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Abstract: As a growing enormously method of financing and selling new products, crowdfunding usually accompanies with the overstating product quality. We consider creators with low product quality in a crowdfunding market may use false advertising to overstate the value of their products and a policy maker can punish such false advertising. We propose a two-period crowdfunding model in which a creator may charge different prices over time to sequentially arriving buyers. Both advertising and prices decisions of creators are discussed in the paper, and we characterize an equilibrium where false advertising interact with crowdfunding pricing dynamics over time.

Keywords: false advertising, crowdfunding, signal game, separating equilibrium, pooling equilibrium.

1. INTRODUCTION

Crowdfunding has emerged as a potentially valuable alternative to the traditional method of financing and selling new products. A buyer in a crowdfunding project not only commits to purchasing the product but also prepays to fund the project. A project will be successfully funded only if the total value of committed purchases exceeds a specified goal within a certain time. It is reported that the crowdfunding industry will soon account for more funding than venture capital [1]. In recent years, crowdfunding has grown enormously, however, even though there are some successful campaigns that rewarding backers' genuine products, such as the Pebble smart watch, there are also many projects that have gathered enough capital but provide buyers the depressed product quality which are deviating from the firms' original commitments. For example, the Kreyos smart watch, launched with a similar target and price as the Pebble, was funded to over ten times its original goal, but the final product was poorly received where the devices lacked many of the promised features and were often defective. In addition, there are also many firms declare bankruptcy after their crowdfunding projects are funded to the targets because of technical difficulties and lacking of talents, such as Zano, a campaign for small drones. In practice, creators overstated their product quality by false advertising so that attracting backers to donate to their campaigns.

False advertising---incorrect or exaggerated product claims, has attracted awareness of policy makers and practitioners for many years. In many countries, because of the potential dangers of false advertising, buyers are protected by a variety of regulations and laws, such as Federal Trade Commission and Unfair Competition Law. Despite potential legal penalties, cases of false statement are still easily to find in the crowdfunding market, an important reason is that a crowdfunding project usually associated with new ventures which are lack of information related to product characteristics. Even though false advertising phenomenon is widely documented in the crowdfunding market, literature on it mainly limit to the conventional product. For example, Reference [2] consider two competing sellers whose private quality cannot be assessed by buyers. Both price and advertising can be utilized by sellers to signal their quality. To mimicking the high-quality seller, the low-quality may make

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false advertising to mislead buyers in a pooling equilibrium. The closest work to our paper is by Reference [3]. They demonstrate the issue of false advertising in a monopoly where the firm has the low or high quality. Different from the full pooling and separating equilibrium in past signaling models, they analyze a richer class of semi-pooling equilibrium where false claims may occur with a probability. Based on a more general form of demand, they provide precise conditions under which false advertising is beneficial for buyer surplus, total welfare and firm profits. Similar to these literatures, we also consider false advertising of the firm with low quality in our paper while a similar semi-pooling equilibrium may occur. However, we highlight the combination of discriminatory pricing strategies and advertising as signals to disclose the quality. Such pricing mechanism gives firms more opportunities to reveal their product quality when the prices are taken as the quality signal. The existing literature on crowdfunding is more recent, in which empirical research has examined aspects, including geographic dispersion of investors [4], backer dynamics over the project funding cycle [5], positive network externalities [6], and factors that lead to successful projects [7]; theoretical research has studied optimal choices of crowdfunding mechanisms [8], pricing and product line design [9], moral hazard [10] [11], and information asymmetry about quality [8] [12]. There are few crowdfunding literatures focusing on the false advertising from the perspective of signaling. To our best knowledge, this is the first paper to consider the false advertising in a crowdfunding market. With the consideration of the new challenges of false advertising in the crowdfunding market mentioned above, we try to answer the following questions in the paper: (i) why do firms in a crowdfunding project engage in false advertising? And when is it more likely that false advertising emerges in a crowdfunding project? (ii) How does the presence of false advertising phenomenon change the crowdfunding selling mechanism, such as the pricing scheme and the campaign success rate? (iii) How will the firm's optimal prices, advertising decisions depend on the buyers' knowledge about the firm's quality level?

