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Abstract. In the last few years, we have seen the emergence of two new ways in which firms interact with outside stakeholders, namely crowdsourcing and crowdfunding service providers. In this article, we define crowdsourcing and crowdfunding terms, compare new business models with traditional ones, review the operations management research community's contribution so far, point out useful frameworks for understanding the phenomena, illuminate promising research paths, and highlight open research questions. We also discuss the parallels between these concepts as well the main differences.

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1. Introduction

Uber and Airbnb, Kickstarter and GoFundMe, Amazon Mechanical Turk and Waze, YouTube and Kaggle are companies, platforms, and services that have dramatically changed the world within a decade while relying on crowdsourcing and crowdfunding business models in some form. In this article, we define *crowdsourcing* and *crowdfunding* terms, compare new business models with traditional ones, review the operations management (OM) research community's contributions so far, point out useful frameworks for understanding the phenomena, illuminate promising research paths, and highlight open research questions.

Although it is natural to focus on recent experiences, crowdsourcing and crowdfunding have long histories. Early notable examples of crowdsourcing include the Longitude Prize, established in 1714, and the creation of the Oxford English dictionary, published in 1884, (appropriately, these examples are crowdsourced by Wikipedia 2019b). More generally, stories about potentates (kings, sultans, emperors) offering prizes to anyone who can come up with the best solution to a particular problem (thus, effectively running innovation contests) appear in both historical records and folklore dating back centuries and millennia.

Early examples of crowdfunding include issuances of war bonds by governments, such as the British government around 1730 (Wikipedia 2019a), and the funding of the pedestal for the Statue of Liberty in the United States. Joseph Pulitzer, the *New York World* publisher and Hungarian immigrant, started this crowdfunding campaign, using newspapers, in the 1880s (Liberty Foundation 2018). Such long histories indicate that there is something fundamental about crowdsourcing and crowdfunding phenomena, and it is important to understand the core ideas, salient features, and fundamental forces.

At the same time, novel technologies, such as the internet, the web, GPS, and mobile phones, reduced transaction and search costs and have magnified the benefits of crowdsourcing and crowdfunding for companies and consumers and changed the process in a nontrivial way. For example, instead of the one-off campaigns we have seen historically, platforms have emerged (e.g., Uber and Kickstarter) that rely on crowdsourcing and crowdfunding as their business models. We highlight recent technology trends, the effects they had on the practice, and the trajectory going forward.

2. Crowdsourcing
2.1. Definition

Although the concept of crowdsourcing has existed for many years, the term "crowdsourcing" was first introduced in 2006 in a *Wired* article (Howe 2006) and defined as

> Simply defined, crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively), but is also often

undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the large network of potential laborers.

The notion of crowdsourcing has received substantial attention from both academics and practitioners, who have generated numerous definitions of the term, described many new applications, and explored the merits and trade-offs as well as implementation challenges of outsourcing.

Estellés-Arolas and González-Ladrón-De-Guevara (2012) propose the following definition of crowdsourcing, summarizing more than 40 other definitions: "Crowdsourcing is a type of participative online activity in which an individual, an institution, a nonprofit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task; of variable complexity and modularity, and; in which the crowd should participate, bringing their work, money, knowledge and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and use to their advantage that which the user has brought to the venture, whose form will depend on the type of activity undertaken." A more concise definition was offered by Bayus (2013): "taking a task once performed by an employee, and outsourcing it to a large, undefined group of people external to the company in the form of an open call." Although this definition focuses on the fact that the call is "open," a more general definition is offered by Prpić et al. (2015): "Crowdsourcing involves organizations using information technology to engage crowds comprised of groups and individuals for the purpose of completing tasks, solving problems or generating ideas." The essential components of crowdsourcing are the following:

i. The use of an open call to a "crowd" (in which the level of openness is debated).

ii. A task that needs to be undertaken.

iii. The fact that the compensation can be economic, social, or related to self-esteem.

We next introduce the main categories of crowdsourcing and discuss the implications, both positive and negative, of their openness, task specificity, and compensation mechanisms.

2.2. Crowdsourcing Types, Motivations, and Examples

As mentioned, crowdsourcing has a long history. The two significant changes that brought the notion of crowdsourcing to its current scale are (i) the ubiquity and low cost of network connectivity and (ii) the speed and low cost of large-scale data processing. The combination of the two, together with the emergence of mobile computing, reduced the transaction cost, enabling firms and platforms to quickly identify and connect agents and firms toward task completion. Crowdsourcing has been used for problem solving, idea generation, and production models with the goal of using the heterogeneity of the crowd and its dispersed knowledge and familiarity with customer preferences and solution concepts. Prpić et al. (2015) divide the types of crowdsourcing into three categories:

Virtual labor markets: These are technology-mediated markets for spot labor, such as Amazon Mechanical Turk and FigureEight, which are used primarily for simple tasks in which people are asked to perform activities that currently cannot be done via the existing technology. For example, Amazon Mechanical Turk is a crowdsourcing marketplace enabling individuals and businesses (known as "requesters") to coordinate the use of human intelligence to perform tasks that computers are currently unable to do. FigureEight is a slightly more specialized market. It uses human intelligence to do simple tasks, such as transcribing text or annotating images, specifically to train machine learning algorithms. These can then be used to improve catalog search results, approve photos, or support customers. Virtual labor markets emerged over time for more sophisticated tasks, such as coding and developing software (Upwork), and complex tasks that require human involvement, such as driving, on platforms such as Uber and Lyft. These markets are characterized by somewhat limited openness in the sense that the platforms moderate who can serve as the crowd. For example, on Upwork, one has to pass a test in programming languages before claiming to be able to program in any specific language. These crowdsourcing labor markets work well when they aim to address a well-defined task, such as driving from point A to B, but usually fail when the task requires a significant level of subjective judgment, such as developing a financial model for a risky investment.

Tournament crowdsourcing: This crowdsourcing type usually takes the form of a tournament or idea competition. Organizations either use their own platforms to post problems (for example Dell's IdeaStorm or Starbucks' MyStarbucks) or use a third-party platform, such as Kaggle. For example, Starbucks' MyStarbucks started in 2008 and was eliminated in 2017. This crowdsourcing platform allowed consumers to submit ideas regarding anything linked to the brand directly to the company, and the initiative has been a great success. According to Starbucks, in its first year, the program generated more than 70,000 ideas, and over the years it has been in place, MyStarbucks has seen more than 150,000 ideas submitted, approximately 300 of which have been implemented.

Kaggle, owned by Google, is an online community of data scientists and machine learners. Kaggle allows users to find and publish data sets, explore and build models, and enter competitions to solve data science challenges. By now, Kaggle has run hundreds of machine learning competitions since the company was founded. Competitions have ranged from improving gesture recognition for Microsoft Kinect to improving the search for the Higgs boson at Cern. This type of crowdsourcing is particularly helpful when firms are looking for actionable solutions yet leveraging the capability of crowdsourcing to generate outside ideas. The ability to harness customers' resources and knowledge to identify implementable solutions is the main strength of this crowdsourcing type. The misalignment of incentives and the lack of accountability are the main weaknesses of this crowdsourcing type, leading to the inability to always meet a predetermined goal.

Open collaboration: In this crowdsourcing type, organizations also post their problems to the public. But, in contrast with tournament crowdsourcing, the contributions are voluntary and usually do not entail any monetary exchange. Community customer-support systems maintained by Apple, Microsoft, and Google as well as the Wikipedia community are examples of open collaboration. Waze, a GPS navigation app, is another example. A unique aspect of Waze is the ability to direct users based on the crowdsourced information. Waze users are able to report a multitude of traffic-related incidents from road conditions to accidents and speed cameras. Waze relies on this data to help other drivers, either by alerting them or rerouting them, to avoid the affected area entirely. The idea underlying Waze (and other open collaboration systems) is that the more people who provide data, the more accurate and useful the service is. In addition to using crowdsourced information for traffic alerts, Waze also allows certain users to modify the map data itself through the Waze map editor. Map editors are allowed to make changes to the map based on where they have driven while using Waze. This type of crowdsourcing works well when the goal is generating outside ideas that are based on building shared knowledge or utilizing the concept of "wisdom of the crowd." The main difference between open collaborations and tournaments is more stringent structure of the latter: tournaments are usually organized as a competition with a specific and tangible deadline.

We have already seen the significant impact that crowdsourcing has on modern business product development, production, and delivery, and that effect will undoubtedly only grow over time. We next turn to the contribution of the operations management literature in understanding these markets.

2.3. OM Research on Crowdsourcing

The operations management literature has primarily explored, utilizing both methodological and empirical methods, the question of how to best run these efforts. For example, for virtual labor markets, the question is how to run these platforms to maximize an objective measure. For tournament competition, it is how to run the competitions to maximize the impact of innovation. We next briefly survey some of the key results in operations management that pertain to each type of crowdsourcing.

2.3.1. Virtual Labor Markets. Over the last several years, the operations literature has devoted significant attention to studying these emerging markets. One of the key differentiating factors among these labor markets is the question of compensation and, in particular, whether the platform dictates prices or not. Allon et al. (2019) studied large-scale service marketplaces in which agents are free to choose their own prices (such as Upwork), focusing on the role of the platform in facilitating (or curbing) competition among agents. The main goal of that paper is to discuss the role of the moderating firm in facilitating information gathering, operational efficiency, and communication among agents in service marketplaces. Surprisingly, they show that operational efficiency, commonly viewed as one of the main benefits of open labor markets (and, thus, the ability to pool resources), may be detrimental to the overall efficiency of the marketplace. Furthermore, they establish that to reap the "expected" gains of operational efficiency of these marketplaces, the platform may need to complement the operational efficiency by enabling communication among its agents. The study emphasizes the scale of such marketplaces and the impact it has on the service outcomes.

