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**The Decision-Making Process in Crowdfunding Through the Lens of Signaling
Theory**

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Abstract

Crowdfunding has become a viable opportunity for the financing of new business ventures. However, founders often compete with several similar projects that are also simultaneously attempting to raise funds. This is because projects are only realized when they reach a given minimum threshold. Furthermore, as there are often several similar projects cooccurring, a coordination problem then arises for potential funders.

This thesis, using signaling theory, analyzes how different types of signals—namely, different third-party seals, the information about the cost of these third-party seals, and the information about prior funders— can solve this coordination problem in crowdfunding. To this end, three experiments were conducted.

In the first experiment, I examined how different types of third-party seals solve this coordination problem. I simulated a crowdfunding situation using a threshold public goods laboratory experiment. The results reveal that funders' willingness to contribute differs between institutionally and non-institutionally issued third-party seals, with funders seemingly preferring the latter.

In the second experiment, I examined how different signals (e.g., a third-party seal or information about prior funders' decisions) solve the coordination problem. Again, I mimicked a crowdfunding situation using a threshold public goods laboratory experiment. The findings illustrate that these signals can substitute for a lack of experience. Inexperienced funders contribute more to a project that involves either a third-party seal or information about prior funders' decisions, whereas experienced funders neglect both of these signals.

In the third experiment, I examined how the cost of signaling affects funders' contributions. I modeled a crowdfunding situation using a modified dictator game in a laboratory setting. The results illustrate that the more a founder has spent on signaling,

the more the funders will contribute, though not without restrictions. Additionally, funders' characteristics matter as reciprocity moderates this effect.

In summary, these findings offer new insights for entrepreneurs, institutions, and researchers. They show that the effect of signals depends on funders' characteristics, such as having prior experiences with crowdfunding, thereby explaining why seemingly identical signals work differently. Furthermore, my findings provide information on how founders can effectively encourage and promote contributions to their crowdfunding projects.

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List of Abbreviations

| | |
|-----|-----------------------------------|
| CEO | Chief Executive Officer |
| CRT | Cognitive Reflection Test |
| EU | European Union |
| FDA | U.S. Food and Drug Administration |
| MBA | Master of Business Administration |
| IPO | Initial Public Offering |

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1 Introduction

1.1 Motivation

“It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own self-interest. We address ourselves not to their humanity but to their self-love, and never talk to them of our own necessities, but of their advantages” — An Inquiry into the Nature and Causes of the Wealth of Nations (Smith, 1776).

What holds true for the butcher, the brewer, and the baker is true for crowdfunding supporters. Although crowdfunders want to support a project, oftentimes for community benefits (e.g., a local theater), it remains an investment on their part. Hence, crowdfunders support founders not out of benevolence (except in donation-based crowdfunding projects) but, rather, out of their own self-interest to benefit from the investment.

These benefits come in various forms. They can be monetary (e.g., loan or equity-based crowdfunding), material (e.g., reward-based crowdfunding), or those that are neither monetary nor material (e.g., community benefits like in reward-based crowdfunding wherein receiving a credential is the reward) (Belleflamme et al., 2014).

As crowdfunders consider a given crowdfunding project as an investment, they behave like investors or venture capitalists (Mollick, 2014). As such, they screen different projects— for example, different breweries or different technologies, such as smartwatches or virtual reality glasses— based on their human, social, and intellectual dimensions to assess their overall quality (Ahlers et al., 2015). However, funders cannot reasonably process the abundance of information that is often provided for a crowdfunding project (Ahlers et al., 2015) because, even if they behave like venture

capitalists, the majority are still “ordinary people” and not financial experts (Allison et al., 2015; Macht & Weatherston, 2015). They do not have the means with which to screen numerous projects across an abundance of crowdfunding platforms due to a lack of time and knowledge (Busenitz et al., 2005; Courtney et al., 2017; Macht & Weatherston, 2014).

Founders, on the other hand, know that they are competing with many other projects. Their competitors may have very different or even similar projects. To avoid being overshadowed, they need to make themselves visible to funders and to, ideally, facilitate quality assessments. This results in a dilemma for the founders; for example, for technologically sophisticated and completely new projects, like 3-D-printers, more detailed information is required for funders to be able to accurately assess its quality. If the founders are unable to provide this information, they will likely not receive sufficient funding as potential funders are not able to assess the project’s prospects of success. Simultaneously, this information is also the project’s business secret and its unique selling point that founders often do not want to reveal. Consequently, founders cannot provide all of the necessary information, thereby resulting in information asymmetry between them and potential funders (Busenitz et al., 2005; Courtney et al., 2017; Macht & Weatherston, 2014). Due to this asymmetric information, founders must then find different ways of signaling their projects’ quality to potential investors.

Founders can signal their project’s quality by providing continual updates about its status and progress (Ahlers et al., 2015). There are also other signals they can use to signify the quality of their project, including the number of prior supporters or friends on social media (Mollick, 2014). Furthermore, the credibility of the founders’ updates is crucial for ensuring that funders invest in a project, (Courtney et al., 2017); however

the reliability of these updates or the value of their numerous friends on social media cannot easily be assessed (M. Lin et al., 2013).

Founders can additionally increase their project's credibility and legitimacy through obligations to their ventures (Calic & Mosakowski, 2016). This may involve offering only a small portion of shares in equity crowdfunding (Vismara, 2018). New venture teams also use commitments to their projects (Busenitz et al., 2005) and entrepreneurial passion (Davis et al., 2017) to convince venture capitalists. However, commitment, passion, and equity retention do not necessarily testify to quality. Thus, credible quality measures are required to evaluate crowdfunding projects (Ahlers et al., 2015; Courtney et al., 2017).

Another way in which to certify the quality and legitimacy of a new venture is via a third party's seal of approval (Courtney et al., 2017; Drover et al., 2017); for a detailed overview of this, see Macht and Weatherston (2015) and Belleflamme et al. (2015). Product certification, as conducted by specialized experts or entities, proves that both the venture and product exist and that the product works (Terlaak & King, 2006). Certification with a management standard thus reduces information asymmetry, thereby generating a competitive advantage for certified firms, as product certification is difficult to achieve (Bapna, 2019; Rindova et al., 2005).

Signaling theory (Spence, 1973) is often used to explain peoples' decisions in investment settings that involve asymmetrically distributed information. Applying signaling theory to decision-making in crowdfunding will provide insights on how to build "the optimal market design" as "crowds tend to [lose] money on average";(McKenny et al., 2017, p. 298), which is why 60 % of projects fail to materialize (Kuppuswamy & Bayus, 2017). Hence, this thesis utilizes signaling theory to broaden the existing knowledge of the decision-making process involved in

crowdfunding by deepening our understanding of how different types of signals affect this process.

