsic reward β', as well as the difference in the productivities α. Specifically,

(a) If the modified intrinsic reward is positive ($\beta' \geq 0$,) as the monetary incentive increases, the equilibrium shifts from case 4 (purely intrinsically-motivated IP and $I\bar{P}$), to case 2 ($\bar{I}P$ joins), then to case 1 ($\overline{IP}$ joins, when $\alpha < 1/2$) or case 6 ($I\bar{P}$ quits, when $\alpha > 1/2$).

(b) If the modified intrinsic reward is negative ($\beta' < 0$,) as the monetary incentive increases, the equilibrium shifts from case 13 (purely non-intrinsically-motivated $\bar{I}P$ and $\overline{IP}$), to case 5 (IP joins), then to case 1 ($I\bar{P}$ joins, when $\alpha < 1/2$) or case 6 ($\overline{IP}$ quits, when $\alpha > 1/2$).

Proposition 2 shows that, raising the monetary incentive can both attract in and crowd out certain types of contributors. More specifically:

(1) The ultimate cases are either Case 1 (all in) or Case 6 (purely production-efficient). Case 1 (all in) is possible only when $\alpha < 1/2$, i.e., when the difference in the production efficiencies is small, which implies that the four types of contributors are similar. Case 6 (purely production-efficient) is possible only when $\alpha \geq 1/2$, i.e., the difference in the production efficiencies is large. Under this condition the production-efficient contributors produces a lot more content than the non-production-efficient ones, and they crowd out the non-production-efficient contributors when there is a large monetary incentive.

(2) Among all the cases, IP is present the most of times (absent only in Case 13). This is because IP is the dominant contributor in the market: it contributes high quality content and has high production efficiency. The only reason for it not to be in the market is when it suffers from the negative intrinsic reward when the monetary incentive is first introduced (Case 13). However, when the monetary incentive is large enough to offset this negative intrinsic reward, the contributor IP will be attracted back into the market.

(3) Among all the cases, $\overline{IP}$ appears the least of times among all the contributors. This is because $\overline{IP}$ is the weakest contributor in the market: it contributes low quality content and has low production efficiency. The contributor $\overline{IP}$ can join the market either when the market "welcomes" all the contributors (Case 1) or when the intrinsically-motivated contributors suffers from the negative intrinsic reward (Case 13 and Case 5).

4.3 Total Content Volume

Now we discuss the impact of monetary incentive on the total content volume. Note that the impact of monetary incentive on market share can be non-continuous when the monetary incentive changes from zero to positive. We classify monetary incentive as Zero,

Small and Large, and study the impact of the monetary incentive in two steps: (1) the introduction of a small monetary incentive, i.e., from no monetary incentive to a small monetary incentive; (2) the increasing of monetary incentive, i.e., from a small to large monetary incentive.

From Lemma 1, the total content volume when there is no monetary incentive is $Q = \frac{(1-\alpha)\beta}{(2-\alpha)}$. According to Proposition 2, when there is a small monetary incentive ($\gamma = 0^+$), if the modification of the intrinsic reward δ is positive, the total market contribution jumps to $\frac{(1-\alpha)(\beta'+\gamma)}{(2-\alpha)} > \frac{(1-\alpha)\beta}{(2-\alpha)}$ (note that $\beta' = \beta + \delta > \beta$ and $\gamma = 0^+$). This is known as the *motivation crowding in effect* (Frey and Jegen 2001). If there is no modification on the intrinsic reward ($\delta = 0$), the total market contribution will be $\frac{(1-\alpha)\beta}{(2-\alpha)} + 0^+$, which is nearly no change. If the modification of intrinsic reward δ is negative yet $\beta' = \beta + \delta > 0$, the total market contribution drops to $\frac{(1-\alpha)(\beta'+\gamma)}{(2-\alpha)} < \frac{(1-\alpha)\beta}{(2-\alpha)}$ (note that $\beta' < \beta$); further, if δ is so negative that $\beta' = \beta + \delta < 0$, the equilibrium shifts to Case 13, then the market contribution will drop to $\frac{(1-\alpha)(1-k)\gamma}{(2-\alpha)} < \frac{(1-\alpha)\beta}{(2-\alpha)}$. Since $\gamma = 0^+$, there is barely market contribution. This is consistent with the *motivation crowding out effect* (Frey and Jegen 2001). Therefore, we have the following proposition:

Proposition 3 (Motivation Crowding In/Out):

When a small monetary incentive is introduced, the total market contribution could either increase or reduce:

(a) when the monetary incentive is associated with a positive modification on the intrinsic motivation, the total market contribution increases;

(b) when there is no modification on the intrinsic motivation, the total market contribution remains unchanged;

(c) when the modification is negative, the total market contribution reduces, and may even drop to close to 0.

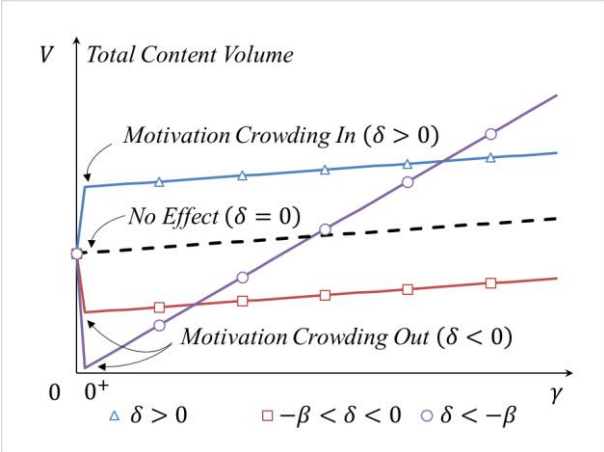


Figure 4, Motivation Crowding In/Out

Proposition 3 indicates that the seemingly contradictory results in the literature can be explained by the magnitude of the modification effect of monetary incentive in our model: when a small monetary incentive is introduced, either a "crowding in" or "crowding out" can happen, depending on the modification of the intrinsic reward by the monetary incentive. The "crowding in effect" is observed if the monetary incentive is perceived to enhance the intrinsic reward (Frey and Jegen 2001), e.g., the ability to make money via contributing content is a good thing and admirable (Tang et al. 2012b); the "crowding out effect" is observed if the monetary incentive breaks certain established social norms (Titmuss 1970) or social reputation (Bénabou and Tirole 2006), e.g., the contributors may not want to be perceived to be greedy when contribution is paid (Bénabou and Tirole 2006). The market contribution could even dramatically disappear when the monetary incentive is small.

