How do backers manage investment uncertainty in equity crowdfunding?

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Doctoral Dissertation Series no. 2024:05

This thesis aims to understand how investment uncertainty is managed in equity crowdfunding. It does so by exploring backer behaviors at different stages of the investment decision-making process during funding windows. Equity crowdfunding is a result of the fintech revolution supported by ICT and innovation as key catalysts. Hence, these catalysts have created a structural change in early-stage finance.

Equity crowdfunding is burdened by information asymmetry. It translates into investment uncertainty and highlights the importance of information availability when backers invest. However, in contrast to traditional funding alternatives in this domain, the absence of face-to-face meetings with entrepreneurs and the lack of individual knowledge are key concerns. Consequently, backers depend on interactions and collaboration based on ICT-driven innovations on digitalized platforms when campaigns go live.

These conditions affect backer behaviors when they invest and enable conclusions about the management of investment uncertainty in relation to established theories in this literature. In addition, findings were also synthesized into a conceptual model for investment decision-making during funding windows. It adds to previous findings about backers in this literature and expands research about decision-making in this domain.

Ola Olsson is a researcher and lecturer in business administration with a specific focus on finance.

Blekinge Institute of Technology
Doctoral Dissertation Series No. 2024:05
ISSN: 1653-2090
ISBN: 978-91-7295-477-9

Printed by Media-Tryck, Lund 2024 NORDIC SWAN ECOLABEL 3041 0903

Blekinge Institute of Technology
Doctoral Dissertation Series No. 2024:05
ISSN 1653-2090
ISBN 978-91-7295-477-9

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Ola Olsson

DOCTORAL DISSERTATION
for the degree of Doctor of Philosophy at Blekinge Institute of Technology to be publicly defended on 2024-05-21 at 01.15 pm in Hall J1630, Valhallavägen 1, Karlskrona

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Abstract

This thesis aims to understand how investment uncertainty is managed in equity crowdfunding (ECF). It does so by exploring backer behaviors at different stages of the investment decision process during funding windows, based on information and communication technology (ICT) and innovation. The included papers in this thesis are also linked to a conceptual model for an overall view of backer behaviors during this phase of the investment decision process. This expands the research on investment decision-making in this domain and provides insights regarding the management of investment uncertainty in ECF.

ECF is a result of the fintech revolution supported by ICT and innovation as key catalysts. These catalysts have created a structural change in early-stage financing, which is burdened by investment uncertainty. Investment uncertainty arises from information asymmetry, and highlights the importance of information availability in managing uncertainty. However, the absence of face-to-face meetings with entrepreneurs and the lack of knowledge among backers are key concerns in the investment decision process. This reduces access to information and reduces the possibility of making independent and accurate decisions.

Hence, backers must find ways to obtain information, and ICT-driven innovations have become an important solution to this problem. In contrast to traditional funding alternatives in this domain, ECF offers unique opportunities based on social capital (the wisdom of the crowd) and context (designed functionalities). These opportunities have full potential during funding windows on digital platforms and come in the shape of interactions and collaborations vital for ICT-driven innovations.

This thesis comprises four papers. Paper 1 analyses the conditions for ICT and innovation that lead to structural changes. Paper 2 evaluates the characteristics embedded in demand-driven signals from discussion boards. Paper 3 explores investment dynamics based on signaling during funding windows. Finally, Paper 4 examines investment strategies based on investor type and portfolio theory. Consequently, Paper 1 presents the conditions for this phenomenon to occur, while Papers 2-4 explore how this affects backer behaviors in relation to theoretical models to draw conclusions about the management of investment uncertainty.

Various patterns emerged from these studies. First, the drivers of ICT and innovation can be clustered and positioned within the innovation lifecycle. Early in this lifecycle, they rely on networks based on interactions and collaboration for new knowledge production. Second, backers tend to appreciate clarity in feedback loops (answers) based on demand-driven signals (questions) from discussion boards when evaluating. Third, some backers invest early, whereas others invest late and receive all available signals during the funding windows. Fourth, more sophisticated backers invest more aggressively than less sophisticated ones. Hence, all patterns depend on ICT and

innovation, and enable conclusions about the management of investment uncertainty during funding windows in ECF.

Keywords: Equity crowdfunding, backer behaviors, investment uncertainty, early-stage finance

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Doctoral Dissertation Series No. 2024:05

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Doctoral Dissertation in Industrial Economics

Department of Industrial Economics
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Blekinge Institute of Technology
Department of Industrial Economics

Blekinge Institute of Technology Doctoral Dissertation Series No. 2024:05
ISBN 978-91-7295-477-9
ISSN 1653-2090
urn:nbn:se:bth-26056

Printed in Sweden by Media-Tryck, Lund University, Lund 2024

Acknowledgements

I would not have been able to write this thesis without inspiration and support from many important people and organizations involved in this journey.

First, and perhaps most importantly, I thank my supervisors. *Martin Andersson*, thank you for your insightful input when it came to important crossroads in this journey, based on your broad and long academic experience. *Emil Numminen*, many thanks for long and constructive discussions regarding the development of potential papers with the ambition of extending this area of research, but also for motivational support during this entire process. Consequently, you have been valuable mentors to me, and although this is the end of one chapter, I hope you will continue to support me in future chapters.

Second, I am grateful to my colleagues at Blekinge Institute of Technology (BTH) and Kristianstad University (HKR). There are, of course, many people to mention, and you have all contributed support in different phases of this process. *Bengt Igelström, Erling Emsfors, and Stefan Hellmer* opened the door for me to start this journey. In addition, members of the TIEK department at BTH (*Pontus Braunerhjelm, Johan Eklund, Viroj Jienwatcharamongkhol, Charlie Karlsson, Jonas Månsson, Monica Nilsson, Philippe Rouchy, Shahiduzzaman Quoreshi, Martin Svensson, and Henrik Sällberg*) and the research environment GRIP at HKR (*Martin Abrahamsson, Daniella Argento, Guiseppe Grossi, Martin Ludvigsson-Wallette, and Emil Nästegård*) have all contributed to valuable support during seminars and coffee-breaks. This also includes PhD students (*Anna Kusetogullari, Cholada Kittipittayakorn, Trude-Ann Stone, Fredrik Söderqvist, and Shujun Wang*) at BTH.

Third, I would like to extend my gratitude to the Research Environment Management and Information Technology (MIT) and the Nordic Research School in Innovation and Entrepreneurship (NORSI) for their constructive feedback in the writing process and learning opportunities in doctoral courses over the last few years. In addition, many thanks also to BTH and HKR as organizations for the possibility for me to develop as an individual, for the creation of engaged and fruitful research environments, and for funding support vital for this project.

Last, but not least, many thanks to my family and friends for all your patience and encouragement during this unique period.

Mia, Herman and Hanna – as a husband and father I hope to share more time with you. You are, and will forever be, my inspiration and navigation in life.

Ola Olsson
Åhus, April 2024

List of Papers

Paper 1

Olsson, O (2018). ICT as a driver of innovation: a life-cycle approach. I: Karlsson, C., Cornett, A.P. and Wallin T. (eds.), *Globalization, International Spillovers and Sectoral Changes*. Cheltenham, Edward Elgar Publishing, pp. 154-169

Paper 2

Olsson, O (2023). Backer behaviors – the value of demand-driven signals in the equity crowdfunding evaluation process. Unpublished.

Paper 3

Olsson, O (2023). Backer behaviors – changing dynamics in equity crowdfunding. *Baltic Journal of Management*, Vol. 18, Issue 6, pp. 1-16

Paper 4

Olsson, O (2021). Backer behaviors - an explorative study of investor types in equity crowdfunding. *International Journal of Entrepreneurship and Small Business*, Vol. 42, No. 1/2, pp. 156-168

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1.0 Introduction

This thesis explores the management of investment uncertainty in equity crowdfunding (ECF). ECF is positioned in the entrepreneurial finance (EF) literature which focuses on early-stage financing and includes studies on resource allocation between new firms (entrepreneurs) and sophisticated investors (venture capitalists and business angels). In contrast to mature firms, our understanding of newly formed firms is limited (Berger and Udell, 1998). Hence, we know much more about global telecom system suppliers such as Ericsson, founded in 1876, compared to newly founded local technology firms with minimal track records and limited assets. Consequently, information availability is a key concern in this domain, leading to significant uncertainty for potential investors (Bonini and Capizzi, 2019). However, advancements in information and communication technology (ICT) have catalyzed innovation in early-stage financing. Fintech is a result of this revolution and includes a new phenomenon called equity crowdfunding (Coakley and Lazos, 2021), which facilitates the transparent and seamless dissemination of information about new firms on digitalized platforms with and between less sophisticated investors (backers). This creates new opportunities to reduce investment uncertainty, with the potential to expand research about how such uncertainty is managed.

1.1 The development of ICT and equity crowdfunding

Technological development began to feature in the industrial dynamics literature in the 1990s (Romer, 1990; Aghion and Howitt, 1993). The term general purpose technology (GPT) was introduced (Breshnahan and Trajtenberg, 1992), representing an enduring technological wave (for example, ICT or the Internet) with the potential to affect productivity and growth based on innovations in application sectors. This enables new knowledge production based on interactions and collaboration in the innovation process, with the possibility of changing entire industries. In the early-stage finance domain, this has created a structural change and initiated the development of ECF with ICT and innovation, which are seen as key catalysts.

In ECF, new firms (entrepreneurs) are funded by many small contributions from people in the crowd (backers). The matchmaking process is possible during brief

funding windows on digitalized platforms and creates open and global multisided marketplaces for early-stage funding with transparent network externalities for all participants involved (Coakley and Lazos, 2021). Hence, this is a result of ICT and innovation, which have the potential to manage information availability in early-stage financing.

From a historical perspective, ECF is the latest step in the evolution of crowdfunding (CF). According to the CF literature, online communities began raising money for charities in the late 1990s, and platforms like Kiva or Prosper for microloans in the early 2000s (Ordanini et al., 2011; Belleflamme et al., 2015). In the late 2000s, Kickstarter and Indiegogo began helping new firms raise small amounts of money on the Internet in exchange for products or services (Cumming et al., 2021). However, the most recent advancement in this development was the creation of online platforms such as CrowdCube and WiSEED. Instead, they offered small funds to new firms in exchange for equity stakes (Ahlers et al. 2015; Schwienbacher, 2019) and initiated the development of ECF.

According to Cambridge Alternative Finance (Ziegler et al., 2021), the CF market was worth approximately USD 113bn (+24%) in 2020 (excluding China). Hence, the affordance of ICT and innovations have not only democratized the early-stage finance arena (Mollick and Robb, 2016), but have also partially complemented ECF with more traditional funding alternatives in the EF literature (Hoegen et al., 2018; Lukkarinen et al., 2022) represented by venture capitalists (VCs) and business angels (BAs). However, unlike these sophisticated investors, less is known about how less sophisticated investors manage investment uncertainty.

Small funding amounts are vital for all new firms to grow and have been the starting point for CF success stories, such as Pebble Technology (in the US) and Flippin' Burger (in SWE), both funded by backers (or enthusiasts) as early as 2012. However, is information availability and investment uncertainty equally important for all backers? According to the literature, backers are driven by different motives (Cholakova and Clarysse, 2015; Moysidou and Spaeth, 2016; Lukkarinen, 2019). However, in ECF, financial motivation based on economic rationality is a key incentive (Cholakova and Clarysse, 2015). Consequently, it seems fair to assume that backers tend to appreciate a higher level of information availability when funding new firms based on shares or debt (investment-based CF), in contrast to products/services/charity (non-investment-based CF). However, subsequent findings in the ECF literature have revealed additional motivations among backers, including altruism, recognition, and image (Bretschneider and Leimeister, 2017). Consequently, transitioning from the group to the individual level, this heterogeneity suggests that we cannot assume that all individuals consider investment uncertainty equally.

1.2 Possibilities and threats from a backer perspective

According to the ECF literature, numerous success stories exist. The first campaign exit, Antabio, launched on WiSEED in 2009 and generated 1.74 times the investment made by participating backers. In addition, some ECF-funded start-ups (BrewDog and Revolut) achieved unicorn status (valuation of +1 billion USD) in 2017 and 2018, respectively. Hence, according to this literature stream, potential financial return is an attractive and important driver for backers at the group level to participate (Cholakova and Clarysee, 2015). However, there are some concerns about this. As many start-ups fail (Hornuf et al., 2018; Sigorni and Vismara, 2018; Walthoff-Borm et al., 2018), future returns are uncertain. Consequently, ECF includes considerable uncertainty regarding potential outcomes (financial returns). Some argue that becoming mainstream in early-stage finance constitutes a major threat to ECF (Schwienbacher, 2019). Hence, based on economic rationality, ECF backers require accurate information to make informed decisions. More importantly, investment uncertainty in the decision-making process must be managed accordingly, and ICT-driven innovations provide tools for this.

From a backer's perspective, there are further concerns that should not be neglected. In the absence of face-to-face meetings, backers are fully dependent on digital platforms for information availability. Hence, unlike sophisticated investors, they lack the opportunity to conduct important due diligence meetings with entrepreneurs to reduce uncertainty ahead of investment decisions. This emphasizes the importance of digitalized platforms. Some platforms pre-select ventures to reduce investment uncertainty (Lukkarinen et al., 2016; Löher, 2018; Cumming et al. 2019). Following this hurdle, investment memorandums are electronically published, providing key information in standardized sections on platforms prior to funding campaigns that help backers make decisions (Shafi, 2019).

However, this limits opportunities for interaction. Instead, platforms have created transparent digital discussion boards, accessible during funding windows and enable questions and answers between backers and entrepreneurs (Estrin et al., 2018) with no restrictions on time or distance. Furthermore, many backers lack experience. Unlike sophisticated investors, most backers are not equipped with sufficient skills or knowledge to invest in new firms (Bonini and Capizzi, 2019). Hence, to reduce investment uncertainty during funding windows, they must collaborate and use platform functionalities to identify and evaluate third-party recommendations (Moritz et al., 2015), firm updates (Block et al., 2018), and investment patterns (Vismara, 2018; Åstebro et al., 2019).

In contrast to the aforementioned traditional alternatives in this domain, this emphasizes the importance of unique opportunities based on the social capital (wisdom of the crowd) and context (different user-friendly functionalities)

embedded in ECF (Hoegen et al., 2018). These opportunities are fully realized during funding windows, potentially alleviating key concerns among backers. However, little is known about the implications of backer behaviors. This raises questions about driving factors behind backer behaviors in the investment decision process, as well as the key conditions for this to occur in this emerging early-stage finance phenomenon.

1.3 Research gaps in the literature

ICT and innovation are important in the industrial dynamics literature, which examines structural changes and underlying processes. Hence, understanding the innovation lifecycle is crucial in this context, focusing on design and potential changes in production (Utterback and Abernathy, 1975). However, the landscape shifted in the early 1990s with the integration of ICT into the literature (Romer, 1990; Aghion and Howitt 1993). This enabled new knowledge production primarily based on collaboration and interaction in the innovation process. The literature also highlights several findings on the drivers of innovation in the ICT sector. However, they are neither clustered nor organized. Consequently, the literature lacks an overall view of the content and distribution of the key drivers to better understand the forces behind structural changes (see Table 1 below). Furthermore, as part of a structural change, this reveals the key conditions for ECF. Hence, this thesis also advocates for studies based on interactions and collaboration.

Findings related to investment uncertainty in the ECF literature mainly take a firm or institutional perspective. Hence, we know some firm success factors (Ahlers et al., 2015; Vulkan et al. 2016; Block et al., 2018) that reduce investment uncertainty. In addition, discussions on government regulations and the implementation of new laws (Cumming and Johan, 2013; Oranburg, 2015; Nehme, 2017) aim to improve investor protection. However, perspectives from investors themselves have been significantly overlooked (Schwienbacher, 2019; Mochkabadi and Volkmann, 2020; Shneor and Maehle, 2020).

Consequently, our understanding of backers and their behaviors at both the group and individual levels remains limited. Findings suggest crowd heterogeneity. However, crowd information is difficult to obtain as platforms tend to protect data on members and their behaviors. Instead, surveys have been used, but with less success when it comes to uncovering behavioral insights (Schwienbacher, 2019). Consequently, research on backer behaviors is less developed, both in terms of empirical findings and theoretical contributions. Nevertheless, backers are vital for capital-seeking entrepreneurs in new firms with capital deficits, rendering it important to comprehend their behaviors and potentially address the lack of research in this stream of literature.

In the investment decision process, backer behaviors have mainly been studied based on motives (Cholakova and Clarysse, 2015; Moysidou and Spaeth, 2016; Lukkarinen, 2019) and return on investments (Signori and Vismara, 2018; Vroomen and Desa, 2018). These factors are important for backer behavior and are connected to the management of investment uncertainty based on economic rationality. However, they are less connected to the aforementioned key concerns among backers or the possibilities of interaction and collaboration supported by the unique opportunities embedded in ECF investment decision-making (Hoegan et al., 2018) during funding windows.

However, others have discussed different behaviors during funding windows that largely depend on the interactions or collaborations facilitated by these unique opportunities (see Table 1 below). Consequently, some studies have focused on evaluating signals exchanged between entrepreneurs and backers on digital discussion boards (Kleinert and Volkmann, 2019; Iurchenko et al., 2022). Both studies supported the importance of signals but disagreed on content. Hence, further research is required to determine their content and effects. Additionally, research on early investments and herding effects (Vismara, 2018; Åstebro et al. 2019) based on platform investment data has paved the way for findings on investment dynamics (Hornuf and Schwienbacher, 2018). However, other observations have implied changing dynamics (Correia, et al., 2019). Hence, additional research on signal distribution is important to better understand when backers invest during funding windows to manage uncertainty. Furthermore, backer behavior has been studied with respect to different investor types including gender, geographic distance, and sophistication level (Abrams, 2017; Guenther et al., 2018; Mohammadi and Shafi, 2018; Wallmeroth, 2019) during funding windows. However, findings remain scarce. Considering the aforementioned key concerns among backers, further investigation into the level of sophistication and its implications on behavior is warranted.

Table 1. Findings and gaps in the literature

RESEARCH AREAS	KEY ARTICLES	MAIN FINDINGS	RESEARCH GAPS AND PAPERS	EMPERICS
ICT and innovation	Utterback and Abernathy, 1975 Romer, 1990 Aghion and Howitt, 1993	Innovation and ICT are important for structural change	Lacks clustering and organization of key drivers in this process (paper 1)	Published papers in Scientific Journals from this stream of literature
Evaluation and backer behaviors	Kleinert and Volkmann, 2019 Iurchenko et al., 2022	Discussion boards are important for funding, but content and effects differ	Funding effects from content characteristics embedded in demand-driven signals during funding windows (paper 2)	Q&A and investments from discussion boards
Investment dynamics and backer behaviors	Vismara, 2018 Hornuf and Schwienbacher, 2018 Åstebro et al. 2019 Correia et al., 2019	Funding depends on herding and early investments, but patterns conflict	Funding effects from changing dynamics during funding windows (paper 3)	Investments from discussion boards visualized at campaign funding meters
Investor types and backer behaviors	Abrams, 2017 Guenther et al., 2018 Mohammadi and Shafi, 2018 Wallmeroth, 2019	Funding differs based on gender, geographic distance, and level of sophistication based on wealth	Fundings effects during funding windows based on level of sophistication and portfolio configurations (paper 4)	Investments from discussion boards visualized by platform functionalities for portfolio profiles
Backer behaviors in the ECF investment decision-making process	Lukkarinen et al. 2016 Hoegan et al. 2018 Shafi, 2019	Initial overall view of the DM process and importance of the unique opportunities embedded in ECF	Lack of studies about backer behaviors based on data from the important funding window (thesis)	Aforementioned papers in this thesis

All data released during the funding windows were hand-collected from the equity-based crowdfunding platform FundedByMe.

