Crowdfunding Adoption in the Presence of Word-of-Mouth Communication

Crowdfunding with Word-of-Mouth

Suggested Citation: Fasheng Xu, Xiaomeng Guo, Guang Xiao and Fuqiang Zhang (2021), "Crowdfunding Adoption in the Presence of Word-of-Mouth Communication", : Vol. xx, No. xx, pp 1–18. DOI: 10.1561/XXXXXXXXX.

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Contents

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ABSTRACT

In the fast growing markets of crowdfunding, firms launch projects not only to raise funding directly from the crowd to cover early stage investment, but also to expand product awareness via word-of-mouth (WoM) communication. In this paper, we investigate a firm's optimal funding choice when launching an innovative product in the market with WoM communication. We characterize the firm's optimal quality and pricing strategies under both crowdfunding and traditional bank financing, and compare these two funding choices and their corresponding welfare implications. Among other results, we show that crowdfunding is a preferable funding choice for a project when (its success probability is below an adoption threshold). More active WOM communication always benefits the firm and favors crowdfunding adoption. However, product quality may either increase or decrease as WOM expands. Consumer surplus and social welfare always increase as WOM communication becomes more active.

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Research Motivation and Problem Description

In rewards-based crowdfunding, production-based firms pre-sell a product to raising funding for launching a business without incurring debt or sacrificing equity/shares. The raised funds could then be used to cover production costs. Rewards-based crowdfunding is the most prolific form of crowdfunding currently taking place in the U.S. The rising popularity of crowdfunding sites, such as *Kickstarter* and *Indiegogo*, has promoted crowdfunding as a modern fund-raising solution (see Figure 1.1 for an example on Kickstarter). Crowdfunding has gone beyond simply being a tool specifically utilized by small businesses and independent entities to get a given project off the ground. Even larger businesses are now turning to crowdfunding as a way to market their products (**nyt2016**).

Besides its financing role, rewards-based crowdfunding brings significant operational benefits to firms. The all-or-nothing (AoN) funding mechanism (where the firm sets a funding target and gets nothing unless the target is achieved) helps firms make better production decisions based on the advance demand information from crowdfunding. Hence, by crowdfunding the pledge of capital is available to firms before committing to large-scale production, which allows them to do fund raising and market testing simultaneously. In the example in Figure 1.1, we can see

the funding target is $10,000 under all-or-nothing funding mode. There is an emerging literature on the AoN design in the context of equity-based crowdfunding, and its impact on moral hazard (**strausz2017theory**), information cascade and herding (**cong2019information**), and financing efficiency (**brown2020financing**).

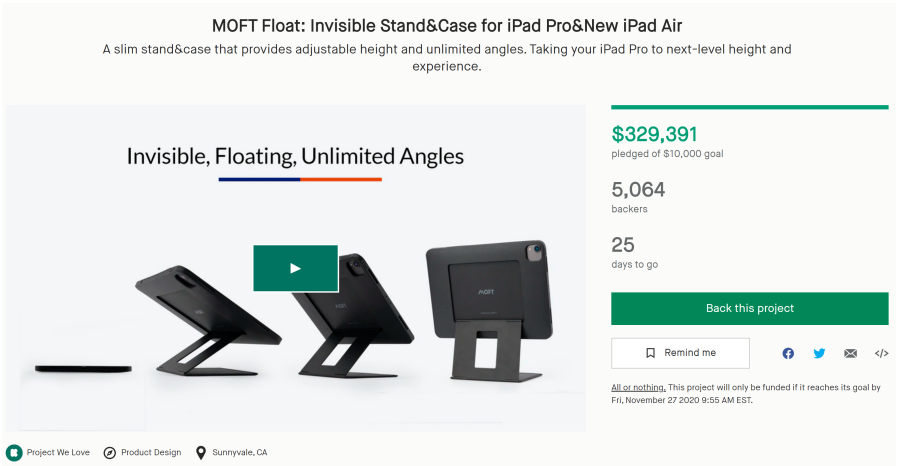

Figure 1.1: A Kickstarter Example

In addition, crowdfunding has become an important marketing tool to help spread product awareness via word-of-mouth (WoM) communication. Typically, crowdfunding platforms encourage and facilitate the use of online WoM through social networks and social media (e.g., Facebook, Instagram), to spread awareness about the crowdfunding campaigns (**moqri2016please**). Again, in the Kickstarter example, we can see there are embedded links for sharing on social media like Facebook and Twitter, or directly through email. Having access to a larger social network enables campaign organizers to get the word out more easily, enabling buzz and awareness for their production.