In a recent paper, Taylor (2018) studied marketplaces in which prices are dictated by the platform (such as Uber) and examines how two defining features of an on-demand service (the platform's delay sensitivity and agent independence) impact the platform's optimal per-service price and wage. Delay sensitivity reduces expected utility for customers and agents, which suggests that the platform should respond by decreasing the price (to encourage participation of customers) and increasing the wage (to encourage participation of agents). These intuitive price and wage prescriptions are valid in a benchmark setting without uncertainty in the customers' valuation or the agents' opportunity costs. However, uncertainty in either dimension can reverse the prescriptions: Delay sensitivity increases the optimal price when customer valuation uncertainty is moderate. Delay sensitivity decreases the optimal wage when agent opportunity cost uncertainty is high and

expected opportunity cost is moderate. Under agent opportunity cost uncertainty, agent independence decreases the price. Under customer valuation uncertainty, agent independence increases the price if and only if valuation uncertainty is sufficiently high. Both papers demonstrate that the principles on which the operations literature has been built—(i) resource pooling is beneficial and (ii) delay sensitivity results in a decreased price—may no longer be true in such markets.

2.3.2. Tournament Crowdsourcing. Terwiesch and Xu (2008) studied a specific type of tournament crowdsourcing: innovation contests. In an innovation contest, a firm (the seeker) facing an innovation-related problem posts this problem to a population of independent agents (the solvers) and then provides an award to the agent that generates the best solution. In this paper, the authors analyze the interaction between a seeker and a set of solvers. Prior research in economics suggests that having many solvers work on an innovation problem leads to a lower equilibrium effort for each solver, which is undesirable from the perspective of the seeker. In contrast, in this paper, the authors establish that the seeker can benefit from a larger solver population because the seeker obtains a more diverse set of solutions, which mitigates and sometimes outweighs the effect of the solvers' underinvestment in effort. The authors demonstrate that the inefficiency of the innovation contest resulting from the solvers' underinvestment can further be reduced by changing the award structure from a fixed-price award to a performance-contingent award. In the paper, the authors also discuss the viability of using crowdsourcing compared with more traditional methods. In particular, they compare the quality of the solutions and seeker profits with the case of an internal innovation process. This allows the authors to predict which types of products and which cost structures are the most likely to benefit from the contest approach to innovation. The main result is supportive of the notion of using these markets to generate outside ideas with actionable solutions.

2.3.3. Open Collaboration. The main questions related to this crowdsourcing type is how to motivate agents. Jain et al. (2014) provide a simple game-theoretic model of an online question-and-answer forum, which is a type of open collaboration. They focus on factual questions for which user responses aggregate while a question remains open. Each user has a unique piece of information and can decide when to report this information. The asker prefers to receive information sooner rather than later and stops the process when satisfied with the cumulative value of the posted information. The authors consider two distinct cases: a complements case, in which each successive piece of information is worth more to the asker than the previous one, and a substitutes case, in which each successive piece of information is worth less than the previous one. A best-answer scoring rule is adopted to model Yahoo! Answers and is effective for substitutes information when it isolates an equilibrium in which all users respond in the first round. But the authors find that this rule is ineffective for complements information, isolating instead an equilibrium in which all users respond in the final round. In addressing this, the paper demonstrates that an approval-voting scoring rule and a proportional-share scoring rule can enable the most efficient equilibrium with complements information under certain conditions by providing incentives for early responders as well as the user who submits the final answer. This does not address the case in which the information is kept for future purposes, so keeping the system as clean as possible is a priority.

Another example of open collaboration crowdsourcing is the research environment. An essential primitive for an efficient research ecosystem is partial-progress sharing, whereby a researcher shares information immediately upon making a breakthrough. This helps prevent duplication of work; however, there is evidence that existing reward structures in research discourage partial-progress sharing. Ensuring partial-progress sharing is especially important for new online collaborative research platforms, which involve many researchers working on large, multistage problems. Banerjee et al. (2014) studied the problem of incentivizing information sharing in research under a stylized model: nonidentical agents work independently on subtasks of a large project with dependencies between subtasks captured via an acyclic subtask network. Each subtask carries a reward given to the first agent that publicly shares its solution. Agents can choose subtasks on which to work and, more importantly, when to reveal solutions to completed subtasks. Under this model, we uncover the strategic rationale behind certain anecdotal phenomena. Moreover, for any acyclic subtask network and under a general model of agent–subtask completion times, we give sufficient conditions that ensure partial-progress sharing is incentive compatible for all agents. One surprising finding is that rewards that are approximately proportional to perceived task difficulties are sufficient to ensure partial-progress sharing in all acyclic subtask networks. The fact that there is no tension between local fairness and global information sharing in multistage projects is encouraging as it suggests practical mechanisms for real-world settings. Finally, Banerjee et al. (2014) also characterize the efficiency of partial-progress sharing and show that it is necessary and, in many cases,

sufficient to ensure a high rate of progress in research. For a comprehensive review of the literature on crowdsourcing, the reader is referred to Chen et al. (2019).