To summarize, there is a lack of understanding of the content and distribution of key drivers of ICT-driven innovation in the industrial dynamics literature. Hence, new findings have the potential to elucidate the innovation process behind structural changes. Equally pertinent to this thesis is the recognition that ECF is a structural change in early-stage finance, establishing key conditions for this phenomenon. Leveraging the unique opportunities embedded in ECF (social capital and context) fosters interaction and collaboration during funding windows, potentially influencing backer behaviors. Consequently, this supports additional studies on

some key factors (evaluation, dynamics, and investor type) of backer behaviors, in relation to theoretical models, to draw conclusions about managing investment uncertainty and bridging existing gaps in this stream of literature. These three factors will be referred to backer behaviors throughout the thesis. Furthermore, to the best of my knowledge, there is no overall view of backer behaviors based on data solely generated by ICT-driven innovations concentrated on the important funding campaign window, supported by the unique opportunities offered in ECF (Hoegan et al., 2018). Hence, this thesis has the potential to extend the research on backer investment decision-making in relation to investment uncertainty, which was previously mainly based on data released before or after funding windows (Lukkarinen et al., 2016; Shafi, 2019).

1.4 Data, method, and research question

The use of behavior to draw conclusions about investment uncertainty relies on observational studies and group comparisons. This raises concerns regarding causality based on selection skewness and data availability. However, the results in Papers 2-4 all depended on population data from the FundedByMe platform, which alleviates this concern. In addition, although data availability is a key concern in the literature, these studies depend on public data generated by ICT and innovation on digital platforms. This creates accessibility and traceability over time. This significantly strengthens the findings about behaviors, as it is based on experienced or revealed (archive data) preferences, rather than expected or stated (attitude data). In addition, quantitative methods were used to statistically test all data for generalized conclusions regarding different backer behaviors during ECF campaign windows.

Findings on ICT and innovation are based on peer-reviewed papers in the industrial dynamics literature (Paper 1), and conclusions about managing investment uncertainty are drawn from backer behaviors based on data exclusively generated during successful funding windows (Papers 2-4). This data was hand-collected from the Swedish equity crowdfunding platform, FundedByMe. This allowed for insights into backer behaviors based on data from an established and regulated market and an entrepreneur-led platform that does not pre-select firms in need of early-stage funding (SOU, 2018). Consequently, backers are expected to be familiar with equity investments, but are also faced with a situation where the platform transfers most investment uncertainty onto backers.

Hence, this thesis presents a selection of new empirical findings based on backer behaviors during the investment decision process concentrated within the funding window. This concept was inspired by Simon's (1955) three-phase model of "intelligence, design, and choice" for bounded rationality decision-making. However, it was moderated to fit this concentrated investment decision-making

process sequentially during funding windows based on the unique properties of ECFs (social capital and context). Consequently, the studies in this thesis focus on the conditions for ICT-driven innovation and the potential effects of evaluation, investment dynamics, and investor types on backer behaviors during funding windows. These effects facilitate conclusions about the management of investment uncertainty based on data collected before, during, and after the investment decision, as shown in Figure 1 below.

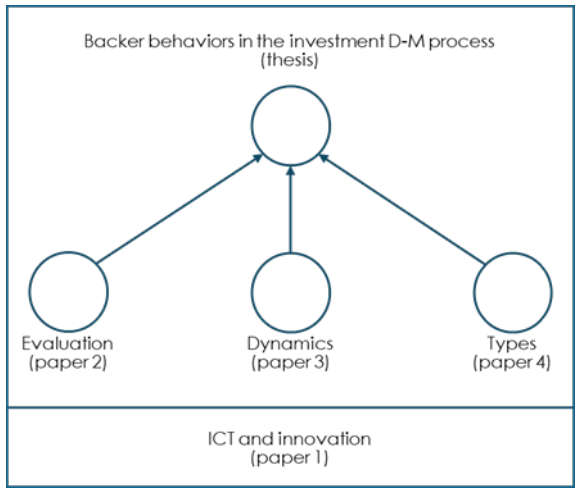

Figure 1. Conceptual model about backer behaviors in the investment decision-making process

This thesis adds to the burgeoning interest in equity crowdfunding, with a specific focus on investment uncertainty from a backer's perspective. It achieves this by addressing the following research question:

How do backers manage investment uncertainty based on ICT-driven innovations during equity crowdfunding windows?

To achieve the goal of this thesis, I intend to:

Explore conditions and key clusters for innovation based on ICT.

Explore the content and effects of evaluating demand-driven signals on discussion boards during equity crowdfunding windows.

Explore the timing of backers' investments during successful campaign windows in equity crowdfunding.

Explore how backers configure investment portfolios during equity crowdfunding windows.

To address these questions, this thesis draws on research within industrial dynamics and the entrepreneurial finance domain, with a specific focus on the equity crowdfunding literature. Furthermore, it focuses on investors to examine their behaviors, based on ICT-driven innovations crucial for the investment decision process, and drawing conclusions about managing investment uncertainty during equity crowdfunding windows.

1.5 Contribution

This thesis contributes to the entrepreneurial finance literature by examining the content and effects of resource allocation (funding) in an innovative ICT setting. It specifically adds to the ECF literature by focusing on backer behaviors and management of investment uncertainty. Theoretical aspects from related fields have been vital for this thesis, especially in terms of signaling and portfolio theories.

Equity crowdfunding is seen as a financial innovation in early-stage finance (Hornuf and Schwienbacher, 2018; Estrin et. al, 2022). ICT has enabled this innovation with the potential to impact behaviors and management of investment uncertainty in this field. Hence, it is important to first explore the conditions for innovation based on ICT. Consequently, Paper 1 is separate from the ECF literature and explores the conditions vital for structural changes like ECF.

The findings of Paper 1 suggest that four clusters are key drivers of innovation based on ICT (see Table 2 below). These clusters are also positioned within the innovation lifecycle. This adds to a better understanding of the content and distribution of key drivers important for ICT-driven innovation in the industrial dynamics literature. Two of these clusters (alliance and production networks) were positioned early in their lifecycle. This position correlates with ECF, which is based on the lifecycle approach to early-stage finance, and emphasizes the importance of interaction and collaboration for new knowledge production within networks. These conditions are fully realized through the unique opportunities inherent in ECF (Hoegan et al., 2018) during funding windows. Consequently, this supports additional studies on backer behaviors in the investment decision process during funding windows based on evaluation, dynamics, and investor types, in contrast to studies based on the motives and return on investments. This also enables conclusions regarding the management of investment uncertainty in relation to the aforementioned theoretical models.

Hence, Papers 2-4 focus on the content and effects of these key factors (evaluation, dynamics, and investor types) on backer behaviors at the group level across different phases of the ECF investment decision process during funding windows. This facilitates conclusions about managing investment uncertainty within this financial innovation and addresses the aforementioned research gaps in the literature (see Table 2 below).

The findings from Papers 2 and 3 suggest that backers depend on a) clarity obtained from demand-driven feedback loops (entrepreneur answers) from discussion boards, and b) the distribution of signals (investments) visualized by platform functionalities. Hence, new knowledge production in ICT-driven innovation depends on interaction and collaboration. According to signaling theory, these signals affect investment uncertainty for backers during funding windows. Hence, clarity from entrepreneurs and the timing of investments by others appear to reduce backer investment uncertainties. This contributes to previous findings on the content and effects of demand-driven signals on discussion boards and has the potential to improve the understanding of investment dynamics in this literature.

Furthermore, the findings of Paper 4 suggest that investment choices and portfolio configurations differ according to backer sophistication levels. This data is generated and visualized by platform functionalities and depends on the potential collaboration among assets. According to portfolio theory, these findings affect investment uncertainty among backers during funding windows. Hence, more sophisticated backers (with broad portfolios) tend to have more aggressive investment strategies than less sophisticated backers, and use portfolio diversification to reduce their investment uncertainty. The findings in this study are, to the best of my knowledge, unique in this stream of literature because they depend on empirical data to compare different backer behaviors based on portfolio theory.

This thesis expands previous research regarding backer behaviors in the investment decision process. It accomplishes this by providing a comprehensive and overall view of this sequential process based on evaluation, dynamics, and investor types generated by data from ICT-driven innovations during funding windows. Previous findings on this process are often fragmented or depend on data released before or after the crucial funding window (Lukkarinen et al., 2016; Shafi, 2019). Hence, this thesis has the potential to expand our understanding of backers and their behaviors in the investment decision-making process, providing insights into how this affects the management of investment uncertainty during funding windows.

Numerous potential implications arise from this thesis. However, since behaviors differ during funding windows and investor types are a key moderator in the investment decision process, it is imperative to further explore crowd heterogeneity. Backer characteristics have historically been neglected in this literature, with findings predominantly relying on VCs and BAs or professional institutional investors (non-rookies) in later funding stages. Hence, additional studies focusing on the level of backer sophistication would not only expand research in ECF but also improve knowledge of differences and similarities among less and more sophisticated investors in this domain, thereby offering fruitful avenues for further research.

Table 2. Papers included in this thesis

STUDY, STATUS	AUTHORSHIP	PUBLICATIONS	PURPOSE	CONCEPT	EMPERICS	MAIN FINDINGS
Paper 1, approved and published	Single author	Olsson, O (2018). ICT as a driver of innovation: a life-cycle approach. I: Karlsson, C., Cornett, A.P. and Wallin T. (edt.), Globalization, International Spillovers and Sectoral Changes. Cheltenham, Edward Elgar Publishing, pp. 154-169	Explore the conditions for innovation based on ICT and innovations	Lifecycle approach	30 peer-reviewed papers	Interaction and collaborations are important conditions for innovation based on ICT. Alliance and production networks, outsourcing, offshoring, and regional clusters are key drivers in the innovation lifecycle.
Paper 2, not submitted	Single author	Unpublished	Explore the effects on backer behaviors based on evaluation of demand-driven signals during funding windows	Signaling theory	5,965 investments and 415 demand-based signals from 28 successful campaigns	Clarity of feedback loops based on demand-driven signals positively effects investment activity. This reduces investment uncertainty based on interaction before investment decisions.
Paper 3, approved and published	Single author	Olsson, O (2023). Backer behaviors – changing dynamics in equity crowdfunding. Baltic Journal of Management, Vol. 18, Issue 6, pp 1-16	Explore the effects on backer behaviors based on investment dynamics from the distribution of investment decisions	Signaling theory	4,938 investments from 61 successful campaigns	Investment dynamics are U-shaped. The distribution of signals implies that some backers invest early and other wait until all information is available. This reduces investment uncertainty based on interaction and collaboration during campaigns.
Paper 4, approved and published	Single author	Olsson, O (2021). Backer behaviors - an explorative study of investor types in equity crowdfunding. International Journal of Entrepreneurship and Small Business, Vol. 42, No. 1/2, pp 156-168	Explore the effects on backer behaviors based on backer types from portfolio profiles and investment decisions	Portfolio theory	4,938 investments from 61 successful campaigns	Most backers only invest in one company. However, others take higher bets and use portfolio diversification. This reduces investment uncertainty based on collaboration after investment decisions.

2.0 Theoretical framework and gaps in the literature

This chapter develops a conceptual framework based on backer behaviors within the investment decision-making process, aiming to address the management of investment uncertainty during funding windows in an innovative ICT setting. First, it contextualizes early-stage financing and the rise of equity crowdfunding based on ICT and innovation. Second, key corporate finance concepts are presented to visualize what we know and do not know about backer behaviors in managing investment uncertainty in the ECF literature. Finally, this thesis is situated within the literature based on previous findings on decision-making under uncertainty. Potential gaps in each section are identified to motivate the papers and the overarching thesis.

2.1 Early-stage finance and the rise of equity crowdfunding

In the following section, ECF is positioned in this domain. This includes a discussion about key concerns among stakeholders in early-stage finance and implications from ICT and innovation, especially when it comes to backers in the crowd during funding windows.

2.1.1 Early-stage finance and its stakeholders

Funding gaps and capital structures have been studied from many perspectives and at different phases of a firm's funding lifecycle. In contrast to the Modigliani-Miller theorem, Berger and Udell (1987) assumed the existence of information asymmetry. They emphasized the importance of information availability, moderated by firm age and size, in determining the level of information asymmetry (Akerlof, 1970) between entrepreneurs and investors, which has implications for investment uncertainty among all stakeholders. Consequently, information asymmetry during the funding process tends to be low in the case of mature firms (e.g., LM Ericsson) and high for newer firms. To eliminate funding gaps, mature firms with established records and substantial collateral turn to stakeholders in credit markets for debt

(banks) or public markets for equity (institutional investors) because they are accustomed to managing lower levels of investment uncertainty. However, new firms lack these resources and predominantly rely on family, friends, BAs, and VCs. These stakeholders are exposed to higher levels of investment uncertainty, which raises questions regarding how they are managed.

BAs and VCs are sophisticated capital providers in early-stage financing. They have full access to entrepreneurs and possess professional skills for managing high levels of investment uncertainty. Consequently, the period 1980-2010 served as a fruitful testbed for studies examining resource allocation between new firms (entrepreneurs) and sophisticated investors (VCs and BAs) with a focus on the management of investment uncertainty in early-stage finance. This research developed the entrepreneurial finance (EF) literature and added to signaling and portfolio, network, and contract theories (Gorman and Sahlmann, 1982; Kaplan and Strömberg, 2003; Cumming, 2008; Ferrary and Granovetter, 2009), enhancing our understanding of investor behaviors among VCs and BAs. However, findings in the EF literature also highlight some unique features that influence their behaviors differently. Although both BAs and VCs carefully screen (before) and monitor (after) their investments, BAs tend to create closer and less formal agreements with entrepreneurs (Mason et al., 2016; Bonini et al., 2018). Additionally, while both invest in new firms facing high levels of investment uncertainty, BAs tend to invest less in radical innovations or disruptive technologies than VCs. However, they still undertake higher idiosyncratic portfolio risks because they diversify to a lesser degree (Bonini and Capizzi, 2019).

2.1.2 Structural changes in early-stage finance

The 2008 financial crisis paralyzed financial institutions (including VCs and BAs) for years. Hence, as investor behaviors started to change, new firms needed to explore other avenues for early-stage financing. The financial escalator in Figure 2 below offers guidance for this change (Murzacheva and Levie, 2020). Initially introduced in the early 2000s (Osnabrugge, 2000; Reitan and Sörheim, 2000), the concept evolved over time (North et al., 2013; Mason and Pierrakis 2013; Harrison, 2013; Bruton et al. 2015; Baldock and Mason, 2015; Owen et al., 2019) as VCs and BAs changed their behavior. One result of this change was the decision to enter in later stages of business development to reduce exposure to investment uncertainty, as shown in Figure 2 below. In the absence of funding alternatives, governments have also initiated public grants to fund new firms in the conceptual stage, often referred to as the "valley of death" (Lefebvre et al., 2022). This stage is characterized by high levels of information asymmetry. However, supported by ICT and innovation, crowdfunding has become a solution to this situation and is now integrated into this model.

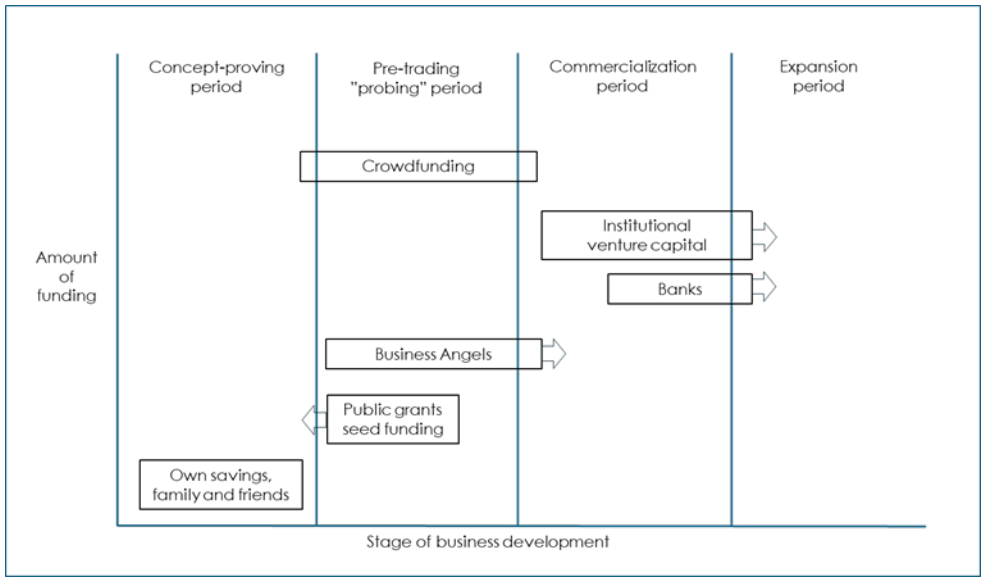

Figure 2. A dynamic representation of the contemporary finance escalator (Murzacheva and Levie, 2020)

During this period, ICT and innovation became important catalysts for the fintech revolution. According to the Swedish National Bank, fintech is a collective term for the interaction between financial operations and technological innovation (Financial Stability, 2017). This emphasizes the importance of ICT and innovation in creating new structures in the financial industry, with crowdfunding emerging as a source of alternative financing in this revolution. The literature on industrial dynamics focuses on processes that change industries or create new structures. Burns (1934) visualized these changes in the magnitude of growth rates to separate old and new industries. Product and innovation lifecycles are key elements (Tarde, 1890) in understanding different growth patterns based on the phases in S-shaped curves. According to the literature, product lifecycles focus mainly on product age and the need for new product development. However, innovation lifecycles focus on the design or potential changes across all production stages (Utterback and Abernathy, 1975). In the 1990s, technological development featured in this literature (Romer, 1990; Aghion and Howitt 1993) and general-purpose technology (GPT) was introduced (Bresnahan and Trajtenberg, 1992). A GPT (for example, ICT or the Internet) can be seen as long technological wave that affects productivity and growth based on innovations in the application sectors. This enables new knowledge production based on interactions and collaboration in the innovation process, with the potential to influence all industries. However, the findings on the effects in this literature are fragmented and lack organization. Paper 1 addresses this gap by adopting a lifecycle approach to better understand the conditions for ICT and

innovation behind structural changes (such as the fintech revolution and crowdfunding in early-stage finance).

2.1.3 Crowdfunding and the importance of ICT

Crowdfunding (CF) is part of a larger concept of crowd sourcing with roots tracing back to the funding of the first English translation of the "The Iliad" in 1713, the support for Mozart's first concerts in the 1780s, and the initial funding of the Statue of Liberty in New York in 1885 (Kallio and Vuola, 2020). However, since the implementation of ICT and the Internet, CF has emerged as a response to high levels of information asymmetry. This emphasizes the collaborative nature of individuals on digital platforms with a common goal: to solve a task, implement a project, or fund an activity. Hence, the key characteristics of CF are collaboration, interaction, and co-determination and are influenced by innovations in ICT, aligning with the aforementioned forces behind ICT-driven innovation and structural changes. Today, CF has become an alternative source of funding in the EF literature (Mollick, 2014). According to research findings, CF is faster and more efficient compared to traditional alternatives (Ahlers et al., 2015). It has three key components: an entrepreneur with capital deficits, a crowd with capital surpluses, and a platform facilitating the connection between the two parties during a funding window (Stevenson et al., 2019).