Proposition 3 shows that either a "crowding in effect" or a "crowding out effect" may happen when a small monetary incentive is introduced. What happens when the monetary incentive keeps increasing? As proved in the Appendix, when $\gamma > 0$, we can get $\frac{dQ}{d\gamma} > 0$. Therefore, we have,

Lemma 2 (Standard Price Effect):

A higher monetary incentive leads to a higher total content volume.

Lemma 2 shows a theoretical support to the "*standard price effect*" of monetary incentive

(Gneezy and Rustichini 2000). Figure 5 illustrates that the total market contribution increases as the monetary incentive increases.

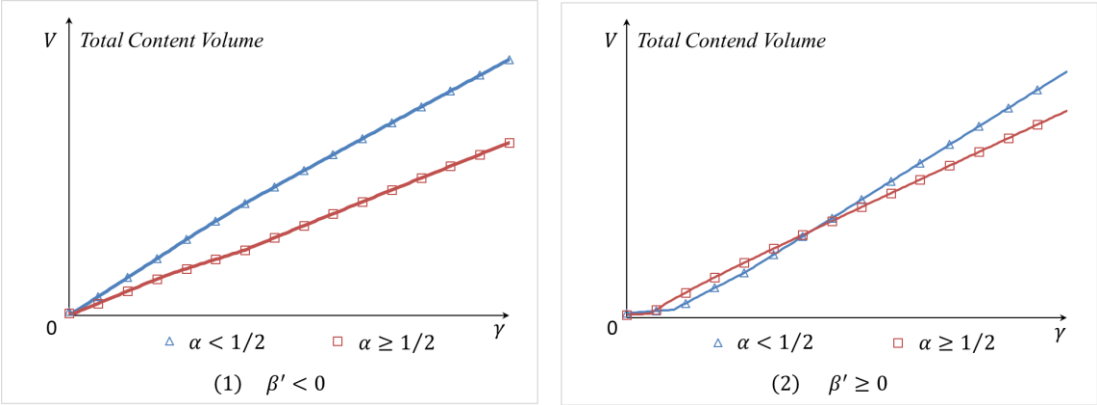


Figure 5, the Effect of Increasing Monetary Incentive on Total Content Volume

Proposition 3 and Lemma 2 together show that the impact of monetary incentive on the total content volume depends on (1) whether the monetary incentive is associated with a positive, zero or negative modification on the intrinsic reward, and (2) the magnitude of monetary incentive. When the modification of an intrinsic reward is non-negative ($\delta \geq 0$), the introduction of monetary incentive increases the total contribution in the market. When the modification of the intrinsic reward is negative ($\delta < 0$), the introduction of a small amount of monetary incentive reduces the total market contribution; however, according to Lemma 2, when the monetary incentive keep increasing, the total contribution volume also increases. So, if the monetary incentive is sufficiently large, the total content volume will be higher than that when there is no monetary incentive.

Therefore, as frequently emphasized by economists, "incentives matter" (Gneezy et al. 2011). Whatever the initial impact of monetary incentive is, if the monetary incentive is sufficiently large, it increases the total market contribution, otherwise the total market contribution can even be lower than the case when no monetary incentive is offered. Similar empirical results, such as "Pay Enough or Don't Pay at All", is reported in Gneezy and Rustichini (2000). Corollary 1 offers theoretical support for such findings."

Corollary 1 (Pay Nothing or Pay Enough):

A sufficiently large monetary incentive $\gamma > \gamma^*$ *induces a higher contribution volume*

than the case without monetary incentive.

4.4 Average Content Quality

To calculate the average content quality (Φ ($\Phi \in [0,1]$) in the market, we assume that each contributor's content quality remain unchanged as the monetary incentive increases, which is commonly observed in the literature (e.g., Mason and Watts 2010; Wang et al. 2012) (the detail of the calculation can be found in the Appendix.) We also relax this assumption in the Appendix.

Since the intrinsically-motivated contributors contribute relatively higher quality content than the non-intrinsically-motivated contributors do, it is then easy to infer that, the average content quality is a function of market shares of each contributor: if the market share of each contributor remains unchanged, the average content quality also remains unchanged, even when the overall contribution volume increases (consistent with Mason and Watts (2010)'s findings); if the market share of the intrinsically-motivated contributors increases, the average content quality increases; and vice versa. Moreover, this impact is further enlarged because a piece of high-quality content attracts more audience than a piece of low-quality content, thus the proportion of high quality content - is - less than of the relative market shares occupied by the intrinsically-motivated contributors.

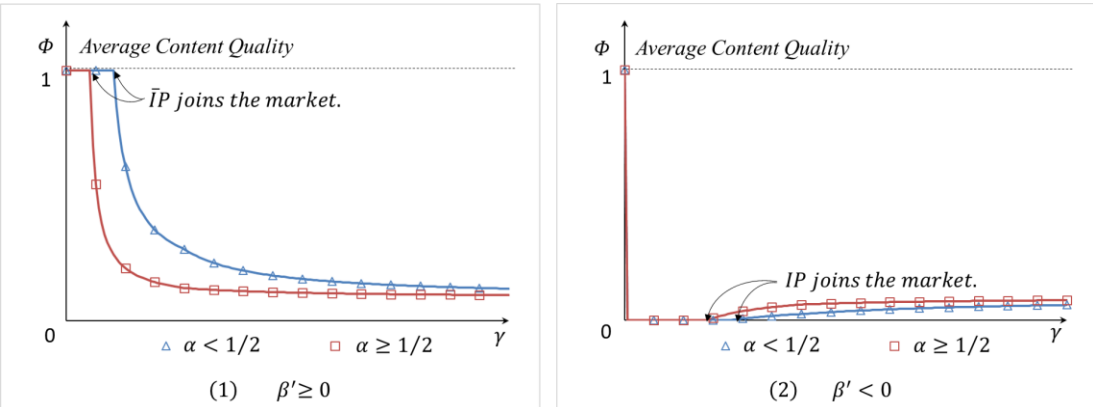


Figure 6, Average Content Quality

Figure 6 illustrates the change of the average content quality Φ with an increase in the monetary incentive. We can easily observe that: (1) When the modified intrinsic reward is

non-negative ($\beta' \geq 0$), after the non-intrinsically-motivated contributors join to contribute, the average content quality drops, as shown in subfigure 6(1). The empirical findings in the literature also support this result (Garud and Kumaraswamy 2005). (2) Interestingly, when the modified intrinsic reward is negative ($\beta' < 0$), we find a U-shape relationship between the average quality and monetary incentive, as depicted in the subfigure 6(2). In this case, when the monetary incentive is first introduced, the intrinsically-motivated contributors are crowded out while the non-intrinsically-motivated contributors enters the market. This "motivation crowd out/in" causes a sudden drop in the average quality in the market. However, when the monetary incentive is sufficiently large and offsets the disutility of the intrinsically-motivated contributors, they re-enter the market and crowd out some non-intrinsically motivated contributors, so the average quality increases again. So, we have:

Proposition 4 (Average Content Quality):

1. *When the modified intrinsic reward is non-negative ($\beta' \geq 0$), the average quality of the contents decreases with the amount of the monetary incentive;*
2. *When the modified intrinsic reward is negative ($\beta' < 0$), introducing a small monetary incentive reduces the average content quality, but further increasing the monetary incentive increases the average content quality, which demonstrates a U-shape relationship.*

Proposition 4 indicates that if the objective of the online community is to encourage higher quality content rather than more content (e.g., co-creation forums, Wikipedia, and knowledge sharing forums within organizations), a monetary incentive may not be effective in encouraging contributors, because it attracts the non-intrinsically-motivated contributors who brings down the average content quality. For example, in the InfoSys case (Garud and Kumaraswamy 2005), introducing a monetary incentive attracted the contributors who "just to secure monetary rewards". The content volume sharply increased while the average contribution quality sharply dropped (Garud and Kumaraswamy 2005). The InfoSys employees reported that they "search the repository, gets three documents and

finds out that they are not useful … a waste of time … they are finding it faster to do things on their own or to ask someone they know instead of searching the repository for reusable content" (Garud and Kumaraswamy 2005). In this case, the more content contributed, the less valuable the knowledge repository is. Therefore, merely offering monetary incentive may be helpful for online communities to increase the contribution volume, but not sufficient for them to control the content quality.

5 Monetary Incentive with Quality Control

5.1 Introducing Quality Control in Monetary Incentives

As we discussed previously, the contribution quality can be more important than volume in some scenarios. In these contexts, a monetary incentive that purely based on the number of attention received may not be sufficient, and it is necessary to add quality control. For example, after visitors view the contribution, they are able to tell the quality of the content, commonly in the form of "like" or "rating", which can be can be used in some quality-based monetary incentive mechanisms.

Since the non-intrinsically-motivated contributors contribute relatively lower quality content, let k represent the quality discount in the monetary incentive they receive. In other words, if the intrinsically-motivated contributors' receive 1 in monetary incentive, the non-intrinsically-motivated contributor receives $1-k$. Therefore, when the monetary incentive for the intrinsically-rewarded contributors is $(\beta'+\gamma)\frac{Q_i}{Q}$, the monetary incentive for the non-intrinsically-rewarded contributors is $\gamma(1-k)\frac{Q_i}{Q}$. Here k can be interpreted as a measure of quality control to show how the online community values contribution quality. The higher the k, the more the contribution quality is valued. Specifically, when $k=0$, the monetary incentive is paid purely based on the number of views without considering quality, as in Section 4. When $k=1$, the non-intrinsically-motivated contributors is never compensated financially so they quit the market, which is not to the interest of this model. So we assume that $0<k<1$ in this section.

Accordingly, the decision problem for each contributor is:

$$max.\begin{cases}\pi_{IP} = (\beta' + \gamma)\dfrac{c_{IP}}{Q} - c_{IP} \\ \pi_{I\bar{P}} = (\beta' + \gamma)\dfrac{(1-\alpha)c_{I\bar{P}}}{Q} - c_{I\bar{P}} \\ \pi_{\bar{I}P} = \gamma\dfrac{(1-k)c_{\bar{I}P}}{Q} - c_{\bar{I}P} \\ \pi_{\overline{IP}} = \gamma\dfrac{(1-\alpha)(1-k)c_{\overline{IP}}}{Q} - c_{\overline{IP}}\end{cases}$$

$$\text{s.t.}\, \pi_i \geq 0 \; and \; c_i \geq 0, where \; i \in \{IP, I\bar{P}, \bar{I}P, \overline{IP}\}$$

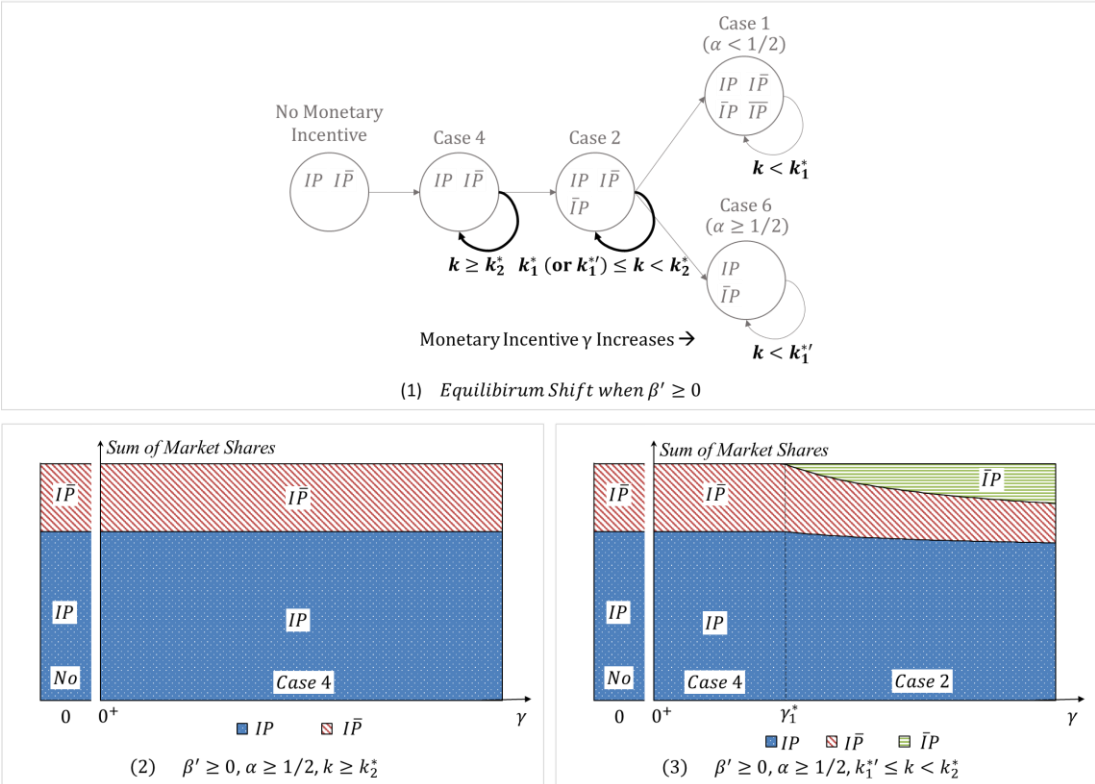
In equilibrium, each contributor i decides its optimal contribution level given other contributors' contribution. Following the same procedure as in the previous section, we work out the equilibrium solutions and discuss the equilibrium shifts when $\beta' \geq 0$ and $\beta' < 0$ seperately.