The remainder of this chapter is organized as follows: First, I derive the three research questions surrounding this thesis based on the research gap outlined in section 1.2. Section 1.3 then presents an overview of signaling theory in the context of investment decisions to lay out the thesis's theoretical background, as well as to provide an overview of the concept of crowdfunding. Investment decisions are often analyzed in laboratory experiments because these are able to present a clear cause-and-effect relationship between variables— for example, a signal and the resulting investment decision. Thus, I used laboratory experiments to examine the decision-making processes involved in crowdfunding. Hence, a brief overview of this experimental research, as well as the data used, are presented in section 1.4. The main results are then summarized in section 1.5, with the chapter then closing with an outline of the final thesis in section 1.6.

1.2 Research Gap and Questions

1.2.1 Research Gap

Signaling theory (Spence, 1973) has been widely applied to investment decision-making research in recent decades. Although not all of the researched signals meet Spence's (1973) original definition of being observable, manipulable, and costly to acquire, it is widely accepted that signals positively affect investment decisions as they reduce information asymmetry.

It is obvious that there is often information asymmetry between funders and founders in crowdfunding. On one hand, the knowledge needed to understand a new product or technology is often limited among funders; therefore, they lack the

necessary information to estimate the chances of a given campaign's success (Belleflamme et al., 2015). Furthermore, founders often do not provide all of the information that they have on their projects. Thus, if potential investors cannot estimate the quality of a given project as a result of this, they refrain from investing. Consequently, crowdfunding becomes less attractive for relatively good projects—which might have raised a good deal of funding otherwise—meaning that only poor-quality projects remain. Thus, founders have to resolve the information asymmetry that develops between them and potential investors.

Research on how to overcome the problem of asymmetrically distributed information in crowdfunding has gained momentum in the last decade. One stream of research focuses on the communication between the founder and their investors, with another focusing on project characteristics.

The tone for the communication between the founder and their funders is determined via the orientation/characteristics of their specific crowdfunding project (i.e., social, environmental, and for-profit). The studies by Calic and Mosakowski (2016) and that of Lehner and Nicholls (2014) found that crowdfunding projects with either a social or environmental orientation tend to experience a greater likelihood of achieving success; however, the research of Hörisch (2015) did not report this same finding. As such, it would be inferable that the type of crowdfunding project affects the success of the call for funding for a social project (Meyskens & Bird, 2015). In addition to the orientation of crowdfunding projects, funders' motives around supporting them have been researched in detail as well, with all motives from helping behaviors to being the first one to have a product (Gerber & Hui, 2013; Ordanini et al., 2011). Therefore, the way funders are addressed in the project description is of tremendous importance. The narratives in the project description are meant to create trust and sympathy within

potential funders, among other reasons (Moritz et al., 2015). Again, the existing research provides contradictory results; for example, framing a project as a helping opportunity, rather than a business one, has been positively correlated with funding success, (Allison et al., 2015), but signaling autonomy and risk-taking behaviors, rather than empathy and warmth, also seem to foster funding success (Moss et al., 2015). Furthermore, an emphasis on the egoistic rather than the altruistic attributes of a project has been found to facilitate increased support for sustainable projects (Testa et al., 2020). One explanation for this is that founders have to align their values with those of their investors, (Nielsen & Binder, 2021), which sometimes seems to be neglected when they are designing their call for funding.

In addition to the communication around a campaign, project characteristics also affect funders' decisions. Regular updates, the provision of additional information, and the use of videos have all been found to foster funding success (Ahlers et al., 2015; Belleflamme et al., 2014; Cumming et al., 2020; Macht & Weatherston, 2015). This soft information is important for funders to assess the project itself. However, a founder who is just starting a crowdfunding campaign usually lacks common legitimacy signals, such as have an already established working product (Taeuscher et al., 2021). Thus, having an affiliation with an established third party is positively related to funding success, as they enhance the credibility and legitimacy of the project (Courtney et al., 2017; Kleinert et al., 2020; Plummer et al., 2016).

So far, research has shown that signals work in crowdfunding as effectively as in any other investment context as they reduce information asymmetry (Ahlers et al., 2015; Courtney et al., 2017; Macht & Weatherston, 2015). However, the existing literature mostly relies on publicly available data from crowdfunding platforms (Ahlers et al., 2015; Courtney et al., 2017; Macht & Weatherston, 2015) or uses an

experimental setting, but without taking into consideration actual investments (Nielsen & Binder, 2021; Stevenson et al., 2019). Therefore, the effect of an individual signal remains unclear, as data from crowdfunding platforms do not allow for the formation of a causal inference, but rather only shows correlations between quality signals and funding success. As such, crowdfunding projects may be associated with numerous, positive, negative, or even contradictory signals. Crowdfunding projects are thus a black box that involve many kinds of signals, which are then transformed into investors' decisions.

In contrast, this thesis uses actual investment decisions in a laboratory setting which determine participants' payoffs. Thus, my findings present clear cause-and-effect relationships between the signal and the resulting investment decisions. I will describe, in more detail in section 1.4, why laboratory experiments are particularly well suited to examine the effect of individual signals in an investment context.

Thus, this thesis contributes to the existing crowdfunding literature by outlining the causal effects of signals on funders' contributions (i.e., the investment decisions of funders) in crowdfunding and, more specifically, how and why signals contribute to project success or failure.

1.2.2 Deduction of the Research Questions

The first study explored whether a seal issued by an independent third party provides valuable support for the crowdfunding of a project, especially if several similar projects are pledging for funding concurrently. A crowdfunding project must meet its funding goal to receive funding. Therefore, enough funders are needed to support the same project for it to reach the required threshold and become realized. This causes a coordination problem for two reasons (Corazzini et al., 2015). First, some projects

may be easy to grasp, such as a packaging-free supermarket. In this case, the sheer number of projects, and the fact that many of them are barely distinguishable from one another, causes a coordination problem. Second, some projects may be technologically sophisticated, such as fuel production using old deep fryer fat. In this case, most funders might not understand the project thus, they do not coordinate on this project.

