Product-driven Entrepreneurs and Crowdfunding

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Abstract

Advancements in information technology is known for enabling new business models and new market mechanisms. Online crowdfunding is one such new mechanism through which entrepreneurs can advertise their potential products and attract investors from the mass. In this study, we advance the existing theory on online crowdfunding markets by recognizing that online crowdfunding pro-vides not only a venue of fundraising to entrepreneurs but also a venue for them to obtain demand in-formation before production and to signal their intention. We formulate a spatial competition model between profit-driven entrepreneurs and product-driven entrepreneurs. We find that, while, on aver-age, profit-driven entrepreneurs earn higher profits than product-driven ones, their advantage is con-strained by the mechanism of the crowdfunding campaign, and product-driven entrepreneurs earn a significant fraction of the market. We also discuss model implications on consumer satisfaction and crowdfunding platform design.

Keywords: Crowdfunding; Entrepreneurs; Spatial Competition; Signaling

Introduction

Recent revolutionary development of information technology creates a plethora of new opportunities for entrepreneurs and has fundamentally changed the business ecosystem. The emergence of new business models, funding avenues and marketing strategies facilitates the rising of heterogeneously motivated entrepreneurs especially those with conscientious motivations (Steininger (2019)).

One such example is the crowdfunding platform. The business model of crowdfunding, on the one hand, makes it possible for entrepreneurs to access funds from "the crowd" through websites, social media and mobile apps etc. On the other hand, it provides a platform for entrepreneurs to tell background stories that convey their ideas and devotions about their products. This capability enables the thriving of non-pecuniary entrepreneurs.

A vast literature on entrepreneurship suggests that entrepreneurs have non-pecuniary motivations and conscientiousness is an essential personal trait to entrepreneurs. (See Kerr, Kerr and Xu (2018) and references therein.) They value their preference on products and devote to improving the quality of their ideal products (Rose-Ackerman (1996)). For instance, Elon Musk describes his motivation of being an entrepreneur: "My motivation for all my companies has been to be involved in something that I thought would have a significant impact on the world (Marcovici (2014))." As addressed by the entrepreneurship literature, entrepreneurs value both profit and other non-pecuniary factors such as their own preferences on products. But they differ in the extent that they value profits over products.

Online crowdfunding helps heterogeneous entrepreneurs especially those conscientious ones grow a successful business. For instance, the crowdfunding campaign of PAKT One–a travel bag designed for the minimalism travelers–on Indiegogo helps the founder build a brand that matched their own taste and standard of quality (Engle (2017)).

To address this question, we build a spatial competition model where heterogeneously motivated entrepreneurs compete for a fund in a crowdfunding campaign, while consumers with heterogeneous preferences on product designs locate on a line. We suppose that entrepreneurs can be conscientious and have preferences on their ideal products—they care their ideal designs of the product and have a quality pursue. They vary in how much they value their ideal products over funding or profit, and thus we call entrepreneurs are of either *product-driven* or *profit-driven* type. Entrepreneurs' types are private information and drawn from a publicly known distribution. The model allows us to understand the effect of competition of heterogeneously motivated entrepreneurs on their product choices, and in turn, consumers and the crowdfunding platform.

Our model has several novel features. The first is about competition, which plays a vital role in the new ear of the internet. Though entrepreneur's strategy in crowdfunding campaign and its influence on the consumer has been studied in the existing literature such as Hu, Li and Shi (2015), Strausz (2017) and Roma, Gal-Or and Chen (2018), there is hardly any study addresses the role of competition in crowdfunding platform, and ours fills this gap. Moreover, our paper allows for different motivations of entrepreneurs including non-pecuniary ones by adopting the concept of *product-driven entrepreneurs* in entrepreneurship literature, whereas most spatial competition literature on firms and entrepreneurs following Hotelling (1929) models entrepreneurs as purely profit-motivated (e.g., Anderson Jr, Parker and Tan (2013) and Janssen and Teteryatnikova (2016)). Finally, we exploit the properties of spatial competition model and use players' location choices as signals of their hidden characteristics. All these features together paint a holistic picture of heterogeneously motivated entrepreneurs' interactions in the crowdfunding market.

Our approach is inspired by two observations of (reward-based) crowdfunding campaign: (i) Funding matters but not all that matters to (conscientious) entrepreneurs and (ii) Quality is only finalized after the crowdfunding campaign.[1] To capture this richness, we model products determined by both the choice of design and quality where entrepreneurs can commit to designs through crowdfunding campaign but not

[1] A key feature of the reward-based crowdfunding campaign is that entrepreneurs can contract with future consumers *before* investing in production. Through the campaign, entrepreneurs can contract with consumers on attributes such as designs and materials but not on intangible attributes such as effort paid to improve product quality.

the quality, which will be implemented afterward. Thus, entrepreneurs first choose designs as locations, then consumers make investment decisions, and finally, entrepreneurs deliver products.

In this richer environment, campaign promises play dual roles: as a commitment to product designs and as signals about how an entrepreneur value the quality of the product. This duality induces a signaling game, and what drives the game is the simple fact that product-driven entrepreneurs care more about ideal products and, in turn, exert more effort to improve product quality after getting funded. Thus, ceteris paribus, consumers prefer to invest in a product-driven entrepreneur rather than a profit-driven one. The endogenous preference of consumers creates an incentive for entrepreneurs to separate and mimic: Product-driven entrepreneurs wish to separate from profit-driven entrepreneurs and signal their types to consumers, whereas profit-driven entrepreneurs seek to mimic product-driven entrepreneurs and hide their types from consumers. This strategic interaction iterates continuously such that the equilibrium behavior differs significantly from that when motivations are homogenous.