5.2 Equilibrium Shifts

Figure 7 shows how the equilibrium change as the monetary incentive increases when the modified monetary incentive β' is non-negative. The major change with quality control is that, the ultimate cases are not necessarily Case 1 or Case 6 anymore. They are also affected by the level of quality control k: only when the quality control is small enough ($k < k_1^*$ or $k < k_1^{*\prime}$), Case 1 or Case 6 can still be the ultimate case. However, if the quality control is moderate (k_1^* or $k_1^{*\prime} \leq k < k_2^*$) or high ($k \geq k_2^*$), the ultimate case can be Case 2 or even Case 4. These changes are highlighted in the subfigure 7(1).

Subfigure 7(2) shows the market share shift when the quality control is high ($k \geq k_2^*$), i.e., Case 4 is the ultimate case. Obviously, there is actually no "market share shift" in this scenario, which means the intrinsically-motivated contributors IP and $I\bar{P}$ are the only contributors in the market no matter how the monetary incentive increases. To understand, when the quality control is sufficiently higher, the non-intrinsically-motivated contributors have no chance to get monetary rewards from contributing. So an increase in the monetary incentive only improves the contribution of the intrinsically-motivated contributors, rather than attracts the non-intrinsically-motivated contributors into the market. Subfigure 7(3) shows the market share shift when the quality control is moderate (k_1^* or $k_1^{*\prime} \leq k < k_2^*$). In this scenario, when the monetary incentive increases,

$\bar{I}P$ enter the market but $\overline{IP}$ will never get a chance. Although both $\bar{I}P$ and $\overline{IP}$ contribute low quality content, $\bar{I}P$ is more production efficient than $\overline{IP}$, so it attracts more audience.



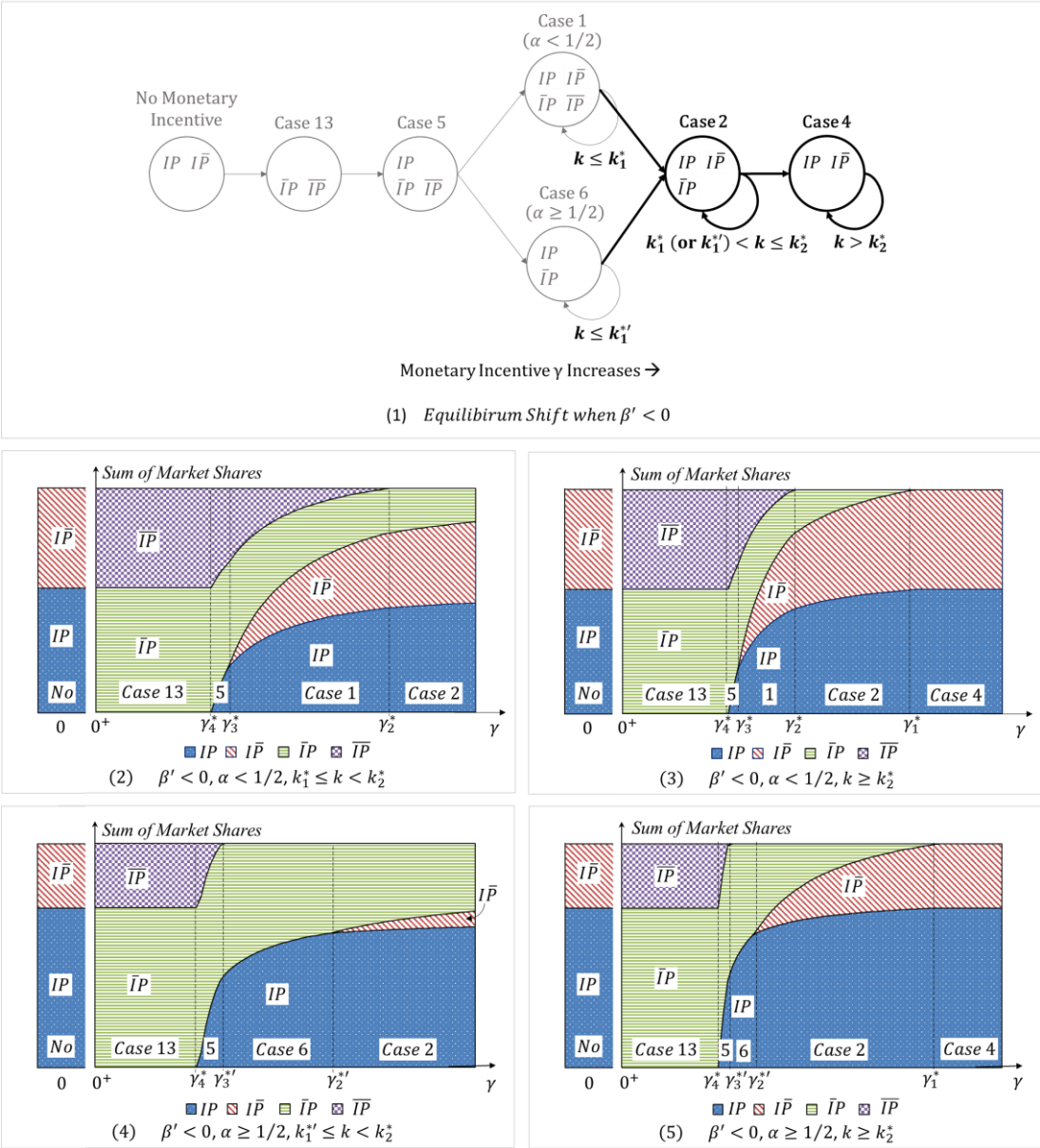
Note: The subfigure (1) shows the equilibrium shifts with quality control when the modified intrinsic reward is non-negative. The bolded places are the different ones compared to Figure 2. And we only present the different market share shift process compared to figure 2.

Figure 7, Equilibrium Shift and Market Shares when $\beta' \geq 0$ with Quality Control

Figure 8 shows the equilibrium shift as the monetary incentive increases when the modified monetary incentive is negative $\beta' < 0$. Comparing to the case without quality control (as depicted in the subfigure 3(1)), the equilibrium shifts are extended thus there are possibilities to shift to Case 2 and Case 4; and the ultimate cases are affected by the quality control k. The differences are highlighted in the subfigure 8(1).