I shed light on the coordination effect of making a project salient through the use of different types of third-party seals. A third-party seal could include, for example, a governmental seal, or a seal issued by a non-governmental institution, such as a trade association. Whether any type of third-party seal works as an effective instrument to overcome the coordination problem in crowdfunding is not yet clear as the signaling effect herein depends on the credibility of the third party itself (Moss et al., 2015). The research question of the first study is thus:

RQ1: *How do third-party seals of different origins affect the coordination of funder contributions in a crowdfunding setting?*

The second study explores whether funders rely more on a seal issued by an independent third party or on prior funders' decisions.

Funders in crowdfunding often lack the experience and capability necessary to assess the quality of these projects (Ahlers et al., 2015). Furthermore, uncertainty about a young venture's quality is a common issue in venture financing. However, as crowdfunding targets non-professional funders, reducing information asymmetry between them and the project's founder is crucial (Cumming et al., 2017). Third-party endorsement reduces information asymmetry between these two parties, thus facilitating fundraising (Drover et al., 2017; Plummer et al., 2016). Another way to reduce information asymmetry is when funders follow the decisions of prior investors.

This pattern occurs for easily understandable projects as well as for more technologically sophisticated ones (Cumming et al., 2017).

Coordination works as individuals form beliefs about other individuals' decisions. These beliefs are influenced by their individual characteristics, such as their personal knowledge, experience, and interests (Scheaf et al., 2018). The second study's research question was as follows:

RQ2: *How does a third-party seal and information about prior funders' decisions affect participants' contributions depending on their own investment experiences?*

The third study examined how the cost of signaling affects funders' contributions. As mentioned, a third party's seal can certify the quality and legitimacy of a given product (Courtney et al., 2017; Drover et al., 2017). Product certification, as conducted by specialized experts or entities, proves that both the venture and the product exist and that they can function (Terlaak & King, 2006). Certification with a management standard therefore reduces information asymmetry, thereby generating a competitive advantage for certified firms (Bapna, 2019). Furthermore, as product certification is difficult to achieve, being certified suggests that the product is unique (Rindova et al., 2005).

Third-party quality seals (i.e., patents or certificates¹) are reliable but costly signals. So far, the current crowdfunding literature has only analyzed the effects of different kinds of signals without considering their associated cost. However, their cost is crucial to examine because money is usually the scarcest resource available when starting a crowdfunding project (Belleflamme et al., 2013). It remains unclear whether funders

¹ For example, a founder vying for investments into a smartwatch can have a technical control board (e.g., the German TÜV) certify either that the smart watch is a safe electronic device or that it is also a medical device (e.g., as a heart rate monitor). The respective costs would then vary.

consider higher signaling costs as an investment of the founders in their projects (Ahlers et al., 2015) or as a waste of scarce resources as the raised funds may be used to repay this expense. I fill in this gap by analyzing the effects of the price of a third-party seal on funders' contributions. The research question of the third study was as follows:

RQ3: *How does the amount spent by founders on an independent third-party seal affect the amount that funders contribute to their projects?*

1.3 Theoretical and Conceptual Background

In this section, I first give a brief introduction to signaling theory as outlined by Spence (1973), followed by an overview of the application of this theory in investment decisions. This overview helps to understand the literature on signaling theory, especially in the context of crowdfunding, in which not all signals meet the criteria as originally proposed by Spence (1973). The second subsection introduces the concept of crowdfunding as a means of fundraising.

1.3.1 Signaling Theory in Investment Decisions

Numerous markets, such as private consumption or financial ones, are characterized by asymmetric information (Leland & Pyle, 1977). That is, one party possesses more information than the other. For example, this occurs in the market for used cars (Akerlof, 1970), in which the seller has more information about the car than the buyer. However, this also occurs for most purchasing decisions, such as during the buying of company shares on the stock market, wherein the buyer may lack information about the company's properties (Nelson, 1970). Understanding how information is communicated between two parties, who have access to different information, to

reduce this asymmetry is the basis of signaling theory (Connelly et al., 2011; Moss et al., 2015).

Signaling theory, as outlined by Spence (1973, 2002), explains how information asymmetry between the sender of a signal and the receiver can be minimized. Thus, it can be used to explain which factors drive the decision-making process in classic investment settings, as well as in new ones, such as crowdfunding, in which the founders and the investor possess different information.

Signalers want to communicate quality (e.g., the venture quality in an investment market) to the relevant receivers. However, the quality cannot be easily assessed by the receiver, at least not before investing. This is because the signalers possess more information than the receivers. In contrast, as the receivers possess something that the signalers want in exchange (i.e., funding), the latter needs to communicate their product's quality, thereby reducing information asymmetry through the use of signals (Connelly et al., 2011).

Signaling theory, although initially used in the context of job markets, can be applied to all market types in which signaling takes place, wherein the primary signalers are relatively numerous and sufficiently infrequent so that they are not expected to (and therefore do not) invest in acquiring a signaling reputation (Spence, 1973). Signals must be both visible and alterable. Additionally, a signal must be costly to acquire, with this cost having to be higher for poor performers and lower for top performers. An example of a typical signal would be an academic degree as it is both visible and can be altered (e.g., Bachelors vs. Masters, Ivy League vs. Community College).

Signaling theory is often used to explain decisions in investment settings. Even if they do not completely match Spence's (1973) original definition, investment-related literature refers to signaling theory when examining dividends, equity retention, stocks

rebuy, and characteristics of top management. Dividends are signals in stock markets as they reveal information about a firm's current earnings (Miller & Rock, 1985). Furthermore, dividend changes reveal information about a firm's future expectations (Kose & Lang, 1991). Similarly, stocks split factors are positive signals for a firm's future earnings (McNichols & Dravid, 1990). Hence, dividends and stocks split factors reveal additional private information that has not been conveyed by corporate audits (Kose & Williams, 1985).

In both initial public offerings (IPOs) and private equity, the founder's characteristics, education, and experience also possess signaling characteristics (Bruton et al., 2009; Piva & Rossi-Lamastra, 2018). Additionally, in IPOs, the board structure (Certo, 2003) and composition of top management (Higgins & Gulati, 2006) signal organizational legitimacy. Founders investing in their firm, or who are retaining equity, also signal the quality of their firm as they show themselves to believe in its future value (Brealey et al., 1977; Bruton et al., 2009). Similarly, there is a significant and positive response by the stock market to chief executive officer (CEO) certification, especially when the CEO holds larger shares because this signals the credibility of their certification (Y. Zhang & Wiersema, 2009).

Furthermore, hiring external consultants or international managers positively affects stock prices because these decisions signal a firm's financial competitiveness (Bergh & Gibbons, 2011), its quality (i.e., less risky business prospects), and its openness to international investors (Schmid & Dauth, 2014).