More specifically, our baseline model focuses on competitive product market, so that the entrepreneurs are price-takers. We find that, in equilibrium, heterogenous entrepreneurs tend to choose (moderately) diversified designs of products. This is in contrast to the predictions in the traditional markets where price-taking entrepreneurs choose the same products catering towards the median consumer (Tirole (1988)). Moreover, on average, profit-driven entrepreneurs earn higher profits than product-driven ones but their advantage is limited by the mechanism of the crowdfunding campaign, and product-driven entrepreneurs earn a significant fraction of the market.

To address the effect of entrepreneurs' equilibrium behavior on consumers and the crowdfunding platform, we investigate how consumer satisfaction vary with model primitives such as entrepreneurs' ideal designs and type distribution in equilibrium and discuss the selection of funding scheme. We evaluate consumer satisfaction by aggregating consumers' preferences and equilibrium decisions and consider the measures of overall quality, design popularity, and consumer welfare. Moreover, we compare the level of consumer satisfaction under different schemes. Our baseline model implicitly assumes that the platform adopts the *Keep-it-all* funding scheme, i.e., entrepreneurs keep the raised fund unconditionally. We further study an alternative funding scheme, *All-or-nothing*, which allows entrepreneurs to keep the raised fund only if the funding goal has been reached. We compare whether this alternative funding scheme improves consumer satisfaction.

Finally, we extend our baseline model allowing for entrepreneurs setting product price. In general, the insights are consistent with those of the baseline model. The model predicts a moderate diversity of designs while in traditional markets price-setting entrepreneurs choose the extreme, i.e., totally differentiated, designs. However, the equilibrium computation is complicated and in general, the equilibrium existence is not guaranteed. So instead, we solve a special case where the crowdfunding market consists of entrepreneurs of either *purely* product-driven or profit-driven type. We view this as a theoretical limit of reality. We further discuss the model implications for platform design in this case. Due to the page limitation, we do not present the results of the extension in the paper, but will be available upon request.

Related Literature

First, our work relates to the theoretical literature of crowdfunding. Most of the literature emphasizes a single firm's problem and study its strategies and associated consequences on consumers and crowdfunding platforms, while ours addresses the role of competition among entrepreneurs. For instance, Hu, Li and Shi (2015) studies optimal pricing and product strategy of a single firm facing heterogeneous consumers. Strausz (2017) addresses how crowdfunding market alleviates moral hazard problem of the entrepreneur through reduction of demand uncertainty. Roma, Gal-Or and Chen (2018) investigates entrepreneur's optimal strategies of attracting funds from venture capital and/or crowdfunding campaign. Ellman and Hurkens (2015) assumes away the entrepreneur's moral hazard problem and characterizes the optimal reward-based crowdfunding mechanism under that environment. Chemla and Tinn (2018) discusses a single firm's crowdfunding strategy in a dynamic setting with the focus on firm's learning on consumer demand.

Second, our study relates to the literature using spatial competition model, which considers spatial competition among homogeneously motivated entrepreneurs (mostly profit-driven), while ours studies heterogeneously motivated entrepreneurs including those with conscientious motivations. This literature stems from Hotelling (1929), arguing that, price-taking entrepreneurs or firms compete on locations and result in converging to the same location, while price-setting entrepreneurs try to differentiate themselves as much as possible so as to maximize profit. (See Tirole (1988) for a comprehensive survey.) There are recent studies using spatial competition model to study online market behaviors. For instance, Anderson Jr, Parker and Tan (2013) discusses how spatial competition among video game platforms influence platforms' investment strategies and performance. Ho, Ho and Tan (2017) studies the impact of spatial competition between online cashback platforms on cashback rate of the market and consumers' choices.

Third, our study relates to the literature discussing non-pecuniary motivations of individuals. A large entrepreneur literature documents entrepreneurs' non-pecuniary motivations. (See Kerr, Kerr and Xu (2018) for a comprehensive survey.) In the meantime, researchers in many fields study the effects of individuals' non-pecuniary motivations on their behaviors and associated outcomes (e.g., Akerlof and Kranton (2005), Benabou and Tirole (2003), Delfgaauw and Dur (2007) and Dixit (2002)). Moreover, our modeling choice about entrepreneurs' motivation relates to a political economy literature which assumes that politicians care both perk and ideology, and the tradeoff between the former and the latter have an impact on political outcomes. (See Austen-Smith and Banks (2009) and references therein.) We adopt a similar model setup in the way that entrepreneurs care both profit and product.

Finally, our paper relates to a growing literature about signaling behavior of online market. For instance, Waldfogel and Chen (2006) finds that firms use online branding strategies as signals of quality. Roberts (2011) shows small online retailers issue warranties to signal the quality of products. Elfenbein, Fisman and McManus (2012) studies whether adding charitable donations to eBay auctions can provide an informative signal about product quality.

Baseline Model

Consider a crowdfunding campaign with two entrepreneurs and a unit mass of consumers. Entrepreneurs produce the same kind of products but with heterogeneous features. They post their products on a crowdfunding platform to attract investors. Here, we focus on the competitive product market such as the market of video games.[2] Thus, entrepreneurs on a crowdfunding platform do not have the market power to set product price, and so take the market price as given.

Entrepreneurs. Entrepreneur $e \in \{A, B\}$ cares funding size, product design and quality. Entrepreneur e has an ideal design d_e. The ideal design could be broadly explained. In practice, some crowdfunding entrepreneurs initially generate their ideas when they are consumers on the market and then launched a crowdfunding campaign with their favorite design. Besides, entrepreneurs may have a specialty in producing products with certain designs. Then the ideal design could be viewed as the one incurs the lowest adjustment (design) cost.