To address these issues, we set a basic two-period crowdfunding model by considering the issues of false advertising. In the crowdfunding framework, a firm may charge different prices over time to sequentially arriving buyers. The decisions of the earlier buyers are posted to the later arrivals. The buyers decide whether to purchase and which product option to choose according to their valuations, which is actively influenced by false advertising. We consider the firm is privately informed about its product quality where buyers only know that quality is either "high" or "low" with a natural possibility. The policy maker firstly commits to a penalty for false advertising. Then having learned its type, the firm chooses its pricing and the advertising (no advertising, truthful advertising for the H-type firm or false advertising for the L-type firm) strategies. Buyers subsequently update their beliefs and make their purchase decisions.

Under the framework of signaling game, we analyze the separating and pooling equilibriums firstly, and then introduce a lexicographically maximum sequential equilibrium (LMSE) concept [13] to refine equilibrium outcomes. We consider that the firm signals high quality through not only his advertising but also the crowdfunding mechanism, such as target and price pair while buyers' beliefs depend on both of the firm's signals and the level of the penalty. We find that (I) when the penalty is low, the L-type firm always falsely claims his quality with a high probability, thus the H-type firm prefers to making no advertising because there is a basic advertising cost for the truthful advertising, the equilibrium is then full pooling with no advertising; (II) when the penalty is large, the L-type never benefits from a false advertising, thus the equilibrium is full separating where the H-type firm separates from the L-type one by only incurring a truthful advertising cost; (III) when the penalty is moderate, the equilibrium may be separating where the H-type firm uses both advertising and price signaling costs to separating from the L-type firm, or the semi-pooling equilibrium where the L-type firm mixes between (i) pooling with the H-type one by making false advertising with the same prices as the H-type, and (ii) separating from the H-type one by making no advertising with the different prices.

2. MODEL DEVELOPMENT

A risk-neutral firm adopts a sequential crowdfunding mechanism for selling products. We consider a simple two-period game where the firm posts a crowdfunding project with specific product quality and price combination (p_L, p_H) on a crowdfunding platform where $p_L \le p_H$. The firm is privately informed about its product quality. Specially, with probability $\lambda \in (0,1)$, the firm is *H*-type with product quality q^H; with probability $1-\lambda$, the firm is *L*-type with product quality q^L where $q^L < q^H$.

Suppose that in each period $t(t=1,2)$, only one buyer arrives at the proposed project, each buyer has a unit demand and ex ante knows the product quality with its prior distribution. In addition, we suppose that buyers may have different basic product valuations that represent the matching degree of the product to the buyer. The basic product valuations are independent of product quality, which are i.i.d with the following two-point distribution:

$$v = \begin{cases} H & with\ probability\ \alpha \\ L & with\ probability\ 1-\alpha, \end{cases} \tag{1}$$

where $H > L > 0$. Note that the buyers know their basic product valuations when learn that the product is good or bad match, and the firm only ex ante knows their prior distribution. We call the buyer who learns that the product is good match as *H*-type buyer, and the buyer who learns that the product is bad match as *L*-type buyer. To make the project success, both buyers must sign up, otherwise the project is cancelled and the collected fund is returned to buyers. Therefore, a buyer's purchasing decision in a reward-based crowdfunding project relies on their type, prices, the expected product quality as well as the campaign success rate. Specially, suppose that a buyer buys the product of known quality q^i at price p_j, her economic surplus or utility is denoted as $u(q^i, p_j) = r^i(q^i v - p_j)$ for $i, j \in \{H, L\}$, where r^i is denoted as the success rate of the project.

Different from that the price can be observed directly by buyers before purchasing, the product quality is the private knowledge of the firm, and buyers formulate their expected product quality depending on all related information disclosed initially by firms. We consider that the firm may make the quality advertising to induce the buyer's expectation [14] [15] at a basic information disclosing cost. In fact, different from the conventional product that buyers are familiar with, the quality advertisement in a crowdfunding project is costly for no matter the H-type firm or the L-type firm. This is because many crowdfunding products are unique, novel and professional so that the majority of buyers are unable to distinguish the product quality through the firm's simple quality statement. The firm's quality report should be clear, visual and some firms usually introduce some professional suggestions from experts.