2.4. Future Research Opportunities

Most of the operations management literature is devoted to studying the optimal way of executing crowdsourcing. To the best of our knowledge, there has not been any study on the effectiveness of crowdsourcing in replacing more traditional sourcing methods in delivering traditional operational tasks. For example, firms are contemplating the idea of crowdsourcing customer support. The main advantage of firm-managed customer service is quality control and the ability to provide a timely response. The main disadvantage is the higher cost and the need to continuously train employees on emerging issues. The main advantage of community-based support is that it is cheaper and solutions suggested by the community are often novel and even better explained than those coming from a firm-trained agent, demonstrating the benefit of information aggregation. The two main disadvantages of the community-based support are poor quality control and the complexity of the search process by users, especially those who are looking for a timely resolution. Crowdsourcing customer service also poses the typical problem faced by a platform: the system is effective only if it gains enough momentum and people both create and resolve these type of issues. The main open questions are (1) which settings (with respect to complexity, frequency, and predictability of issues) are better suited for community-based support, and (2) what customer preferences (e.g., a timely versus an accurate response) and product characteristics (e.g., developing versus mature) make such systems more appropriate?

3. Crowdfunding
3.1. Definition and Examples

Crowdfunding is an act of raising capital, typically in small amounts, directly from a large group of investors (a crowd of investors), bypassing traditional financing intermediaries (e.g., banks, stockbrokers, exchanges) but typically with the help of an internet-based platform. The process of raising money is often called a *campaign*. Three types of participants are directly engaged in crowdfunding: (1) a person, persons, or organization that solicits funds for a project or a cause (we refer to these persons and organizations as entrepreneurs, recipients, creators, and firms); (2) a crowd of potential investors that provide funds (we also call these investors backers, donors, and funders); and (3) a crowdfunding platform (if one is used).

We discuss a number of crowdfunding examples. To organize this discussion, we use crowdfunding taxonomy by the type of compensation to the backers. Other taxonomies are possible, for example, based on the degree of specialization (e.g., generalists versus specialists in a particular industry or reward structure), the types of projects (e.g., medical expenses, education, creative projects, entrepreneurs, real estate, scientific research, movies, energy, etc.), or geographic location (global, U.S. based, Europe based, Asia based; locations are associated with different regulatory and legal environments).

There are four categories of crowdfunding, according to the compensation type taxonomy: (1) reward, (2) charity, (3) debt, and (4) equity. Table 1 illustrates the differences between categories.

In reward crowdfunding, backers are promised rewards if a campaign is successful. Rewards are either products or some form of recognition (e.g., being named in movie credits). Popular reward-based crowdfunding platforms are Kickstarter and IndieGoGo. An example of a project funded on Kickstarter is the Pebble Time smart watch. This campaign raised more than $20 million in 2015 (Pesce 2017). This is the most successful Kickstarter campaign (by the amount of funds raised) as of the time of this writing. Typical projects are smaller. According to Kickstarter statistics (Kickstarter 2018), there have been 428,499 projects launched over the lifetime of the platform, the campaign success rate is 36.62%, and the total amount of funds given to successful projects is $3.61 billion, which works out to approximately $23,000 per successful project.

In charity crowdfunding, no tangible rewards are offered to backers. An example of a charity crowdfunding platform is GoFundMe. According to GoFundMe's CEO (Advisory Board 2018), the platform helped to raise more than $5 billion from 50 million donations ($100 per donation, on average), and one-third of the campaigns are to raise funds to pay for medical bills.

Table 1. Differences Between Crowdfunding Categories

	Reward	Charity	Debt	Equity
Compensation to backers	Rewards (e.g., products)	Nontangible	Stream of fixed payments	Share of future profits
Typical projects	Games, gadgets, music, video	Pay off medical bills	Refinance loans, pay off credit cards	Technology startups
Examples of platforms	Kickstarter, IndieGoGo	GoFundMe	LendingClub, Prosper	AngelList, CircleUp

In debt crowdfunding, backers are promised a stream of fixed payments in return for the initial investment. This arrangement resembles the structure of loan contracts. Examples of debt crowdfunding platforms are LendingClub and Prosper. According to LendingClub statistics (LendingClub 2018), the platform helped to issue more than $41 billion in loans, 45% of which were used by the borrowers to refinance their existing loans and 23% to pay off credit card debt.