Moreover, each entrepreneur e has a random type $t_e \in \{0, T\}$ $(T > 0)$, which measures how she values her ideal product over profit. We call an entrepreneur profit-driven if $t_e = 0$ and product-driven if $t_e = T$. The type is private information and the prior probability of $t_e = 0$ is $\lambda \in [0, 1]$. The utility of the entrepreneurs e is

$$u_e(\boldsymbol{x}, \boldsymbol{q}; d_e, t_e) = -t_e \left[(d_e - x_e)^2 + (1 - q_e)^2\right] + ps_e(\boldsymbol{x}) - \gamma q_e^2, \tag{1}$$

where $x_e \in [-1, 1]$ is e's product design, and $\boldsymbol{x} = (x_A, x_B)$; t_e is e's type; $s_e \in [0, 1]$ is e's share of fund. The quality of entrepreneur e's product is represented by $q_e \in [0, 1]$, and $\boldsymbol{q} = (q_A, q_B)$. Thus $(1 - q_e)^2$ represents entrepreneur e's disutility from producing low-quality products.

[2]For instance, most of the video games launched on Kickstarter or Indiegogo are base price around $ 25 to $30. The commonly adopted price for the traditional video game industry is around $ 30 (Wilde (2017)).

The marginal development cost of improving product quality is γ, and the cost of delivering q_e quality product is γq_e^2. The marginal development cost does not vary with the number of products but does increase with the product quality. In reality, we can think about it as the cost of adopting new production technology or the cost of improving managerial practice to conduct better quality control.

To simplify the analysis, we assume that the two entrepreneurs' ideal designs are symmetric. That is, $-d_A = d_B = d \geq 0$, and henceforth we drop the subscript e. Throughout, we assume $x_A \leq 0 \leq x_B$ without loss of generality.

Consumers. Consumers care both the design and quality of the product, and each consumer c decides to invest one unit of investment in Entrepreneur A or B. By slightly abusing notation, we write consumer c's ideal design as c, which is uniformly distributed in $[-1, 1]$. Suppose consumer c invest in the product, whose realized characteristics are represented by $(\hat{x}, \hat{q})$, then the utility of the consumer is

$$u_c(\hat{x}, \hat{q}; c) = -\left[(c - \hat{x})^2 + (1 - \hat{q})^2\right] - p.$$

The timeline of the crowdfunding campaign is as follows.

1. Nature randomly chooses each entrepreneur's type t_e, and entrepreneurs observe their types.
2. Each entrepreneur announce her product design x on the crowdfunding platform.
3. Consumers observe the designs and decide whether to invest.
4. Each entrepreneur gets funded and pays the cost γq_e^2 to develop the product; otherwise, they exit the market.
5. Products are delivered to consumers (investors), and quality q is realized.

The game we have described is essentially a signaling game, which has two senders (entrepreneurs) and multiple receivers (consumers). The solution concept here is *Perfect Bayesian Equilibrium*, where the entrepreneurs and consumers optimize their utilities at every history given the beliefs. Beliefs are derived by Bayes' rule whenever possible. For analytical simplicity, we restrict attention to symmetric equilibria.

Consumer's Problem Consumers do not observe entrepreneurs' types and so product quality when they make purchasing decisions. However, the information carried by the description of the product design can help them to draw inferences about the type (and in turn the product quality). That is, the announced design can serve as a signal of product quality.

The consumers' posterior belief that the entrepreneur e is profit-driven, i.e. $t_e = 0$, given observing design x, is $\mu_e(x)$. Write $\mu = (\mu_A(x_A), \mu_B(x_B))$. Besides, we assume consumers do not use weakly dominated strategies, and they only invest for the entrepreneur that maximize their expected utility. Taking entrepreneurs' equilibrium design announcement $\boldsymbol{x}^*$ as given, the expected utility of consumer c investing in e's product is

$$\mathbb{E}_{t_e}\left[u_c(x_e^*; c)|\mu_e(x_e^*)\right] = -\left\{(c - x)^2 + \mathbb{E}_{t_e}\left[(1 - \hat{q})^2|\mu_e(x_e^*)\right]\right\} - p.$$

Each consumer c forms a posterior belief and makes a binary decision of investing in A or investing in B by comparing the associated expected utilities. In equilibrium, all consumers' decision can be summarized by the market share of entrepreneur B, $s(\boldsymbol{x}^*)$. The market share of entrepreneur A is simply $1 - s(\boldsymbol{x}^*)$.

Entrepreneur's Problem Entrepreneur e's strategy can be written as $\boldsymbol{r}_e = (x_{et}, q_{et})_{\forall t \in \{0,T\}}$, and we denote $r_{et} = (x_{et}, q_{et})$ for $t \in \{0, T\}$. Taking all consumers' strategies, and the opponent entrepreneur $-e$'s announced design $x_{-e}^*(t_{-e})$ as given, entrepreneur e's strategy $r_{et} = (x_{et}, q_{et})$ maximizes his expected utility at each information set:

$$\mathbb{E}_{t_{-e}}\left[u_e(x_{et}, x_{-e}^*, q_{et}; d, t)\right] = -t\left[(d - x_{et})^2 + (1 - q_{et})^2\right] + p\mathbb{E}_{t_{-e}}[s_e(x_{et}, x_{-e}^*)] - \gamma q_{et}^2.$$

Equilibrium Analysis

We start our equilibrium analysis by analyzing the special case where all entrepreneurs are profit-driven. Then we turn to characterize equilibria of the baseline model and compare the predictions.

Benchmark: Profit-driven Entrepreneurs

When entrepreneurs are both profit-driven, i.e., $\lambda = 1$, our model has the same prediction as in the literature of spatial competition models: Price-taking entrepreneurs choose the same design–the ideal design of the median consumer, whereas price-setting entrepreneurs differentiate themselves as much as possible and choose the most extreme designs. This is because that profit-driven entrepreneurs cater towards the median when they are price takers, or choose extreme designs to differentiate as much as possible from the opponent and charge a high price when they are price setters (Tirole (1988)).