We assume that each type of firm sends a publicly observable advertisement $\delta \in \{0,1\}$ at a basic advertising cost c. At $\delta = 0$, the firm makes no quality advertisement, and at $\delta = 1$, the firm discloses his quality information in the advertisement. Intuitively, a low-type firm will not claim his low-quality information by incurring an advertising cost (Rhodes and Wilson 2018), hence $\delta = 1$ means that the L-type firm uses a high-quality report to misleading buyers, which is called as false advertising. A policy maker is able to verify any advertised claim and we suppose a penalty ϕ for false advertising which is imposed by the policy maker [3]. A higher ϕ reflects more intensive monitoring by public authorities. We assume that the policy maker can choose any level of penalty to maximize its objectives, which may be firm's profit, buyer surplus, or total welfare.

3. EQUILIBRIUM ANALYSIS

3.1 A complete-information benchmark

In the complete-information benchmark, the firm's quality is common knowledge. We easily find that quality claims are needless because any type of advertising will incur a positive cost. The creator then decides the

optimal pricing strategy to maximize his profit without any quality advertisement, which is given by

$$\pi^i(\delta^i, p_H^i, p_L^i) = r^i(p_H^i + p_L^i), \quad i = L, H, \ (1)$$

where the success rate r^i is given by

$$r^i = \begin{cases} 1 & if \quad p_L^i \le p_H^i \le q^i L \\ \alpha^2 & if \quad q^i L < p_L^i \le p_H^i \le q^i H \\ \alpha & if \quad p_L^i \le q^i L < p_H^i \ \& (1-\alpha) q^i H + \alpha p_L^i < p_H^i \le q^i H \\ 2\alpha - \alpha^2 & if \quad p_L^i \le q^i L < p_H^i \le (1-\alpha) q^i H + \alpha p_L^i. \end{cases} \quad (2)$$

Maximizing the creators' profits in Equation (1), we can get four pricing policies for the creator which are accompanying with four different campaign success rates. We call these four price strategies as volume, margin, intertemporal pricing and menu pricing strategies, respectively. Under the volume strategy, both buyers sign up, regardless of their types, and the project always succeeds; under the margin strategy, the project is open only to high-type buyers, and any low-type buyers arriving at each period will leave the site without giving a purchase; under the intertemporal pricing strategy, the buyer arriving at the first period always signs up at a lower price and thus the project can be successful only when the buyer arriving at the second period can afford the price, that is the buyer must be *H*-type; under the menu pricing strategy, the higher price is lower than that in the intertemporal pricing strategy while the lower price equals to that in the intertemporal pricing strategy. Buyers in the crowdfunding market face a single price in the two former strategies and discriminatory prices in the two latter strategies. For two discriminatory prices strategies, the menu pricing strategy is accompanying with a higher campaign success rate comparing to intertemporal pricing strategy because the H-type buyers arriving at the first period are willing to overpay in the menu pricing strategy, that is choosing the higher price, if such a choice could increase the chance of the project success, which is called incentive compatibility.

3.2 Asymmetric information

Usually, products launched by the crowdfunding project are newly and novelty that consumers cannot have perfect knowledge about the product quality except the firm chooses to self-disclose the information before the purchase of buyers. How does such information asymmetry affect the market outcome, such as the firm's advertising and pricing policies as well as the buyers' purchasing behavior? Now, we focus on the case where buyers can not directly observe the firm's types.

Recall that if the L-type firm makes advertising, i.e., $\delta^L = 1$, he will make a false advertising to pretend to be high quality, which incurs not only the basic information disclosing cost, c, but also the penalty of false advertising, ϕ. For the H-type firm, when $\delta^H = 1$, his truthful advertising only incurs a basic advertising cost. The advertising costs of both types of firms are given by

$$C(\delta^H) = \begin{cases} 0 & if \quad \delta_H = 0 \\ c & if \quad \delta_H = 1 \end{cases}, \quad \text{and} \quad C(\delta^L) = \begin{cases} 0 & if \quad \delta_L = 0 \\ c + \phi & if \quad \delta_L = 1. \end{cases}$$

Then, the profit of the i-type firm is

$$\pi^i(\delta^i, p_H^i, p_L^i) = r^i(p_H^i + p_L^i) - C(\delta^i), \quad i = L, H. \quad (3)$$

where r^i is given by Equation (2).

There are two types of Perfect Bayesian Equilibria (PBE) in our asymmetric-information setting: separating equilibrium and pooling equilibrium. At a separating equilibrium, the L-type and H-type firms choose different prices and advertising pairs, from which buyers can infer the firm's type. At a pooling equilibrium, both types of firms choose the same prices and advertising policies. We firstly show a separating equilibrium

with some analytical features.