The CF literature encompasses four streams. First, the donation-based form is derived from charities between non-governmental institutions or private parties (Block et al., 2018). In its pure form, the new firm receives money, but no rewards are offered to the contributors, akin to grants with no expectation of returns (Lehner and Nicholls, 2014). Second, the reward-based model operates on a pre-sales basis, with individuals in the crowd pre-paying for desired products or services (Cox and Nguyen, 2018). The requested contribution amount is based on estimations of the fair market value. Hence, the total funding obtained by the new firm depends on the number of pre-sales and the price per unit. Pebble smartwatches exemplify this model, raising over 10 million USD from 70,000 backers on the Kickstarter platform (Schroter, 2014). Third, lending crowdfunding relies on peer-to-peer or peer-to-business models, where funders receive fixed interest rates as returns on their loans (Lin et al., 2013). Projects are assessed based on their investment uncertainty levels (credit risk) by either platforms or third-party evaluators. Hence, individuals choose the level of uncertainty they are prepared to accept (Paschen, 2017). Fourth, equity-based CF offers individuals shares in return for funding (Walthoff-Borm et al., 2018). This form can be categorized into entrepreneur-led or investor-led equity crowdfunding. Investor-led equity crowdfunding includes accredited investors (VCs, BAs, or sector specialists). They negotiate terms directly with founders before launching campaigns. However, these platforms are often open to members only and not to a broad crowd (Wagner, 2014). Hence, entrepreneur-led equity

crowdfunding is the predominant concept, wherein entrepreneurs establish all terms (valuation and key determinants) before it is offered to the crowd.

In 2020, the aggregated value of CF was worth approximately 113 billion USD (+24%) (excluding China). This implies strong global growth compared to more traditional alternatives in this domain. The first two forms of CF (donation- and reward-based) are categorized as non-investment-based crowdfunding and were worth approximately 8.4 billion USD according to Statisa (2020). The last two forms (loan- and equity-based) are categorized as investment-based crowdfunding and were worth approximately 105 billion, with equity-crowdfunding representing 4.4 billion USD (2020). For a more dynamic view, Cambridge Alternative Finance collected data on platforms offering digital capital raising or lending from 2010-2020, revealing a rapid expansion within this period (from 167 to 1781 platforms), with Europe and Central Asia being key drivers. Lending-based platforms were the dominant mechanism, comprising two-thirds of the total, although both digital lending and capital raising platforms exhibited similar growth rates of 840 percent. ECF has been the rising star as these platforms significantly expanded from 17 to 202 (or 1088% versus 749% in the capital raising group) during this period, as shown in Figure 3 below.

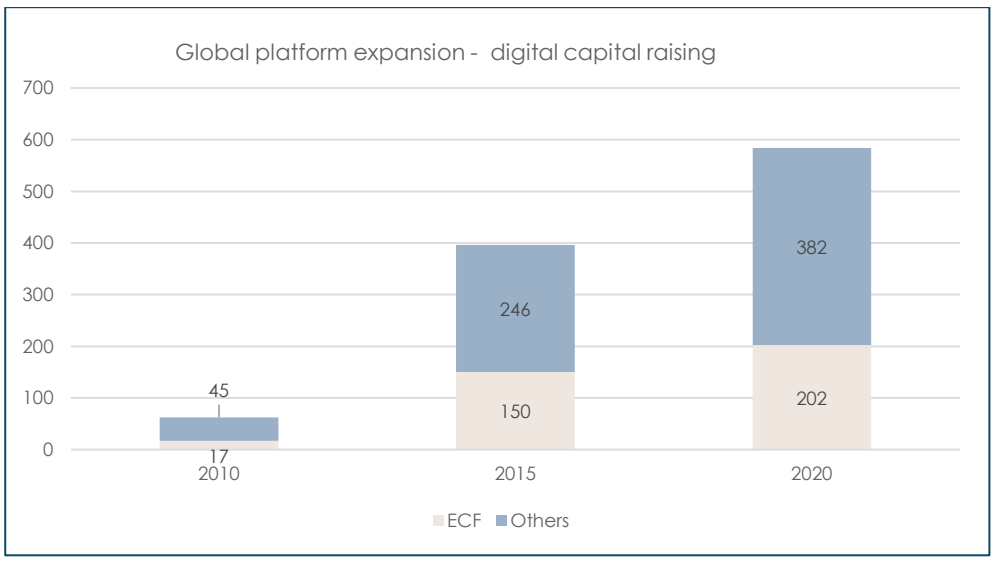

Figure 3. The global platform expansion, digital capital raising, ECF versus other platforms
Source: Cambridge Alternative Finance 2023

Since its inception in 2008, ECF has emerged as an interesting alternative in the early-stage finance domain (Lukkarinen et al., 2022). However, investment uncertainty must be managed in order to become mainstream. Hence, this has

become a priority in typical ECF processes. As the first step in this process, entrepreneurs commonly contact platforms for legal and financial due diligence (Löher, 2018; Schwienbacher, 2019). This emphasizes the importance of managing investment uncertainty through platforms. According to the literature, European platforms accept only 6 percent of venture applicants (Ziegler et al., 2019). Hence, most platforms address this situation using a rigorous pre-selection process to alleviate investment uncertainty for backers (Lukkarinen et al., 2016; Löher, 2018; Cumming et al. 2019; Guenther et al., 2018). If the criteria are fulfilled, entrepreneurs take the next step and prepare their ventures for a campaign launch. This involves campaign preparation and implementation on the platform based on standardized demands for key venture information, which is important for backers during evaluation (Lukkarinen et al., 2016), as shown in Figure 4 below. Subsequently, the pitch goes live, and the funding window opens.

2.1.4 Equity crowdfunding and the important funding window

During the funding window, platforms offer functionalities designed to reduce investment uncertainty. Based on the key concerns raised by backers in this thesis (lack of face-to-face meetings and limited knowledge), discussion boards are an important innovation for releasing the full potential of social capital (Moritz et al.,2015; Estrin et al., 2018). This innovation depends on ICT and enables backers to interact with entrepreneurs and fellow backers on the platform during the six-week campaign window. Backers can ask questions and obtain answers regarding issues of concern that are not available elsewhere. These boards can also release firm updates and third-party recommendations (Dorfleitner et al., 2018; Bapna, 2017). In addition, all backer investments are made public, allowing platforms to show real-time accumulated funding amounts or previous investments during campaigns. This significantly contrasts with initial public offerings and VC or BA fundraising activities, where investors lack the opportunity to engage in discussions with founders or monitor fundraising progress (Vismara, 2016). Hence, these interactive features have the potential to affect backer behaviors regarding the management of investment uncertainty during funding windows.

In addition, most platforms rely on all-or-nothing models. Thus, once the funding window opens, campaigns must reach a minimum funding amount. Otherwise, funds are returned to the backers when the funding windows are closed (Tuomi and Harrison, 2017). Because the minimum amount is vital for the venture to advance in its development, lower amounts would significantly threaten this possibility. This represents another assurance implemented by platforms for backers to reduce investment uncertainty.

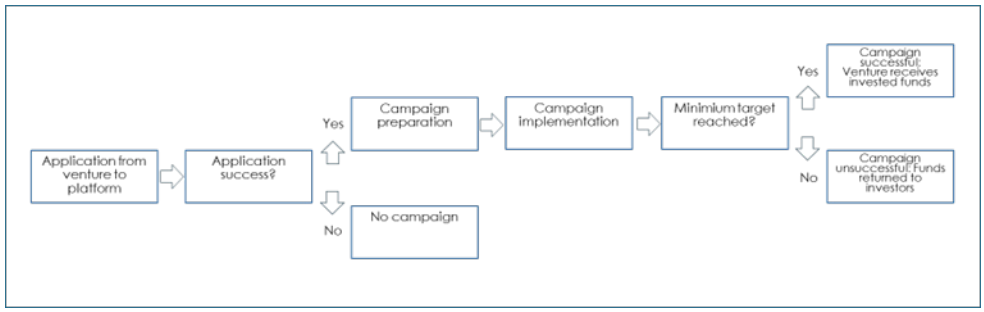

Figure 4. Typical equity crowdfunding process under the all-or-nothing model (Lukkarinen et al., 2016)

This thesis aims to explore backer behaviors in the investment decision process during funding windows. This phase occurs after the campaign implementation when campaigns go live, see Figure 4 above. To reduce investment uncertainty during this phase, backers rely on the unique opportunities embedded in ECF to interact and collaborate. These conditions are pivotal for fostering new knowledge production within networks based on ICT-driven innovations, potentially to influencing their behaviors during funding windows.

However, crowds are heterogeneous. Consequently, conclusions about backer behaviors are complex. According to the literature, backers vary in their level of professionalism and educational backgrounds (Lukkarinen et al., 2016; Guenther et al., 2018). While the majority have no professional backgrounds, there evidence regarding the recurring presence of BAs and VCs (Bessiere et al., 2019; Wang et al., 2019). Additionally, backers are predominantly male, though the share of female backers is rising (Ziegler et al., 2018:2019). Regarding age, the average backer is 40 years old, yet the investment experience varies significantly (Hornuf and Neuenkirch, 2017; Mohammadi and Shafi, 2018; Lukkarinen, 2019). Hence, at the individual level, behaviors are bound to differ because backers range from enthusiasts to professionals. Instead, the behavioral findings in this thesis are based on the group level.

In addition, backer behaviors have been studied regarding motives (Cholakova and Clarysse, 2015; Moysidou and Spaeth, 2016; Bretschneider and Leimeister, 2017; Lukkarinen, 2019) and return on investments (Signori and Vismara, 2018; Vroomen and Desa, 2018). These findings suggest that backers tend to be motivated mainly by financial returns, although minor findings exist regarding altruism, recognition, and image. Hence, while most backers tend to rely on economic rationality, some may adopt a mixed approach. Furthermore, the return on investment in ECF is higher but riskier compared to other investment alternatives in this domain, indicating a risk premium associated with ECF investments. Consequently, at the group level, these findings rely on awareness of investment uncertainty based on economic rationality. However, although this affects backer behaviors, these factors

seem less dependent on interaction and collaborations based on ICT-driven innovations during funding windows. Instead, this thesis explores backer behaviors through evaluations, investment dynamics, and investor types. They are fully dependent on these conditions and provide insights into the management of investment uncertainty during funding windows in relation to established theoretical perspectives.

2.2 Signaling to reduce uncertainty and equity crowdfunding

Investment uncertainty has been studied extensively in the field of entrepreneurial finance. This area is burdened by information asymmetry between entrepreneurs and investors, and translates into investment uncertainty based on adverse selection and moral hazard issues (Akerlof, 1970). Consequently, investors are concerned about making investment choices based on quality and fraud issues. Knight (1921) pioneered this field by distinguishing between risk and uncertainty, emphasizing situations where potential outcomes and probabilities are unknown, a scenario often encountered in early-stage finance. Signaling has become a priority tool for managing this hurdle between entrepreneurs and potential investors. Signaling was first introduced by Spence (1973) to reduce information asymmetries between employers and applicants in job interviews, but the concept was quickly adopted in other contexts, including early-stage finance. Connelly et al. (2011) later delineated the concept into a timeline, including a signaler, signal, receiver, and feedback loop within a signaling environment. This translates into information (signals) between entrepreneurs (signalers) and backers (receivers) as well as additional interactions (feedback loops) in equity crowdfunding (signaling environment). In addition, prior research has highlighted the significance of content, visibility, and cost of the signals. To hold value, signals must not only be understandable and recognizable, but also reduce the search cost for backers (Block et al., 2018; Dorfleitner et al., 2018). This emphasizes the importance of ICT and innovation in ECF, as all signals are released on digitalized platforms accessible to all participants. Furthermore, signals can be either supply- or demand-driven. This means that they are sent from either a venture (supply-driven) or a unique backer (demand-driven). Supply-driven signals are important for backer decision-making, but demand-driven signals give backers the opportunity to fill potential gaps before they decide. In summary, signaling helps backers manage information asymmetry in ECF, facilitating the study of backer behaviors in the investment decision process and contributing to the management of investment uncertainty.

2.2.1 Quality signals released before and during funding windows

The ECF literature is dominated by findings on the determinants (supply-driven signals) of funding success from a firm's perspective. This comes in the shape of investment memorandums or video presentations on the platform in the implementation phase before the campaign windows open. The literature emphasizes the importance of business models or financial outlooks, especially targeting human capital, social capital, and equity retention as quality signals to invest (Ahlers et al., 2015; Vismara, 2016; Nitani and Riding, 2017; Angerer et al., 2017). Shafi (2019) built upon these findings by exploring the relative weight between the key content of signals for backers in the decision-making process. This study drew on findings from the EF literature (VCs and BAs) and used data on campaign outcomes (success or failure) from 257 campaigns on CrowdCube and official ratings (third-party) of key traditional content (financial, team, and product/service) released ahead of funding campaign windows. The findings imply that backers ranked information about products and services as well as aspects of the team higher than financials. They concluded that backers lacking experience in assessing complex investment information downplayed the importance of financials. Hence, these supply-driven signals were seen as too complex to evaluate independently. This prompts inquiry into behaviors during the decision-making process during funding windows based on information availability and the possibility of learning about the object through interactions with entrepreneurs or collaborations within the crowd.

Previous research has emphasized the importance of active firm update communications (Dorfleitner et al., 2018; Block et al., 2018) and third-party recommendations (Ralcheva and Roosenboom, 2016; Bapna, 2017) during funding windows. These are all considered to be important quality signals. Based on 71 campaigns and 40,000 investments from different German ECF platforms, Block et al. (2018) suggested that firm updates during campaigns have a positive effect on the number of investments made by the crowd. In addition, Ralcheva and Roosenboom (2016) and Bapna (2017) argued for the importance of certification from others in the crowd. This perspective is now broadened slightly to include supply-driven signals from other stakeholders (not only firm-specific) in equity crowdfunding networks. In this group, investors such as friends and family (Angerer et al., 2017), anchor investors (Li et al., 2016), or sophisticated or strategic backers (Abrams, 2017; Wallmeroth, 2019) are also mentioned as quality signals in the literature. This puts the investor at the center of this discussion. In addition, it raises interest in the pool of knowledge in the crowd (and network externalities) and in how demand-driven signals might affect backer behaviors.

2.2.2 Signaling and backer behaviors based on evaluation

When funding windows are open, backers can ask entrepreneurs (or other backers) questions and obtain answers on transparent discussion boards. These are demand-driven signals and their feedback loops. Moritz et al. (2015) confirmed that backers consider information from discussion boards and Estrin et al. (2018) argued that it represents an important tool in the evaluation process. This emphasizes the importance of interactions but raises questions about different behaviors based on the content of demand-driven signals. In a study based on 754 interactions on CrowdCube, Kleinert and Volkmann (2019) argued that signals from discussion boards have a generally positive effect on crowd participation. However, the findings also implied that out of the nine key themes, financial gained the most attention. The authors also explored qualitative data about valuation, financial snapshots, and likely returns, and revealed concerns about information asymmetries and agency risk. This indicates that interactions based on demand-based signals are important for learning and reducing investment uncertainty in ECF.

Subsequently, Iurchenko et al. (2022) supported the general positive effect of discussion boards. However, based on 264 campaigns and 4,400 discussion threads on the same platform (CrowdCube), there were no observed differences between topics. Although there is a consensus that demand-driven signals from discussion boards increase participation (and reduce investment uncertainty), conflicts remain concerning the effects of different types of content. One way to address this situation is to explore linguistic styles (clarity) or other psychological properties (sentiments) underlying the language on discussion boards. This type of approach has been successfully used to better understand the effect of supply-driven signals on backer behaviors in firm news updates in ECF (Block et al., 2018). It has also been used to address this issue in the case of demand-driven signals from discussion boards in rewards-based crowdfunding (Courtney et al., 2017). However, little is known about the effects of this content on demand-driven signals in ECF. Hence, Paper 2 intends to fill this research gap regarding backer behaviors in the evaluation process.

2.2.3 Signaling and backer behaviors based on investment dynamics

Other studies have focused on investment dynamics and backer behaviors, offering insights into when investment decisions occur during funding windows, but also why they occur at specific points in time. This stream of literature includes findings on early investment and related herding behaviors (Vulkan et al. 2016; Vismara, 2018; Åsterbro et al., 2019). Early investments refer to backers investing directly when funding windows open, creating a momentum by signaling from entrepreneurs (signalers) to backers (receivers) before the funding period begins. This is called the private phase (Åstebro et al., 2019) and includes the aforementioned lead investors (anchors), family, and friends (Angerer et al., 2017; Li et al., 2016). It suggests not

such much a need for more information (or interaction with others) to reduce investment uncertainty during funding windows, but rather triggers others to follow immediately and can be viewed as a collaboration. Hence, anchors, family, and friends transform from receivers to signalers based on their early investment activities and create herding behaviors which further strengthens the early investment phenomenon (Vismara, 2018; Åstebro et al., 2019). Hence, some backers rely on investment dynamics observed through platform functionalities and imitate others when they invest to reduce investment uncertainty.

Hornauf and Schwienbacher (2018) added to this discussion based on findings from a German study. They claimed that investment patterns are L-shaped on platforms using the first-come, first-served mechanism (FCFS) based on uncertainty over share supply, while they exhibit U-shapes on platforms using the action mechanism based on uncertainty over bidding power. Hence, different share allocation mechanisms trigger different behaviors during funding windows. However, Correia et al. (2019) observed significant investment activity at the end of successful funding windows using the FCFS mechanism. This suggests a potential U-shaped curve on platforms using the FCFS mechanism. Because prices are fixed, this behavior is hardly connected to the uncertainty of bidding power. Paper 3 explores this conflict in investment dynamics to better understand the different behaviors regarding when backers invest during funding windows and its implications for the management of investment uncertainty.

2.2.4 Signaling and backer behaviors based on different investor types

Finally, a separate stream of the literature has tried to elaborate on investor types and how they affect backer behaviors in the investment decision process. These findings are all based on investments from funding windows, but are scattered because the composition of the crowd is less homogeneous (Wallmeroth, 2019). Some of these studies focused on gender and implied that women are more risk-averse than men and invest less frequently in young and high-tech ventures (Mohammadi and Shafi, 2018). Herve et al. (2017) added to this finding by validating risk aversion based on social interactions with others during campaigns. Hence, social interaction is a positive signal for women to participate (and reduce investment uncertainty). Others have focused on geographic distance and argued that local bias tends to be found only among home country backers (Guenther et al., 2018) or among backers that invest large amounts (Hornuf and Schmitt, 2016). Regarding the level of sophistication, Abrams (2017) argued that new legislation has brought more experts from the financial industry to ECF, and that they tend to invest late during funding campaigns (to reduce investment uncertainty). Still, although sophisticated backers (more strategic and based on personal wealth)

represent the majority of the funding amount, they are still a minority in terms of the number of investments in ECF (Wallmeroth, 2019).

Hence, behaviors differ significantly, but the findings are still nascent and fragmented, especially concerning investor types. Consequently, there is much more to explore regarding the management of investment uncertainty. To address this situation, further research on different backer behaviors is required. In addition, this stream lacks diversity from a theoretical perspective. Portfolio theory has been used successfully to understand investor behavior in other domains (see below). Hence, this is introduced as a potential avenue for future research.

2.3 Portfolio theory to reduce uncertainty and equity crowdfunding

Portfolio theory, first established by Markowitz (1952), revolutionized our view on investments, compelling investors to consider individual investments as part of a larger investment portfolio. He showed that diversification can partly reduce portfolio risks. Hence, by adding additional investments to a portfolio, risk can be minimized to approach systematic risk, and the expected return can be maximized. In contrast to inefficient portfolios, efficient portfolios give investors the opportunity to choose portfolios with maximized returns based on the desired risk, or portfolios with minimized risk based on the desired returns. Hence, according to the mean-variance framework, rational investors always choose portfolios that maximize the expected return per risk unit. Sharpe (1963) and Merton (1969) extended this theory and established its importance for academic financial research and institutional portfolio management in the financial industry.