Comparing to the scenarios when there is quality control and the monetary incentive is non-negative $\beta' \geq 0$ (as depicted in the subfigure 7(1)), the ultimate cases and the corresponding conditions, are nearly the same, except the special cases when the quality

control k equals to the threshold values k_1^*, $k_1^{*\prime}$ and k_2^*. Subfigures 8(2)~(5) show the market share changes with Case 2 or Case 4 as the ultimate case.



Note: The subfigure (1) shows the equilibrium shifts with quality control when the modified intrinsic reward is negative. We only present the different market share shift process comparing to figure 3.

Figure 8, Equilibrium Shift and Market Shares with Quality Control when $\beta' < 0$

In summary, we have the following proposition:

Proposition 5 (Equilibrium Shifts with Quality Control):

With an increase in the monetary incentive, contributors may be attracted in or crowded

out of the contribution market. Specifically, as the monetary incentive increases,

(a) If the modified intrinsic reward is positive ($\beta' \geq 0$,), the equilibrium cases may shift following the sequence NMI→4→2→1(or 6);

(b) If the modified intrinsic reward is negative ($\beta' < 0$,) the equilibrium cases may shift following the sequence NMI→13→5→1(or 6)→2→4;

(c) The ultimate cases depend on the level of quality control k: the ultimate case is Case 4 (purely intrinsically-motivated IP and $I\bar{P}$) when the quality control is high; Case 2 (all except $\overline{IP}$) when the quality control is moderate; and Case 1 (all in) or Case 6 (purely production-efficient) when quality control is low.

Proposition 5 indicates several findings:

(1) Note that Case 4 (purely intrinsically-motivated IP and $I\bar{P}$) produces the highest quality; Case 1 and 6 produces the lowest quality. Given a sufficiently high monetary incentive, by increasing the quality control, the equilibrium shift from relatively lower quality case to higher quality case, as illustrated in the following figure 9:

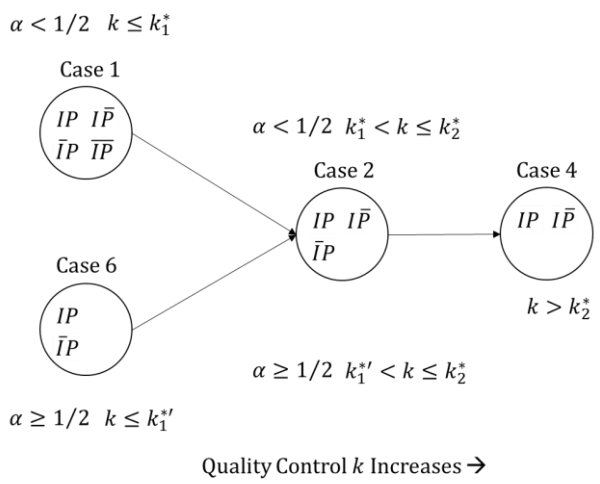


Figure 9, Equilibrium Shift when Quality Control Increases

(2) When the monetary incentive attracts in the contributors, the sequences will be IP, then $I\bar{P}$ or $\bar{I}P$, then finally $\overline{IP}$. When the monetary incentive crowds out contributors, the sequences will be reversed, i.e., first $\overline{IP}$, then $I\bar{P}$ or $\bar{I}P$, finally IP. The order of $I\bar{P}$

and $\bar{I}P$ depends on the tradeoff between the difference in the production efficiency and the quality control level. A big difference in the production efficiency increases the $\bar{I}P$'s competitiveness, while a high quality control increases the $I\bar{P}$'s competitiveness.

5.3 Total Content Volume

After quality control is added, while Proposition 3 (i.e., the motivation crowding in/out effect) still hold, Lemma 2 (i.e., the standard price effect) does not hold any more. More specifically, when increasing the monetary incentive, the total content volume does not monotonically change. As shown in Figure 10, when the quality control is high, the intrinsically-motivated contributors, who contribute high quality content with low quantity, enter the market and crowd out the non-intrinsically-motivated contributors. So the market share of the intrinsically-motivated contributors increase, while the total content volume reduces. We refer to this as "competition crowding out effect". Moreover, when the quality control k is higher and the productivity difference α is low, the "competition crowding out" is more likely to happen. Therefore, we have,

Proposition 6 (Competition Crowding Out):

An increase in the monetary incentive may reduce the total content volume, when the quality control is high ($k \geq k_2^*$) and the modified intrinsic reward is negative.

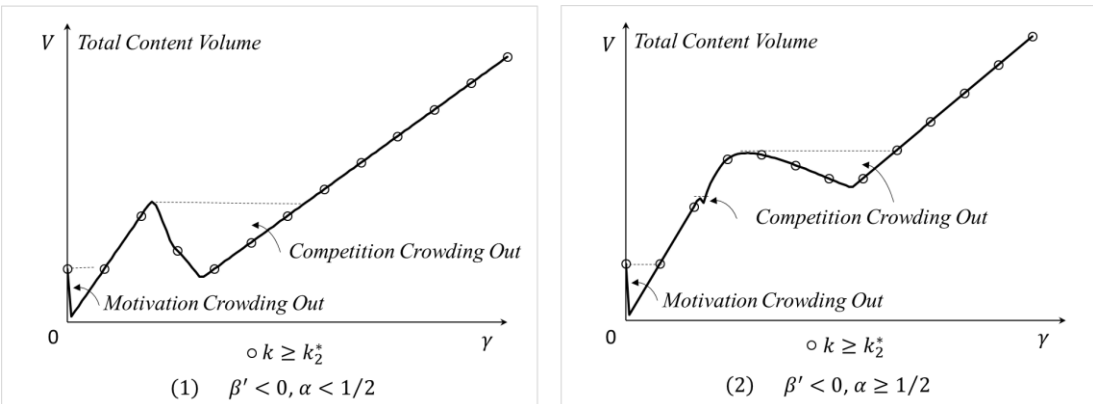


Figure 10, Competition Crowding Out

Proposition 3 and 6 show that, the impact of monetary incentive on total content volume is more complex than what is described in the literature. It demonstrates a "W" shape. The first drop of total content volume is due to the "motivation crowding out effect", while the

second drop is due to the "competition crowding out effect". In the other regions, the "standard price effect" holds where the total content volume increases as the monetary incentive increases.

5.4 Average Content Quality

We also calculate the average content quality when there is quality control. Figure 11 illustrates the change of the average content quality Φ with an increase in the monetary incentive in various scenarios. Since the $k \geq k_2^*$ line is higher than the $k_1^* \leq k < k_2^*$ line, which is higher than the $\mathrm{k} < k_1^*$ line, it shows that the higher the quality control, the higher the average content quality. Therefore, we have:

Proposition 7 (Average Content Quality with Quality Control):

The higher the quality control, the higher the average quality of content.