Equilibrium Characterization

We now turn to characterize the equilibria of the baseline model. For the rest of the paper, unless specified, we consider $\lambda \in (0, 1)$, i.e., entrepreneurs are heterogeneously motivated. Since the environment is symmetric, our analysis will focus on entrepreneur B's equilibrium strategie, and entrepreneur A plays a symmetry strategy accordingly.

We solve equilibrium backward and start with backing out the entrepreneur's choice of quality. Consumers aim to infer entrepreneurs' types so as to predict quality. Inferring one's type is confound and determined through the strategic interactions among players. But predicting product quality given one's type is clear and described by following Lemma.

Lemma 1. *In equilibrium, the product quality of type t entrepreneur B (if that entrepreneur succeeds the crowdfunding campaign) is $q_B^* = \frac{t}{t+\gamma}$.*

The proofs of the paper are put in the appendix, and are available upon request. By Lemma 1, in any equilibrium, we have $q_0^* = 0$, and $q_T^* = \frac{T}{T+\gamma}$ for both entrepreneurs. By slightly abuse notation, we define $\boldsymbol{q}^* = (q_0^*, q_T^*)$. This lemma implies a simple yet important property of the equilibrium—product quality is increasing in one's type. As a consequence, ceteris paribus, consumers prefer products from entrepreneurs that are product-driven.

Next, we turn to the entrepreneur's decision on design. We show that in any equilibrium, profit-driven entrepreneurs choose equilibrium designs weakly closer to the median 0, and earn weakly greater market share or revenue than the product-driven entrepreneurs. It is because that market size and ideal design are strategic substitutes for entrepreneurs. Since profit-driven entrepreneurs are less concerned about the design, they are more willing to compromise on design for profit, which results in a (weakly) greater expected market share and expected revenue. In the meanwhile, product-driven entrepreneurs would choose designs that are closer to the ideal ones. Lemma 2 formally states this property.

Lemma 2. *In any equilibrium, the following statements hold:*

(i) Product-driven entrepreneurs choose product design located weakly closer to their own ideal design, i.e., $|x_{B0}^* - d| \geq |x_{BT}^* - d|$.

(ii) Profit-driven entrepreneurs earn weakly greater market shares ex-ante. That is, $\mathbb{E}_{t_A}[s(x_{B0}^*, x_{At}^*)] \geq \mathbb{E}_{t_A}[s(x_{BT}^*, x_{At}^*)]$.

In general, there are many equilibria in our game, since *Perfect Bayesian Equilibrium* allows for arbitrary off-equilibrium-path beliefs. To restrict the off-equilibrium-path beliefs in a reasonable way, we characterize equilibrium under the requirement of *Condition D1*. The idea is as follows. If type t entrepreneur benefits more from a deviation than type t', then after observe the deviation, consumers

would think that type t' is less likely to be the deviator, and Condition D1 pushes the logic to the limit, so that, consumers would assign probability zero to type t'.[3]

The rest of this section characterizes the equilibrium under Condition D1. By Lemma 1, consumers prefer product-driven entrepreneurs ceteris paribus due to quality concern, which creates an incentive for entrepreneurs to separate and mimic: Product-driven entrepreneurs wish to separate from profit-driven entrepreneurs and signal their types to consumers, whereas profit-driven entrepreneurs seek to mimic product-driven entrepreneurs and hide their types from consumers.

In the first case, when the entrepreneurs' ideal design is close to the median design 0, the median consumer may prefer to buy a high-quality product which locates at entrepreneur's ideal design rather than a low-quality product which locates at the median. In this case, a profit-driven entrepreneur would have an incentive to mimic the product-driven type to hide his type from consumers. Meanwhile, a product-driven entrepreneur cannot separate the profit-driven type even if she sticks to her own ideal design. Theorem 1 characterizes the equilibrium for this case.

Theorem 1. *There is a unique symmetric pooling equilibrium* $(-d, -d, \boldsymbol{q}^*; d, d, \boldsymbol{q}^*)$ *if* $d \in [0, d_1]$*, where* $d_1 = \sqrt{(1-\lambda)[1-(1-q_T^*)^2]}$*. Moreover, there does not exists a pooling equilibrium if* $d \in [d_1, 1]$*.*

In the second case, when the ideal design is far from 0, so that median consumer would rather choose the product with median design and low quality than the product with relatively extreme design and high quality. Since profit-type cares only about market share, she would no longer mimic the product-driven type; instead, she would pick the design at the median 0 which gives him the highest market share. In this case, product-driven entrepreneur separates from the profit-driven by caring for designs. Theorem 2 characterizes this separating equilibrium.

Theorem 2. *There exists a symmetric separating equilibrium if and only if* $d \in [d_2, 1]$*, where* $d_2 = \sqrt{1-(1-q_T^*)^2}$*. In any separating equilibrium,* $-x_{A0}^* = x_{B0}^* = 0$*, and* $-x_{AT}^* = x_{BT}^* \in [d_2, d)$*. The equilibrium is unique if* $T < \frac{\lambda d_2^2}{4d^3}$ *or* $T > \frac{1}{4d_2}$*. In particular,* $-x_{AT}^* = x_{BT}^* = d_2$ *if* $T < \frac{\lambda d_2^2}{4d^3}$ *and;* $-x_{AT}^* = x_{BT}^* > d_2$ *if* $d > d_2 + \frac{1-\lambda}{8T}$*.*

In the third case, when the ideal design is in between (d_1, d_2), the median consumer may be indifferent between the product with median design and low quality, and the product with relatively extreme design and high quality. In this case, product-driven type chooses design at her ideal design, while profit-driven type is mixing between mimicking the product-driven type and deviating to the median design. Theorem 3 characterizes this hybrid equilibrium.