2.3.1 Portfolio theory and backer behaviors based on investor types

A growing stream of literature focuses on individual investors. Elton and Gruber (1997) argued that modern portfolio theory is important when institutions serve individual investors, and Rubinstein (2002) suggested that individual investors tend to employ it in their portfolio choices. Abrahamson (2016, 2018) further extended this stream of literature by using portfolio theory to examine the behaviors of individuals that enter the stock market (rookies). The findings suggest that their portfolios are mostly less diversified and that they are more attracted to initial public offers compared to non-rookies. Findings on individual investors based on portfolio theory in early-stage funding include BAs and VCs (Bartkus and Hassan, 2009; Bock et al., 2022). However, these are sophisticated investors and do not carry the

same load of key concerns raised in this thesis regarding ECF backers (lack of face-to-face meetings and skills).

In ECF, there is a lack of research on different behaviors based on backer type and portfolio theory. Vroomen and Desa (2018) used portfolio theory to compare the rate of return for efficient portfolios in private equity classes (VC, BA, and CF) and argued that CF portfolio returns on investment are at least 28 percent but 10 percent riskier than BA portfolios. This provided insights into the varying behaviors among different investors in the EF domain. However, it reveals less about the different behaviors among ECF backers. In addition, Blagoev and Petkov (2019) used portfolio theory to create a conceptual methodological model for the selection of portfolio investments based on previous findings on key concepts in the literature. This created possibilities for a general discussion on investment selection. However, empirical data from real-life cases are lacking in exploring the different behaviors for conclusions about the management of investment uncertainty based on collaborations between assets. Paper 4 intends to fill this research gap with the potential to extend our knowledge of portfolio theory through the contribution of backer perspective.

2.4 Decision-making under uncertainty and equity crowdfunding

Research about decision-making under uncertainty has developed over time. The next section aims to shed some light over this development which has been a fruitful testbed to establish important theories in this area of research. However, this also reveals research gaps in this literature especially when it comes to backer behaviors in the investment-decision process.

2.4.1 Rational and bounded rationality

Previously, economic decision-making was the only option for rational decision-makers. It was normative and focused on the utility measured by the outcome. Game theory (von Neumann and Morgenstern, 1947) has become a rational way to make decisions about real-life problems using mathematical methods. Hence, decisions were focused on profit maximization or loss minimization. This aligns with Black (1921), who separated risk from uncertainty by measurability based on the probability of future outcomes, paving the way for other neoclassical papers, such as portfolio selection (based on optimization) and the capital asset pricing model (Markowitz, 1952; Sharp, 1964) with a significant lasting impact on the financial industry.

However, decision-making theory is not concerned only with normative economic decision-making (Arnott and Gao, 2019). It also concerns descriptive behavioral decision-making, which was transformed into behavioral economics (B.E) in the 1950s. Consequently, the focus changed from "how we ought to think" to "how we do think" according to Steven Pinker. Early B.E was initiated by Simon, who focused on humans and situations during the decision-making process. He refused to accept that decision-makers (economic men) could make rational decisions based on perfect information, as they have information processing limitations. In addition, they have different characteristics and do not have the ability to make optimal decisions. Instead, they make the best decisions for each situation.

Hence, he transformed "rationality" into "bounded rationality" and argued that decision-makers decide based on heuristics and rule of thumb. This marked the beginning of the early behavioral economic era. Simon configured the phase model as a descriptive decision-making model. This model attempts to explain the decision-making process with respect to bounded rationality and includes three phases (intelligence, design, and choice). Intelligence includes searching and collecting data in the environment, while design encompasses inventing, developing, and analyzing possible courses of action, and choice includes selecting a particular course of action from those available. The phase model is a staged, iterative, and recursive decision-making model that is well-established in the management business literature.

2.4.2 Contemporary behavioral economics

However, a new set of psychological scholars (Tversky and Kahneman, 1974) subsequently began to use experimental research methods to better understand human decision-making. They tested an economic man in the laboratory for heuristics and cognitive biases. This has paved the way for economists such as Akerlof (1970) and Spence (1973) to study information asymmetry and signaling, respectively. In other words, bounded rationality, heuristics, and cognitive biases are the beginning of contemporary BE. It has two foundations: the dual-process theory of decision-making cognition, and a set of heuristics and cognitive biases.

The first foundation stipulates that decision-making occurs within and between two cognitive systems, labelled System 1 and System 2. System 1 works like a reflex movement; it is fast and unconscious but based on intuition and can be best described as a gut feeling. In contrast, System 2 works slowly; it is controlled and can best be described as a rule-based analytical tool to assure quality in the decision-making process. Both systems can work simultaneously and interact, but System 2 requires much more resource allocation. System 1 is the product of human evolution (for example, run when you are in danger), while System 2 is a product of education or social and family interactions. However, System 2 tasks can be gradually

transformed into System 1 tasks based on the practice and development of experience.

The second foundation of contemporary B.E comprises heuristics and cognitive bias. This enabled us to delve deeper into the System 1 decision process. Heuristics are the fuel of effectiveness in this system, and cognitive biases are byproducts that increase the risk of failure in the decision-making process. Tversky and Kahneman addressed three general heuristics as support for decision-making. These are all part of the human brain and can be easily accessed while decision-making (availability, representativeness, and adjustments/anchoring). According to Pinker, the by-products of heuristics are biases. This is a cognitive or mental behavior that reduces the decision quality of System 1 processes. Tversky and Kahneman perceived them as failures of general heuristics, whereas others view them as separate cognitive biases that systematically disturb the decision-making process (confirmation and overconfidence).

2.4.3 Backer behaviors and the investment decision process

According to the crowdfunding literature, Hoegen et al. (2018) gathered some preliminary pieces to this puzzle for a framework about investment decision-making.

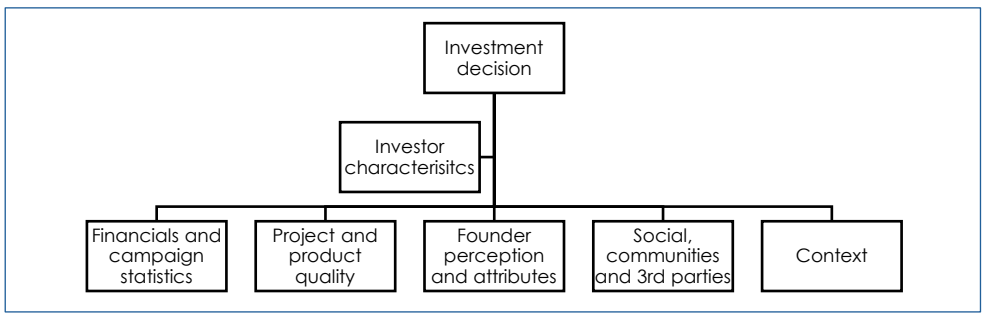

Figure 5. Crowdfunding decision-making framework (Hoegen et al., 2018)

They emphasized the importance of cognitive behaviors and clustered 68 articles into five themes (financial and campaign statistics, project and product quality, founder perceptions, social communities, third-party recommendations, and different contexts). Hence, the themes are all important in the investment decision process, but are moderated by investor characteristics (backer types). Driven by different motives (Cholakova and Clarysee, 2015), this suggests different backer behaviors among crowdfunding forms. However, Hoegan et al. (2018) noted that

social dynamics (wisdom of the crowd), third-party endorsement (expert knowledge), and platform contexts (the affordance of ICT-driven features and functionalities) are key differences between this process and traditional investors (VCs and BAs) in the EF domain, see Figure 5 above. In contrast to the first three themes, the latter two were highly dependent on the funding window. To understand the effects of these themes, additional research based on data from an important funding window is needed to explore different behaviors in the investment decision process.

Hence, this thesis focuses on backer behavior in the investment decision process. They address different elements (evaluation, investment dynamics, and investor types) that are important for backers when investing during funding windows. This enables the management of investment uncertainty during the selection phase of this process. Additionally, we know little about how they are sequentially linked. Shafi (2019) attempted to address this but focused only on evaluation based on data from the campaign implementation phase (before the funding windows open) to better understand the final investment decision. Furthermore, Lukkarinen et al. (2016) paid more attention to what happens before and after an important funding window (see Figure 4). Consequently, we know less about the process of these potential dynamic effects that take place when campaigns go live and their implications for backer behaviors when it comes to the management of investment uncertainty.

This thesis aims to address these research gap, which have potential to extend current research on the decision-making process in this domain. It does so by sequentially synthesizing papers for an overall view of this process based on data generated solely by interaction and collaboration from ICT-driven innovations during an important funding window.

3.0 Methodology

The research in this thesis is designed to explore backer behaviors in the investment decision process for conclusions about the management of investment uncertainty during the important funding window. To do this, a main research question was formulated, supported by four sub-questions to guide this process forward. This design was used to explore these behaviors in different stages of the investment decision process based on interaction and collaboration from ICT-driven innovations.

To answer the research question in this thesis, findings about backer behaviors rely on effect studies, and this raises questions about causality. Causality is important in effect studies and decides the strength of the relationship between independent and dependent variables and, ultimately, the actual effect. Hence, how can we be sure that a change makes a difference? These types of studies depend on comparisons between two groups. In a perfect world, the groups are identical and only differ when it comes to one specific reason with the potential to make an effect. However, in real life, there are challenges when it comes to selection skewness and data access and availability, which might impact the results.

As an example, if we look for the effects of tax reductions on green investments, there will hardly be a random search among applicants. Hence, the characteristics and ambitions of this group will most likely be similar, in contrast to those of the comparison group based on non-applicants. This might affect the results based on self-selection skewness. Furthermore, if an administrator approves applicants based on personal wealth, this will also have the potential to affect the result based on administrator-selection skewness. However, there are also concerns when it comes to data and availability. Hence, the effect can be measured differently, or data can be hard to attain. Hence, some would argue that the most important effect from the aforementioned example would be environmental, while others would argue that economic effect is a priority. In addition, there might be problems getting information about driving distances or styles (who drives the car?) from this period, creating concerns about data availability over time.

To collect relevant data for the research questions in this thesis, findings about backer behaviors (Papers 2-4) depend on observation studies and not on conducted experiments. Consequently, I did not decide on the events in the studies, which made conclusions about different behaviors harder. Instead, I have observed and collected empirical data from real-life cases on an equity crowdfunding platform

(FundedByMe) based on downloading and coding that data. In these observation studies, causality depends on group comparisons and statistical methods. This raises questions about potential selection skewness. However, these findings all depend on population data from FundedByMe, which eliminated this concern. Hence, I did not randomly select campaigns or funding activities but instead collected data from the entire population on the platform. When it comes to potential concerns about data availability, this is normally problematic in this stream of literature since data limitation is a key reason for less knowledge about backers and their behaviors. This limitation is based on the protection of data about platform members. Consequently, most findings are instead based on surveys among backers but with less success when it comes to conclusions about their behaviors (Schwienbacher, 2019).

However, during funding windows, ICT-driven innovations release a lot of data. Hence, findings from these studies are based on such data, which is traceable, open, and publicly available on the platform FundedByMe. This strengthens findings about behaviors in these papers as they are available and based on experienced preferences (archive data) instead of expectations (attitude data). Consequently, and as a response to the lack of findings about backer behaviors based on empirical data, the design of the empirical studies in this thesis was based on new empirical data relevant to the research questions. However, the ambition is to contribute to the existing literature about backer behaviors in the investment decision process for conclusions about the management of investment uncertainty. Hence, it is of priority that findings from the studies can be used to generalize the understanding of their behaviors as investors. Consequently, this thesis's research findings aim to be generalizable. Quantitative methods are therefore used to draw general conclusions.

The methods used are established within this stream of literature. Paper 2 used multivariate regressions to test the causal relationship of what factors determine backer behaviors (Block et al., 2018; Dorfleitner et al., 2018; Kleinert and Volkmann, 2019; Goethner et al., 2021; Iurachenko et al., 2022). Whereas Paper 3 instead used t-tests and one-way ANOVAs, to analyze if behaviors differ between groups (Li et al., 2016; Feola et al., 2021) in contrast to, paper 4, which relied on descriptive statistics. Consequently, the papers on an overall level in this thesis rely on a positivistic perspective. For further references about the methods used for results and findings to the different research questions, see the respective papers.

Findings from the observational studies, i.e. Papers 2-4, are based on one dataset. However, the data in this set has been collected in different periods and is based on different variables from FundedByMe. This has implications when it comes to both reliability and validity. As mentioned above, the data is publicly available on the platform. Consequently, investment patterns can be reproduced in line with procedures detailed in each paper. This strengthens reliability over time when it comes to findings about different behaviors during funding windows. In addition, when it comes to validity, this also enabled analysis of behaviors based on different methods appropriate for different phases of the investment decision process

according to this stream of literature (Papers 2-4). Furthermore, this also enabled the analysis of behaviors based on dynamics measured by the same method but with different time horizons (Paper 3). This had the potential to reveal additional findings but instead confirmed the results, which also reduced concerns over causality. Lastly, findings based on statistical models increase the requirements for control variables. Hence, by choosing methods that allowed control variables important for behaviors in this stream of literature, validity was further strengthened (Papers 2 and 3). Consequently, funding effects from sentiment and clarity embedded in demand-driven signals (evaluation) and the timing of investment decisions (dynamics), were carefully controlled by alternative factors important for behaviors.

Findings in Paper 1 are, however, not based on empirical data. Instead, as an approach and method, it relied on a systematic literature review based on previous findings about ICT and innovation to understand key conditions for this phenomenon to occur. This is in line with the protocol outlined by Transfield et al. (2003) to secure reliability and was used as an inspiration when it came to the definition of search string and the set-up of inclusion criteria.

To summarize, with an ambition to answer the research question in this thesis, findings about backer backers rely on a quantitative approach to explore their behaviors in different phases of the investment decision process during funding windows. This approach has previously been used to explore different behaviors (Block et al., 2018; Dorfleitner et al., 2018; Kleinert and Volkmann, 2019; Cho et al., 2019; Goethner et al., 2021; Iurachenko et al., 2022) during funding windows and captures potential effects from ICT-driven innovations. Furthermore, conclusions about their different behaviors draw on established theoretical perspectives previously used in this domain over time (Gorman and Sahlmann, 1982; Kaplan and Strömberg, 2003; Cumming, 2008).

4.0 Empirical context

Paper 1 focused on findings concerning ICT and innovation in the industrial dynamics literature. The study included 30 peer-reviewed papers from ranked journals published between 2000-2015. Due to a lack of literature reviews, they were collected to explore the potential effects of ICT on the innovation process and its ability to create structural changes. According to Rowley and Slack (2004), key papers for literature reviews are best identified online using keyword searches. In this paper, the search terms "ICT," "Innovation," and "Industrial dynamic" were used to identify approximately 60 papers on Google Scholar. Subsequently, papers lacking all specified search terms were manually excluded, leaving a selection of 30 well-cited papers. These were then clustered and positioned using an innovative lifecycle approach based on interactions and collaboration.

Findings on backer behaviors (Papers 2-4) were based on data exclusively generated during funding windows and hand-collected from the Swedish equity crowdfunding platform, FundedByMe[1]. According to Cambridge Alternative Finance (2020), the Swedish equity crowdfunding market was worth approximately 30 million USD in 2018. Hence, it is a small market from a global perspective, but has grown significantly (from 15 million USD in 2015). In addition, in contrast to other countries in the global market, ECF dominates the regulated investment-based crowdfunding market in Sweden (SOU, 2018), supporting previous findings on a potential pathway to maturation (Lukkarinen et al., 2022). Furthermore, FundedByMe do not pre-select campaigns. Instead, entrepreneurs decide on content and terms. This contrasts with most platforms in ECF and other crowdfunding alternatives. Hence, when most platforms perform their due diligence, they rely on a professional and established screening process to assess financials, products/services, and management, thereby reducing uncertainty concerning adverse selection and moral hazard issues. Consequently, this situation has enabled studies based on data from a regulated market and a platform that did not pre-select firms in need of early-stage funding. Investors were expected to understand that they were investing in an established risk capital market, yet the platform shifted a significant portion of investment uncertainty onto backers, potentially influencing their behaviors.

Paper 2 included time-stamped backer investments, backer questions, and entrepreneur answers from discussion boards based on 28 successfully funded campaigns during 2020-2021 to explore the effect on backer behaviors regarding

evaluations made during funding windows. The data included 5,965 backer investments, 415 interactions between backers and entrepreneurs, and 1,786 funding days. It enabled the identification of different backer behaviors based on investment activities from sentiment analysis (based on the Azure Cognitive Service for Language) and clarity assessments (based on the Flesch-Index) of supply-driven signals, previously only explored among supply-driven signals (Block et al., 2018; Dorfleitner et al., 2018).

Papers 3 and 4 used data derived from time-stamped backer investments and campaign characteristics to analyze investment patterns and portfolio configurations, thereby exploring different backer behaviors based on investment dynamics and backer types. The dataset included 4,938 investments from 3,584 unique backers. It also included data from 61 campaigns based on firm names, sector identifications, funding amounts, number of new shareholders, equity retention, and funding periods (2013-2016). Paper 3 enabled the creation of investment patterns for findings about different backer behaviors observed in funding windows, which was previously only conducted by Schwienbacher and Hornuf (2018). Paper 4 enabled the creation of backer portfolios (seen as a backer characteristic) for findings on different behaviors based on the level of investment uncertainties.

[1] Currently, FundedByMe is incorporated into the Swedish crowdfunding platform Pepin AB. Hence, this unique dataset is no longer publicly available. In contrast to FundedByMe, all ventures on PEPIN are screened and preselected by the platform.

5.0 Summary of papers

This thesis comprises four papers. Paper 1 explored the importance of ICT and innovation for structural changes, and organized the key drivers of innovation using a lifecycle approach. Paper 2 revealed the importance of demand-based signals from discussion boards when evaluating backers. Paper 3 drew on signaling theory to explore different behaviors when backers invest during funding windows. Paper 4 drew on portfolio theory to understand backer behaviors based on portfolio configurations.

Paper 1, "ICT as a driver of innovation: a life-cycle approach" is a single authored paper and has been published as a book chapter in "Globalization, International Spillovers and Sectoral Changes" by Edward Elgar Publishing, Cheltenham, UK.

Paper 1 explored the effects of ICT on innovation in the industrial dynamics literature. These effects are important for new knowledge production based on interaction and collaboration and have the potential to create structural changes. This paper presented key studies and introduced the importance of the lifecycle approach in the literature. In addition, it demonstrated the importance of ICT for innovation and its connection to knowledge production systems. This study also organized 30 peer-reviewed papers into clusters positioned in the innovation lifecycle to better understand the effects of ICT on innovation.

The findings suggest that ICT significantly affects innovation and that the key drivers are alliances and production networks, outsourcing and offshoring, and regional clusters. These drivers are based on interaction and collaboration, and are organized in the innovation lifecycle from a holistic perspective to better understand the sequential effects. However, the magnitude of the effects of innovation is difficult to measure and seems to depend on learning strategies.

This study contributes to this thesis by providing a better understanding of the conditions for ICT and innovation that lead to structural changes. In addition, it provides support for additional studies on the different factors behind backer behaviors in Papers 2-4. Equity crowdfunding is an example of structural change in early-stage finance. Hence, it is important to understand the importance of interactions and collaborations for new knowledge production that leads to a structural change when exploring the key factors behind different backer behaviors and to draw conclusions about how investment uncertainty is managed in equity crowdfunding.

Paper 2, "Backer behaviors – the value of demand-based signals in the equity crowdfunding evaluation process", is a unpublished and single authored paper.

Paper 2 explored the funding effects of the embedded values hidden in demand-driven signals from discussion boards. It drew on signaling theory to better understand the content and effects of these signals in the evaluation process and their implications for backer behaviors. This paper presented the current conflicts in this stream of the literature to motivate the study. In addition, it used regression analyses to estimate the effects of sentiment and clarity of demand-driven signals on crowd participation. The data was based on 415 interactions and 5,965 investments (2020-2021) from the Swedish equity crowdfunding platform FundedByMe.

The findings suggest that the sentiment embedded in questions has less of an effect on crowd participation. However, the level of clarity in answers significantly increases investment activity. Hence, clarity in feedback loops generated from demand-based signals is important for backer behavior in ECF and has the potential to reduce investment uncertainty.