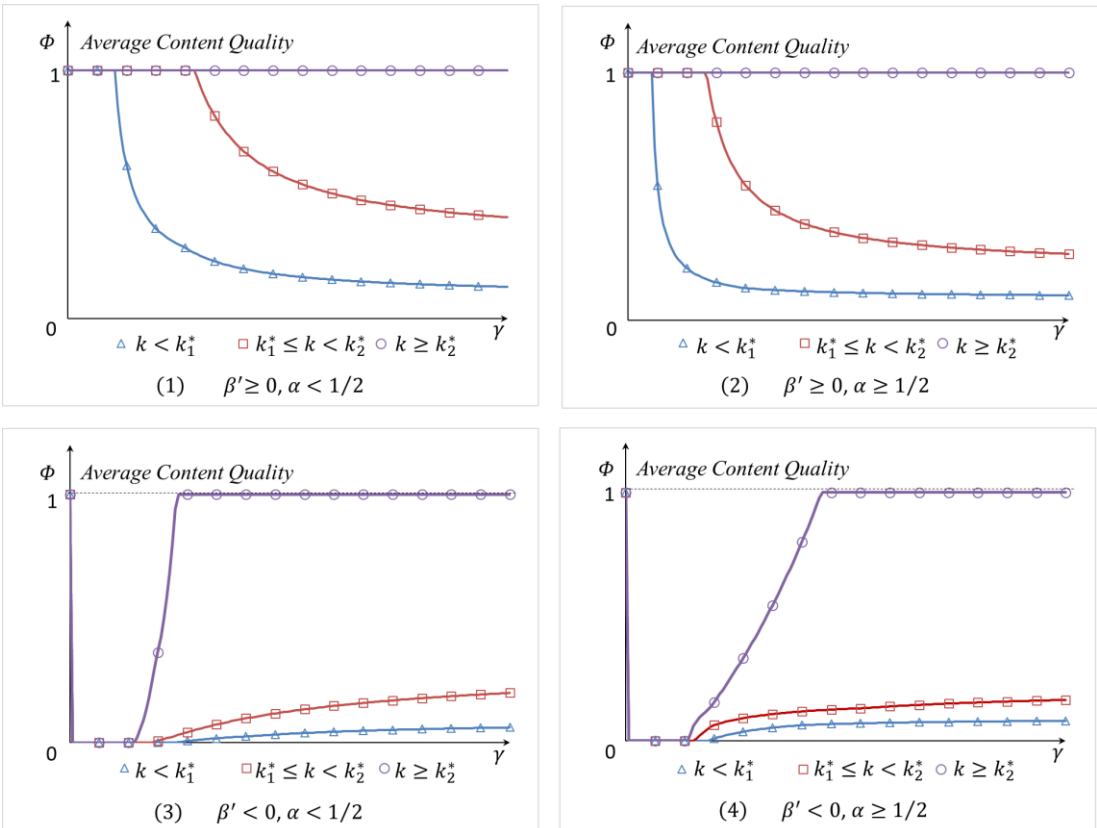


Figure 11, Average Content Quality

According to Proposition 4 and Proposition 7, we conclude that, to elicit high content

quality, offering monetary incentive alone maybe not be sufficient. Quality control is also needed.

6 Practical Implications

In practice the impact of monetary incentive on UGC contribution is complex. The outcome varies with the magnitude of the monetary incentive, whether it is associated with quality control, as well as other market conditions such as the difference between the efficiencies levels of the intrinsically motivated and non-intrinsically motivated contributors.

This paper provides a theoretical framework to understand the complex, and dynamic nature of the impact of monetary incentive. For example, when a monetary incentive is first introduced at InfoSys without quality control, it attracted contributors who "just to secure monetary rewards" (Garud and Kumaraswamy 2005.) This corresponds to the equilibrium shift from Case NMI to Case 2 or even Case 1 (Proposition 2, see Figure 2) in our model. According to Lemma 2 and Proposition 4, this should be associated with an increase in the contribution volume and a drop of overall contribution quality, which were actually observed. Then the KM group in the InfoSys company modified the incentive scheme to enhance quality control. The resulting equilibrium shift then follows Case 1→Case 2→Case 4 (see Figure 9), and those who are not intrinsically-motivated were crowded out. The observation—the contributors who "have contributed to KShop just to secure monetary rewards reduced their participation"—is also consistent with our theoretical prediction.

Second, our model offers guidelines to different UGC platforms on designing monetary incentive mechanisms. Different UGC platforms, or at different stages of one single UGC platform, may have different objectives with respect to market composition, the volume of contribution, or quality of the contribution, and thus may desire a different equilibrium illustrated in our model. So, in order to achieve their objectives, the UGC platforms need to design their monetary incentive (namely, the level of monetary incentive and as well as quality control) associated with the equilibrium desired.

For example, if the objective is to attract all the contributors into the market (Case 1), which is probably critical in the early stage of a platform, the monetary incentive cannot be too high or too low. If it is too low, the production-efficient contributors will not join; if too high, the intrinsically-motivated contributors will be driven out of the market; If the objective is to remain high contribution quality (Case 4), the monetary incentive should not be too high, in order to avoid attracting too much contribution from the non-intrinsically-motivated but productive contributors, which hurt the overall contribution quality; If the objective is to increase the total market contribution, the monetary incentive should be above a threshold level, otherwise it will reduce the total market contribution.

Third, our model also implies an unexpected consequence of introducing monetary incentive: transferring the UGC platform to a PGC (professionally generated content) platform. Once the monetary incentive is sufficiently high, the UGC contribution becomes a business, i.e., professionalized or commercialized. Then the production-efficient contributors crowd out non-production-efficient contributors (e.g., the equilibrium shift from Case 2 to Case 6). For example, after Youtube was purchased by Google in 2006 and the ad-revenue-sharing program was introduced in 2007, the traditional network and cable broadcasters (such as ABC, NBC and CBS), who represent the $\bar{I}P$ contributors in our model, enter the market and contribute PGC on Youtube. In 2009, YouTube reorganized its categories to four: Movies, Music, Show and Video, where the 'Video' option is the only UGC clip category (Kim 2012). Then the "dominance of PGC marginalizes UGC": although there is still room for UGC, the "ubiquitous PGC will overshadow UGC, marginalizing individuals' own creations." (Kim 2012)

Our model shows that it is not always good to be "professionalized" or "commercialized", because the crowding out of the contributors $I\bar{P}$ may cause the drop of content variety and even content quality. The intrinsically-motivated but non production efficient contributors $I\bar{P}$ represents those contributors who contribute high quality, yet niche contents which are typically not appeal to the mass market. Such contents bring value to the platform as well as the society, especially for the knowledge

sharing platforms. When the monetary incentive is introduced, these contributors are crowded out and the variety of content reduces (Sun and Zhu 2013). Our model offers an explanation on why the commercialized UGC platforms are fulfilled with similar "hot topics" (Sun and Zhu 2013; Szabo and Huberman 2010). This is perhaps one of the reasons why Wikipedia remains to be a nonprofit UGC platform.