Theorem 3. *Given* $\lambda \in (0, 1)$*, then for any* $d \in (d_1, d_2)$*, there exists a unique hybrid equilibrium: product-driven entrepreneurs choose their ideal design and profit-driven entrepreneurs mix over their ideal design and the ideal design of the median consumers,* 0*. In particular, profit-motivated entrepreneur* B *choose design* 0 *with probability* σ^* *and choose design* d *with probability* $1-\sigma^*$*, and*

$$\sigma^* = \frac{1}{\lambda}\left[1 - \frac{d_1^2}{d^2}\right].$$

Immediately following Theorem 1-3, we can summarize the equilibrium by Corollary 1:

Corollary 1. *There exists an equilibrium for all* $d \in [0, 1]$*. In any equilibrium, where* $q_{e0}^* = 0$*, and* $q_{eT}^* = \frac{T}{T+\gamma}$ *for all* e*. Equilibrium designs depend on where entrepreneurs' ideal designs locate:*

i) If $d \in [0, d_1]$*,* $-x_{At}^* = x_{Bt}^* = d$*, for all* $t \in \{0, T\}$*.*

ii) If $d \in (d_1, d_2)$*,* $-x_{AT}^* = x_{BT}^* = d$*,* $x_{A0}^* = x_{B0}^* = 0$ *with probability* σ^* *and* $-x_{A0}^* = x_{B0}^* = d$ *with probability* $1-\sigma^*$*.*

iii) If $d \in [d_2, 1]$*,* $x_{A0}^* = x_{B0}^* = 0$*, and* $-x_{AT}^* = x_{BT}^* \in [d_2, d)$*. Moreover,* x_{eT}^* *for each* e *is unique if* $T < \frac{\lambda d_2^2}{4d^3}$ *or* $T > \frac{1}{4d_2}$*. In particular,* $-x_{AT}^* = x_{BT}^* = d_2$ *if* $T < \frac{\lambda d_2^2}{4d^3}$ *and;* $-x_{AT}^* = x_{BT}^* > d_2$ *if* $d > d_2 + \frac{1-\lambda}{8T}$*.*

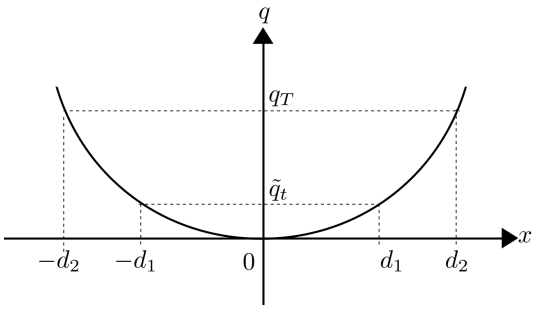

Figure 1: Median Consumer's Indifference Curve

Figure 1 depicts the median consumer's indifference curve which goes through the design-quality pairs of $(0, 0)$, $(\pm d_1, \tilde{q}_t)$, $(\pm d_2, q_T)$, where $\tilde{q}_t$ represents equilibrium quality as a random variable that depends on the prior distribution of t. This means, the median consumer is indifferent among the combination of the median design and low quality, the combination of design d_1 and average quality (across the distribution of entrepreneurs), and the combination of design d_2 and high quality.

The reason is twofold. First, in any pooling equilibrium, competition between two symmetric entrepreneurs leaves each half of the market. That is, the median consumer is indifferent between investing in both entrepreneurs, and all the consumers on the right (respectively, left) to the median strictly prefer entrepreneur B (respectively, entrepreneur A). Thus, a profit-driven entrepreneur B who focuses more on occupying the market would not deviate from the uninformative equilibrium if and only if at every deviation, she cannot attract the median consumer, or in other words, the median weakly prefers investing in entrepreneur A. This holds true for all $d \in [0, d_1]$. In particular, the median is indifferent among $(0, 0)$ and $(\pm d_1, \tilde{q}_t)$. Thus in the pooling equilibrium where the announcements of designs are $\pm d_1$ irrespective of entrepreneurs' types, fixing entrepreneur A's strategies, the most attractive deviation of profit-driven entrepreneur B–choosing design at 0–makes the median consumer indifferent between both entrepreneurs. But as d moves further away from median, the above no longer holds.

Second, in any separating equilibrium, profit-driven entrepreneurs no longer mimic the product-driven ones exactly because in the equilibrium they can occupy at least half of the market which results in higher profit than mimicking. This means, in a separating equilibrium, the median consumer weakly prefers entrepreneur B if she is of profit-driven type. This holds true if $d \in [d_2, 1]$. In particular, the median is indifferent among $(0, 0)$ and $(\pm d_2, q_T)$. Thus, in the separating equilibrium where the profit-driven type takes action $(0, 0)$, and the product-driven type takes action $(\pm d_2, q_T)$, fixing A's strategies, the profit-driven type entrepreneur B's design at 0 makes the median indifferent between both entrepreneurs. When d moves further away from the median, the latter may strictly prefer entrepreneur B if she is of profit-driven type.

Discussion

Design diversification. In the benchmark, competition among homogenous types of entrepreneurs drives them to the converging designs catering for the median consumer. As crowdfunding campaign attracts heterogenous types of entrepreneurs, the latter can convey information about their products (including privately known quality) through announcements of product designs. Accordingly, consumers make inferences from entrepreneurs' actions, and choose products based on announced designs and inferred quality. In response to consumers' demand for high-quality products as well as preferred designs, entrepreneurs are deliberately mimicking or differentiating from others, which results in design diversification.

[3]The concept of Condition D1 is originated from Cho and K. (1987).

Profit of entrepreneurs. Which kinds of entrepreneurs earn higher market shares and/or higher profits? In general, profit-driven entrepreneurs focus more on attracting consumers rather than sticking to their own ideal designs and improving quality, thus on average, profit-driven entrepreneurs obtain (weakly) larger customer base. As consumers become sophisticated on forming beliefs about the preferences of varying kinds of entrepreneurs, product-driven entrepreneurs attract half of the market share when information is not revealed, i.e., $d < d_1$. Otherwise, they earn a smaller size of the market than the profit-driven ones.