This study contributes to this thesis by providing additional knowledge about how backers behave when evaluating potential investments, as part of the first step in the investment decision-making process during funding windows in ECF. In addition, demand-driven signals (and their feedback loops) are generated by backer questions (and entrepreneur answers) on digitalized discussion boards on ECF platforms. This innovation is based on ICT to increase knowledge production from interactions among backers to reduce investment uncertainty.

Paper 3, "Backer behaviors – changing dynamics in equity crowdfunding" is a single authored paper and has been published in the Baltic Journal of Management.

Paper 3 explored when backers invest during funding windows. It has the potential to extend our knowledge of signaling theory based on ECF and addresses conflicts about investment dynamics in this literature. Paper 3 contrasts with Paper 2 in that it changed the focus from content to the distribution of signals during funding windows. This enables findings on different backer behaviors and implications in the management of investment uncertainty. The study used t-tests to compare different phases of the funding window based on data from 4,938 investments and 3,584 backers (2013-2016) hand-collected from the Swedish crowdfunding platform FundedByMe.

These findings imply that investment patterns are more U-shaped than L-shaped in ECF that use the dominant FCFS mechanism. Hence, it confirms the importance of early investments but also focuses on late investments. This enables potential herding behaviors at the latter end of successful funding windows, which were previously found only in the early stages. However, it also suggests that some backers wait until all the information generated during the funding window is

available before they invest. This correlates with more sophisticated behavior (Abrams, 2017) to reduce investment uncertainty.

This study contributes to this thesis by understanding how backers behave in terms of the distribution of investments. This is part of the second step in the investment decision-making process during funding windows in ECF. In addition, investment dynamics are generated by backer investments with the help of digitalized functionalities (discussion boards and campaign funding meters) on the platform. These innovations are based on ICT to increase knowledge production through interaction and collaboration based on signaling and potential herding effects among backers to reduce investment uncertainty.

Paper 4, "Backer behaviors - an explorative study of investor types in equity crowdfunding" is a single authored paper and has been published in the International Journal of Entrepreneurship and Small Business.

Paper 4 explored different backer behaviors based on the configuration of portfolio investments. It has the potential to extend portfolio theory based on ECF while also broadening the literature based on an additional theoretical perspective. Hence, Paper 4 differs from Papers 2 and 3 by using portfolio theory to better understand backer behaviors. It focused on investor types to better understand different behaviors based on portfolio configurations. The study was based on 4,938 investments from 3,584 backers (2013-2016) from the Swedish equity crowdfunding platform FundedByMe.

These findings suggest that most backers invested in only a single asset. Consequently, only a minority in the crowd creates portfolios with more than one asset. However, this minority invests in assets that carry relatively more uncertainty than the majority. Hence, they possess more aggressive investment behavior than backers, who create portfolios with only one asset. Simultaneously, portfolio diversification compensates for this aggressive behavior. This effect reduces portfolio uncertainty and is similar to the behavior found among more sophisticated investors in the EF domain.

This study contributes to this thesis by providing additional knowledge about investor types to better understand backer behaviors. This is the third step in the investment decision-making process, which is based on investments made during funding windows in ECF. Portfolio holdings are based on backer investments and are generated and visualized by digitalized functionalities (discussion boards and backer portfolio sections) on ECF platforms. These innovations are based on ICT, which increases knowledge production through collaboration between assets used by backers to reduce investment uncertainty.

6.0 Analysis and discussion

The four papers included in this thesis contribute to various streams of literature. However, collectively, they have the potential to respond to the research question posed in this thesis. Therefore, in the following section, these papers will be synthesized into a conceptual model of investment decision-making based on ICT and innovation to draw conclusions about the management of investment uncertainty. Furthermore, concerning backer behaviors, the findings at each stage of the investment decision-making process will be discussed in relation to previous findings in the literature.

6.1 The synthesis of a conceptual model for decision-making in equity crowdfunding

Paper 1 constitutes the foundation of this model and introduces the conditions for ICT and innovation that have the potential for structural change. In this paper, findings were clustered and positioned in the innovation lifecycle, emphasizing that new knowledge production depends on interaction and collaboration. Alliance and production networks are two clusters positioned early in the innovation lifecycle that depend significantly on these conditions. Based on a lifecycle approach, this correlates with ECF in early-stage financing and emphasizes the importance of interaction and collaboration for new knowledge production in networks, a phenomenon fully realized through the opportunities inherent in ECF (Hoegan et al., 2018) during funding windows. This significantly differs from traditional decision-making in this domain and supports additional studies on backer behaviors based on evaluation, dynamics, and investor types (in contrast to motives and return on investments). Papers 2-4, instead, explored backer behaviors at different stages of the investment decision-making process based on interactions and collaborations enabled by ICT and innovation. These studies differ in terms of behaviors based on evaluation, dynamics, and types, but are interconnected within the conceptual model of investment decision-making during important funding windows when campaigns go live, see Figure 6 below.

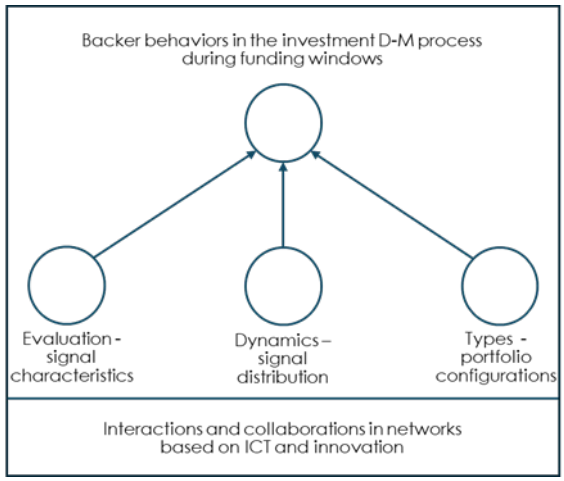

Figure 6. Conceptual model about behaviors in the investment decision-making process

The conceptual model was inspired by the phase model (Simon, 1955) from early BE literature. Simon's phase model comprises three phases (intelligence, design, and choice), and is based on bounded rationality. This conceptual model also includes a three-step process (evaluation, dynamics, and types) sequentially linked together. All steps reveal different investment behaviors based on interactions or collaborations during the crucial funding window. "Intelligence" and "design" include both search and collection of data, and analysis of potential courses of action. These phases correspond to the initial "evaluation" phase, where conclusions are drawn based on the content gleaned from discussion boards based on signaling theory (Paper 2). The next phase, "dynamics," has no direct correlation to Simon's original model, but offers conclusions about the distribution or timing of the investment based on investment dynamics and signaling theory (Paper 3). Lastly, "choice" includes the selection of a course of action. This is connected to the last phase, "types," and enables conclusions regarding how backer portfolio configurations influence investment choices based on portfolio theory (Paper 4).

This conceptual model is positioned following the campaign implementation phase within the typical process of equity crowdfunding (Lukkarinen et al., 2016) and focuses on investment decision-making based on data from an important funding window, an aspect previously neglected by Shafi (2019). In response to the research question posed in this thesis, a set of sequentially coordinated findings on dynamic funding effects from different backer behaviors have been synthesized (Papers 2-4). These behaviors have been affected by key conditions in ICT-driven innovation (Paper 1) facilitated by the unique opportunities in ECF (Hoegan et al., 2018) to reduce key concerns among backers. This enables the derivation of conclusions about the management of investment uncertainty in relation to established theories.

Hence, this model emphasizes that backers, based on behaviors at the group level, tend to use a variety of techniques (see the findings below) to manage investment uncertainty during funding windows. These techniques depend on interaction and collaboration based on ICT-driven innovations available during funding windows to reduce concerns among backers in the absence of face-to-face meetings and a lack of skills.

6.2 Findings about backer behaviors in the conceptual model

The first step of this conceptual model focused on behaviors based on the evaluation of information from discussion boards when campaigns go live (Paper 2). This suggests that sentiments in backer questions (demand-driven signals) are less important, but clarity in entrepreneur answers (feedback loops based on demand-driven signals) are more important when backers evaluate. This aligns with previous findings on news updates (supply-driven signals) released by entrepreneurs during funding windows (Block et al., 2018; Dorfleitner et al., 2018). More importantly, it adds a new dimension to the findings on behaviors based on content and the effects of demand-driven signals on discussion boards (Kleinert and Volkmann, 2019; Iurachenko et al., 2022) previously based on more traditional frameworks. Hence, based on signaling theory, clarity in answers reduces investment uncertainty when backers make evaluations during funding windows.

The next step in the conceptual model focused on when backers invest during funding windows and depends on signaling theory (Paper 3). This study explored different behaviors based on investment dynamics and the findings imply that the dynamics were U-shaped. Hence, some backers invest early, whereas others invest later. This contrasts with previous findings of an L-shaped curve based on behavior to reduce uncertainty over share supply (Hornuf and Schwienbacher, 2018). However, this finding supports previous observations about late investment activities during funding windows (Correia et al., 2019) and identifies more sophisticated backers (Abrams, 2017) to reduce investment uncertainty. In addition, this also suggests the potential of late herding effects previously found only at the beginning of ECF funding windows (Vismara, 2018; Åstebro et al. 2019).

The last step in the conceptual model focused on different behaviors based on backer type and relied on the configuration of investments from a portfolio theory perspective (Paper 4). These findings imply that most backers are less sophisticated, confirming previous findings on their dominance in ECF (Wallmeroth, 2019). More importantly, more sophisticated backers tend to be more aggressive when investing during funding windows because they diversify to a larger extent than less sophisticated backers. These different behaviors are supported by separate streams

of literature. First, men are more aggressive than women when investing in ECF (Mohammadi and Shafi, 2018). Second, compared with other investors in the EF literature, VCs also tend to be more aggressive than BAs. However, they manage this higher level of investment uncertainty and tend to diversify to a larger extent than BAs (Bonini and Capizzi, 2019) which correlates with the behaviors of more and less sophisticated backers. Furthermore, "rookie investors" tend to carry less diversified portfolios (Abrahamson, 2016, 2018) versus non-rookies on public marketplaces. This aligns with the aforementioned findings between more and less sophisticated backers. Therefore, while backers tend to be more aggressive than other investors in this domain (Vroomen and Desa, 2018), only more sophisticated backers tend to manage investment uncertainty in a manner akin to VCs and non-rookies, based upon portfolio theory.

7.0 Contribution and suggestions for further research

This thesis aimed to better understand how backers manage investment uncertainty in ECF. This was accomplished by exploring different behaviors in the backer investment decision process during funding windows. The key concerns for backers in this process included the absence of face-to-face meetings with entrepreneurs and a lack of individual knowledge and skills. To address information asymmetry, backers interact and collaborate with others on digitalized platforms during funding windows, including both entrepreneurs and fellow backers in the crowd. This reliance on ICT-driven innovations (discussion boards, investment parameters, and other functionalities) holds the potential to mitigate investment uncertainty in the backer investment decision-making process.

The findings of this thesis indicate that these conditions influence backer behaviors at the group level, allowing for conclusions regarding how investment uncertainty is managed based on established theories in this domain. Theoretical frameworks derived from research on rational decision-making and bounded rationality, heuristics, and biases (von Neumann and Morgenstern, 1940; Simon, 1955; Tversky and Kahneman, 1974) have been applied to delineate different techniques crucial for backers to manage investment uncertainty across different phases of the investment decision process. This enabled the synthetization of a conceptual model for investment decision-making in ECF. The model is based on evaluation, investment dynamics, and investor types, which are all key factors for backer behaviors in the investment decision process. These behaviors are influenced by interactions or collaborations facilitated by ICT-driven innovations and have been sequentially linked together, inspired by a phase model based on bounded rationality (Simon, 1950). Consequently, the model considers key steps in an investment decision process, encompassing both data search and collection, as well as the final choice of action, with the potential to reduce investment uncertainty for backers during funding windows. As a result, this model has the potential to sequentially manage investment uncertainty in the investment decision process during funding windows based on a) the evaluation of clarity from entrepreneur answers, b) the timing of investment decisions, and c) the final choice of investment opportunity based on the level of backer sophistication.

7.1 Theoretical contributions

As mentioned above, this conceptual model for investment decision-making in ECF depends on interaction and collaboration based on ICT and innovation for new knowledge production, which has been previously neglected in the literature. The model also depends on sequentially connected behaviors, informed by data from different phases of the investment decision-making process during the funding window. This not only strengthens previous findings on the significance of social capital (the crowd) and context (functionalities) embedded in ECF (Hoegan et al., 2018) for investment decision-making but also extends this research by delving into investment decision-making beyond previous findings mainly based on data released before or after funding windows (Lukkarinen et al., 2016; Shafi, 2019).

A key implication of this conceptual model for investment decision-making is its potential to mitigate investment uncertainty for backers across various phases of funding windows. Regarding the search and collection of data, this model emphasizes the importance of clarity for backers evaluating investment opportunities. Hence, based on signaling theory, the importance of clarity in demand-driven signals adds to research on backer evaluation and investment uncertainty, which was previously mainly based on quality signals released before funding windows (Ahlers et al., 2015; Vismara, 2016; Nitani and Riding, 2017; Angerer et al., 2017). This study also sheds additional light on the value of interaction on discussion boards that have previously been based on supply-driven (Block et al., 2018; Dorfleitner, 2018) or demand-driven signals within more traditional frameworks (Kleinert and Volkmann, 2019; Iurachenko et al., 2022).

This model also supports backers in timing their investment decisions based on evolving investment dynamics in the ECF landscape. While some backers continue to invest early, others tend to invest late when all the information is available, and herding behaviors may occur. Based on signaling theory, this behavior reduces investment uncertainty in this phase of the investment decision model, supporting previous findings about early investments and uncertainty over share supply (Hornuf and Schwienbacher, 2018) while also expanding research on investment dynamics to encompass behaviors based on late investments. Additionally, it extends research on herding behaviors (Vismara, 2018; Åstebro et al. 2019), which depend on the interaction and collaboration enabled by ICT-driven innovations, such as discussion boards and funding meters, aimed at reducing investment uncertainty during funding windows.

Furthermore, the model has the potential to support backers in their final choices of action. Informed by portfolio theory, the sophistication level (or portfolio configuration) appears to influence investment strategies and ultimately determines the final investment choice in this conceptual decision-making model. Hence, backers with broad portfolios tend to invest in more complex ventures, as portfolio diversification manages investment uncertainty. This enriches research on backer

behaviors based on various investor types and investment uncertainty previously mainly based on gender or distance (Mohammadi and Shafi, 2018; Guenther et al., 2018). Additionally, it expands previous research on sophistication levels (Wallmeroth, 2019) during funding windows or later phases of a firm's funding lifecycle (Abrahamson, 2016, 2018; Bonini and Capizzi, 2019). This is particularly pertinent when drawing conclusions about investment uncertainty based on asset collaboration, facilitated by data generated and visualized by ICT-driven innovations.

7.2 Practical contributions

From a practical perspective, this conceptual model has the potential to navigate ECF backers driven by financial motives in the investment decision-making process during funding windows. The navigation focuses on managing investment uncertainty, and depends on the interaction and collaboration enabled by ICT-driven innovations. Moreover, understanding this model could also guide capital-seeking entrepreneurs by informing their communication strategies and the allocation of important information during different phases of the funding windows, thereby potentially improving the probability of funding success. Consequently, this framework significantly encourages both backers and entrepreneurs to interact and collaborate based on the ICT-driven innovations offered by digitalized platforms in ECF.

As backers prioritize clarity in responses on discussion boards, entrepreneurs must consider not only traditional content related to financials, teams, or products/services, but also other characteristics embedded in these communications. Hence, employing clear language to enhance information comprehension in these interactions will improve the likelihood of funding success. This also broadens the spectrum of quality elements available to backers when evaluating investment opportunities, thereby reducing investment uncertainty during this phase of the investment decision process. Additionally, since this interaction is public, it also has the potential to affect not only the specific backer but also others in the crowd. Furthermore, this dynamic could encourage platforms to further improve the matchmaking process by investing in more innovative and user-friendly tools on discussion boards to streamline entrepreneurs' responses to backers. However, there seems to be less emphasis on sentiments in backer questions. However, these findings were based on a group-level perspective.

Although most backers tend to invest early during funding windows, some invest later. Hence, to improve the probability of funding success, entrepreneurs require a communication strategy that covers the entire funding window. Consequently, there is no room for complacency after the initial road shows and campaign implementation phases. Instead, entrepreneurs must maintain interaction with

backers throughout the entire funding window, as some backers may decide later. Backers increase their possibility of considering all available information when they invest later, thereby reducing investment uncertainty based on economic rationality. However, some backers also tend to observe others before deciding. Hence, platforms could enhance funding activities by creating alternatives to funding meters or discussion boards, and perhaps also illustrate funding patterns during important funding windows.

Furthermore, as backers invest differently based on their level of sophistication, entrepreneurs can leverage this knowledge, which has previously been primarily based on gender or distance. This has the potential to improve guidance for capital-seeking entrepreneurs targeting specific backers in the crowd, based on campaign complexity and portfolio configurations. Hence, if campaigns are more complex, there is a higher probability of funding success among backers with broad portfolios than others. In addition,this study offers various practical implications for backers. Broader portfolios not only imply greater ECF investments but also reduces investment uncertainty based on portfolio diversification (or specialization) in the decision process. This draws on economic rationality and enables a more aggressive investment strategy based on complex campaigns among backers equipped with broad investment portfolios, and vice versa. Consequently, to improve the distribution of funding opportunities (for entrepreneurs) or investment opportunities (for backers), platforms could specialize or create tools that improve the visualization of campaign complexity and portfolio configurations.

7.3 Suggestions for further research

The findings presented in this thesis inevitably carry limitations, which might lead to potential avenues for further research.

First, to extend upon this research regarding the decision-making process based on social capital and contexts embedded in ECF, additional studies should focus on backer characteristics. Backers are at the center of this analysis, and given their varying behaviors, the heterogeneity of the crowd must be further explored. Hence, obtaining broader and more detailed datasets concerning investor types would be invaluable to further understand different behaviors regarding more or less sophisticated backers. In addition, since the backer is seen as the key moderator in the investment decision-making process, a deeper comprehension of their characteristics would also enable further conclusions about the differences and similarities among backers and other investors in this domain. Furthermore, this would also have the potential to expand research on herding behaviors and certification effects, thereby enhancing our understanding of the impact of other investors on the investment decision process in both the ECF and this domain.

Second, the findings on backer behavior in this conceptual model are limited to the group-level perspective. Hence, when transitioning from the group to the individual level, some backers may act differently. Consequently, some backers might appreciate the sentiments in questions (or disregard clarity in answers) during evaluation, while others might invest halfway through a funding window or adopt an aggressive investment strategy, despite being less sophisticated. This triggers isolated investment decisions, in contrast to the aforementioned findings. It could reveal additional behaviors among individual backers with varying degrees of consideration for investment uncertainty and economic rationality. This could prompt further exploration of this literature, based on findings about general heuristics or cognitive biases from contemporary BE.

Third, the findings of this model rely on studies based on quantitative methods and well-established theories in this domain. Hence, future studies might benefit from using qualitative methods to improve our understanding of different backer behaviors during funding windows. Other theories, such as the network theory, could also offer alternative conclusions about the management of investment uncertainty in the investment decision-making process.

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Appendixes

Paper 1 – ICT as a driver of innovation: a life-cycle approach

Published by Edward Elgar Publishing

Olsson, O (2018). ICT as a driver of innovation: a life-cycle approach. I: Karlsson, C., Cornett, A.P. and Wallin T. (eds.), Globalization, International Spillovers and Sectoral Changes. Cheltenham, Edward Elgar Publishing, pp. 154-169

Paper 2 – Backer behaviors – the value of demand-driven signals in the equity crowdfunding evaluation process

Published by Ola Olsson

Olsson, O (2023). Backer behaviors – the value of demand-driven signals in the equity crowdfunding evaluation process. Unpublished.