WoM communication seems to account for an increasing role in consumer decisions. There has been exponential growth in terms of the volume, depth, and breadth of social interactions, particularly online. For example, according to **WMMA2011**, 54% of purchase decisions are influenced by WoM. **nielsen2012global** also finds that 84% of respondents trust a "recommendations from others". This is higher than

the 78% reported in 2007 and higher than all other forms of advertising.

A growing number of studies have empirically examined WOM communication and shown that the volume and valence of WOM can have a significant impact on consumers' purchase and adoption behaviors (**godes2004using**; **liu2006word**; **chen2011online**; **berger2011drives**). On the analytical side, **campbell2013word** captures social learning via WOM communication and finds the optimal advertising targets are generally not the individuals with the most friends. **ajorlou2016dynamic** study the problem of dynamic pricing when selling to a network of consumers. **godes2016product** investigates the relationship between product quality and WOM communication. Despite its importance, the role of WOM communication in crowdfunding has not been well explored in the literature. The enriched dynamics in crowdfunding enable us to convey new insights on the impact of WOM which differs from the existing literature.

Motivated by the above practical observations, we investigate a firm's optimal choice between crowdfunding and traditional bank financing to fund its innovative product in the presence of WOM communication. More specifically, we ask three main research questions in this paper: (*i*) What is the value of crowdfunding relative to traditional bank financing without WOM communication? (*ii*) What is the optimal crowdfunding strategy (pricing strategy, funding target, and quality choice) with WOM communication and consequently the firm's equilibrium funding choice? (*iii*) What happens to crowdfunding adoption, product quality, and consumer surplus as WOM communication becomes more active?

2

Modeling Approach and Methodology

To answer our research questions, we develop an analytical model in which the firm optimizes its operational decisions (quality choice, pricing strategy, funding target) while taking into account the financing role (i.e., raising funds to support product development) and the marketing role (i.e., the benefit from WoM communication due to stalled market base in the crowdfunding stage).

2.1 Crowdfunding Strategy

A cash constrained firm (she) wants to launch an innovative product in the marketplace with quality q, which is an endogenous decision. To develop and produce the product, the firm needs to raise capital, either via crowdfunding or bank financing, to meet an initial investment requirement of product development cost γq^2. For expositional convenience, we normalize the marginal production cost to zero. If the firm chooses crowdfunding, she needs to sell the product through two stages: the crowdfunding stage with *crowdfunding price* p_1 and the retail stage with *retail price* p_2. In this paper, we focus on the commonly used AoN funding mechanism: The firm sets a funding target T, together with a crowdfunding price p_1. Surviving the crowdfunding stage requires

$p_1 d_1 \geq T$, where d_1 denotes the number of consumers purchasing in crowdfunding. If the funding target is successfully reached, then the firm proceeds with the product development and continues selling the product in period 2 with the retail price p_2; otherwise the crowdfunding project fails without further production activities. Alternatively, the firm could use bank financing as the source of capital. Given the product development cost γq^2, the bank evaluates the market risk and decides the interest rate r_s to charge. The firm will produce and sell to the market by setting a retail price $p_{\mathcal{B}}$.

Since it is a new product, the firm is uncertain about the market response. The potential market size for the new product is $X(1+\alpha)$, where X is a Bernoulli random variable equal to x_h (i.e., the high/good market response) with probability $\beta \in (0,1)$ and equal to x_l (i.e., the low/bad market response) otherwise, where $x_h > x_l \geq 0$. $\alpha > 0$ is an exogenous parameter that characterizes the two segments of consumer population. Specifically, X is the consumer mass of the *crowdfunding market* and αX is the consumer mass of the *retail market*. We call α the *retail market proportion*. We assume $x_l = 0$ for expositional clarity. Each consumer's valuation of the product is θq, where q is the product quality, and θ represents the consumer's willingness-to-pay. We assume θ follows a uniform distribution on $[0,1]$.