Meanwhile, profit-driven entrepreneurs are less willing to pay effort to improve product quality. Indeed, in equilibrium, they produce low-quality products and incur less cost in production. As a consequence, they earn higher profits than those product-driven entrepreneurs.

Information revelation. Our equilibrium predictions suggest that design announcements become more informative about product quality as ideal designs move further away from the median consumer: Information revealing happens when $d \geq d_2$, and uninformative equilibrium occurs when $d \leq d_1$.

Moreover, information asymmetry of product quality between entrepreneurs and consumers is mitigated when there are less product-driven entrepreneurs in the population, product-driven entrepreneurs weigh less on profit, and/or the costs of improving quality reduce.

On the one hand, when entrepreneurs' ideal designs are further away from the median, $d \in [d_2, 1]$, information about product quality can be revealed through the announcement of designs. In particular, d_2 is decreasing in T and increasing in γ. Hence, as product-driven entrepreneurs weigh less on profit, and/or the cost of improving product quality reduces, d_2 decreases and, in turn, more ideal designs would induce information revealing equilibrium.

On the other hand, when entrepreneurs' ideal designs are closer to median, $d \in [0, d_1]$, the announced designs are uninformative about quality. In particular, d_1 is decreasing in λ and T while increasing in γ. As the fraction of product-driven entrepreneurs in the population decreases, product-driven entrepreneurs weigh more on profit, and/or the cost of improving product quality reduces, d_2 decreases, and, in turn, more ideal designs would induce uninformative equilibrium.

Implication for Crowdfunding Platform Design

This section discusses the implications for platform design from two aspects: (i) How can we improve the level of consumer satisfaction from the platform's perspective? (ii) How does consumers' feedback vary across different funding schemes?

Consumer satisfaction.

Obtaining satisfactory feedback from existing customers is vital for the functionality of a crowdfunding platform, including creating and maintaining the customer base, attracting investors for the platform, etc. We discuss consumer satisfaction from the aspects of quality concern, design popularity, and consumer welfare.

Overall quality. The quality of a product is private information of the entrepreneur when she announces the product on the crowdfunding platform. Thus, the feedback about the overall product quality of the platform is critical for attracting future customers. In particular, we define the overall product quality of the platform by the average quality of all funded products:

$$\overline{Q} = \frac{1}{2}\mathbb{E}\left[\int_{-1}^{\hat{c}} q_t dc + \int_{\hat{c}}^{1} q_t dc\right],$$

where $\hat{c}$ is the consumer who is indifferent between investing in either entrepreneur.[4]

[4] In equilibrium, any consumer $c \in [-1, \hat{c}]$ invests in entrepreneur A, while any consumer $c \in [\hat{c}, 1]$ invests in entrepreneur B.

We analyze average quality under pooling equilibrium when $d \in [0, d_1]$, separating equilibrium when $d \in [d_2, 1]$, and hybrid equilibrium when $d \in (d_1, d_2)$ respectively. In any equilibrium, the overall quality can be represented by

$$\overline{Q} = \begin{cases} (1-\lambda)\frac{T}{T+\gamma} \equiv \overline{Q}^p & \text{if } d \in [0, d_1], \\ (1-\lambda)\left[(1-\lambda) + \frac{1}{2}\lambda(1-c^*)\right]\frac{T}{T+\gamma} \equiv \overline{Q}^s & \text{if } d \in [d_2, 1], \\ \sigma^*\overline{Q}^s + (1-\sigma^*)\overline{Q}^p \equiv \overline{Q}^h & \text{if } d \in (d_1, d_2), \end{cases}$$

where $c^* = \frac{x_T^*}{2} - \frac{1-(1-q_T^*)^2}{2x_T^*}$. Here we write $\overline{Q}^p$, $\overline{Q}^s$ and $\overline{Q}^h$ for overall quality under pooling equilibrium, separating equilibrium and hybrid equilibrium respectively.

Who should we include in the crowdfunding platform from the perspective of product quality? Proposition 1 answers the question. First, on average, products appear to be of high quality under pooling equilibrium, i.e., when $d \in [0, d_1]$. Second, overall quality is decreasing in the fraction of profit-driven entrepreneurs. Moreover, $\overline{Q}$ is decreasing in marginal development cost.

Proposition 1. *The overall quality $\overline{Q}$ of the platform has the following properties: i) $\overline{Q}^p > \overline{Q}^h > \overline{Q}^s$; ii) $\overline{Q}$ is strictly decreasing in λ. iii) $\overline{Q}$ is strictly decreasing in γ.*

Not surprisingly, to improve overall product quality on the platform, we should include more product-driven entrepreneurs. Yet interestingly, we want all the entrepreneurs to end up with announcing the same design so that no information about quality is revealed through the design announcements. Therefore, to improve overall quality, we would want to include more product-driven entrepreneurs whose ideal designs are not too far away from the median.

Another effective way of improving product quality is by helping entrepreneurs reduce marginal development cost (γ). For instance, the platform can subsidize technology adoption, and provide consultant service for improving the managerial practice of production.

Design popularity. Whether the designs of the products are popular among various consumers has a great impact on the platform's market reputation. Converging designs such as the benchmark in Section would benefit consumers who prefer median designs most while overlooking those who prefer the extreme. Over diversified designs, on the contrary, would benefit the ones prefer the extreme but overlook those prefer the median.