7 Conclusions

To the best of our knowledge, this paper makes the first effort to theoretically address the impact of monetary incentive on UGC contribution. By considering different types of contributors, and incorporating both intrinsic motivation and competition among contributors, we provide a framework to explain the seemingly contradictory findings in the previous literature. We characterize two crowd in/out based on whether the intrinsic motivation of contribution is dramatically affected, that is, the motivation crowd in/out and the competition crowd in/out. When the monetary incentive is introduced (from zero to positive), contributors' intrinsic motivation of contribution can be dramatically affected (characterized by the modification of intrinsic motivation δ). This leads to a sudden change in the number of contributors, or the total content volume in the market—a motivation crowd in/out. For example, when the monetary incentive is negatively correlated with a contributor's intrinsic motivation, this contributor will be crowded out when the monetary incentive turns from zero to positive. Similar results are reported in the literature of prosocial behavior (Bénabou and Tirole 2006; Gneezy et al. 2011). When the monetary incentive is already positive, with a change in the level of monetary incentive, contributors with higher quality or efficiency may join the market while contributors with lower quality or efficiency are crowded out—a competition crowd in/out. It is worth noting that contrary to the traditional wisdom that money is always good (standard price effect), we find that the impact of monetary incentive is non-monotonic on the number of contributors in the market, the volume as well as the quality level of the content contributed.

Our results also show that contrary to the conventional thinking that competition always leads to a more desirable market outcome, in the context of UGC contribution, when a

monetary incentive is provided with quality control, the number of contributors may reduce, so does the total contribution volume in the market. This is due to the "competition crowding out" effect where when monetary incentive increases, contributors that are attracted to the market with higher quality or higher production efficiency dilutes the attention received by the existing contributors, and may even drive them out of the market; or when the contributors focus more on the quality of contents, the volume of contribution drops. Such market outcome may not be ideal for the UGC platform depending on its objective.

By studying the shift of equilibrium under different conditions, this model provides a way to reconcile the seemingly contradictory empirical findings on the impact of monetary incentives on UGC contribution (e.g., Garud and Kumaraswamy 2005; Lin and Huang 2013; Mason and Watts 2010; Ogawa 2014; Tang et al. 2012a; Wang et al. 2012). We also offer guidelines in designing a better monetary incentive scheme by adjusting two variables: the level of monetary incentive as well as the quality control.

This study is not without limitation. First, for tractability, we assume that a contributor's reward is a linear function of her market share. In reality, the reward function can be either convex or concave in its market share. It is worthwhile to relax this assumption and explore non-linear functions. Second, in this model we consider only one social media website. In practice there is typically one dominant social media website that dominates the field, e.g., Facebook, Twitter, YouTube, etc. It is possible that new social media websites compete with the established one by offering significantly higher monetary incentive. It will be interesting to model such competitions. Finally, it is valuable to collect field data or conduct field experiments to verify our research findings. Gneezy et al. (2011) indicate that, "Incentives do matter, but in various and sometimes unexpected ways". Our paper shows some initial efforts on understanding the effect of monetary incentive on UGC contribution. More efforts are still needed in future.

References

Alexy, O., and Leitner, M. 2011. "A fistful of dollars: Are financial rewards a suitable management practice for distributed models of innovation?," *European Management Review* (8:3), pp 165-185.

Andreoni, J. 2007. "Giving gifts to groups: How altruism depends on the number of recipients," *Journal of Public Economics* (91:9), pp 1731-1749.

Antorini, Y. M., Muniz, A. M., and Askildsen, T. 2012. "Collaborating with customer communities: Lessons from the Lego group," *MIT Sloan Management Review* (53:3), pp 73-79.

Ariely, D., Bracha, A., and Meier, S. 2009. "Doing good or doing well? Image motivation and monetary incentives in behaving prosocially," *American Economic Review* (99:1), pp 544-555.

Bénabou, R., and Tirole, J. 2006. "Incentives and Prosocial Behavior," *American Economic Review* (96:5), pp 1652-1678.

Becker, J. U., Clement, M., and Schaedel, U. 2010. "The impact of network size and financial incentives on adoption and participation in new online communities," *Journal of Media Economics* (23:3), pp 165-179.

Chen, J., Xu, H., and Whinston, A. B. 2011. "Moderated online communities and quality of user-generated content," *Journal of Management Information Systems* (28:2), pp 237-268.

Deci, E. L., Koestner, R., and Ryan, R. M. 1999. "A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation," *Psychological bulletin* (125:6), p 627.

Fehr, E., and Falk, A. 2002. "Psychological foundations of incentives," *European economic review* (46:4), pp 687-724.

Frey, B. S., and Jegen, R. 2001. "Motivation crowding theory," *Journal of economic surveys* (15:5), pp 589-611.

Frey, B. S., and Oberholzer-Gee, F. 1997. "The cost of price incentives: An empirical analysis of motivation crowding-out," *American Economic Review* (87:4), pp 746-755.

Garud, R., and Kumaraswamy, A. 2005. "Vicious and virtuous circles in the management of knowledge: The case of Infosys Technologies," *MIS Quarterly* (29:1), pp 9-33.

Ghose, A., Ipeirotis, P. G., and Li, B. 2012. "Designing ranking systems for hotels on travel search engines by mining user-generated and crowdsourced content," *Marketing Science* (31:3), pp 493-520.

Ghosh, A., and McAfee, P. Year. "Incentivizing high-quality user-generated content," Proceedings of the 20th international conference on World wide web, ACM2011, pp. 137-146.

Gneezy, U., Meier, S., and Rey-Biel, P. 2011. "When and why incentives (don't) work to modify behavior," *The Journal of Economic Perspectives* (25:4), pp 191-209.

Gneezy, U., and Rustichini, A. 2000. "Pay enough or don't pay at all," *Quarterly journal of economics* (115:3), pp 791-810.

Goes, P. B., Lin, M., and Au Yeung, C.-m. 2014. "“Popularity Effect” in User-Generated Content: Evidence from Online Product Reviews," *Information Systems Research* (25:2), pp 222-238.

Goh, K.-Y., Heng, C.-S., and Lin, Z. 2013. "Social media brand community and consumer behavior: Quantifying the relative impact of user-and marketer-generated content," *Information Systems Research* (24:1), pp 88-107.