During the retail stage, consumers buy the product if and only if they are aware of it and their utility exceeds the retail price. We define the awareness expansion function $A(\rho) \geq 1$ to represent the additional consumer population in the retail market that become aware of the product, given ρ fraction of consumers who have already purchased in the crowdfunding stage (we can show $\rho \in [1/2, 1]$). Hence, the retail market size becomes $A(\rho)\alpha X$. For expositional convenience, we assume a simple form of the awareness expansion function as follows, $A(\rho) = k\rho$, where $k \geq 2$ is the *WOM intensity* (here we assume $k \geq 2$ to ensure $A(\rho) \geq 1$). Note that the awareness expansion function $A(\rho)$ increases in ρ, meaning the larger the fraction of consumers purchasing in the crowdfunding stage, the larger the consumer population in the retail market that will be informed about the product. The WOM intensity k captures how actively the consumers are communicating with each other, or how much buzz the product can generate. A product's WOM

intensity also reflects the propensity that its information disseminates among consumers via social forces. For example, a product with more chat-worthy features tends to have a higher WOM intensity.

The firm needs to choose the retail price p_2 at the beginning of period 2 given the installed market base $\rho = (1 - \theta_1)$ through crowdfunding. Suppose the firm chooses the retail price p_2, and the consumers in the retail market with $\theta \geq \theta_2 = p_2/q$ will purchase. The expected revenue in the retail stage can be written as $\pi_2(\theta_2; \theta_1, q) = \beta x_h[\alpha k(1 - \theta_1)](1 - \theta_2)\theta_2 q$, where $[\alpha k(1 - \theta_1)]$ is the expanded retail market size given the purchase cutoff θ_1 in crowdfunding. For a given quality q, the optimal retail price is always $p_2^* = q/2$ (i.e., $\theta_2^* = 1/2$), regardless of the WOM effect. Hence, the optimal revenue in the retail stage becomes $\pi_2^*(\theta_1, q) = \beta x_h[\alpha k(1 - \theta_1)]q/4$. Back to the crowdfunding stage, the expected revenue is $\pi_1(\theta_1, q) = \beta x_h q\theta_1(1 - \theta_1)$. Considering the fund-raising constraint of product development cost γq^2, the firm's profit optimization problem is given below, where subscript "$\mathcal{I}$" denotes the case of crowdfunding under WOM.

$$\max_{\theta_1, q} \pi_{\mathcal{I}}(\theta_1, q) = \max_{\theta_1, q} \beta \left\{ \frac{q x_h}{4} [4\theta_1(1 - \theta_1) + \alpha k(1 - \theta_1)] - \gamma q^2 \right\},$$

$$s.t.\ x_h q\theta_1(1 - \theta_1) \geq \gamma q^2.$$

The optimal quality choice $q_{\mathcal{I}}$ and pricing scheme $\{\theta_1^*, \theta_2^*\}$ are summarized in the next proposition.

Proposition 2.1. The optimal crowdfunding strategy and associated profit under WOM can be summarized as follows:

(i) If the WOM intensity is relatively low, i.e., $2 \leq k < \frac{4}{3\alpha}$,

$$\theta_1^* = \frac{4 - \alpha k}{8},\ \theta_2^* = \frac{1}{2},\ q_{\mathcal{I}} = \frac{(4 + \alpha k)^2 x_h}{128\gamma},\ \pi_{\mathcal{I}}^* = \frac{(4 + \alpha k)^4 \beta x_h^2}{128^2 \gamma}.$$

(ii) If the WOM intensity is relatively high, i.e., $k \geq \frac{4}{3\alpha}$,

$$\theta_1^* = \frac{1}{3},\ \theta_2^* = \frac{1}{2},\ q_{\mathcal{I}} = \frac{2x_h}{9\gamma},\ \pi_{\mathcal{I}}^* = \frac{\alpha k \beta x_h^2}{27\gamma}.$$

Proposition 2.1 characterizes the firm's optimal pricing and quality strategies under different levels of WOM. Recall that $p_i^* = \theta_i^* q_{\mathcal{I}}$ and $T^* =$