Our model predictions suggest that products launched on crowdfunding platforms seem to be more popular in terms of the design comparing to the traditional markets. In what follows, we discuss factors that may influence design popularity of the crowdfunding platform. More specifically, we define design popularity of a platform by aggregating all consumer' preference on designs across all funded products:

$$U_x = \frac{1}{2}\mathbb{E}\left[\int_{-1}^{\hat{c}} -(c - x_{At}^*)^2 dc + \int_{\hat{c}}^{1} -(c - x_{Bt}^*)^2 dc\right].$$

We analyze design popularity under the pooling equilibrium when $d \in [0, d_1]$, separating equilibrium when $d \in [d_2, 1]$, and the hybrid equilibrium when $d \in [d_1, d_2]$ respectively. In any equilibrium, design popularity is represented by

$$U_x = \begin{cases} -\frac{1}{3} + d - d^2 & \text{if } d \in [0, d_1], \\ (-\frac{1}{3} + (1-\lambda)(x_T^* - {x_T^*}^2) + \lambda(1-\lambda)(c^* {x_T^*}^2 - {c^*}^2 x_T^*) & \text{if } d \in [d_2, 1], \\ -\frac{1}{3} + (1-\sigma\lambda)(d - d^2) + \sigma\lambda(1-\lambda)c^{**}d(d - c^{**}) & \text{if } d \in (d_1, d_2), \end{cases}$$

where $c^{**} = \frac{d}{2} - \frac{1-(1-q_T^*)^2}{2d} > 0$.

How entrepreneurs' ideal design affect consumer satisfaction from the perspective of design popularity is not clear. Under pooling equilibrium (i.e., $d \in [0, d_1]$), the most popular pair of designs among all consumers is $\pm\min\{d_1, 1/2\}$. At the very least, the platform would not want to include entrepreneurs whose ideal designs are very close to the median. But beyond that, the result is more subtle.

Proposition 2 discusses how design popularity varies across marginal development cost γ.

Proposition 2. *U_x is nondecreasing in γ, and strictly increasing in γ if $d > d_1$.*

Therefore, U_x^s and U_x^h are both increasing in γ whereas U_x^p is independent of γ. Therefore, reducing marginal development cost helps improve design popularity when designs are not that close to the median ($d > d_1$) while it has no effect on design popularity otherwise.

Consumer welfare. Finally, we combine consumer's preference on quality and design and study consumers' overall experience measured by consumer welfare. In particular, we define consumer welfare W by the total utility of all consumers:

$$W = \frac{1}{2}\mathbb{E}\left[\int_{-1}^{\hat{c}} u_c(x_{At}^*, q_{At}^*; c)dc + \int_{\hat{c}}^{1} u_c(x_{Bt}^*, q_{Bt}^*; c)dc\right].$$

We analyze consumer welfare under the pooling equilibrium when $d \in [0, d_1]$, the hybrid equilibrium when $d \in [d_1, d_2]$, and separating equilibrium when $d \in [d_2, 1]$ respectively. In any equilibrium, consumer welfare can be written as

$$W = \begin{cases} W^p & \text{if } d \in [0, d_1], \\ W^s & \text{if } d \in [d_2, 1], \\ W^h & \text{if } d \in (d_1, d_2), \end{cases}$$

where

$$W^p = -\frac{1}{3} + d - d^2 - \lambda - (1-\lambda)(1-q_T^*)^2 - p,$$

$$\begin{aligned} W^s = &-\lambda^2 \int_0^1 \left(c^2+1\right) dc - (1-\lambda)^2 \int_0^1 \left[(c-x_T^*)^2 + (1-q_T^*)^2\right] dc \\ &- \lambda(1-\lambda)\left[\int_{-1}^{c^*} \left[(c-0)^2+1\right] dc + \int_{c^*}^{1} \left[(c-x_T^*)^2 + (1-q_T^*)^2\right] dc\right] - p, \end{aligned}$$

and

$$\begin{aligned} W^h = (1-\sigma^*)W^p + \sigma^* \Bigg\{ &-\lambda^2 \int_0^1 \left(c^2+1\right) dc - (1-\lambda)^2 \int_0^1 \left[(c-x_T^*)^2 + (1-q_T^*)^2\right] \\ &-\lambda(1-\lambda)\left[\int_{-1}^{c^{**}} \left[(c-0)^2+1\right] dc + \int_{c^{**}}^{1} \left[(c-x_T^*)^2 + (1-q_T^*)^2\right] dc\right]\Bigg\} - p. \end{aligned}$$

Under pooling equilibrium, W reaches maximum at $d = \min\{d_1, 1/2\}$. This is consistent with the results of overall quality and design popularity: Fixing $d \in [0, d_1]$, the overall quality is independent of d, and design diversity reaches its maximum at $d = \min\{d_1, 1/2\}$. Consumer welfare is increasing in q_T^*, and thus it is decreasing in γ. This is because, under pooling equilibrium, overall quality is decreasing in γ whereas design popularity is independent of γ.

Under separating equilibrium, the relationship between consumer welfare and marginal development cost is more subtle. Reducing marginal development cost increases overall quality, but decreases design popularity. Thus, how it affects consumer welfare depends on which effect dominates the other.

Under hybrid equilibrium, consistent with the case of design popularity, the relationship between consumer welfare and entrepreneurs' ideal designs are not clear. Moreover, since marginal development cost has opposite effects on overall quality and design, its impact on consumer welfare is more subtle.

The takeaway is twofold. First, if entrepreneurs' ideal designs are not that far from the median consumer so that $d < d_1$, then it's the best for the platform to include entrepreneurs with ideal designs close to $1/2$. Meanwhile, adopting strategies that can help entrepreneurs reduce marginal development cost improves consumer welfare. Second, beyond the above situation, the answer is not clear. In particular, whether the platform should help entrepreneurs reduce development cost can depend on whether the platform is more incline to improve overall quality or design popularity.

Alternative funding scheme.