Venture capital funding is a signal that showcases the quality of a given start-up (Davila et al., 2003), as well as their affiliations with prominent venture capitalists in syndicate networks, which are signals for the quality and positive prospects of a new venture (Ozmel et al., 2013). Additionally, a venture capital firm can signal its own

quality. If this firm has a higher proportion of innovative human capital or investment banking experience, its likelihood of raising additional funding increases (Milosevic et al., 2020).

As previously mentioned, not all of these signals match Spence's (1973) original definition. However, many of them are those that are used in crowdfunding, including equity retention, funders qualifications, or affiliation with a venture capitalist. However, the above-mentioned studies analyzed the reaction of professional investors to different signals in the stock market. Furthermore, venture capitalists or stock markets receive numerous signals simultaneously. By contrast, crowdfunding primarily aims at non-professional investors who have neither the time nor the ability to screen all of the information provided for a project (Busenitz et al., 2005; Courtney et al., 2017; Macht & Weatherston, 2014). Thus, the focus of this thesis is to understand how isolated signals affect funders' decision-making processes in the context of crowdfunding.

1.3.2 The Concept of Crowdfunding as a Fundraising Strategy

A famous and very early example of a crowdfunding project is the Statue of Liberty in New York, USA (Landström et al., 2019, p. 1). However, the most common belief is that crowdfunding is a rather young phenomenon, as it is mostly associated with Web 2.0, meaning the interaction of web users (Ordanini et al., 2011).

Crowdfunding is typically defined by one of the following definitions: First, crowdfunding comprises all "efforts by individual entrepreneurs or groups [...] to fund their ventures by drawing relatively small contributions from a relatively large number of individuals using the internet, without standard financial intermediaries" (Mollick, 2014, p. 2). Second, crowdfunding refers to an "open call, mostly through the Internet, for the provision of financial resources either in the form of donation or in exchange for

the future product or some form of reward to support initiatives for specific purposes” (Belleflamme et al., 2014, p. 588). According to these two definitions, there are three parties involved in crowdfunding: the fund seeker (i.e., a founder or entrepreneur), the fund provider (i.e., the crowd that gives funding), and an intermediary (i.e., crowdfunding platforms) (Macht & Weatherston, 2015).

- Fund seekers (hereafter referred to as “founders”) participate in crowdfunding because they cannot or do not want to rely on traditional financing means. However, they also participate in crowdfunding to receive public attention and/or to obtain feedback for their products or services (Belleflamme et al., 2013). Even companies participate in crowdfunding for public attention and/or feedback, such as the BOSE Corporation testing the public resonance for their “sleepbuds.” The motives for participating in crowdfunding are as different as the products and services are and include notions like “save our local theater” (Josefy et al., 2017) to products like craft-breweries, and from music and art performances to smart-watches and 3-D printers.
- Fund providers (hereafter referred to as “funders”) and their characteristics are seen as black boxes. Oftentimes, more men than women participate in crowdfunding projects, (Landström et al., 2019, p. 4), with 52 % of funders being under the age of 35 years, while just over 56 % have provided crowdfunding only once or twice in the preceding three months (Macht & Weatherston, 2015). Funders offer support for various reasons. These can be classified into either financial or social reasons (Belleflamme et al., 2014). Financial reasons often involve the simple expectation of interest rates, but underlying these is the desire to be the first one to have a product

(Belleflamme et al., 2015). Social reasons often involve the desire to be part of a community (Belleflamme et al., 2014), to provide patronage, to provide encouragement, (Ordanini et al., 2011), or to affect social change (Shaw & Carter, 2007).

- Intermediaries (hereafter referred to as “crowdfunding platforms”) exist across four different types of models: equity-, loan-, donation-, and reward-based crowdfunding (Belleflamme et al., 2015). Platforms are usually specialized in one of these. In equity-based crowdfunding platforms, funders offer equity stakes for the investors of their campaign, whereas in loan-based ones funders receive a certain interest rate. This is the main difference between crowdfunding and a traditional bank and is one reason why crowdfunding serves as a substitute for traditional bank loans as the former does not screen any project. Rather, it is up to the funders to decide whether to support a project. In reward-based crowdfunding, funders either pre-purchase a product, such as a new album or a computer game, or they receive a (small) reward for supporting a project. This may be a small material token or a credential in a new business. Kickstarter, for example, which is one of the most prominent crowdfunding platforms, is a provider of reward-based crowdfunding. Lastly, donation-based crowdfunding relies on voluntary contributions to a given product. All these platforms generate revenue by transaction fees, service charges, and by receiving interest rates from the pledged money. Once a funder gives money to a project, the crowdfunding platform receives this amount and keeps it until the end of the funding call. Then, the money is either transferred to the founder (if the project is successful) or is transferred back to the funder. On most

crowdfunding platforms, funding is only transferred to the founder if a pre-defined goal is met (all-or-nothing), but there are also major platforms, such as Indiegogo, that provide the option to keep any money contributed to a project (keep-it-all) (Cumming et al., 2020).

1.4 Methodological Approach and Data Structure

The focus of this thesis is to understand the effects of individual signals on the decision-making processes of funders in crowdfunding. Investment decisions are often analyzed in laboratory experiments as these present a clear cause-and-effect relationship between variables; in this case, between a signal and the following investment decision. Thus, this section provides an overview of laboratory experiments and why they have been chosen as the research method of this study. Furthermore, I briefly describe the data structure of the three studies in this thesis.

1.4.1 Laboratory Experiments in the Investment Literature

Existing research on crowdfunding primarily relies on publicly available data, such as platform datasets. Platform data can be described as happenstance data (i.e., a by-product of the crowdfunding process) and is thus gathered under uncontrolled conditions (Friedman & Sunder, 1994, p. 3). Happenstance data does not allow for causal conclusions, as the absence of a control does not allow for the derivation of a cause-and-effect relationship. Thus, they are better suited to uncover correlations between variables and are not suitable for analyzing individual decision-making under uncertain conditions. Furthermore, they do not provide information about how and why individuals make their decisions (McMullen & Shepherd, 2006).