$\gamma q_{\mathcal{I}}^2$. More specifically, part (i) focuses on the low WOM intensity case, i.e., $2 \leq k < \frac{4}{3\alpha}$, and shows that the the optimal purchase cutoff θ_1^* is decreasing in the WOM intensity k and the optimal quality $q_{\mathcal{I}}$ is convexly increasing in k. Moreover, the optimal crowdfunding price p_1^*, as the product of these two, is eventually increasing in k. It is straightforward to deduce that as the informative effect of WOM increases, the value of retail market expansion increases and thus the firm tends to increase the adoption rate in crowdfunding (decrease the purchase cutoff θ_1^*). The less obvious and more interesting aspect of the result is that the quality choice increases as WOM expands, which further offsets the decrease in the consumer's purchase cutoff θ_1^* and leads to a higher crowdfunding price. Briefly, the proposition implies that the optimal response to a more active WOM is the *quality-enhancing* strategy instead of the *price-discount* strategy (which can also boost more retail market expansion).

The condition $2 \leq k < \frac{4}{3\alpha}$ also implies that $\alpha < 2/3$. If the retail market proportion is larger than $2/3$ or if the WOM intensity is higher than $\frac{4}{3\alpha}$, part (ii) shows that the optimal crowdfunding price and quality choice are both independent from the WOM intensity k. This connects to the quality-ceiling effect of crowdfunding as we discussed earlier. Though it is optimal to continue the quality-enhancing strategy as WOM intensity increases, such a strategy is constrained by the capital-raising ability of crowdfunding. As a result, the optimal purchase cutoff and quality choice is to stay put even though the WOM increases. Lastly, it is worth noticing that the quality ceiling $q_{\mathcal{I}} = \frac{2x_h}{9\gamma}$ under WOM is lower than the one $q_{\mathcal{C}} = \frac{2x_h}{8\gamma}$ in our baseline model without WOM. That said, with WOM, a lower quality is chosen when the retail market proportion α is relatively large. However, the opposite is true when the retail market proportion α is lower than a threshold.

2.2 Bank Financing Strategy

Suppose the firm chooses the retail price $p_{\mathcal{B}}$, then the consumer's purchase cutoff is $\theta_{\mathcal{B}} = p_{\mathcal{B}}/q$, where subscript "$\mathcal{B}$" denotes the case of bank financing. As the total market size $(1+\alpha)X$ is uncertain, the bank's interest rate r_s would be chosen so that it is indifferent between issuing

the loan to the firm and earning a risk-free rate (which is normalized to zero for expositional brevity), i.e.,

$$\gamma q^2 = \mathbb{E}_X[\min\{q\theta_{\mathcal{B}}(1-\theta_{\mathcal{B}})(1+\alpha)X, \gamma q^2(1+r_s)\}]. \tag{2.1}$$

Based on such risk pricing mechanism, we can further derive the explicit formula of the bank's interest rate r_s, and its dependence on the market size uncertainty as well as the firm's decisions on price and quality in the following proposition.

Proposition 2.2. The optimal bank financing strategy and associated profit are:

$$q_{\mathcal{B}} = \frac{\beta(1+\alpha)x_h}{8\gamma}, \quad p^*_{\mathcal{B}} = \frac{q_{\mathcal{B}}}{2}, \quad \pi^*_{\mathcal{B}} = \frac{[\beta(1+\alpha)x_h]^2}{64\gamma}.$$

Proposition 2.2 indicates that when the quality is chosen optimally, the startup can always get access to bank financing.

3

Results and Insights

We are now ready to characterize the equilibrium funding choice by comparing crowdfunding strategy with bank financing strategy.

3.1 Equilibrium Funding Choice

Proposition 3.1. (i) When $\alpha \leq 1$, crowdfunding is always adopted.

(ii) When $\alpha > 1$, crowdfunding is adopted if and only if

$$\beta \leq \beta_{\mathcal{I}} = \frac{64\alpha k}{27(1+\alpha)^2}.$$

Proposition 3.1 suggests that crowdfunding is a preferable funding choice for a project when its success probability is below a threshold $\beta_{\mathcal{I}}$, which is referred to as the *adoption threshold*. The intuition behind Proposition 3.1 can be explained by decomposing the value of

crowdfunding under WOM into three components as follows:

$$\underbrace{\pi^*_{\mathcal{I}}(\alpha,\beta,k)-\pi^*_{\mathcal{B}}(\alpha,\beta)}_{\text{value of crowdfunding}} = \underbrace{\pi^*_{\mathcal{I}}(\alpha,\beta,k)-\pi^*_{\mathcal{C}}(\alpha,\beta)}_{\text{awareness-expanding benefit}>0} + \underbrace{\pi^*_{\mathcal{O}}(\alpha,\beta)-\pi^*_{\mathcal{B}}(\alpha,\beta)}_{\text{market-validating benefit}>0} + \underbrace{\pi^*_{\mathcal{C}}(\alpha,\beta)-\pi^*_{\mathcal{O}}(\alpha,\beta)}_{\text{quality-ceiling loss}\leq 0},$$

where $\pi^*_{\mathcal{C}}(\alpha,\beta)$ is the optimal crowdfunding profit without WOM, $\pi^*_{\mathcal{O}}(\alpha,\beta)$ is the maximum crowdfunding profit without the financial constraint, and $\pi^*_{\mathcal{B}}(\alpha,\beta)$ is the optimal profit under bank financing. Then, the first component $\pi^*_{\mathcal{I}}(\alpha,\beta,k)-\pi^*_{\mathcal{C}}(\alpha,\beta)$ is referred to as the awareness-expanding benefit and is always positive (and increasing in k). The second component $\pi^*_{\mathcal{O}}(\alpha,\beta)-\pi^*_{\mathcal{B}}(\alpha,\beta)$ is the *market-validating benefit*, which comes from the fact that the firm can condition its production (and relevant cost) on high demand due to the AoN mechanism. As long as the project faces the risk of poor market response ($\beta<1$), the market-validating benefit is always positive. The third component $\pi^*_{\mathcal{C}}(\alpha,\beta)-\pi^*_{\mathcal{O}}(\alpha,\beta)$ is the *quality-ceiling loss*, which quantifies the profit loss from the inflexibility of quality choice due to the funding constraint for the product development requirement in crowdfunding.

Our model can explain a number of stylized facts about reward-based crowdfunding. A general prediction of our model is that crowdfunding encourages highly risky projects and provides an important funding channel for high-risk ventures, which is typically the case for innovative ideas and projects. Our model prediction is consistent with empirical evidence that entrepreneurs entering Kickstarter shift to projects that face higher uncertainty when crowdfunding becomes relatively more costly (**xu2018learning**). Such favor for high-risk projects can also help explain why the average success rate for crowdfunding projects on Kickstarter is only 39.43% across all categorizes.[1]

Moreover, an important observation of the project success rate on Kickstarter is that the technology category has a significantly lower

[1]Data retrieved from https://www.kickstarter.com/help/stats?ref=about_subnav, on February 4, 2022

success rate compared with other categories like games and music (see Figure 3.1). This difference could be potentially driven by the different levels of WOM communications. The WOM about games and music is typically more active compared to the technology category, as they are digital by product nature and can generate more buzz among consumers. Our model suggests that those projects with less active WOM (e.g., the technology category) tend to have lower adoption thresholds of success probability, meaning only risky projects would favor crowdfunding as a funding choice upfront and thus there would be a lower success rate in crowdfunding.

Category	Launched Projects	Total Dollars	Successful Dollars	Unsuccessful Dollars	Live Dollars	Live Projects	Success Rate
All	499,068	$5.29 B	$4.75 B	$480 M	$61 M	3,512	38.03%
Games	55,029	$1.39 B	$1.28 B	$85.15 M	$19.14 M	594	41.64%
Design	42,645	$1.21 B	$1.10 B	$89.30 M	$18.94 M	389	38.70%
Technology	44,073	$986.24 M	$865.94 M	$108.08 M	$12.21 M	395	20.77%
Film & Video	75,456	$477.20 M	$406.40 M	$69.49 M	$1.30 M	291	37.60%
Music	63,110	$252.59 M	$231.03 M	$20.63 M	$930.36 K	215	50.04%

Figure 3.1: Success rates for different project categories on Kickstarter (https://www.kickstarter.com/help/stats?ref=global-footer)

3.2 Impact of WOM Intensity

Next, we conduct sensitivity analysis to understand the impact of WOM intensity k on the firm's crowdfunding adoption (i.e., firm's profit), equilibrium product quality, and consumer surplus. The following theorem formalizes related results.