Paper 3 – Backer behaviors – changing dynamics in equity crowdfunding

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Olsson, O (2023). Backer behaviors – changing dynamics in equity crowdfunding. Baltic Journal of Management, Vol. 18, Issue 6, pp. 1-16

Paper 4 – Backer behaviors - an explorative study of investor types in equity crowdfunding

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Olsson, O (2021). Backer behaviors - an explorative study of investor types in equity crowdfunding. International Journal of Entrepreneurship and Small Business, Vol. 42, No. 1/2, pp. 156-168

Paper I

6. ICT as a driver of innovation: a life-cycle approach

Ola Olsson

INTRODUCTION

The literature stream of the industrial dynamic depends on the evolution of technologies and the formation of new industrial structures. Burns (1934) visualized these types of changes when he separated old and new industries by the magnitude of growth rates. In his paper, he used the cement industry as a context to show how new knowledge production fueled innovation and technology development, which enabled the start of a new growth industry. However, the relevance of contexts change over time and since the 1980s information and communication technology (ICT) has found its way into academic research, which raises questions over how this phenomenon has nourished this literature stream during past decades.

Information and communication technology is a broad and important concept but is separated from information technology (IT) as it also adds the aspect of communication, which includes the integration of telecommunication, computer and software that enables users to access, store and transmit information. In practice, ICT is very important as it improves productivity and economic growth globally. These hard facts are well documented in this academic stream but also by international councils such as the Organisation for Economic Co-operation and Development (OECD), indicating that ICT has fueled national productivity growth rates and labor market momentum during past decades (Van Ark et al. 2002; OECD 2015a, 2015b). In addition, these effects are also seen outside ICT industries. According to Van Ark et al. (2002) the ICT producing or using industries significantly outpaced non-ICT industries when it came to labor productivity, although with a slight diffusion lag in Europe compared with the US. There is no doubt that ICT has a significant impact on a variety of industries, however, in this chapter I concentrate only on industries within ICT.

The industrial dynamic literature stream is broad but focuses on processes that change industries over time. Product and innovation life cycles

are key elements (Tarde 1890) in understanding and forecasting industrial growth patterns (Prescott 1922; Kuznets 1929). However, variation of growth rates can also be addressed by taking into account economic phases of high and slow growth. This gave birth to the stream of literature that includes Kondratieff cycles (Kondratieff 1935) and long waves (Schumpeter 1939) which also emphasized the importance of innovation. Hence, industrial growth patterns are of key interest to identify and understand structural changes and innovation (Gaston 1961; Gold 1964) and Fischer and Pry (1971) further added to this stream when he launched a substitution model based on technological changes to predict future growth prospects. So why is all this of interest? The understanding of structural changes within an economy is both a pre-condition as well as a result of economic growth processes as firms adjust and change industries according to the environment. This dynamic is important to study from a competitive corporate perspective but equally important for governments as they set policies to support new and growing industries as well as to manage problematic ones. The common goal for both firms and governments is productivity improvements and economic growth. Productivity improvements can be achieved by technological development based on new knowledge production from innovation. This narrows down my area of interest within industrial dynamics into questions over the innovation process in the context of ICT.

The innovation process can be divided into two separate categories depending on the level of new knowledge usage (Dewar and Dutton 1986). The first is incremental innovation that consists of 'small-step improvements', and the second is radical innovation (Dewar and Dutton 1986) that can be seen as a total game-changer. However, at the beginning of the 1990s, technological development found its way back into this literature stream (Romer 1990) and the term general purpose technology (GPT) was introduced as a significant support to technological progress and economic growth (Breshnahan and Trajtenberg 1992). A GPT is seen as a long technological wave that influences productivity owing to innovational complementarities with application sectors. Hence, new knowledge production is vital for innovation, which calls for interactions and collaboration activities between firms to boost the innovation process that has the potential to affect entire industries. My research question in this chapter is, has ICT nourished the industrial dynamic literature stream when it comes to drivers in the innovation process? If so, are there some implications for the ICT industry?

First, the life-cycle approach is discussed based on some classical key nodes within the industrial dynamic literature stream. Second, innovation, GPT, innovation systems as well as knowledge production systems are

addressed to clarify the position of innovation and the need of interactions and collaborations for new contextualized knowledge production in this academic stream. After that, peer-reviewed papers based on interactions and collaborations in the innovation process are scrutinized to be able to identify the impact of ICT during past decades. Finally, some findings and suggestions for future research are presented.

THEORETICAL FRAMEWORK: THE LIFE-CYCLES APPROACH

Long Waves and Industrial Growth Laws

According to Tarde (1890) all innovations or products originally have three growth phases forming an S-shaped growth curve, before entering into a fourth, declining, phase in its life cycle. This approach is fundamental in this literature stream to be able to understand changes in industrial growth patterns as well as structural changes. However, changes or variations of growth patterns in economies can also be understood by looking at the academic stream of long waves or the Kondratieff cycles. This stream of literature is built on a belief that capitalistic economies pass through extended phases of rapid and slow growth. Kondratieff (1935) identified two separate economic long cycles (and the beginning of a new cycle) with expansion, stagnation and recession during the 1800s. Schumpeter (1939) added to this stream of literature and said that it is vital for a leading industry to go through crises as it fuels innovation and that a technology shift creates a new phase of rapid growth. In this perspective, it is important for an incumbent to be ready to take on a new strategy if the technology changes and start-ups adapt to a new environment. In the ICT segment this could be exemplified by the entrance of the Internet forcing most agents to act. This could even mean that an industry ends and is replaced by a new industry based on this new technology.

This type of experience is called creative destruction (Schumpeter 1942) and was experienced by Facit AB in the beginning of the 1970s. The company started to sell manual calculators during the 1930s and was soon a global market leader. However, the company did not respond to a technology shift to smaller electronic calculators and lost its momentum as the entire industry changed. In a way, this was also the case for Nokia during the 2000s. The company held a 40 percent global market share in the terminal segment. However, as the mobile system industry developed from voice into data traffic solutions, the terminal industry gradually converted to more mobile smartphones. Apple launched the first smartphone

(iPhone) in 2007 but Nokia went on selling various traditional terminals in the low-, mid- and high-end segment but was forced to lay off 10 000 employees during 2012 (New York Times 2012). The company finally sold their terminal business to Microsoft in 2013 (BBC 2014) after losing most of its market shares in less than five years because of the structural change in the terminal industry.

Schumpeter's long wave theory of economic growth also emphasizes that innovation is the fundamental impulse to keep investors alert. It comes in swarms but also with different impacts, which is the key reason why these cycles are different in length. In addition, the long waves are caused by basic innovation, for example the steam engine, the railroad, electricity cars, electronics and chemical products as well as computerization and the mobile phone – all forming the basis of Kondratieff's one to five long waves. This stream of literature focuses on basic innovation which enables a broad spectrum of applications. In addition, these long waves are also connected to investments in new infrastructure which Hartman and Wheeler (1979) establish when looking at innovation and infrastructure development in Great Britain and United States.

Kuznets (1929) and Prescott (1922) were the first to use Tardes 'law' based on the product life-cycle approach to make forecasts and connect it to industrial growth. In addition, Burns (1934) analyzed industrial growth patterns in the US during 1870–1929 to estimate the speed and the maximum production value in the retardation process. However, industrial growth laws have been criticized by Gold (1964) showing that growth paths are different in both single- and multi-product industries when adding another 25 years of empirical data. Nevertheless, Hirsch (1967) supported the product life-cycle approach when he looked at industry growth pattern characteristics and said that industry growth trends occur systematically and are therefore predictable. Van Duijn (1980) added to this opinion of the S-shaped curve and suggested that it should be conceptualized on industrial growth by adding a new product before the declining phase of the old product. That is the reason why, within the telecommunication system industry, agents such as Ericsson and Nokia launch 5G systems ahead of the decline phase of 4G systems when they replace an improved technology.

Products and Innovation Life Cycles

Hirsch defined a new product on the basis of a new method or a new invention and was supported by Vernon (1966) and Freeman (1978) when claiming that different kinds of input (such as labor knowledge and skills) are needed during the life cycle of a new product. Gold (1971) also stressed

that factors such as product improvements and geographical market expansion as well as new areas of use change the life cycle. Dean (1950) and Levitt (1965) also claimed that the life-cycle model works in a marketing context. The first stage (introduction) is when the product enters the market. The second stage (growth) is when the product has proven itself technologically and demand accelerates and expands the market rapidly. After that, demands starts to ease (maturity) and grows on the basis of replacements. Finally, the product loses consumer attraction and start to lose momentum (decline).

The product and the innovation process are, however, seen academically as separate things in a model of technological change (Utterback and Abernathy 1975; Abernathy 1976; Utterback 1979; Malecki 1981). The focus in a product life-cycle model is that products get old and firms have to put effort into research and development (R&D) and new product development to be able to drive future growth. The innovation life cycle focuses on potential changes of the organization of all stages of production, which is perhaps more obvious in large firms. According to the Vernon–Abernathy–Utterback model, the first phase includes focus on product mix extension or product improvements but also includes innovative efforts to develop a new business line. The second phase has a stronger focus on efforts to increase the volume of a product to gain economies of scale. In the final phase, the large scale and standardization targets has been met. Innovative steps are now more on the cost-cutting side and a constant focus on low input costs (knowledge and skills) which might be met by relocation of production to low-wage regions (Windrum 2005). Nokia was extremely dedicated to the two first phases during its peak-terminal period and did rapidly change product lines following market demand.

Design is, however, also a key factor in this model. In the first phase uncertainty is high when it comes to customer preferences and market size as well as technical advantage (Windrum 2005). This attracts start-ups to enter the market as well as incumbents to experiment as the reward is high. Rival designs will eventually melt down into an industry shake-out as the first phase ends with a dominant design that has market acceptance and technological stability. After this process, the focus of competitive advantage switches from product to process innovation. Neonode might be a good example of start-up design failure. The company tried to launch a smartphone at the beginning of 2000s when customers were still not ready and data-traffic solutions were too slow. However, Apple successfully launched its first iPhone in 2007 based on a much-appreciated touchscreen solution and, as the technology was now stable, this paved the way for the smartphone design. So, it seems fair to say that Apple managed this much better than the former market leader, Nokia. In addition, Apple has

managed to keep its strong position in this industry since the first release 20 years ago thanks to new models illustrated by new product life cycles based on incremental innovations.

INNOVATIONS AND GENERAL PURPOSE TECHNOLOGY

According to Dewar and Dutton (1986) the innovation process can be divided into two categories depending on the degree of new knowledge usage. Incremental innovations can be characterized as add-on innovations and are based on intentional (or unintentional) small-step improvements (Helpman 1998). This could, for example, consist of production changes for new gadgets made by Apple to further improve the usage or utility of a mobile telephone. Radical or drastic innovations instead gradually replace an old technology, as electricity finally changed the calculator market for Facit during the 1970s, or as digitalization changed the telecommunication industry, going from fixed to mobile systems, during the 1990s. The outcome as well as the production pattern might change slowly and at first only slightly affect the economy before it accelerates. Hence, a radical product innovation significantly incorporates a new core technology and improves the customer benefits compared with previous products (Chandy and Tellis 1998). However, Helpman (1998) also addressed the importance of radical innovation investments as an engine for the incremental innovation process allocating resources to a number of new incremental innovations. This emphasizes the important perspective of risk. The potential outcomes of incremental innovation investments are easier to calculate, which means that risk can be measured and evaluated. However, radical innovation investments carry greater uncertainties that substantially aggravate the risk evaluation process. These investments are therefore more expensive to ensure and innovators often need to carry the total load of risk themselves (Helpman 1998). According to the literature (Hendersen 1993; Utterback 1994) incumbents and large firms are less successful when it comes to radical product innovation and even hold back on 'minor' changes (Henderson and Clark 1990), maximizing their return from the known technology. However, these firms seem well equipped to succeed considering their superior technological capabilities as well as strong financial resources compared non-incumbents and smaller firms (Chandy and Tellis 2000). According to their 150-year study, small firms and non-incumbents introduced only slightly more radical product innovations than large firms and incumbents. In addition, large firms and incumbents were superior when only taking into account the postwar period, pointing

out General Electrics, Phillips and Seiko as front-runners when it came to radical product innovation for lamps, recorders and watches. This theme was also supported by Hill and Rothaermel (2003) criticizing the view of general incumbent decline in markets shaken by a radical technology innovation.

At the beginning of 1990s, technological development once again found its way into this literature stream, expressed as a key role to the growth process (Grossman and Grossman and Helpman 1990; Romer 1990; Aghion and Howitt 1993). Breshnahan and Trajtenberg (1992) significantly added to the stream when they noted that technological progress and economic growth as well as social structures seem to be heavily influenced by a few key technologies called general purpose technologies (GPTs). They also said that a GPT could be seen as a type of long technological wave, at the top of a hierarchical tree, which has influenced the productivity of technological development owing to innovational complementarities with the application sectors. First, sub-technologies learn by inventing, cutting the cost when inventing the next sub-technology based on the GPT. Second, sub-sectors learn by doing, cutting the cost of producing generalized GPT inputs and expanding the range and the quality of applications. They also addressed two types of externalities. The first (vertical) concerns problems between the GPT inventor and the application sectors and is related to underpricing when institutional conditions were unfavorable. The second (horizontal) concerns problems across the application sectors and is related to coordination problems. However, when sectors were coordinated for a joint expansion the full benefit of the GTP could be released. A good example is digitalization, which enables ICT to find its way into almost any industry.

According to Breshnahan and Trajtenberg (1992) the 'binary logic' is the heart of the dominant GPT of our time –semiconductor technology. The general purposefulness of integrated electronic circuits is that it (on the basis of binary elements) could replace most electronic-mechanical parts in a wide range of electronic systems (clocks, washing machines, locks, and so on). This means that it fits into a variety of products, materials or production methods supporting economies of scale. In addition, the standardization process drives the learning process of these integrated circuits. The result is accelerating reliability but also lower prices and smaller sizes, making it more cost-effective and flexible to use them. This has significantly driven investments in R&D and technological development in the entire electronical value-chain during the past decades.

INNOVATION AND KNOWLEDGE PRODUCTION SYSTEMS

The demand in the ICT industry seems to have changed, going from military needs to a soaring demand for multiple consumer-friendly functions on a global mass market for applications, but what about the role of innovation in increasingly knowledge-based societies? According to Etzkowitz and Leydesdorff (2000) the role of the military has reduced while academia has risen, changing the relationships between academia, industry and government. The evolution of innovation systems are mirrored in a variety of institutional arrangements of university–industry–government relations (Etzkowitz and Leydesdorff 2000). The Triple Helix 1 model was where the state was the key driver (military) to innovation, guiding the industry and academia independently from each other. This type of model could be found in the former Soviet Union. The next model was Triple Helix 2. This model was based on three highly separated spheres with strong boarders and equal power of innovation potential. By reducing the boarders, the three spheres came closer, creating Triple Helix 3 with overlapping spheres. This interface for interactions created a knowledge transfer atmosphere with tri-lateral networks and hybrid organization fueling the innovation system. This later model is adopted by most countries when trying to create an innovative environment for university spin-off firms, strategic alliances among firms, governmental laboratories and academic research platforms.

Innovation systems are built by components (government, universities and firms, but also buyers, sellers and so on) glued together by different types of relationships depending on its unique properties. Innovation is seen as an interactive process where agents cooperate and form long-term relationships. However, in order to innovate, a firm must learn (Lagendijk 2001). The innovation system then aims to improve the output from the included agents when it comes to capabilities of creating, spreading and utilizing technologies with economic value. The academic stream of national innovation systems maintains a focus on how to explain differences in national growth rates based on differences in R&D (Nelson and Rosenberg 1993). However, this stream also includes regional innovation systems (RIS) which address the economic value of interactions and collaborations between agents on the basis of proximity. According to Andersson and Karlsson (2004), accessibility can be used to operationalize proximity. However, in this chapter accessibility will be further addressed when it comes to regional clusters seen as a driver to boost innovation.

At the same time, science also seems to adapt to a more complex society finding new ways to be able to produce relevant knowledge. This has

transformed knowledge institutions such as universities, as well as government research and industrial research. New knowledge production systems (Mode-2) are based on dynamic and transparent relationships which depend on two-way communication between science and society (Nowotny et al. 2001). Mode-2 knowledge production is connected to problems in society, which means that the process is contextualized and not motivated by scientific knowledge alone. Instead, applications in society are important, which also means that the research process is integrated in society including more people in the process compared with mode-1 (science in isolation). New mode-2 knowledge production can be achieved in a variety of contexts, but in this chapter is connected to ICT.

DRIVERS TO BOOST INNOVATION AND TECHNOLOGY DEVELOPMENT

Innovation and technology development depend very much on interaction and collaboration activities for forming the basis for new knowledge production. In this part of the chapter I address four important drivers distributed along the innovation life cycle: alliance networks, product networks, regional clusters and outsourcing or offshoring. Key node papers with different contexts are used as references but ICT papers are the main focus to identify potential impacts on these drivers based on new mode-2 knowledge production.

Alliance Networks

According to Porter (1990) and Chesbrough (2003) networks stimulate innovation. In addition, Lamming (1993) and Spekman et al. (1998) argued that strategic alliances benefit the technological innovation of members with complementing resources at the same level of the value-chain (horizontal integration) or with key sources upstream or downstream in the supply chain (vertically integration). However, Dittrich et al. (2007) added to this literature stream when looking at IBM and the dynamic of their alliance network portfolios over time. In an alliance network the core focus is knowledge exchange, and Dittrich et al. (2007) stressed the importance of two key techniques to improve this dynamic. The first technique was to increase the speed of change of partners and the second technique was to look for partners outside the existing competence. According to the authors the full effect of this dynamic comes when using both mechanisms simultaneously. The composition is, however, very much pending on choice of learning strategy. An exploitative learning strategy

is connected to refinement and extension of an existing technology. This strategy leads to strong tie alliances (Granovetter 1973) and aims to make the very best of the knowledge exchange when it comes to an established technique or product and to benefit from economic of scale. In these alliance networks, partners have comparable knowledge and the innovation level will stay within the current technological area. According to Mowery et al. (1996) these alliances have lower potential for learning outcomes. An explorative learning strategy is characterized with experimentation and the exploration of new technological fields (March 1991). This strategy leads to weak tie alliances (Granovetter 1973) based on low-commitment partners because the outcome of the new technology is unknown and resources are therefore carefully allocated. The turnover of partners is much higher in these alliance networks. These networks require a high diversity of knowledge and firms continue to scan for new technological opportunities as these might be found outside the current alliance network. Companies using this strategy look for partners with competences outside their own core business. This leads to innovative alliance networks with partners in new technological areas.

According to Dittrich et al. (2007) alliance networks can be used to facilitate a strategic change and help a company to reposition itself in an industry. According to these authors, IBM made this journey in the 1990s when moving from a traditional computer hardware company into a more service-led firm. During this period (1991–92, 1996–97 and 2001–02) the structure of its alliance portfolio changed significantly versus it top-five competitors. The number of alliance partners grew from 44 to 59 compared with the peer average of 20 to 36. More importantly however, the company increased its new partner turnover from 63 percent to 78 percent compared with the peer average of 38 percent to 65 percent. In addition, IBM significantly increased its share of non-core capability alliance partners (such as telecommunication, software and Internet) as well as reduced its share of core-capability alliance partners (hardware) during the second half of the 1990s. This change of learning strategy (from exploitive to explorative) used in the alliance network activities gradually changed IBM during this period and, by 2001, revenues from the global service business actually outgrew the hardware business.