As an alternative, entrepreneurial decision-making can best be researched using experiments that allow for the examination of causality (Hsu et al., 2017; Short et al., 2009). Their ability to uncover causality has led to the widespread use of experimental methods across different fields, such as those of consumer behavior, psychology, sociology, and economics. The reason that experimental data allows researchers to draw causal inferences is because they are gathered deliberately under controlled conditions (Friedman & Sunder, 1994, p. 3). This means that only one factor of interest varies at a given time, while all other variables are held constant (Croson & Gächter, 2010). Within these controlled boundaries, the participants were randomly assigned to different treatment groups. Randomization is necessary to eliminate the effects of any unobserved (exogenous) variables, such as biases, individual attributes, and environmental conditions. Hence, the potential effect of these unobserved factors on the outcome variable is reduced. This then allows for the identification of any causality between study variables as they are examined in isolation (Grégoire et al., 2009). Furthermore, examining participants in a laboratory setting reduces potential noise factors, such as environmental influences (Colquitt, 2008).

As previously mentioned, signaling theory has been applied in the investment context wherein there is information asymmetry between the signaler and the receiver. Signals are then meant to reduce this information asymmetry.

Furthermore, the impact of a person's social preferences, or their psychological and emotional characteristics, on decision-making has been widely examined through various experiments in the field of *behavioral economics*. In the following, I will briefly describe two well-known experiments in *behavioral economics*, which have been used in subsequent studies: the dictator game and the public goods game. The public goods game is a generalization of the prisoner's dilemma. Group members are tasked with

deciding how much to invest in one or multiple public goods (Levitt & List, 2007). Public goods experiments are used to examine free-riding behaviors in investment decisions or within a teamwork context (Cadsby & Maynes, 1999). Furthermore, these experiments are especially well suited to mimicking crowdfunding situations in the laboratory (Corazzini et al., 2015). The dictator game is a variation in the ultimatum game, without strategic concerns (Forsythe et al., 1994; Güth et al., 1982). The proposer (dictator) simply states what the split will be and the other party has to accept, rendering the proposed split as effective (Levitt & List, 2007). The social preferences that have been revealed by these experiments include altruism, reciprocity, fairness, and inequity-aversion.

Because laboratory experiments reduce the impact of exogenous variables, they can be used to understand investors' decision-making processes as they allow for the control of time and risk preferences among participants (Gneezy & Potters, 1997). Similarly, cultural differences may substantially affect peoples' decision-making processes. These results indicate individual differences in what people perceive to be fair or what is expected under certain circumstances (Henrich, 2000).

The effects of gender and gender-associated factors, such as risk preferences and decision-making under uncertainty, on investment decisions have also been examined in controlled laboratory experiments (Fehr-Duda et al., 2006). Furthermore, laboratory experiments have been conducted to examine how gender influences peoples' trusting behaviors (Buchan et al., 2008; M. Dittrich, 2015) and degree of overconfidence (D. A. V. Dittrich et al., 2005). Similarly, social preferences, such as reciprocity (Fehr et al., 1997; Fehr & Gächter, 1998) or fairness (Fehr & Gächter, 2000; Fehr & Schmidt, 2000), have also been analyzed in the laboratory setting. Moreover, the influence of cultural

differences on reciprocal behavior, fairness, and trust has been experimentally examined in prior studies (Henrich, 2000; Willinger et al., 2003).

Besides individual characteristics (i.e., gender or culture) and available signals, other investors influence individual investment decisions. The behavior of group members to imitate the decisions of other members is called herding (Banerjee, 1992). Data from actual investments, such as those of stock markets or crowdfunding platforms, do not allow for analyzing what information, whether it be private or based on others' decisions, influences actual investment decisions. In contrast, laboratory experiments are able to identify the causality between information about others' decisions and peoples' actual investment decisions. Thus, the effect of subsequent herding behaviors can be examined in this context as it provides clear evidence that people often neglect their own private information and follow others' decisions (Cipriani & Guarino, 2005; Drehmann et al., 2005). Furthermore, laboratory experiments can depict actual and simultaneous group behaviors. For example, public goods experiments are used to examine free-riding behaviors in investment decisions or within teamwork contexts (Cadsby & Maynes, 1999). Thus, public goods experiments are especially well-suited to mimic crowdfunding situations in the laboratory setting (Corazzini et al., 2015) because, similar to actual crowdfunding, funders need to coordinate on a single public good and reach a certain threshold.

A well-designed experiment uses its comparative advantages to determine how, when, and why certain features of a crowdfunding project influence funders' behaviors (Libby et al., 2002). Current practices within crowdfunding platforms are still, relatively speaking, black boxes (Floyd & List, 2016). Hence, experiments represent a powerful tool with which to open these boxes and, when combined with an applicable theory, they provide a deeper understanding of the processes leading to funding success in

crowdfunding. Thus, to analyze the effects of specific manipulations within a controlled setting, laboratory experiments qualify as an appropriate methodological approach for my thesis.

1.4.2 Data Structure

In both studies, as outlined in chapters 2 and 3, I applied a modified threshold public good laboratory experiment to mimic the situation of crowdfunding platforms. Both in the experimental setting and on these platforms, funders have to coordinate on a project or public good as their individual endowments typically do not allow for them to completely fund a project on their own, with this being the case of my two experiments.

In the first study, the manipulations within the different treatments involved different third-party seals, either framed as regional (but without information about the issuing entity) or as issued by the European Union (EU) (i.e., issued by a governmental entity), for one of the public goods in order to analyze the coordination effect of these seals between treatments. In a further treatment, the two different third-party seals were then analyzed within one treatment each applied to a different public good.

In the second study, the coordination effect of the regional third-party seal from study one is compared to the coordination effect of the information about prior funders' decisions.

In the third study, as outlined in chapter 4, I use a dictator game to mimic the situation between the founder and funder. Typically, on a crowdfunding platform, the funder assigns an amount to the founder without having engaged in any prior interactions, similar to that of the dictator game. In this experiment, the founders could “communicate” with their funders by stating either how much they had invested in a

third-party seal or only if they had invested in a seal or none of them, depending on the treatment.

All three studies were run in the laboratory for experimental research in economics at TU München. Furthermore, the studies were run in German, with the complete population pool receiving invitation (i.e., no restrictions concerning the field of study, gender, age, etc.).

1.5 Main Results and Outlook

In the first study, I compared two different third-party seals for crowdfunding projects: one was framed as regional (but without information about the issuing entity) and the other as issued by the EU (i.e., issued by a governmental entity). From a more general perspective, the regionally framed seal can also be seen as any self-managed signal, such as updates on project status, which are common tools in crowdfunding (Ahlers et al., 2015). In contrast, the seal issued by a governmental entity like the EU could represent any officially issued document, such as a funder's Master of Business Administration (MBA) degree or patents that the new venture holds, which are also typical signals in crowdfunding (Ahlers et al., 2015). The results show that the crowdfunding project with the regional seal received significantly more contributions than that with the EU seal. In addition, if there are two projects competing for funding at the same time, each with a different third-party seal, the overall contribution for both projects is reduced instead of being divided.

