Crowdfunding under Social Learning, Network Externalities, and Financial Constraints

Introduction. Crowdfunding describes the collective cooperation, attention and trust by people who network and pool their money together, usually via the Internet, in order to support efforts initiated by other people or organizations. Crowdfunding occurs for any variety of purposes, from disaster relief to citizen journalism to artists seeking support from fans, to political campaigns. In this paper, we study the reward-crowdfunding (also called rewards-based crowdfunding) under the “Keep-it-All” (KiA) fundraising model, where production-based firms (campaigners) pre-sell a new product to launch a business without incurring debt or sacrificing equity/shares. In such environment, a firm solicits financial contributions from the crowd, mostly in the form of pre-buying a product, to cover production costs. When first introducing a new product to the market, product quality uncertainty is an inevitable issue, and both the firm and the consumers face uncertainty about the new product’s true quality. Over time, they learn more information (possibly noisy) about the product quality from the reviews of fellow consumers and gain a better sense of its value. Hence, strategic consumers may recognize that future learning will occur and may choose to delay a purchase until they have more information about a product’s value. In addition, we consider positive network externalities under the social network of the crowdfunding campaign, where more fellow consumers’ purchase will induce higher perceived utility for the consumer population. In the spirit of these characteristics, we provide a two-period model (crowdfunding period and regular retail period) that captures three salient features - (i) network externalities, (ii) two-sided social learning, and (iii) financial constraints - as a decision support framework to address the strategic interactions between the firm and consumer population. Crowdfunding is a cornucopia of important research questions, of which we consider three: (i) what is the impact of network externalities on the purchasing game dynamics in the “crowd” of strategic consumers, (ii) what is the firm’s optimal crowdfunding reward choice under different strength of network externalities, (iii) what is the impact of the firm’s financial constraints, i.e., the “funding” of role of crowdfunding.

Literature Review. Our work is related to the growing stream of literature on social operations management, which studies the implications of social interactions among consumers for firms’ operational strategies. In respect to different types of social interaction, we consider two in this paper: network externalities and social learning. Candogan et al. (2012) and Hu and Wang (2016) study optimal pricing in social networks with positive externalities. Hu et al. (2015b) consider a firm selling two substitutable products to a stream of consumers who arrive sequentially and whose purchasing decisions can be influenced by earlier purchases through a social utility component. Feldman et al. (2016) study the impact of review-based social learning on a monopolist firm’s choice of product design (quality).
In the social learning literature, there are Bayesian and non-Bayesian approaches to modeling how individuals are influenced by others. Papanastasiou and Savva (2016) study the strategic behavior of firms and consumers in the presence of social learning. Our study differs from the aforementioned literature and is among the first to integrate both network externalities and social learning into a unified modeling framework. Our research is also related to the growing literature that deals with various facets of crowdfunding. Several papers have empirically investigated the network externalities and herding behavior in crowdfunding caused by asymmetric quality information and observational learning from early contributions (see Li and Duan, 2016; Mollick, 2014). Hu et al. (2015a) study the optimal product and pricing decisions in a crowdfunding mechanism. Agrawal et al. (2013) provide a preliminary exploration of its underlying economics and highlight the extent to which economic theory can explain the rise of non-equity crowdfunding.

**Main Results.** We consider a crowdfunding campaign, where a single firm sells a new product of ex ante unknown quality to a potential population of heterogeneous consumers over two periods, the crowdfunding season and the regular retail season. The firm charges two different prices, crowdfunding price and retail price, where the difference is the crowdfunding reward. The retail price is exogenous determined due to competitive market, thus the firm’s key decision is the crowdfunding price, or equivalently the crowdfunding reward choice. Our model of consumer’s gross utility distinctively captures three components: a preference component, a quality component and a social component. Under this modeling framework, we first identify the consumers’ purchasing pattern as a function of the crowdfunding reward, by adopting the perfect rational expectations equilibrium (PREE) as the solution approach. Under weak network externalities, a larger fraction of consumer population will purchase in the crowdfunding season if a higher reward is offered. But under strong externalities, it turns out, somewhat surprisingly perhaps, that the crowdfunding sales increases as the crowdfunding reward decreases. That means demand is higher as the price goes higher. The economics literature documents this as the Veblen effect, which refers to the phenomenon of conspicuous consumption; to the extent to which the demand for a consumers’ good is increased because it bears a higher rather than a lower price. Different from extant economic literature, we provide an alternative explanation of the Veblen effect under the specific setting of crowdfunding, where the underlying driving force is a combination of the strategic consumer behavior and positive network externalities. Next, we fully characterize the firm’s unique optimal crowdfunding reward choice and the induced consumer purchasing game equilibrium. Interestingly, we find under strong network externalities firm should only choose either extremely high or extremely low reward (depending on the profit margin) to induce either all consumers purchasing during crowdfunding season or zero purchase. Lastly, we incorporate the financial constraints into our model as the funding needed to support the high manufacturing
setup cost. The optimal reward strategy also differs under different network scenarios, but remains
conscisely structured. Comparing to the case without financial constraints, the optimal reward choice
can be either higher or lower in each network externalities scenario, depending on the product’s cost
structure and the prior uncertainty in quality.

We now summarize our main contributions to the literature, and some relevant managerial in-
sights. First, existing literature in (social) operations management has helped us understand the
consumers’ “strategicness” in one dimension, either a trade-off between personal valuation and quality
component under social learning, or a trade-off between personal preference and social utility under
network externalities. We are among the first to integrate the two strategic dimensions into a unified
modeling framework, articulate the underlying connections and trade-offs between them, and charac-
terize the induced behavior pattern among consumer population. Second, we present a model that
captures important features of the emerging business model, crowdfunding, where a relatively new
price structure appears as the pronounced pricing with increasing pattern. Our work conveys insights
on the role of crowdfunding reward for campaigners to optimally interact with strategic consumers in
potential market. Third, we are among the first to model, analyze and quantify the impact of financial
constraints on firm’s optimal reward choice and profit. Since the crowdfunding origins as a funding
tool for startups who have budget constraints, our analysis offers insights as well as implementable
operational strategy to fully exploit the “funding” role of crowdfunding.

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