3.2.1 Separating equilibrium

A separating equilibrium (shown in Figure 1) in which prices and advertising pairs fully reveal qualities, that is firms of different qualities post different advertising and prices pairs.

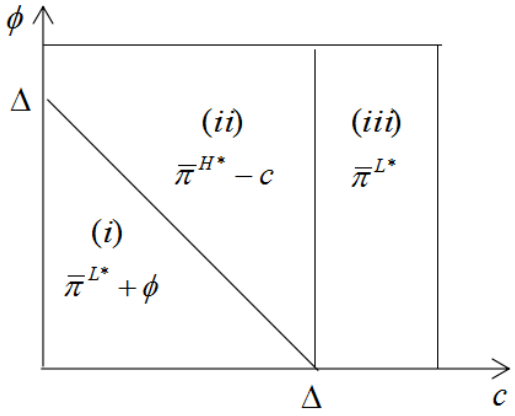

Figure 1. Separating Equilibrium Outcomes ($\Delta = \bar{\pi}^{H^*} - \bar{\pi}^{L^*}$).

Figure 1 depicts the separating equilibrium outcome in different (c, ϕ) parameter regions. Note that $\bar{\pi}^{H^*}$ and $\bar{\pi}^{L^*}$ are the H-type and L-type firms' optimal profits in the complete-information case. We find that the H-type firm can distinguish himself from the L-type firm by two methods, the discriminating advertising and the discriminating price pairs, which incur the two types of signaling costs, advertising cost and the price distortion cost. When the condition $c + \phi \le \Delta$ holds, the only advertising distortion cannot prevent the L-type firm's mimicry, and the H-type firm has to make advertising and prices distortion to separating from the L-type firm. When the false advertising cost of the L-type firm is large enough, i.e., $c + \phi > \Delta$, the only advertising distortion of the H-type firm can separate from the L-type firm. As the advertising cost of the H-type firm increases to a level, i.e., $c > \Delta$, the advertising distortion of the H-type firm becomes less effective than the prices distortion, thus for preventing the L-type firm's mimicry, the H-type firm reduces the prices to the get the same profit as the L-type firm.

As mentioned above, the advertising distortion is a more effective way than prices distortion for the H-type firm to keep the L-type firm from mimicking under this condition. This is because the penalty of false advertising make the L-type firm have to pay more advertising cost compared to the H-type firm for mimicry, which reduces the H-type firm to a much lesser extent than it will reduce the L-type firm's profit. However, the price distortion requires a large price reduction to prevent mimicry by the L-type firm, it is less efficient for the H-type firm under the condition, because the same amount of profit reduction as the L-type firm's is also for the H-type firm when the prices are reduced.

3.2.2 Pooling Equilibrium

In the pooling equilibrium (shown in Figure 2), firms are expected to post the same advertising and price strategies in equilibrium. There are two cases for the advertising and price pairs in the pooling equilibrium, (a) both types of firms post the same prices without making advertising, and (b) both types of firms post the same prices while the H-type firm makes truthful advertising and the L-type firm makes false advertising. In case (a), buyers do not receive any quality information from prices and advertising, thus buyers' posterior belief is the same as their prior, and in case (b), even though both types of firms give the same high-quality report, buyers may still get some useful quality information from the advertising. Following a pooling equilibrium, when buyers do not receive a high-quality report, the buyers' belief of the probability of the H-type firm is not updated, thus the buyers make purchasing decisions depending on the natural expected quality of the product. Specially, we find that a semi-pooling equilibrium may exist where the false advertising occurs where if buyers receive a

high report, they will update their belief of the probability of the H-type firm from λ to β with $\beta \geq \lambda$.

Comparing the H-type firm's profits in cases a) and b), we can get the pooling equilibrium. Specially, we find that the false advertising may occur in a pooling equilibrium under two conditions---a small basic advertising cost, $c < (1-\lambda)\Delta$, and a medium penalty, $\phi \in (\underline{\phi}^*, \bar{\phi}^*)$. Both of the two conditions are affected by λ and Δ. In detail, as λ decreases and Δ increases, which indicate a high value of information disclosing, it is more likely for false advertising occurring in the pooling equilibrium.