In the baseline model, we implicitly assume that the crowdfunding platform adopts the *Keep-it-all* (henceforth, KIA) funding scheme, i.e., entrepreneurs keep the raised fund unconditionally. In practice, some crowdfunding platforms such us Indiegogo use this scheme. Meanwhile, other platforms such as Kickstarter use the scheme of *All-or-nothing* (henceforth, AON), which allows entrepreneurs to keep the raised fund only if the funding goal has been reached. This section we consider the *All-or-nothing* scheme where the funding goal is $\frac{p}{2}$. That is, the entrepreneur can keep the fund only if she obtains a half share of the market. Then we compare how consumer satisfaction varies across different funding schemes.

Following the same logic of the analysis in Section , we obtain the equilibrium predictions as follows.

Corollary 2. *There exists a unique equilibrium for all $d \in [0,1]$. In any equilibrium, where $q^*_{e0} = 0$, and $q^*_{eT} = \frac{T}{T+\gamma}$ for all e. Equilibrium designs depend on where entrepreneurs' ideal designs locate:*

i) If $d \in [0, d_1]$, $-x^*_{At} = x^*_{Bt} = d$, for all t.

ii) If $d \in (d_1, d_2)$, $-x^*_{AT} = x^*_{BT} = d$, $x^*_{A0} = x^*_{B0} = 0$ with probability σ^* and $-x^*_{A0} = x^*_{B0} = d$ with probability $1 - \sigma^*$.

iii) If $d \in [d_2, 1]$, $x^*_{A0} = x^*_{B0} = 0$, and $-x^*_{AT} = x^*_{BT} = d_2$.

Under this AON scheme, the entrepreneur has to win at least half of the market to get funded. Then the product-driven entrepreneur faces a tighter constraint of moving toward ideal design. Had she move too close to the ideal design, she might lose the median consumer so that the entire funding. As a consequence, she chooses the design d_2 that makes the median consumer indifferent between profit-driven and product-driven entrepreneurs in equilibrium so that she earns half of the market. Recall that, under KIA scheme, she would choose design $x^*_T \geq d_2$ that maximizes her expected utility by considering the tradeoff of profit vs. product unconditionally. Therefore she chooses a design closer to the median and earns a weakly higher market share and profit in the AON scheme than the KIA scheme.

In what follows, we compare consumer satisfaction under the two funding schemes.

Quality concern. The overall quality is the same with the KIA funding scheme in Section when $d \in [0, d_1]$. Now we consider the case where $d \in [d_2, 1]$:

$$\overline{Q}^{s\dagger} = (1-\lambda)^2 q^*_T + \frac{1}{2}\lambda(1-\lambda)(1-\hat{c})q^*_T = \left[(1-\lambda)^2 + \frac{1}{2}\lambda(1-\lambda)\right]\frac{T}{T+\gamma}.$$

Finally, when $d \in [d_1, d_2]$:

$$\overline{Q}^{h\dagger} = \sigma\overline{Q}^{p} + (1-\sigma)\overline{Q}^{s\dagger}.$$

Apparently, $\overline{Q}^{s\dagger} \geq \overline{Q}^{s}$ and $\overline{Q}^{h\dagger} \geq \overline{Q}^{h}$. On the one hand, under pooling equilibrium and $d \leq d_1$, overall quality is still the highest and does not depend on whether the funding scheme is AON or KIA. But on the other hand, if $d > d_1$, adopting the AON scheme increases the overall quality of the platform.

Design popularity. The design popularity is the same with the KIA funding scheme in Section when $d \in [0, d_2]$. When $d \in [d_2, 1]$, the design quality is

$$\begin{aligned} U^{s\dagger}_x &= -\lambda^2 \int_0^1 c^2 dc - (1-\lambda)^2 \int_0^1 (c-d_2)^2 dc - \lambda(1-\lambda)\left[\int_{-1}^0 c^2 + \int_0^1 (c-d_2)^2\right] \\ &= -\frac{1}{3} + (1-\lambda)(d_2 - {d_2}^2) > U^s_x. \end{aligned}$$

Thus, adopting AON decreases design popularity when $d > d_2$, i.e, under separating equilibrium. Otherwise, the design popularity is the same under the two funding schemes.

Consumer welfare. The consumer welfare is the same with the case in Section when $d \in [0, d_2]$. When $d \in [d_2, 1]$:

$$W^{s\dagger} = -\lambda^2 \int_0^1 \left(c^2 + 1\right) dc - (1-\lambda)^2 \int_0^1 \left[(c-d_2)^2 + (1-q_T^*)^2\right] dc$$
$$- \lambda(1-\lambda)\left[\int_{-1}^0 \left[(c-0)^2 + 1\right] dc + \int_0^1 \left[(c-d_2)^2 + (1-q_T^*)^2\right] dc\right] - p.$$

Thus, under separating equilibrium, the impact of adopting AON on consumer welfare is more subtle. It depends on whether its positive effect on quality dominates its negative impact on design diversification. Otherwise, consumer welfare is the same under the two funding schemes.

Concluding Remarks

Competition among heterogeneously motivated entrepreneurs leaves footprints on consumers' feedback about the crowdfunding platform and thus has important implications for crowdfunding platform design and policy makers. We make the first attempt to address how online crowdfunding facilitates competition among heterogeneously motivated entrepreneurs. To this end, we formulate a spatial competition model between profit-driven entrepreneurs and product-driven entrepreneurs. Our results indicate that, while, on average, profit-driven entrepreneurs earn higher profits than product-driven ones, their advantage is constrained by the mechanism of the crowdfunding campaign, and product-driven entrepreneurs earn a significant fraction of the market. The richness of our model allows us to discuss implications on consumer satisfaction and crowdfunding platform design.

In the meantime, our analysis leaves several questions open. What would happen if we allow for more complicated pricing scheme similar to literature studies pricing strategies of crowdfunding platforms? Can we use the framework to study entrepreneurs' choices when facing different degrees of competition? And can we endogenize entrepreneur's occupational choice and discuss which kinds of individuals are more likely to be an entrepreneur? We hope that someone, maybe ourselves, will pursue these research agendas in the future.

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