In the second study, I found that signals substitute for prior experience. Only the inexperienced funders considered signals to coordinate, independent of whether the signal is a third-party seal or the information about prior funders' decisions. However, only if the signal appears before funders make their decision do they increase the

overall funding for the salient public good wherein their contributions do not differ from that of more experienced investors. If two different projects are highlighted simultaneously, one with a third-party seal and the other with information about prior funders' decisions, funders solely support the project using the latter and neglect the one using on the former.

Participants with prior investment experiences neglect both the information about prior funders' decisions and the seal. Instead, they choose their own strategy that involves deciding which public good to support, with them then sticking to their decision even after the seal appears. By doing so, they then send their own signals.

The third study found that funders invest more into a project if its founder uses a more costly signal. However, this is not a linear relationship because, at a certain threshold, funders tend to stop their support and do not invest anymore no matter how much more the founder invests. Additionally, if investors only know that the founder invested in a costly signal, but not how much, their support is moderated by their altruistic tendencies. If funders know if and how much the founder invested in a costly signal, reciprocity then drives their support.

These findings contribute to the crowdfunding literature by bridging the current research gap and by identifying the causality between funding success and different types of signals. These findings then enrich and broaden the existing crowdfunding theory. I show that the choice of an effective signal is sensitive to the type of crowdfunding project. Furthermore, I found that the effect of a signal on an individual depends on their unique characteristics. This means that signals work differently for men and women or for experienced and inexperienced funders. Thus, these results explain why seemingly identical projects fail or succeed in vying for funding.

Finally, the results of my experiments have the following implications for platform operators and policymakers:

First, a third-party seal can provide valuable support for crowdfunding projects, especially when these projects differ little in their inherent characteristics from others. This is because a third-party seal certifies both the quality and legitimacy of the project. Thus, it helps potential funders to coordinate on a project. However, the type of third-party seal (i.e., an official or non-official seal) must be chosen carefully.

Second, founders should carefully consider whether they should frame their project as a business opportunity (i.e., equity-based crowdfunding) or as a more social project (donation or reward-based crowdfunding). Accordingly, they should put more (equity-based crowdfunding) or less (donation-based crowdfunding) emphasis on the cost of signaling. This is because potential funders are driven by different motives, such as altruism or reciprocity, depending on the type of project.

Third, the signals should be chosen carefully according to the potential audience. Projects that seemingly attract men rather than women (e.g., a 3-D printer or craft beer) should not overemphasize their certificates. Projects that aim to attract more experienced funders, rather than novice ones, might not need any signal as the former tends to ignore them.

1.6 Structure of the Thesis

The remainder of this thesis is organized as follows: In chapter 2, I present the study *“Coordinating Contributions in Crowdfunding Sustainable Entrepreneurship”*, which answers the first research question. In chapter 3, the second research question is answered within the study *“Do Signals Substitute Experience? Funders’ Considerations in Crowdfunding.”* The third research question is then answered in

chapter 4 “*On Founders and Dictators: Does it pay to pay for Signals in Crowdfunding?*”

Chapter 5 presents a reflection on the applied method and avenues for future research.

In chapter 6, I summarize the results of this dissertation and derive its theoretical and practical implications.

2 Coordinating Contributions in Crowdfunding for Sustainable Entrepreneurship²

Summary

Crowdfunding has become a serious opportunity for financing sustainable entrepreneurship. However, funders oftentimes compete with several similar projects for funding. In crowdfunding, projects are only realized if they reach a minimum funding threshold, and this means that funders need to coordinate to reach such a threshold. In this study, I examine how different types of sustainability seals help solve this coordination problem. I simulate a crowdfunding situation using a threshold public goods laboratory experiment. My results show that the choice of a signal is sensitive to the type of crowdfunding project. For a sustainability project, a nongovernmental seal is a better match. My findings offer new insights for innovators, entrepreneurs, and institutions on how to obtain contributions for sustainability projects and ultimately bring more of this type of project to life.

² This chapter is based on a paper co-authored by Alwine Mohnen and Martina Wayand published in the *Journal of Cleaner Production*, Volume 319, October 2021. The full chapter is included in the examiners' copies of this dissertation. In order to avoid any kind of plagiarism or dual publication it is not included in the freely accessible version of this dissertation. My contribution to the paper is summarized in Appendix A (signed by the authors in the examiners' copies of this dissertation).

3 Do Signals Substitute Experience? Funders' Considerations in Crowdfunding³

Summary

Crowdfunding is set to become a serious means of financing. However, funders face several similar projects, all seeking funds. As only those projects that reach a minimum funds threshold are realized, a coordination problem arises within the group of funders. I examine how different signals, such as a seal from a third-party or information about prior funders' decisions, solve this coordination problem. I mimic a crowdfunding situation using a threshold public goods laboratory experiment. My findings illustrate that signals substitute experience. Inexperienced funders contribute more to a project that comes with either a seal or information about prior funders' decisions, whereas experienced funders neglect both types of signals. My findings offer new insights for user innovators, entrepreneurs, and institutions on how to encourage and promote contributions to crowdfunding projects.

³ This chapter is based on a working paper co-authored by Alwine Mohnen. The full chapter is included in the examiners' copies of this dissertation. In order to avoid any kind of plagiarism or dual publication it is not included in the freely accessible version of this dissertation. My contribution to the paper is summarized in Appendix B (signed by the authors in the examiners' copies of this dissertation). The working paper was presented at the GfeW-Jahrestagung 2019 in Düsseldorf.

4 On Founders and Dictators: Does it pay to pay for Signals in Crowdfunding?⁴

Summary

Crowdfunding has become a serious means of financing new ventures. Funders come across numerous, often similar, projects seeking funds, which makes it difficult for them to decide which project to support. Founders can invest in signals (e.g., filing a patent) to highlight their projects, as signals are a typical communication channel on crowdfunding platforms. I examine how the cost of signaling affects funders' contributions. I modeled a crowdfunding situation using a modified dictator game in the laboratory. My results illustrate that the higher the founders' cost of signaling, the more the funders contribute, though not without restrictions. The characteristics of funders matter as reciprocity moderates this effect. Thus, my findings offer new insights for user innovators, entrepreneurs, and institutions, and explain why seemingly identical signals work differently.