In equity crowdfunding, backers are promised a share of future profits of the firm. Examples of equity crowdfunding platforms are AngelList and CircleUp. AngelList advertises that it has invested $1 billion in technology startups and that several venture capital (VC) funds use AngelList as a sole source of their deal flow (AngelList 2018).

3.2. Motivations and Contributions by Participants

Depending on the category of crowdfunding, the motivations of its participants (funders, entrepreneurs, platforms) differ. To better understand crowdfunding, it is important to understand those motivations. Table 2 summarizes the following discussion.

Funders are motivated by the prospect of financial returns, by the dedication to a cause, by charitable feelings, and by the consumption utility from a product. In addition, crowdfunding provides funders with the enjoyment of competition (e.g., winning perks for early contributions or receiving access to oversubscribed investments), with feelings of being a part of a community (e.g., a community of people who support a certain cause, such as sustainability), or with the pleasure of social interactions (with entrepreneurs or other funders). Funders can also express their creative sides by offering ideas and feedback on games, music, movies, and technology gadgets.

Recipients of the funds are motivated by the desire to achieve objectives (e.g., grow their startup, reduce monthly financing costs, or make a movie), to meet essential needs (e.g., pay medical bills or educational expenses), to advance a cause (e.g., sustainability),

and to express themselves creatively (e.g., while creating a game or a product). Financial motivation is clearly important for entrepreneurs.

Platforms' motives are primarily financial. In addition, some platforms advance certain causes (e.g., helping charity, promoting creativity, and advancing science).

Table 2 also lists contributions and value added from different participants. Funders' primary contribution is capital. In addition, they often participate in cocreation of products, providing ideas and feedback to entrepreneurs. Moreover, funders screen out fraudulent projects. This is particularly important for reward crowdfunding. For example, campaign creators on Kickstarter are not legally obligated to deliver on their promises to the backers (although both Kickstarter and creators would suffer reputational damage if these promises are not fulfilled). Creators only have to show good faith efforts. Interestingly, the cases of outright fraud on crowdfunding platforms are infrequent. A spokesmen for the GoFundMe platform is quoted as saying (Grant 2018) that "campaigns involving misuse make up less than one tenth of one percent of all GoFundMe campaigns." The wisdom of the crowd of the funders weeds out fraud. This is what happened in the "Kobe Red" Kickstarter campaign. The funders raised concerns about the plausibility of the creators' claims, and the campaign was marked as fraudulent (Pepitone 2013). Equity and debt crowdfunding are subject to much stricter regulatory oversight compared with donation- and reward-based crowdfunding. But even for those categories, larger and more experienced investors lead syndicates of regular investors in order to address asymmetric information and detect fraud (Agrawal et al. 2016).

Another form of value added from funders is market testing. Funders of reward-based crowdfunding are signaling with their money whether a product is in demand or not (Strausz 2017, Chemla and Tinn 2018, Babich et al. 2019). Moreover, campaigns that raise significant funds receive press coverage, which

Table 2. Motivations and Contributions by Crowdfunding Participants

Participant	Motivations	Contributions
Funders (backers, donors, investors)	Financial; social; enjoyment of collaboration, competition, creation; contribution to a cause; consumption; charity; sense of belonging; contract formalization	Capital, ideas, design feedback, fraud screening, market testing, advertisement, social support
Recipients (entrepreneurs, creators, firms)	Financial, fulfillment of objectives, meet needs, contribution to a cause, product sales, advertising	Time, effort, ideas, labor, marshaling of resources
Platform	Financial, contribution to a cause	Lower costs of search and crowd coordination; screening of investors, projects, entrepreneurs; advertisement; retail; contract formalization

helps in raising awareness among the general consumer population about companies and their products.

Entrepreneurs' contributions are time, effort, ideas, labor, and marshaling of resources. Platforms' contributions are in reducing search costs for investors and entrepreneurs; screening of investors, entrepreneurs, and projects; reducing logistics costs of crowd coordination; and advertising for a product or an idea. For equity and debt crowdfunding, platforms formalize relationships between backers and entrepreneurs, substituting for informal family and friends ties (Agrawal et al. 2014). Platforms also serve as an alternative retail channel.
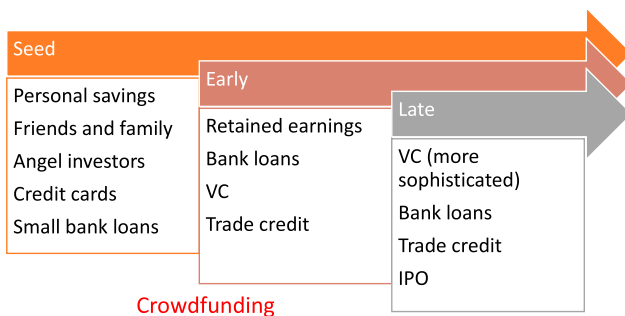
3.3. Crowdfunding Alternatives

A useful way to understand a new phenomenon, such as crowdfunding, is to compare it with the existing alternatives. Alternatives to crowdfunding match with crowdfunding categories. Charity crowdfunding competes with more traditional charity organizations, such as the Red Cross and Salvation Army. Debt crowdfunding competes with loans from financial organizations and from friends and family. Equity crowdfunding competes with angel and VC investments. Reward-based crowdfunding competes with both traditional sources of startup financing and sales channels.