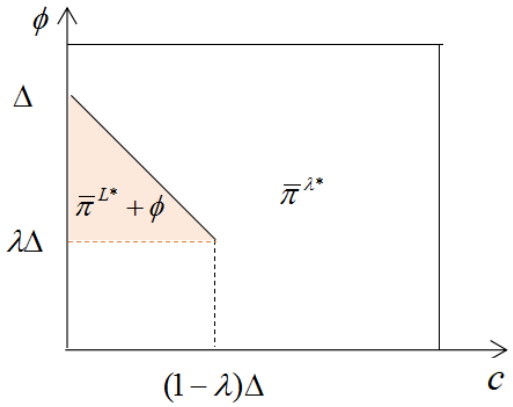

Figure 2. Pooling Equilibrium Outcomes ($\Delta = \bar{\pi}^{H*} - \bar{\pi}^{L*}$, $\bar{\pi}^{\lambda*} = \lambda\bar{\pi}^{H*} + (1-\lambda)\bar{\pi}^{L*}$).

3.2.3 Lexicographically Maximum Sequential Equilibrium

In signaling games, there are multiple perfect Bayesian equilibriums (PBE) since the PBE concept imposes no restrictions on out-of-equilibrium beliefs. To further refine equilibrium outcomes, we apply the lexicographically maximum sequential equilibrium (LMSE) concept introduced by Reference [13], which is often used as an alternative equilibrium-selection criterion. Below we adapt the definition of LMSE to our setting.

Definition. In a signaling game G, we denote the set of types by $\{H, L\}$, the i-type player's payoff by $\pi^i(\cdot)$, and the set of pure-strategy perfect Bayesian equilibria by PBE(G). The strategy profile $\sigma' \in PBE(G)$ lexicographically dominates (l-dominates) $\sigma \in PBE(G)$ if $\pi_H(\sigma') > \pi_H(\sigma)$, or $\pi_H(\sigma') = \pi_H(\sigma)$ and $\pi_L(\sigma') > \pi_L(\sigma)$. The strategy profile $\sigma \in PBE(G)$ is a LMSE if there does not exist $\sigma' \in PBE(G)$ that *l*-dominates σ.

In our model, a PBE is an LMSE if it is the H-type firm's most profitable outcome among all PBE and if, conditional on being the most profitable for the H-type firm, it is also the L-type firm's most profitable outcome.

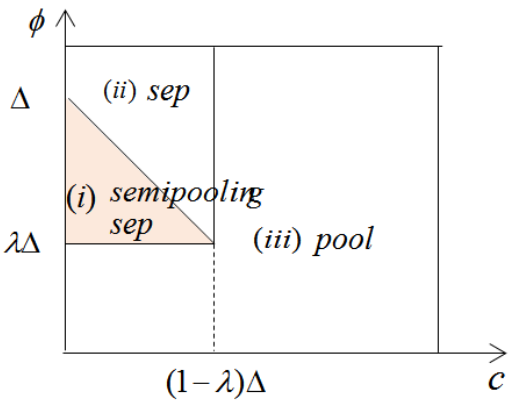

Figure 3. LMSE outcome ($\Delta = \bar{\pi}^{H*} - \bar{\pi}^{L*}$).

Figure 3 depicts three cases of the equilibrium market outcomes in different (c,ϕ) parameter regions:

(i) The case of semi-pooling/separating equilibrium where conditions $c+\phi<\Delta$ and $\phi>\lambda\Delta$ both hold. In this case, the H-type firm can either incur a signaling cost to separate itself from the L-type firm, or pool with the L-type, thus the equilibrium is semi-pooling or full separating. In the semi-pooling equilibrium, the L-type firm randomizes in the separating and pooling equilibrium: In the former, the L-type firm charges the same prices with the H-type firm, and in the latter, he charges his first-best prices in the information symmetric case. In the full separating equilibrium, the H-type firm uses both of advertising and prices as signals to separate from the L-type firm. Specially, the H-type firm claims a high-quality report and charges prices lower than his first-best prices given in the information symmetric case, but different from that in the semi-pooling equilibrium, and the L-type firm separates himself from the H-type by choosing the same advertising and pricing strategies as the symmetric information. In this case, the firms' profits are the same under the semi-pooling and separating equilibriums.

(ii) The case of full separating equilibrium where conditions $c+\phi>\Delta$ and $c<(1-\lambda)\Delta$ hold. In this case, the equilibrium has full separation, and buyers can distinguish the type of the firm from the advertising and prices signals. Specially, the advertising is perfectly informative here because the penalty is sufficiently high that being honest is the dominant strategy for the low type one, thus the H-type firm makes truthful advertising while the L-type firm makes no advertising. The signaling cost of the H-type firm is only its advertising cost c. The prices strategies of the two types of firms are accordance with their first-best prices in the symmetric case.