Dittrich et al. (2007) note that large organizations are able to adapt to changing environmental conditions as they bring new capabilities into alliance networks changing the innovation process and re-position themselves in a competitive industry. However, there is less evidence that this is also the case for small firms although the transition of organizational change should be easier for smaller compared with larger firms. Instead Ganz et al. (2000) focused on the return of the innovation and the choice of

commercialization strategy for high-technology start-ups suggesting high probability of cooperation (instead of market competition) in cases of intellectual property rights and cases associated with venture capitalists. They also claimed that environmental changes affect the nature of strategic interaction (such as alliances) between incumbents and entrants (start-ups) from competition of innovations to cooperation in the market of ideas.

Production Networks

The innovation life-cycle approach is very much addressing organization of the production stages (Utterback and Abernathy 1975). In this perspective, one could take a closer look at the organization of computer system firms in Silicon Valley (Saxenian 1991). These firms are organized to combine components and sub-systems made by specialist suppliers when creating new computer systems. It all depends on an 'open source' way of working and is a direct action to manage the uncertainty of rising costs, shorter product life cycles and rapid technology changes. Apple is, for example, creating production networks with key suppliers to adjust or produce new systems, speeding up the process of product development as well as formalizing the possibilities of knowledge exchange. This is a very clear contrast of doing it all in-house (vertically integrated model used in the postwar period) and a superb way of diversification when it comes to uncertainty and development costs. Hewlett-Packard (HP) also stress the need of bringing complex products to market in a rapid pace which is impossible when working alone as new technologies create a constant flow of new components. Hence, modern system firms are focusing on their core businesses and acquire the rest of their inputs from a network of state-of-the art suppliers.

This means a higher priority for supplier relationships and the key to these agreements is trust (Saxenian 1991). In the same article Sun Microsystems claimed that 'the quality of our products is embedded in the quality of the products we purchase' further emphasizing the modern view of a supplier relation. There is also a general view that the intensity of these types of partnership are getting higher the more complex the components or products are. In addition, the relationships are now viewed as a long-term investment in contrast to traditional short-term procurements. According to Saxenian (1991), modern system firms in the Silicon Valley also tries to tag about 20 percent of its suppliers as 'privileged', representing close to 80 percent of the total value of needed components. This group then has a shared goal of getting the final product to the market.

These close relationships have also found their way into the designing phase, connecting it to the very first stage of the innovation cycle. This

helps suppliers adapt to new market demands but also reveals new component technologies to the system firm engineers. As production starts, the relationship spreads to all levels in the organization. This process enables adjustments of specifications as well solving technological or manufacturing problems on an ongoing basis.

This way of collaboration is very different to the traditional way of sending out specification of components to suppliers hoping for a low-price bid to create an already designed product. Currently, these firms instead go for engaged high-quality suppliers and long-term relationships. Apple also adds in this article (Saxenian 1991) that a formal contract is not always necessary as this process creates trust over time. The flip-side of this coin is the constant tension in finding a balance between collaboration and control. However, this could be managed by face-to-face interaction smoothing the information exchange process enabling better teamwork activities and long-term trust in these relationships.

This literature stream has now turned more into global production networks. Henderson et al. (2002) argues in a keynote paper that ICT development has increased the possibility of finding specialist suppliers abroad and that regions, in this perspective, are important to drive innovation. These drivers of innovation will be addressed in the next two sections.

Regional Clusters

Looking at the car industry in Detroit, Klepper (2002) noted the importance of geographic concentrations and claimed that an early entrance as well as pre-experience significantly improves the chances of survival in an industry shakeout. In addition, Breshnahan et al. (2001) suggested that a key factor in the success of entrepreneurship and innovation is regional clusters, defined as a spatial and sectorial concentration of firms attracting a growing number of start-ups. This is hard evidence for both a large incumbent and a start-up to think about location to be able to reap the benefits of RIS. A typical regional cluster is Silicon Valley in Santa Clara County, California. Stanford University was founded in this region (Palo Alto) in 1891 and supplied property or land to high-technology firms, creating a close connection between researchers and the industry, which forms the core of Silicon Valley. In 1939, HP was formed by two Stanford students (Bill Hewlett and David Packard) but when adding Intel (1968) and Apple (1976) to this region, a new wave of innovation took off.

The locational dynamics is vital for innovation activity and firm growth potential and can be illustrated by the anchor tenant concept (Feldman 2003). Feldman used the US biotechnology industry to visualize the importance of not only university spillovers (Feldman 2000) but also

the presence of large incumbents (anchor firms) to take care of applications and the commercialization phase. A large anchor firm is expected to be better positioned to develop the technology than several small firms with the equivalent amount of expertise thanks to the advantage of size, financial strength and increased information flows. This is a healthy environment for start-ups to be located, working as potential suppliers to the incumbents (anchors). Anchor firms attract pools of expertise creating local innovation networks (von Hippel 1994) and a need for specialization inputs (Bhide 1999) creating knowledge externalities (Feldman 2003) supporting new start-ups in the region. Klepper (2007) added that an incumbent (anchor firm) provides potential spinoffs fueling the start-up environment. That is, a large incumbent works as an anchor tenant in a system trying to pull start-ups into a cluster driving innovation like an established brand-store (anchor and tenant) in a supermall suppling customers to less well-known stores (no anchor but a tenant) adding rent for the landlord.

Outsourcing and Offshoring

Other drivers of innovation are outsourcing and offshoring. According to Kogut (1985) a value-chain is the process of mixing material and labor inputs based on a technology. The processed inputs are then assembled, marketed and distributed. This covers a number of firm activities linking together all nodes in the value-chain. A firm can consist of only one link in this process but also control the entire spectrum of links (vertically integrated) covering the entire value-chain. The upstream end of this process includes activities such as basic and applied R&D. In the middle, manufacturing activities play a key role and in the downstream end activities such as marketing, advertising and brand management have full attention. However, all parts of the value-chain include the potential for innovation and the key question for a firm is more or less 'make or buy' on the national or international arena.

Outsourcing has significantly increased since the beginning of 1990s (Gereffi and Sturgeon 2004) emphasizing the process of 'deverticalization' of the modern firm (Carter 1977) with a higher focus on specialization and core competences (Prahalad and Hamel 1990). Coombs and Metcalfe (1998) also add to this stream by noting that the 'distributedness' of production and innovation processes has increased over time, which means that firms let go of functions previously kept 'in-house'. One reason for this is cost-saving initiatives, especially when it comes to assembling and production as the commodification of products has strongly changed the ICT industry (Ernst and O'Conner 1992). Other reasons include a

closer focus on core activities to be a specialist. This means contracting out non-core activities and thereby harnessing the potential for a firm to also reap the benefits of 'outside' supplier specialization. Globalization has expanded this literature stream to include offshoring, which mean that a firm might consider moving a business process to another country. Technological changes haves cut the cost of communication and coordination, which makes it possible to move some value-chain nodes abroad. By moving a business process (product or service) the company interacts in a new market and is able to take advantage of changing market conditions based on innovation and the benefit of new revenue streams. To summarize, this opens up for a variety of control strategies including vertical integrated modes such as 'onshore, in-house' or 'captive offshore' but also specialization modes like 'onshore, outsourced' and 'offshore, outsourced'. However, all of these control strategies enable new knowledge production to boost innovation.

According to Quinn (2000) outsourcing innovation is the new engine of growth. He visualized this by how software (the service segment) and embedded electronics (the manufacturing segment) can be combined in trillions of ways to create potential products or processes. A single market leader is not able to internally cover this changing environment and therefore needs to partner up with external knowledge leaders to be able to offer quality products or services as well as to co-fuel the innovation process. Cisco is a great example of this and started at the beginning of 1990s to build long-term relationships with selective manufacturers to keep its leading position on the router market. They opened up systems, processes and networks for joint development with these partners driving component, hardware and manufacturing innovation. In addition, the company invites vendors as well as service providers to jointly develop new technologies and to optimize applications for its businesses, as for example within clouding (Cisco 2015).

Quinn (2000) adds that most elements of the value-chain can be outsourced. The technology chain can easily rely on the growing number of specialist suppliers. Suppliers drive the development in their specific level of the value-chain. Dell has, for example, a higher focus on the downstream end and invests only in customer-requested component integration (computers) and outsources innovation of components, software and design that takes place higher up the value-chain. As a supplier, Intel keeps out of the downstream end of the value-chain and instead invests only in specialized competences to develop and offer microprocessors and complex integrated circuits for computers. In addition, business processes as well as new-product introduction could also be outsourced successfully. Others are, for example, much better suited to drive innovation in

advertising or logistics. This connects to von Hippel (1988) who suggested that most innovation takes place at the interface between innovative suppliers and customers. Quinn (2000) also notes that outsourcing interfaces upstream and cooperative relationships with distribution partners downstream reduce the cost of innovation and significantly increase the value of innovation for customers. Thus, benefitting both product introduction and modification processes. However, according to Soosay et al. (2008) this interplay could also lead to radical and incremental innovation.

Cost cutting potential and specialization are key elements when considering how to manage R&D outsourcing. In situations of commodification, technical function and design, it is outsourced to suppliers offering standard products or services at the lowest possible cost. This is very much in line with the low-end segment for mobile phones. However, in situations of specialization, the academic stream is more divided. Teece and Pisano (1994) claimed that outsourcing increase the risk of losing knowledge-creating activities and should instead be placed in-house. However, Pavitt (1998) suggested that when products and production processes become more complex, firms are forced to initiate R&D collaborations, and this was supported by Quintas (2003) claiming that specialization calls for greater interaction between firms and organizations. This is very much in line with the high-end segment of mobile phones.

By seeing the R&D outsourcing phenomena as a knowledge-searching strategy, R&D suppliers could complement in-house R&D centers which are necessary to retain the quality of the absorbing capability (Cohen and Levinthal 1989). However, this mean also that the potential to take advantage of a global division of labor research (Arora and Gambardella 1990; Howell 1999). When putting this in the perspective of offshoring, these types of knowledge-intensive activities (upstream) are mostly found in the advanced markets. However, this is also the case for advertising and logistics (downstream) but when looking at less knowledge-intensive activities such as manufacturing or routine services (in the middle of the value-chain) they are to be found in emerging markets.

CONCLUSION

Information and communication technology is an industry characterized by short product cycles, rapid technological changes, core-competences focus as well as specialization. Firms within this industry have to adjust constantly to this environment which puts pressure on new knowledge production. This calls for interactions and has the potential to effect innovation in all parts of the value-chain, according to the papers reviewed in

this chapter. In a life-cycle approach, however, alliance as well as production networks have an impact on the first stage of the innovation cycle in the ICT industry. This indicates that new contextualized knowledge production is created in collaboration with, and in some cases by, specialists or state-of-the art suppliers as no dominant design is yet established. The trust and strength of these relationships decide the potential amount of innovation and technological change, and a lot of resources are allocated to R&D. Low-tie alliance networks enable new technologies to arise, while high-tie alliance networks reduce this possibility. However, high-tie alliance networks instead support economies of scale (the second stage of the innovation cycle). The product or industry takes off and a dominant design is established. When it comes to cost-savings (the third stage of the innovation cycle) outsourcing and offshoring control strategies are implemented. At this stage, the product or industry has matured. The product is standardized and there is stiff competition. Different control strategies are applied but innovations at this stage are considered incremental. Finally, regional clusters are important for the ICT industry as large incumbents tend to need small start-ups to drive innovation (as suppliers) or take care of spin-offs. In a life-cycle approach this means that a new S-shaped curve could arise, starting the life cycle all over again. Hence, ICT has nourished the industrial dynamic literature stream when it comes to drivers in the innovation process during the past decade.

The magnitude of innovation – and potential for technical change – is hard to measure but seems to very much depend on learning strategy. If the firm takes an exploitative learning strategy, the expectations of magnitude is low, which only produces enough new knowledge for an incremental innovation. However, if the strategy is instead exploratory, there is a possibility that new knowledge production could be enough to create a new radical innovation or even release a new GPT.

The practical implications for the ICT industry are that it seems to have left the vertical postwar strategy by doing it all in-house. Instead, there is evidence of an open and inviting way of pushing the innovation process forward. If a firm (say, IBM) takes an exploratory learning strategy, it can reposition itself (from a hardware- to a service-dominated firm) in a competitive industry. Networks as well as location are of key importance to navigate in this industry. In addition, ICT firms significantly depend on specialist suppliers and large incumbents such as Intel and Dell are hard evidence of the fact that all nodes in the same value-chain can be outsourced to drive innovation and support a new innovation life cycle.

To put this in a specific industry perspective, the telecommunication industry has changed during past decades as the creators of the infrastructure (the telecommunication suppliers such as Ericsson and Nokia)

have responded to product and innovation life cycles. Hence, this segment seems to have gradually changed, with a core focus on mobile systems as they have bailed out of the terminal market (FT 2011; BBC 2014). The creators of the vehicles (mobile phones, tablets, computers, consoles such Apple, Samsung, IBM, Dell and so on) that enable the customers to enter the system infrastructure are adapting (Dittrich et al. 2007,) using different kinds of networks and outsourcing strategies to stimulate the innovation process. The owners of the infrastructure (telecommunication operators such as Teliasonera and Telenor) are customizing vehicle performance depending on the choice of infrastructure railways (speed limits as a well as fueling capabilities or usage of data per month). They seem able to manage shifts in market demands (Fischer 1971) or supply as they address technology shifts, like going from fixed to mobile solutions, or try out new business models to be able to manage new technologies going from voice to data traffic solutions (Ericsson 2015a). Finally, the creators of the expanding number of new cities in this digital landscape (the content providers such as social media and the entertainment industry) are also impacted by new technologies changing the dynamic of their industries. This forces traditional content providers to respond to alternative distribution channels as well as start-ups to adapt and try out new business concepts to challenge the traditional incumbents – sometimes until creative destruction. A good example is the film and music industry going through structural changes thanks to companies like Netflix and Spotify successfully using the streaming technology instead of traditional CD and DVDs to reach the customers.

My suggestions for future research is to try to measure the magnitude of innovation by further study of learning strategies within the ICT industry. This would strengthen my argument for ICT as a driver for innovation. In addition, most of these papers have a focus on large firms which increases the interest in implications when it comes to firm size as a booster of innovation in ICT.

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Paper II

Backer behaviors – the value of demand-driven signals in the equity crowdfunding evaluation process

Abstract

Purpose

This study explores the content and funding effects of hidden characteristics in questions (sentiment) and answers (clarity) on ECF discussion boards. It is important to expand the research on backer evaluation based on demand-driven signals and draw conclusions about backer behaviors in the investment decision-making process.

Design/methodology/approach

This quantitative study relies on a regression analysis of hand-collected data from discussion boards on the Swedish equity crowdfunding platform FundedByMe (2020-2021). The data is based on 415 interactions and 5,965 backer investments from 28 successful campaign-funding windows.

Findings

The results suggest that the sentiment in the questions has no funding effect. However, clarity in answers seems to be of great importance for backers to invest since the findings imply both instant and delayed funding effects. However, no instant interaction effects were reported.

Research limitations/implications

This provides evidence of the importance of clarity in answers (feedback loops based on demand-driven signals) during funding windows. This expands the research on the evaluation of demand-driven signals from discussion boards and supports previous findings on news updates (supply-driven signals). Furthermore, this adds to the research on backer behaviors based on evaluation and confirms previous findings on learning behaviors in the investment decision-making process. However, richer datasets with the potential to identify other characteristics can reveal additional behaviors in the backer evaluation process.

Practical implications

In contrast to sentiment in backer questions, backers tend to pay more attention to clarity in entrepreneur answers when evaluating information from discussion boards during funding windows. Hence, since funding is vital for new firms, capital-seeking entrepreneurs need to consider clarity in their communication strategy and platforms could offer guidelines or even tools to help entrepreneurs simplify their answers on discussion boards during funding windows.

1.0 Introduction

This study focuses on the content and effects of demand-driven signals (Q&As) released on equity crowdfunding (ECF) discussion boards during funding windows. The ECF is a result of the fintech revolution (Coakley and Lazos, 2021). It is positioned in the entrepreneurial finance domain (EF) and offers new firms and micro-funding solutions on digital platforms. On these platforms, entrepreneurs with capital deficits match investors (backers) with their capital surpluses. However, this domain is affected by information asymmetry (Akerlof, 1970). Hence, entrepreneurs know more about their new firms than less-informed backers do. This translates into large investment uncertainty and must be managed accordingly. Consequently, because quality signals reduce investment uncertainty in the evaluation process, signaling has become a common approach to better understand backer behavior before deciding (Mochkabadi and Volkmann, 2020). When it comes to evaluation, most findings are based on supply-driven signals (Ahlers *et al.*, 2015; Vismara, 2018; Piva and Rossi-Lamastra, 2018; Block *et al.*, 2018; Dorfleitner *et al.*, 2018; Correia *et al.*, 2019; Estrin *et al.*, 2022) sent from entrepreneurs to backers (ETB) before or during funding windows. However, we know less about the demand-driven signals sent from backers to entrepreneurs (BTE) during funding windows. Additionally, the findings are based on demand-driven signal conflicts (Volkmann and Kleinert, 2019; Iurachenko, 2022). Hence, this study aims to expand the research on ECF evaluation based on demand-driven signals released during funding windows to conclude backer behavior in the investment decision process.

Supply-driven signals come in the shape of venture determinants from investment memoranda or news updates (Ahlers *et al.*, 2015; Vismara, 2018; Block *et al.*, 2018; Dorfleitner *et al.*, 2018) released on the platform. However, in the absence of face-to-face meetings, demand-driven signals appear as questions on platform discussion boards when campaigns go live. These signals enable backers to answer their questions, reducing investment uncertainty and emphasizing the potential value of feedback loops based on demand-driven signals in the evaluation process. In addition, most backers are considered less sophisticated investors (Ahlers *et al.*, 2015; Lukkarinen, 2016). Hence, they are less equipped to evaluate investment opportunities than more sophisticated investors (venture capitalists or business angels) in the EF domain (Bonini and Capizzi, 2019). However, because interactions on discussion boards are visible to all backers on the platform, they have the potential to release value to crowds based on demand-driven signals. Consequently, demand-driven signals (and their feedback loops) represent a pool of different knowledge (the wisdom of the crowd) released on discussion boards with the potential to reduce investment uncertainty before backer decisions.

Discussion boards offer a unique way to explore the content and effects of demand-driven signals during the evaluation process. However, only a few studies have used this possibility to present initial frameworks on content and funding effects (Kleinert and Volkmann, 2019; Iurchenko *et al.*, 2022) in the UK market. These studies mainly rely on traditional frameworks based on the content of financials, products, teams etc. (Petty and Gruber, 2011; Carpenter and Sturet, 2015). Overall, these findings confirm that discussions positively affect funding. However, they differ in terms of the effects of the content or topic. This raises questions about the potential impact of the hidden content (characteristics) embedded in these signals. Supply-driven signals (news updates) have been explored in terms of hidden content based on clarity and sentiment (Block *et al.*, 2018; Dorfleitner *et al.*, 2018) during funding windows. However, little is known about these characteristics among demand-driven signals. Hence, to fill this research gap, this study aims to look beyond the traditional preferences previously found among demand-driven signals and draw conclusions regarding the potential implications of backer behavior in the evaluation process.

To explore the content and potential funding effects based on sentiment and clarity embedded in demand-driven signals, this study uses data from the Swedish equity crowdfunding platform FundedByMe. The data were based on 415 interactions with discussion boards and 5,965 backer investments from 28 successful campaigns (2020-2021). In contrast to other parts of Europe, the ECF

dominates the Swedish crowdfunding market (SOU, 2018). In addition, FundedByMe does not preselect ventures before campaigns are launched. This transfers most of the uncertainty from platforms to backers and enables conclusions about their behavior in a mature market exposed to large investment uncertainty. This study uses quantitative methods to explore content and measure the funding effect based on a) sentiment in questions, b) clarity in answers, and c) potential interaction effects from demand-driven signals on discussion boards.