Heyman, J., and Ariely, D. 2004. "Effort for payment: a tale of two markets," *Psychological science* (15:11), pp 787-793.

Huang, Y., Singh, P. V., and Ghose, A. 2015. "A structural model of employee behavioral dynamics in

enterprise social media," *Management Science*).

Jabr, W., Mookerjee, R., Tan, Y., and Mookerjee, V. 2013. "Leveraging Philanthropic Behavior for Customer Support: The case of user support forums," *MIS Quarterly* (38:1).

Kankanhalli, A., Tan, B. C., and Wei, K.-K. 2005. "Contributing knowledge to electronic knowledge repositories: an empirical investigation," *MIS Quarterly* (29:1), pp 113-143.

Kim, J. 2012. "The institutionalization of YouTube: From user-generated content to professionally generated content," *Media, Culture & Society* (34:1), pp 53-67.

Kreps, D. M. 1997. "Intrinsic motivation and extrinsic incentives," *American Economic Review* (87:2), pp 359-364.

Lee, U., Kim, J., Yi, E., Sung, J., and Gerla, M. Year. "Analyzing crowd workers in mobile pay-for-answer q&a," Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM2013, pp. 533-542.

Lepper, M. R., Greene, D., and Nisbett, R. E. 1973. "Undermining children's intrinsic interest with extrinsic reward: A test of the" overjustification" hypothesis," *Journal of Personality and social Psychology* (28:1), p 129.

Levina, N., and Arriaga, M. 2014. "Distinction and Status Production on User-Generated Content Platforms: Using Bourdieu's Theory of Cultural Production to Understand Social Dynamics in Online Fields," *Information Systems Research* (25:3), pp 468-488.

Lin, F.-r., and Huang, H.-y. 2013. "Why people share knowledge in virtual communities? The use of Yahoo! Kimo Knowledge+ as an example," *Internet Research* (23:2), pp 133-159.

Lou, J., Fang, Y., Lim, K. H., and Peng, J. Z. 2013. "Contributing high quantity and quality knowledge to online Q&A communities," *Journal of the American Society for Information Science and Technology* (64:2), pp 356-371.

Lukyanenko, R., Parsons, J., and Wiersma, Y. F. 2014. "The IQ of the Crowd: Understanding and Improving Information Quality in Structured User-Generated Content," *Information Systems Research* (25:4), pp 669-689.

Ma, L., Kesten, O., and Mukhopadhyay, T. Year. "Attracting Whom? Managing User-Generated-Content Communities for Monetization," ICIS 2009 Proceedings2009, p. 8.

Mason, W., and Watts, D. J. 2010. "Financial incentives and the performance of crowds," *ACM SigKDD Explorations Newsletter* (11:2), pp 100-108.

McKenzie, P. J., Burkell, J., Wong, L., Whippey, C., Trosow, S. E., and McNally, M. B. 2012. "User-generated online content: overview, current state and context," *First Monday* (17:6).

Mellström, C., and Johannesson, M. 2008. "Crowding out in blood donation: was Titmuss right?," *Journal of the European Economic Association* (6:4), pp 845-863.

Moens, M.-F., Li, J., and Chua, T.-S. 2014. *Mining user generated content*, (CRC Press.

Moon, H., and Park, M. 2002. "Effective reward systems for knowledge sharing: facilitating knowledge flow at Samsung life insurance," *Knowledge Management Review* (4:6), pp 22-25.

Ogawa, S. 2014. "How to manage the quantity and quality of idea in a co-creation community: The case of recipe site."

Pal, A., Harper, F. M., and Konstan, J. A. 2012. "Exploring question selection bias to identify experts and potential experts in community question answering," *ACM Transactions on Information Systems (TOIS)* (30:2), p 10.

Roberts, J. A., Hann, I.-H., and Slaughter, S. A. 2006. "Understanding the motivations, participation, and performance of open source software developers: A longitudinal study of the Apache

projects," *Management Science* (52:7), pp 984-999.

Sun, M., and Zhu, F. 2013. "Ad revenue and content commercialization: Evidence from blogs," *Management Science* (59:10), pp 2314-2331.

Sun, Y., Dong, X., and Du, J. 2013. "An Empirical Investigation of Intrinsic and Monetary Incentives for Product Review Contribution in a Connected Community."

Susarla, A., Oh, J.-H., and Tan, Y. 2012. "Social networks and the diffusion of user-generated content: Evidence from YouTube," *Information Systems Research* (23:1), pp 23-41.

Szabo, G., and Huberman, B. A. 2010. "Predicting the popularity of online content," *Communications of the ACM* (53:8), pp 80-88.

Tang, Q., Gu, B., and Whinston, A. Year. "Content Contribution in Social Media: The Case of YouTube," System Science (HICSS), 2012 45th Hawaii International Conference on, IEEE2012a, pp. 4476-4485.

Tang, Q., Gu, B., and Whinston, A. B. 2012b. "Content contribution for revenue sharing and reputation in social media: A dynamic structural model," *Journal of Management Information Systems* (29:2), pp 41-76.

Titmuss, R. M. 1970. *The gift relationship*, (London, George Allen and Unwin Ltd.

van Mierlo, T. 2014. "The 1% rule in four digital health social networks: an observational study," *Journal of medical Internet research* (16:2).

Voelpel, S. C., Dous, M., and Davenport, T. H. 2005. "Five steps to creating a global knowledge-sharing system: Siemens' ShareNet," *The academy of management executive* (19:2), pp 9-23.

Wang, J., Ghose, A., and Ipeirotis, P. Year. "Bonus, Disclosure, and Choice: What Motivates the Creation of High-Quality Paid Reviews?," International Conference on Information Systems2012.

Wasko, M. M., and Faraj, S. 2005. "Why should I share? Examining social capital and knowledge contribution in electronic networks of practice," *MIS Quarterly* (29:1), pp 35-57.

Wendelken, A., Danzinger, F., Rau, C., and Moeslein, K. M. 2014. "Innovation without me: why employees do (not) participate in organizational innovation communities," *R&D Management* (44:2), pp 217-236.

Zhang, K., and Sarvary, M. 2014. "Differentiation with User-Generated Content," *Management Science* (61:4), pp 898-914.

Zhang, X., Vogel, D., Chen, Z., and Yuan, M. Year. "Is Reward always effective as Incentive in Electronic Knowledge Repositories? A Game-Theoretical Perspective," AMCIS 2006 Proceedings2006, p. 213.

Zhang, X. M., and Zhu, F. 2010. "Group size and incentives to contribute: A natural experiment at Chinese Wikipedia," *American Economic Review* (101:4), pp 07-22.