⁴ This chapter is based on a paper co-authored by Alwine Mohnen published in *Journal of Business Venturing Insights*, Volume 15, June 2021. The full chapter is included in the examiners' copies of this dissertation. In order to avoid any kind of plagiarism or dual publication it is not included in the freely accessible version of this dissertation. My contribution to the paper is summarized in Appendix C (signed by the authors in the examiners' copies of this dissertation).

5 Reflection on the Method Used and Future Research

Implications

In this thesis, the effects of different types of signals— namely, information about prior funders, third-party seals, and the associated cost of these third-party seals— were compared in a laboratory setting. This setting allows for the formation of causal inferences (Hsu et al., 2017): as such, within each experiment, only one signal is changed within each treatment whereas all other factors are held constant, thereby allowing for the identification of the underlying causal relationship between the signals and the amount contributed. This is a clear distinction between the three presented studies and the existing literature that could not differentiate between the specific factors that lead to funding success.

The scope of these three studies sheds light on whether a possibly uninformed crowd (represented by students) considers the impact of costly quality signals when coordinating their decisions. Thus, real crowdfunding situations have been accurately depicted in my laboratory experiments. The identified cause-and-effect relationship between signals and investment decisions is a clear distinction between this thesis and the existing research. Prior crowdfunding research has primarily relied on panel data. Within panel data, the signaling effect cannot necessarily be assigned to a single signal as multiple signals might change or appear during a call for funding, which does not allow for an examination of cause-and-effect relationships.

The three studies presented in this thesis utilized laboratory experiments with a student sample as their methodological approach. As such, the external validity of laboratory experiments must be addressed. Laboratory experiments can be used to test existing, or discover new, theories. Consequently, the challenge for researchers is

to construct an experimental setting in which a causal theory can be tested with maximum internal validity (Swieringa & Weick, 1982). This means that the experiment needs to depict reality in as accurate a manner as possible so that participants believe in the created situation, thereby taking it seriously (Swieringa & Weick, 1982). Thus, when compared to reality, a simplified design is not a disadvantage as long as the aspects relevant to the research questions are incorporated (Friedman & Sunder, 1994, p. 11). In all three studies, the participants received a payoff depending on their decisions. Thus, the payoff resembles what participants would have received in a real crowdfunding setting; either a monetary return on equity-based crowdfunding or a reward. Thus, it can be assured that the participants took the experiment and its topic seriously. Additional quizzes before all three studies then ensured that participants understood each of the tasks. By presenting three rudimentary settings, I created a controlled environment. Additionally, the key aspects of crowdfunding platforms, including information asymmetry and coordination problems, remain identical in this kind of laboratory setting (Corazzini et al., 2015).

Laboratory experiments are often conducted with students, resulting in the “college sophomore problem” (Cooper et al., 2011) (i.e., the overrepresentation of college students as a sample) and a selection bias, which is the cost for higher control inherent within the experimental situation (Al-Ubaydli & List, 2015), meaning that these limitations need to be addressed.

Most of the participants in the three studies were university students, with an average age of 25 years. Most of them were neither entrepreneurs nor had any prior experience with crowdfunding. However, this was not a disadvantage as 52 % of crowdfunders are under the age of 35 years, while just over 56 % have provided crowdfunding only once or twice in the preceding three months (Macht & Weatherston,

2015). Hence, students are able to either resemble the population of first-time founders or of future funders (Hsu et al., 2017).

Furthermore, business administration students (which constituted most of the sample pool) are a good proxy for non-professional investors (Elliott et al., 2007). This is because they resemble the population from which they were taken with regard to risk aversion (Cleave et al., 2013), which allows for the assumption that their investment decisions are representative of non-professional investors on crowdfunding platforms. Lastly, if the sample of students has a systematic effect on the various investment decisions across the treatments, this effect would occur within all the treatments as they were all conducted with the same participant pool.

The social orientation of a given project is positively correlated with funding success (Calic & Mosakowski, 2016; Lehner & Nicholls, 2014) as funders' motives around supporting projects are driven by various factors; for example, as helping behaviors (Gerber & Hui, 2013; Ordanini et al., 2011). Thus, participants' attitudes would not likely differ from those of actual crowdfunders. Although pro-social behaviors are typically more accentuated in the laboratory setting, they still correlate with these behaviors in the real-world context (Benz & Meier, 2008), which allows for the assumption that the participants' preferences are representative of the overall population from which they were recruited (Cleave et al., 2013). Hence, the results of the three studies are generalizable and applicable to crowdfunding platforms.

This study's findings provide several interesting avenues for future research, which can help overcome the current limitations mentioned above. First, by using software that allows for a more sophisticated graphical design, an experiment could be crafted that incorporates more features of a typical call for crowdfunding, such as an extensive project description or even a video. This would help to understand whether funders still

rely on the third-party seal when there is other, more graphical, information (i.e., a video) or on the information about other funders' decisions when there is other written information (i.e., the project's description).

Second, the effect of rather simple, easy-to-grasp signals, such as a third-party seal or information about prior funders, were tested in my rather rudimentary setting. However, this is not the case for more dynamic signals, such as regular project updates. In addition, due to the time constraints of a laboratory experiment, the effect of signals over the entire funding period could not be assessed. Thus, field experiments on real crowdfunding platforms offer a promising path for further research. This is especially true as there are often a myriad of similar projects being run at the same time, which would allow for a "ceteris paribus" comparison.

6 Summary and Implications

6.1 Summary

Crowdfunding has been crucial in facilitating numerous innovative products in recent years, such as smartwatches, virtual reality glasses, or 3D-printers. However, 60 % of projects have failed to materialize (Kuppuswamy & Bayus, 2017). Thus, research is required to provide greater insight into how to build “the optimal market design” as “crowds tend to [lose] money on average” (McKenny et al., 2017, p. 298).

In the first study, I conducted a threshold public good experiment to compare two different third-party seals for a crowdfunding project; one was framed as regional and the other as being issued by the EU (i.e., a governmental entity). Similar to a real-life crowdfunding platform, funders needed to coordinate on one project to meet the threshold. The project is realized only if it meets the threshold wherein they receive a payoff. Having multiple, hardly distinguishable projects that are running at the same time causes coordination problems on real-life platforms. The same coordination problem was mirrored in my laboratory experiment. The results show that the crowdfunding project with the regional third-party seal received significantly more contributions than the one with an EU seal. This means that the former solves the coordination problem more effectively with regard to its contributions. In addition, if two different third-party seals, each for a different project, compete, the overall contribution is reduced instead of divided between them.