In the entrepreneurial financing cycle (Figure 1), crowdfunding often takes place during the seed and early financing stages. Even for small projects, crowdfunding is rarely the sole source of financing. For charity crowdfunding, the recipients cannot live exclusively on the proceeds from crowdfunding campaigns. For startups, the amount of money given by the VCs dwarfs the funds raised through crowdfunding (in a famous example, Oculus Rift, a virtual reality headset, raised $2.4 million on Kickstarter and went on to receive $75 million in VC financing; it was acquired by Facebook for $2 billion). Berger and Udell (1998) show that bank loans contribute four times the amount of VC financing for a typical company.

Crowdfunding differs from traditional financing in the following dimensions: the number of investors (personal and family savings are on the lower end of this measure, equity and debt markets are on the higher end, and crowdfunding is in the middle), degree of personal connection between investors and the project (this measure is inversely proportional to the number of investors), and the motivation of investors. Crowdfunding backers are often motivated by considerations of charity, concern for the environment, or a desire to advance a cause, all of which play minor roles for traditional equity and debt investors.

Another key difference between crowdfunding and traditional alternatives is that crowdfunding blends the roles of investors, customers, and designers (Figure 2). Crowdfunding platforms replace both traditional financial intermediaries and retail channels.

Extending the discussion that follows Table 2, Table 3 lays out the advantages and disadvantages of crowdfunding relative to the traditional alternatives from the points of view of the investors and entrepreneurs. Investments in crowdfunding projects are highly illiquid. This issue is particularly salient for equity and debt crowdfunding, in which backers can be committing their investments for decades. The liquidity problem is exacerbated by the lack of information about projects offered through crowdfunding, lack of the same regulatory protections afforded to regular investors, lack of voting rights, and lack of investment sophistication on the part of the investors. This creates a nasty tangle of adverse selection and moral hazard problems that should give any equity and debt crowdfunding investor a reason to be concerned (Dorff 2013, Agrawal et al. 2016).

Soliciting funding via a crowdfunding platform comes with a risk of someone stealing your idea (Guzman 2017). Although it is possible to win a copyright battle, the process is expensive and protracted, especially if thieves are located in another country (Burgess 2016). Tapping a crowd of unaccredited investors exposes entrepreneurs to a significant regulatory burden (according to the 2012 JOBS act; Dorff (2013)). There is evidence that crowdfunding changes

Figure 1. (Color online) Entrepreneurial Financing Cycle and Crowdfunding

Figure 2. (Color online) Crowdfunding Blends Role of Investors, Customers, and Designers and Replaces Financial Intermediaries and Retail Channels
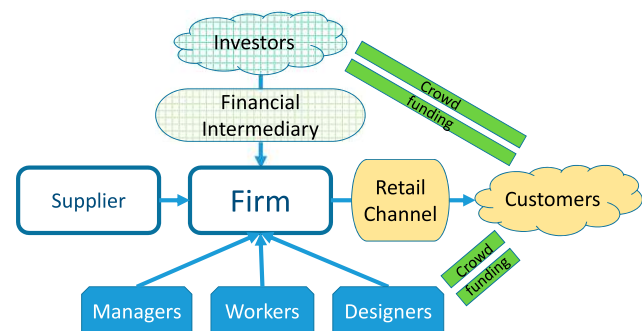
Table 3. Advantages and Disadvantages of Crowdfunding Relative to Traditional Alternatives

Participant	Advantages	Disadvantages
Funders (backers, donors, investors)	More investment options (not limited by geography, financial markets, availability of information, age of the company)	Lack of information, regulation, screening, expertise of intermediaries, liquidity, voting rights
Recipients (entrepreneurs, creators, firms)	Wider pool of investors (not limited by geography, financial sophistication), market testing, idea crowdsourcing, funding for causes	Ideas theft, regulatory and reporting burden, changing relationships with traditional investors, manufacturer holdup

access to traditional financing sources for both better and worse (Stocker and Sucharow 2012, Babich et al. 2019). Successful campaigns put pressure on entrepreneurs to deliver on their promises and expose them to a holdup by contract manufacturers (Fleishman 2016).