(iii) The full pooling equilibrium where either $\phi\le\lambda\Delta$ or $c\ge(1-\lambda)\Delta$ hold. In full pooling equilibrium, either the penalty of false advertising is so low or the basic advertising cost is so high that the H-type firm gets a profit loss from claiming a high-quality report by incurring an advertising cost c. Buyers' posterior belief is the same as their prior. Both of the H-type and L-type firms make no advertising and charge the same prices, then the profits of the H-type firm and L-type firm are the same.

4. CONCLUSIONS

We study the issue of information asymmetry about quality in the context of crowdfunding. In our crowdfunding model, a creator may charge different prices over time to sequentially arriving buyers who are considered to be heterogeneous in their basic product valuations (i.e., match degree). The buyers decide whether to purchase according to their valuations, which is determined by their types and expected product quality. The creator is privately informed about its product quality while buyers only know that quality is either "high" or "low" with a natural possibility. To signal quality, the creator can take both of price pair and advertising as signals. Especially, for mimicking the creator with high quality, the creator with low quality may make false advertising to mislead buyers. We also consider a policy maker who commits to a penalty for the false advertising.

Our results show three types of equilibrium by utilizing the lexicographically maximum sequential equilibrium concept, i.e., full separating, full pooling and semi-pooling equilibriums. The penalty of false advertising plays a key role in these equilibrium results. There is an interesting situation when the penalty is moderate. Under the situation, the equilibrium may be either separating where the signaling costs of the H-type creator include both advertising and price signaling costs, or semi-pooling where false advertising will occur with a possibility. We find that the campaign success rate and price pair vary in separating equilibrium under this situation but those in semi-pooling equilibrium are fixed.

Crowdfunding is an emerging area where there are many issues being not considered in our paper, such as product line design and the information searching cost for buyers, future research may take into account those issues in the context of asymmetry information.

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REFERENCES

[1] Barnett C. (2015). Trends show crowdfunding to surpass VC in 2016. Forbes, June, 9.

[2] Piccolo S, Tedeschi P, Ursino G. (2017). Deceptive advertising with rational buyers. Management Science, 64(3): 1291-1310.

[3] Rhodes A, Wilson C M. (2018). False advertising. The RAND Journal of Economics, 49(2): 348-369.

[4] Agrawal A K, Catalini, C, Goldfarb A. (2011). The geography of crowdfunding (No. w16820). National bureau of economic research.

[5] Kuppuswamy V, Bayus B L. (2018). Crowdfunding creative ideas: The dynamics of project backers. In The Economics of Crowdfunding (pp. 151-182). Palgrave Macmillan, Cham.

[6] Li Z, Duan J A. (2016). Network externalities in collaborative consumption: Theory, experiment, and empirical investigation of crowdfunding. Working Paper.

[7] Mollick E. (2014). The dynamics of crowdfunding: An exploratory study. Journal of business venturing, 29(1): 1-16.

[8] Belleflamme P, Peitz M. (2014). Asymmetric information and overinvestment in quality. European Economic Review, 66(1): 127-143.

[9] Hu M, Li X, Shi M. (2015). Product and pricing decisions in crowdfunding. Marketing Science, 34(3), 331-345.

[10] Chang J W. (2016). The economics of crowdfunding. (http://dx.doi.org/10.2139/ssrn.2827354)

[11] Strausz R. (2017). A theory of crowdfunding: A mechanism design approach with demand uncertainty and moral hazard. American Economic Review, 107(6): 1430-76.

[12] Belavina E, Marinesi S, Tsoukalas G. (2018). Designing crowdfunding platform rules to deter misconduct. (http://dx.doi.org/10.2139/ssrn.3093437)

[13] Mailath G J, Okuno-Fujiwara M, Postlewaite A. (1993). Belief-based refinements in signalling games. Journal of Economic Theory, 60(2): 241-276.

[14] Anderson S P, Renault R. (2009). Comparative advertising: disclosing horizontal match information. The RAND Journal of Economics, 40(3): 558-581.

[15] Du L, Hu M, Wu J. (2017). Contingent stimulus in crowdfunding. (http://dx.doi.org/10.2139/ssrn.2925962)