Theorem 3.1. More active WOM always increases crowdfunding adoption, and achieves win-win for consumer surplus and firm profit, but may decrease product quality.

Theorem 3.1 highlights the benefits of more active WOM for both the firm and the consumers. As k increases, the funding choice may

either (i) always be crowdfunding or (ii) switch from bank financing to crowdfunding at a certain threshold. The former case (i) always leads to an increase in the firm's profit and product quality. The increase in consumer surplus is driven by the decreased purchase cutoff, increased product quality, and the retail market expansion. The latter case (ii) not only benefits the firm (as endogenously chosen) but also increases consumer surplus. To see this, we can show from the consumer surplus perspective that it is also optimal to follow a threshold-type strategy, with an adoption threshold $\beta_{\mathcal{I}}^{c}$. Furthermore, we find $\beta_{\mathcal{I}}^{c} > \beta_{\mathcal{I}}$ (see proof of Theorem 3.1), which means consumers favor crowdfunding more and thus a bank-to-crowdfunding switch enhances consumer surplus. Even though the product quality may decrease in the latter case (ii) when $q_{\mathcal{I}} = \frac{2x_h}{9\gamma} < q_{\mathcal{B}} = \frac{\beta(1+\alpha)x_h}{8\gamma}$ (or equivalently, $\beta(1+\alpha) > 16/9$), the consumer surplus always increases as more consumers purchase in both the crowdfunding stage (i.e., lower purchase cutoff θ_1^*) and the retail stage (i.e., more retail consumers know the product due to WOM communication).

Theorem 3.1, along with the quality-ceiling loss effect of crowdfunding, suggests one important caveat: product quality might be impeded due to the constraint on how much funding can be raised from the crowdfunding market. An example is the "The Flare Audio" campaign, which developed a set of headphones. After product delivery, the backers quickly started to complain about the build quality of the product, as the cables seemed to fail from unexpectedly early fatigue. Such issues are also acknowledged by some of the main actors in the crowdfunding community. A recent initiative have been launched by Kickstarter, the electronic component distributor Avnet, and the hardware consultancy firm Dragon Innovation (**jensen2018identifying**). The initiative aims to support the creators in design and manufacturing before they launch their crowdfunding campaigns, so that their quality design and investment are not limited by the capital-raising limitation in crowdfunding.

4

Conclusion and Future Research

Rewards-based crowdfunding has the potential to not only democratize access to capital, but also to create entirely new forms of social interactions among consumers (backers). However, making the most out of crowdfunding requires a comprehensive value positioning anchored in traditional bank financing. This paper attempts to advance our understanding of crowdfunding and its implications for product quality and social welfare.

We highlight several main results from this paper. First, more active WOM communication always benefits the firm and increases crowdfunding adoption. Second, crowdfunding adoption may lead to lower quality choice by the firm and the product quality may either increase or decrease as WOM expands. Lastly, consumer surplus and social welfare always increase in WOM.

This paper is among the first to study the interaction between a firm's funding choice and word-of-mouth (WOM) communication, and its consequent impact on product quality, consumer surplus, and social welfare. Our findings help explain several phenomenal real-world puzzles, such as why established companies have begun to launch products via crowdfunding platforms and why the success rate of the technology

category is significantly lower than that in some other categories like games and music. The key contribution of our work is to provide thorough comparisons (firm profit, product quality, consumer surplus, and social welfare) between crowdfunding and bank financing under WOM communication. The managerial insights provide useful guidance on whether firms (including both startups and established firms) should go crowdfunding, and (if so) how to tailor their crowdfunding strategy in response to the WOM communication among consumers. Our model also provides welfare implications on when crowdfunding is a win-win alternative fund-raising solution to support entrepreneurship and innovation.

This research can be extended to further explore the crowdfunding strategy in different business environments. For instance, besides the WOM communication through crowdfunding, the firm can directly invest in informative advertising to spread product information and increase consumer awareness. It is worth studying when the firm might find it beneficial to directly invest in advertising. In addition, the firm is assumed to be a monopolist in the marketplace. It would be interesting to explore the effect of market competition on the firm's crowdfunding strategy and funding choice.

Acknowledgement

Xiaomeng Guo acknowledges financial support from the Research Grants Council of Hong Kong [General Research Fund Grant PolyU 15507318].