3.4. Is Crowdfunding an Example of Crowdsourcing?

There are obvious parallels between our definitions of crowdfunding and crowdsourcing. In both cases, there is an appeal to a crowd. The designers of the campaign have a need to fulfill. The crowdsourcing task in the crowdfunding context is to raise capital. The contributors' compensation includes financial, social, and self-esteem benefits. In both crowdfunding and crowdsourcing, platforms provide value by reducing search costs and facilitating transactions between campaign creators and members of the crowd. Both business models increase flexibility of the firms to increase capacity (labor or financial) because of the lower fixed costs (of hiring and firing workers, complying with Securities and Exchange Commission regulations). This makes them attractive in uncertain environments. Both business models open up access to microresources: labor that can be done in the manner of minutes, microinvestments that might otherwise be unused. This improves the utilization of resources from the perspective of both workers and investors and the recipients of labor and funds. At the same time, by treating workers and investors more like a flexible resource overlooks the fact that there are fixed needs that they have, for example, health coverage, family obligations. It is difficult to have a career assembling IKEA furniture. There are fixed costs of regulating firms and protecting investors.

There are differences between crowdsourcing and crowdfunding. The obvious one is the form of the main contributions (e.g., time and labor versus capital). Furthermore, crowdfunding crowds perform multiple functions simultaneously (e.g., supply capital, offer design feedback, screen out frauds). Crowdsourcing differs from its alternatives more than crowdfunding does from its alternatives. Research and development processes within a company are much

more different than the innovation contests compared with the differences between angel investments and equity crowdfunding. Relatively speaking, thus far, crowdsourcing has attracted more attention from OM researchers than crowdfunding has. We are arguing that there are numerous research opportunities in both topics.

3.5. Crowdfunding Research: A Cornucopia of Questions

Research opportunities on crowdfunding range from descriptive to prescriptive, from empirical to theoretical, from tactical to strategic, from optimization to mechanism design. The early research on crowdfunding used data from platforms such as Kickstarter to understand the basics about the campaigns and this new phenomena. One can think of this as descriptive analytics of crowdfunding campaigns.

3.5.1. Descriptive Analytics of Crowdfunding Campaigns. Earlier studies looked into campaign, creator, and backer characteristics as to how those relate to campaign success (Agrawal et al. 2011, Frydrych et al. 2014, Mollick 2014, Lukkarinen et al. 2016). These studies showed that geographic proximity between backers and creators matters less for crowdfunding success than it does for angel financing, that the size of the social network of the entrepreneur matters, and that having videos about the products increases campaign success.

We have also learned from prior studies (Kuppuswamy and Bayus 2015, Vismara 2018) about information diffusion during campaigns and artifacts of backers' behavior with respect to this information. We now know that it is important to have significant initial contributions (perhaps from friends and family) and that there is herding behavior among backers, information cascades, and the "bystander" effect (backers invest less if they think the campaign will succeed regardless). Thus, funding patterns emerge with high contribution rates at the beginning and the end of a campaign and a lower rate in the middle.

This research direction remains relevant today as well. It is interesting to see (1) if the insights from earlier papers remain true today, (2) if media and academic attention altered crowdfunding practice,

and (3) if backers and creators learned how to do crowdfunding better over the last decade (Kickstarter launched in 2009). Regulatory changes, notably the JOBS act of 2012 that opened access to equity and debt crowdfunding to nonaccredited investors, and technological breakthroughs, notably Blockchain technology, changed entrepreneurial financing options.

3.5.2. Optimal Campaign and Platform Market Designs.
From the perspective of campaign analytics, the next natural step is to determine the optimal campaign and platform market designs.

First, pricing and revenue management insights are applicable to campaign design. Prior to the start of a campaign, creators choose the reward structure, which can be quite complex (funding levels, categories of rewards, reward prices, bundles, the number of rewards in each category), attempting to segment the backers' market. During the campaign, creators can adjust this reward structure, channel contributions from family and friends, and manage communications with the backers to derive the most value out of the scarce resource they are offering and exploit the herding and bystander artifacts in the backers' behavior. Examples of campaign design papers are Alaei et al. (2016) and Zhang et al. (2017). Burtch et al. (2018) studied how timing of referrals affects campaign success. Furthermore, most of the theoretical crowdfunding papers include a model with a pricing decision. Unlike the classical pricing and revenue management settings, the criteria in the objective function is not revenue. Crowdfunding platform policies usually stipulate that only campaigns that have reached the set target funding level get to keep the money. Campaigns that fail to reach the target must return contributions to the backers.

This and other platform policies (e.g., choices of the duration of campaigns, the nature of the screening process, the use of syndicates) help to address issues of information asymmetry between creators and backers, reduce fraud, and mitigate moral hazard. There are numerous research opportunities along this direction. For example, Chakraborty and Swinney (2019) consider crowdfunding design as a signal of quality. Fatehi and Wagner (2019) argue that a classical (in OM) revenue-sharing contract structure should be adopted by platforms. Belavina et al. (2018) look into the design of campaign rules by platforms with the goal of avoiding moral hazard. Strausz (2017) argues that popular platform design choices help to mitigate the entrepreneur's moral hazard and share consumer's private information about demand.