Result 1: The regional framed seal solves the coordination problem as if there was no coordination problem concerning contributions.

Result 2: The regional framed seal coordinates the contributions better than the EU seal but is not as effective as if there is only one public good. The utilization of two different seals simultaneously, each for a different project, hinders coordination.

Building on the results of the study in chapter 2, in chapter 3 I conducted a similar threshold public good experiment. Again, the coordination effects of the different signals were compared. The regional third-party seal was compared with having available information about the number of prior funders, the “wisdom of the crowd” effect. First, the results from the study in chapter 2 were confirmed, as using a signal leads to an increase in contributions. Funders increase their funding for a salient public good with either a third-party seal or when the information about the number of prior funders is made available.

Result 3: Participants contribute more to a project that is highlighted by a signal.

If the third-party seal and the information about the number of prior funders’ decisions are in direct competition, funders solely rely on the latter.

Result 4: Participants consider a signal differently depending on the level of information available.

Finally, I found that signals act as a substitute for prior experience. Only inexperienced funders consider signals (i.e., a third-party seal or information about the number of prior funders’ decisions) to coordinate. In contrast, participants with prior investment experiences neglect both the information about prior funders’ decisions and the third-party seal. Instead, they choose a particular strategy when deciding which public good to support and stick to their decision even after the signal appears. Thus, they generate their own signals.

Result 5: Participants with prior investment experiences neglect both the presence of herding information and third-party seals.

The study in chapter 4 was based on a modified dictator game. A funder decided the founder's payoff without any direct communication. However, the founder can still invest in a signal. Depending on the treatment, the funder either receives only information on whether or not the founder has invested in a signal or also how much they invested in it. Based on this information, the funder then decides whether to support the founder or not. This study found that funders invest more if the founder has utilized a more costly signal. However, this stops at a certain upper threshold in terms of the signal's cost.

Result 6: Information about how much the founder spent on signaling positively affects funders' contributions, but with an upper threshold.

Additionally, if funders only know that the founder invested in a costly signal, but not how much, their support is moderated by their altruistic tendencies. If funders know if and how much the founder has invested in a costly signal, reciprocity moderates their overall support.

Result 7: Depending on the availability of information about either if only a costly signal was used or if both information on if one was used and the actual cost is available, altruism or reciprocity drive funders' decisions, respectively.

6.2 Theoretical and Practical Implications

The results of the three studies contribute to the literature as they offer two possible explanations for why seemingly identical signals can have contradictory effects. Funders' prior experiences and personal motives for participating in a crowdfunding project influence how they perceive the received signals, which then influences their decision-making process.

The existing literature has only focused on panel data from crowdfunding platforms; thus, information about funders' characteristics is rare. However, my use of laboratory experiments allowed for the differentiation of experienced and inexperienced funders and their decisions. Experienced funders are those who choose a strategy and stick to it. Thus, a project that signals a degree of autonomy and risk-taking behaviors, or if it is framed as a business opportunity, is more likely to attract experienced funders. In contrast, inexperienced funders are more likely to follow prior funders' decisions. They are more risk-avoidant and thus are more attracted to funding calls that are framed as a helping opportunity rather than as a risky business one.

Founders start their projects for different reasons, with funders then supporting them for various other reasons of their own. Accordingly, depending on the scope of a crowdfunding project, different signals work better than others. This study explains why: altruism and reciprocity. These two basics, other-regarding motives for monetary exchange situations, and well-known in the field of *behavioral economics*, influence funders' behaviors. Funders who show high altruistic tendencies are more likely to be attracted by a call for a project that is framed as a helping situation. However, funders with these tendencies do not only screen the framing of the project in question (Nielsen & Binder, 2021), but also take into account the quality of the utilized signals under an altruistic lens. Thus, they are more likely to favor other funders' sentiments but would disapprove if a venture capitalist is involved in a project, although both are third parties. Funders with high reciprocal tendencies are more likely to appreciate the monetary effort involved in signaling and are more tempted if the signaling effort is seen as high. This type of funder is less likely to be interested in funding calls that emphasize warmth and empathy. They might feel that they are being forced to give without receiving back.

The results from the three studies offer the following practical implications for platform operators and founders:

First, crowdfunding is a system that is similar to any common market wherein founders compete for customers (i.e., the funders). Accordingly, founders must act like they would in a real market. They first have to carefully assess who their customers are and, then, design their call for funding in a way that specifically addresses and appeals to their target audience.

Second, customers/funders typically want quality products and services. Thus, they appreciate quality signals as they offer easy-to-grasp information about the project's quality. However, the information provided by the signal must be selected carefully. Again, founders must carefully assess who their customers are to provide them with the right quality signal.

Third, funders appreciate the monetary effort involved in utilizing quality signals. However, they are sensitive to the associated costs. Thus, founders should critically reflect on if they should provide funders with that information. Technologically sophisticated projects seem to be more suitable for this type of quality signal rather than charitable ones.

Lastly, crowdfunding platforms should aim to gather as much data on their users as possible so that they can offer a more personalized presentation of their projects, similar to the personalized advertisements utilized on the internet.

Ultimately, the selection of a signal is crucial for a crowdfunding project: First, it fosters support, but its message has to fit both the crowdfunding project itself as well as the targeted funders. Second, the presentation of a signal, can either emphasize or conceal its cost, which then affects the target funders' perceptions.

7 Appendices

Appendix A: Statement of authorship working paper 1 (Chapter 2)

I was responsible for the development of the research questions and the design of the experiment. Furthermore, I planned and was in charge of the experimental sessions in the laboratory, conducted the data analysis largely independently, and wrote most part of the article.

Stefan Pabst (lead author)

Alwine Mohnen (co-author)

Martina Wayand (co-author)

Appendix B: Statement of authorship working paper 2 (Chapter 3)

I was responsible for the development of the research questions and the design of the experiment. Furthermore, I planned and was in charge of the experimental sessions in the laboratory, conducted the data analysis largely independently, and wrote most part of the article.

Stefan Pabst (lead author)

Alwine Mohnen (co-author)

Appendix C: Statement of authorship working paper 3 (Chapter 4)

I was responsible for the development of the research questions and the design of the experiment. Furthermore, I planned and was in charge of the experimental sessions in the laboratory, conducted the data analysis largely independently, and wrote most part of the article.

Stefan Pabst (lead author)

Alwine Mohnen (co-author)

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