The remarkably low levels of fraud (see Section 3.2) in crowdfunding remains a puzzle. As Agrawal et al. (2014) argue, unlike other online markets, there are fewer opportunities for creators of crowdfunding campaigns to build reputation. Crowdfunding investors are less sophisticated. They have access to less information than angel and VC investors and enjoy less protection than stock and bond investors. Recently, an alternative to crowdfunding, initial coin offerings (ICOs) gained in popularity. Unlike crowdfunding, however, many of the ICOs turned out to be scams and frauds. The U.S. Securities and Exchange Commission (2019) has suspended multiple ICOs as scams. In 2017, China's Central Bank banned all ICO trading for the same reason (Weese 2017). There are claims (Alexandre 2018) that the majority of ICOs are scams. What explains the difference between Kickstarter projects and ICOs? How does ICO market failure bode for equity and debt crowdfunding? When is the wisdom of the crowd sufficient to weed out scams?

3.5.3. What Happens After Crowdfunding Campaigns?
The greatest potential for new insights is about what happens after crowdfunding campaigns. Mollick and Kuppuswamy (2014) survey projects several years after they were posted on Kickstarter. The authors investigate whether having a successful crowdfunding project correlates with the subsequent venture performance and how well the successful projects delivered on the promises made during campaigns.

A decade after Kickstarter was launched, we have an opportunity to evaluate longer term effects of reward crowdfunding. Even more importantly, we should look into equity and debt crowdfunding because these forms have payments to backers distributed over decades. It is essential to analyze the distribution of these payments and project returns. We should determine how correlated such returns are with factors explaining returns on traditional investments (e.g., Fama and French (1993)) and whether crowdfunded projects are a new asset class, which enhances investors' ability to diversify risks.

There is evidence that crowdfunding could be a substitute for traditional financing (Agrawal et al. 2014) and that successful crowdfunding enables access to traditional financing sources for some projects (Neuherz 2014) but not for all (Stocker and Sucharow 2012, Ryu and Kim 2017). Babich et al. (2019) provide a theoretical foundation for these empirical observations. They also demonstrate that, in general, adding crowdfunding platforms to an economy could hurt some of the VCs and entrepreneurs and benefit others. Roma et al. (2018) is another example of a study of interactions between traditional financing sources and crowdfunding.

In the same spirit that crowdfunding is just one step in a firm's life, Belleflamme et al. (2014) considered strategic backers who make decisions over time and

enjoy community benefits from crowdfunding. The backers that did not buy the product through crowdfunding can become regular customers if the crowdfunding campaign succeeds. Chemla and Tinn (2018) analyze crowdfunding as a mechanism for learning about future market demand.

There still much unclear about the marketing nature of crowdfunding. For example, are backers a representative sample of consumers? Crowdfunding provides an advertising boost. How significant is this effect, and does it compound the estimation of the future demand based on the signal from the campaign?

The OM questions about the fulfillment of crowdfunding campaign promises remains largely unexplored. Does crowdfunding undermine social causes by diverting resources from the traditional channels that support such causes? How does crowdfunding compare with the alternatives in achieving nonfinancial objectives of the backers?

3.5.4. Beyond Crowdfunding. There are several settings that resemble crowdfunding, but are not exactly crowdfunding. We have already discussed ICOs, enabled by breakthroughs in Blockchain technologies. The value of crowdfunding platforms came from removing the need for traditional financial intermediaries. ICOs go one step further and remove the need for crowdfunding platforms by allowing entrepreneurs to issue and sell so-called tokens directly to backers. As discussed in Section 3.5.2, ICO practices have been marred by fraud. Understanding the differences between crowdfunding and ICOs may hold a key to understanding the value of crowdfunding platforms in the economy.

Another setting that shares common features with crowdfunding is community supported agriculture (CSA). In CSA contracts, farmers sell their future harvest directly to consumers. Similar to crowdfunding, CSA consumers face uncertainty about the value of the harvest share they will receive but are motivated not only by financial interests, but by the sense of community and the connection with the farmers. The farmers' efforts are noncontractible and often unobservable. After the harvest is collected, farmers have strong incentives to divert the harvest from CSA consumers (who already paid) to other customers (who are yet to pay). CSA contracts are offered online, and other forms of financing are typically used by farmers as well. Unlike crowdfunding, there are no dynamic campaigns during which information is being shared. Again, by comparing crowdfunding and CSAs we can understand the role of information diffusion and perhaps improve on both practices.

4. Conclusions

We have explained the terms, concepts, and processes. We have reviewed several key frameworks for analyzing these concepts. We believe that the fundamental ideas behind crowdsourcing and crowdfunding have staying power because these business models are addressing essential problems. At the same time, the practice continues to grow and evolve in response to technological developments. The research will follow practice, and the OM research community has much to contribute.

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