The remainder of this paper is organized as follows. Section 2 discusses the signaling theory and the existing literature on backer behaviors and demand-driven signals from ECF discussion boards. Section 3 describes the data, methods, and variables used in the study. Section 4 presents the results, and Section 5 discusses the findings. Finally, Section 6 concludes the paper, including contributions, limitations, and suggestions for future research.

2.0 Signaling and backer behaviors in ECF investment decision-making

Signaling has become a key approach for exploring different behaviors in contexts burdened by information asymmetry (Akerlof, 1970). It is driven by the need for information availability to reduce uncertainty and draws from the seminal work of Spence (1973) based on uncertainties in the hiring process. In early-stage funding, this translates into uncertainties in the investment decision-making process and covers the key elements of a signaling system (Connelly *et al.*, 2011). Hence, entrepreneurs (senders) send information (signals) about their new ventures to investors (receivers) with the ability to make correlated requests (feedback loops) during the funding process (environment) to reduce investment uncertainty. Consequently, there are many findings in the literature based on observable and unobservable supply-driven signal characteristics sent by entrepreneurs to venture capitalists (VCs) or business angels (BAs) to improve the probability of funding success and explore investor behavior (Ahlstrom and Bruton, 2006; Coleman and Robb, 2014; Cosh *et al.*, 2009; Jääskeläinen *et al.*, 2006; Robb and Robinson, 2014).

This tradition has also found its way into different streams in the ECF literature to better understand backer behavior in the investment decision process. Different behaviors have been explored in terms of investment dynamics based on investment patterns (Hornauf and Schwienbacker, 2018; Correia *et al.*, 2019; Olsson, 2023) and herding effects (Vismara, 2018). The findings of these studies support different behaviors based on uncertainty over share supply and investment uncertainty. In addition, they suggest that investment decisions can be seen as supply-driven signals for others in a crowd with the potential to imitate their behavior during funding windows. Consequently, these signals have the potential to reduce investment uncertainty before backers decide. In addition, studies have been conducted on different behaviors based on investor types (Abrams, 2018; Wallmeroth, 2019). According to these authors, more strategic or sophisticated backers are more selective and invest later in funding windows. This suggests a learning behavior that reduces investment uncertainty for some backers before they invest but also potential herding effects from these investment decisions during the funding window. Hence, specific backer investments can also be viewed as important supply-driven signals for others in a crowd, which reduce investment uncertainty in the investment decision process. These behaviors are supported by Moritz *et al.* (2015) on the importance of third-party endorsements. The endorsements in this study were based on reviews or recommendations from experts, customers, or other investors and tended to reduce investment uncertainty for some backers before they decided. Hence, this emphasizes the importance of the backer-to-backer (BTB) perspective when it comes to learning behaviors in the evaluation process and makes backers potential signalers in this signaling system.

However, most evaluation findings depend on supply-driven signals. This relies on the entrepreneur-to-backer (ETB) perspective. In this stream of literature, entrepreneurs start to send supply-driven signals to backers before funding campaign windows open, based on investment memorandums, to reduce

information asymmetry about the new venture. This comes in the form of human capital, social capital, and equity retention (Ahlers *et al.*, 2015; Vismara, 2018; Rossi-Lamestra, 2017) and is seen as an important signal when backers evaluate. Hence, these signals are important for backers to decide and enable early momentum in successful campaigns when funding windows are open (Vismara, 2018). However, in an ECF, the possibility of sending supply-driven signals continues during funding windows. Block *et al.* (2018) and Dorfleitner *et al.* (2018) add to this stream of literature by exploring the content and dynamics of venture news updates during funding campaigns. This enabled us to draw conclusions about backers' learning behaviors and venture strategic behaviors when backers evaluated the investment decision process.

These findings confirm the learning behavior of some backers based on supply-driven signals (Block *et al.*, 2018) from the ETB and BTB perspectives (Vismara, 2018). Hence, this behavior seems important in the backer evaluation process and emphasizes the value of signaling to reduce investment uncertainty before backers invest during funding windows. However, little is known about the potential behaviors based on the evaluation of demand-driven signals from a backer-to-entrepreneur perspective (BTE). This raises questions about the content and effects of interactions on discussion boards.

2.1 Content and effects from demand-driven signals on discussion boards in ECF evaluation

VCs and BAs depend on face-to-face meetings with entrepreneurs to ask questions and obtain answers behind closed doors when evaluating ahead of their investment decisions. This is part of their due diligence to reduce investment uncertainty (Cumming et al., 2010; Bonini and Capizzi, 2019) before they invest. However, backers do not have this possibility and can only assess business ideas based on their personal experience or specific expertise (Gunther *et al.*, 2015). This emphasizes the importance of discussion boards during campaign windows. However, decision boards have been neglected in the literature.

Moritz *et al.* (2015) emphasize that backers consider information from discussion boards, and Estrin *et al.* (2018) suggest that it is an important tool in the evaluation process ahead of an investment decision. This raises questions regarding the content and effects of demand-driven signals from BTE interactions. Kleinert and Volkmann (2018) presented the first content framework and its funding effects. The data were collected in 2015 based on 574 interactions on the UK-based platform Crowdcube. These findings imply a positive funding effect on crowd participation from discussion boards. However, the authors also suggested that different topics have different effects. Of the nine main themes and 19 corresponding categories, valuation (+), market risk (-), financial snapshots (+), likely returns (+), and shareholder rights (-) affected backer funding activities. This supports the idea that ECF backers have financial motives (Cholakova and Clarysse, 2015) when they ask questions and that topics affect backers differently. However, the findings in this stream of literature seem conflicting. Iurchenko *et al.* (2022) supported the general positive effect based on headlines from 4,400 discussion threads from 264 campaigns collected during 2017-2018 on Crowdcube. They found five main themes (products, markets, financials, teams, and fundraising strategies) but no statistical differences in funding activity between topics, although the data came from the same platform.

The themes and topics from these studies are not identical but are closely related to more traditional characteristics previously found among sophisticated investors (VCs and BAs), which have led to a better understanding of their investment behaviors (Carpenter & Sturet, 2015; Petty & Gruber, 2011). In addition, it highlights large variations between themes or topics regarding effects. This correlates with previous findings based on supply-driven signals (Shafi, 2019) and suggests the potential impact of something less obvious. This raises questions about the hidden content and potential sensitivity over other signal characteristics embedded in this interaction, which might be important for backers when they evaluate.

According to Connelly *et al.* (2011), the characteristics of a signal are fundamental to the signaling system. Consequently, supply-driven signals in ECF have been scrutinized in terms of both sentiment and clarity (Block *et al.*, 2018; Dorfleitner *et al.*, 2018) during funding windows. To better understand the investment effects of sentiment, Dorfleitner *et al.* (2018) use data based on 751 news updates and 39,036 investments from two German platforms for the period 2012-2015. They used the text analysis software Linguistic Inquiry and Word count (LIWC) to evaluate sentiments in news updates. However, they find no support for entrepreneurs using a positive tone in news updates (supply-driven signals) to encourage investment activity during funding windows. However, little is known about the demand-driven signals from discussion boards. To the best of my knowledge, the only study that touches upon this issue is that of Courtney *et al.* (2016). According to this study, reward-based backers are sensitive to positive and negative comments from others on crowd discussion boards. This suggests that these backers relied on the sentiments embedded in others' questions when evaluating them. However, these data were collected on discussion boards during 2009-2015 on the US-based non-investment crowdfunding platform Kickstarter.

Consequently, these differ in terms of time and crowdfunding mechanisms. Hence, this paper looks beyond more traditional characteristics in this domain to better understand the value of sentiment from demand-driven signals in the evaluation of ECF investment opportunities with the following hypothesis:

H1: Positive sentiments in demand-driven signals (i.e. questions) on discussion boards positively affect funding activities during successful ECF campaigns.

For clarity, we did not know much more about this issue. Lukkarinen *et al.* (2016) find that backers are more attracted to B2C (less complex) than to B2B (more complex) campaigns. In addition, Shafi (2019) argued that backers play down the importance of financials (seen as more complex) in contrast to information about businesses and teams (seen as less complex) when they evaluate. Hence, both studies imply that backers pay attention to clarity but also avoid complexity on a relative basis. However, these findings only consider supply-driven signals launched by entrepreneurs before funding windows open.

During funding windows, Block *et al.* (2018) used the Flesch Readability Index to measure language complexity. Based on data from 71 campaigns and 39, 399 investments in Germany, they concluded that less complex news updates (easy language or more words) encouraged backers to invest during campaigns (and vice versa). This is once again based on supply-driven signals but implies that backers are interested in learning (Vismara, 2018) if knowledge transfer is easy to understand. Hence, clarity may be of paramount importance in ECF to make complex issues easier to comprehend. This further emphasizes the importance of studies based on discussion board interactions during funding windows. Hence, the value of clarity in news updates (based on supply-driven signals) during campaigns raises curiosity about entrepreneurs' answers (based on demand-driven signals). If a backer asks about finances, the entrepreneur's answer is financial.

Consequently, the answers were 100 percent topic dependent. From this perspective, it is fully connected to the backer demand-driven signal, in contrast to the supply-driven signal (news update). Hence, it can be considered as an important feedback loop based on the demand-driven signal in this signaling system. To further expand knowledge about clarity based on signaling in this literature stream and to explore potential effects from demand-driven signals in the backer evaluation process, this paper raise the following hypothesis:

H2: Increased clarity in feedback loops (i.e. answers) based on demand-driven signals on discussion boards positively affects funding activities during successful ECF campaigns.

Prior hypotheses have focused on potential funding effects from sentiment and clarity from demand-driven signals in the evaluation process. However, the results from these potential effects only rely on direct effects without consideration to interaction effects between sentiment in backer questions and clarity in entrepreneur answers. Previous findings about funding effects based on supply-driven signals

have taken this into consideration (Lim and Busenitz, 2019; Estrin *et al.*, 2022). This enabled us to conclude the indirect effects of an alternative variable. For example, does team structure matter when it comes to the positive effect of human capital on funding success (Lim and Busenitz, 2019), or do investor networks matter when it comes to the positive effect of soft information in funding campaigns (Estrin *et al.*, 2022)? Hence, interaction effects help us better understand the direct effect of an independent variable on a dependent variable based on a moderating variable. Because direct effects do not always tell us the full story, this enables us to see whether the direct effects are affected by other forces (indirect effects). This raise questions about potential interaction effects between sentiment and clarity based on demand-driven signals? According to previous finding, backers tend to appreciate clarity (Lukkarinen et al., 2016; Block et al., 2018; Shafi, 2019).

Hence, if clarity in entrepreneur answers positively effects funding, this could also be affected by the sentiment of backer questions already loaded in the demand-driven signal. Hence, to broaden findings about funding effects based on interaction effects in this literature and to get deeper understanding about direct funding effects from clarity based on demand-driven signals when backers evaluate, the following hypothesis is formulated:

H3: Positive sentiment in demand-driven signals (i.e. questions) increase the funding activities from the clarity in the feed-back loops (i.e. answer) during successful ECF funding windows.

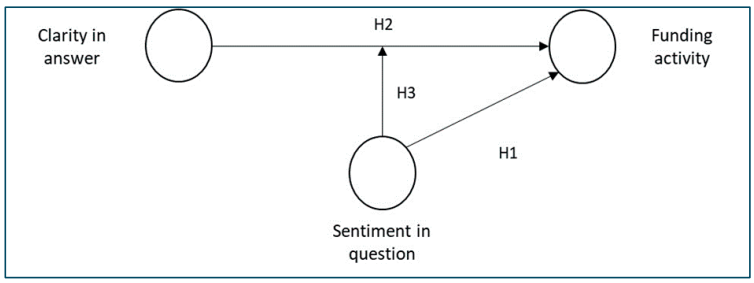

Figure 1. Funding effects from sentiment in backer questions and clarity in entrepreneur answers on discussion boards.

Figure 1 above summarizes the three hypotheses. In addition, dependent and independent variables are further described in the next chapter.

3.0 Data, method, and variables

This section will first describe the data and motivate methods used in this paper. Lastly, all variables included are thoroughly described in relation to previous findings in this literature to better understand the results in the following section.

3.1 Data

The main data in this study were collected during 2020 to 2021 on the crowdfunding platform FundedByMe. This platform had a strong position in Sweden, seen as a developed market for equity crowdfunding (SOU, 2018). Hence, driven by financial motives, backers in this market are expected to be aware of investment uncertainty. To reduce investment uncertainty for backers, this platform was based on an "all-or-nothing" model. Hence, ventures had to achieve their funding goals during the funding window (approximately six weeks) to be funded; otherwise, pledges were reversed to backers. However, there were also other platform functionalities with potential to reduce this uncertainty. Before

the funding window opens, ventures were expected to publish a minimum amount of information on the platform. This came in the form of investment memoranda and included information about the venture regarding markets, products, services, financials, future outlooks, and founders. If not accepted by backers, the campaign window never opened. In addition, when campaign windows were opened, this platform offered discussion boards for entrepreneurs and backers to interact in each specific campaign. Hence, the platform provided tools to reduce investment uncertainty based on information availability, but backers needed to take full responsibility to use this based on ICT and interaction. This study focuses on content and funding effects of this interaction based on demand-driven signals from discussion boards which rely on the BTE perspective. Hence, it includes data from 5,965 backer investments and 415 interactions from 28 successful ECF campaigns, hand-collected from this platform based on ICT-driven functionalities. The funding value from these campaigns was worth approximately SEK 82m. Regarding backers, information on the individuals were published voluntarily. Publicly available investment decisions were tagged with campaign names, sector identifications, backer names, and timestamps. Pepin AB incorporated this platform at the end of 2021 and is now the leading crowdfunding platform in Sweden, with 33,987 backers and has raised the app. SEK +1bn in funding.

3.2 Method

The aim of this paper is to better understand backer behaviors when they evaluate for conclusions about how they manage investment uncertainty. Findings depend on observational studies and conclusions draws from established theories in this domain (Cumming et al., 2010; Bonini and Capizzi, 2019). When it comes to observational studies and potential effects, key concerns about causality includes selection skewness and data availability. When it comes to selection skewness, this is less problematic. The data is not randomly selected on the platform, but instead rely on population data from FundedByMe (see above). Hence, all available platform data about campaigns have been used which reduce this concern. Furthermore, data limitation is also a key reason for lack of knowledge about backers and their behaviors (Schweinbacher, 2018). However, the data in this study have been generated and stored on an open and digitalized platform. Hence, it is publicly available but also traceable online. This strengthens findings about behaviors as they are based in experienced preferences (archive data) instead of expected data (attitude data) and reduce concerns over data availability over time.

To test the hypotheses based on the content and its funding effects, this study used a quantitative approach. Hence, in-line with previous findings about funding effects in this literature stream (Kleinert and Volkmann, 2018; Block *et al.,* 2018; Dorfleitner *et al.*, 2018; Iurchenko *et al.,* 2022), the results relied on regressions analysis and panel data. As mentioned above, the panel data was based on 5,965 investments, 415 interactions, and 1,786 funding days. Interactions were based on 182 questions to entrepreneurs and 233 answers to backers. In addition, funding effects were log transformed to handle skewness and kurtosis. This eliminated all observation based on no funding activities, i.e. coded as zero. Hence, this reduced observations from 415 to 360 (156 questions and 204 answers) for analysis of instant funding effects and from 415 to 407 (178 questions and 229 answers) for the additional analysis of lagged funding effects (see below).

3.3 Variables

Dependent variable,

In this study, the dependent variable was the number of investments pledged during a successful campaign on a given day. This translates into an accumulated crowd effect from *investments from questions (IQ)* and *investment from answers (IA)* after one day (instant effects). Hence, to reject or support the hypothesis, the regressions were based on one day to enable the estimation of instant funding effects from the evaluation of demand-driven signals on discussion boards. This is consistent with the findings of previous studies (Kleinert and Volkmann, 2018; Iurchenko et al., 2022) on discussion boards. Both use investment effects as proxies for positive investment decisions based on demand-driven signals

in backer evaluation processes. However, this study also conducts an additional analysis for seven days (lagged effect) to explore whether the funding effects remain over time. Lagged investment effects have previously been used to explore potential learning behaviors among backers based on both demand-driven (Block *et al.*, 2018) and supply-driven signals (Kleinert and Volkmann, 2018) from discussion boards.

Independent variables

To explore the direct effect of sentiment in backer questions on potential investment decisions (H1), we consider the continuous variable *Sentiment (SQ)*, which measures sentiment from a backer question in a specific campaign. This study used Microsoft Azure Machine Learning (MAML) software in Excel, based on a generic dictionary of positive and negative words, to determine sentiments in all backer questions (182) collected from unique discussion boards. Machine learning tools provide sentiment without human bias and are an approach previously used to measure sentiment among news updates (supply-driven signals) on discussion boards (Dorfleitner *et al.*, 2018). MAML returns sentiment values as positive, neutral, or negative, but also with numerical scores based on polarity. In this study, sentiments were based on numeric scores (0-1). All the questions examined were collected from discussion boards during successful funding windows.

To explore the direct effect of clarity in entrepreneur answers on potential investment decisions (H2), we used the continuous variable *Clarity (CA)*, which measures clarity from an entrepreneur answer (233) hand-collected during funding campaigns. To clarify this, this study used the Flesch Readability Index (FRI) software, which measures the language complexity of answers previously used in studies based on news updates (supply-driven signals) on discussion boards (Block *et al.*, 2018). Flesh Reading Ease (FRI) returns clarity values from 0 to 100 and is based on sentence and word length. Hence, a low clarity score was generated by a high average number of words in sentences and a high average number of syllables (and vice versa).

Furthermore, to investigate H3, we consider the continuous variable *Interaction Effect (IE),* which calculates a value to explore indirect effects from sentiment in backer questions on potential investment decisions based on the clarity of entrepreneurs' answers. The *IE* variable was calculated by multiplying the independent variables, *SQ* and *CA,* for all answered questions. Hence, it returns a value between 0-100, dependent on the moderating effect.

Control variables

Following previous research, we control for several campaign-specific factors that might affect backer behavior when making investment decisions. According to the literature, backers tend to follow other Backers when investing. This imitation behavior is well established in signaling (Spence, 1973). In this context, this is called herding (Vismara, 2018; Åstebro *et al.*, 2023) and is used to reduce investment uncertainty when backers invest. Hence, campaigns must be crowded for this behavior to exist. To account for this potential phenomenon, we use a dummy variable called *Number of Investments Total (NoIT),* where all campaigns with less than 300 investments get 0, and others get 1, in line with previous research (Olsson, 2023).

Additionally, entrepreneurs' willingness to invest in their projects is seen as a quality signal (Leland & Pyle, 1977). If entrepreneurs are confident that a firm will generate future cash flows, they tend to sell a lower proportion of their equity to investors. Hence, a low level of Equity Retention has become a key factor in predicting funding success (Ahlers *et al.*, 2015; Vismara, 2018), and we use a dummy called *Equity Retention (ER)* to control for this. The average campaign equity retention level in this sample is 11 percent; hence, all campaigns with dilution levels below 11 percent receive 1, and others receive 0.

Finally, this study controls for the level of venture complexity, which is of key importance according to previous studies on backer evaluation and quality signals (Lukkarinen *et al.*, 2016; Shafi, 2019; Olsson,

2023). This was accomplished in two ways. First, we create three control variables based on the level of industry complexity. Low-tech (LT) is seen as less complex, high-tech (HT) as more complex, and mid-tech (MT) as intermediate, all with corresponding values (0/1). Second, we use two control variables based on the business model. *Business-to-business (B2B)* campaigns are seen as more complex ventures, and *business-to-consumers (B2C)* campaigns are seen as less complex (0/1).

4. Results

This section presents a descriptive overview of the dataset. The results from the multiple regression models were then used to explore the potential funding effect based on sentiment, clarity, and interaction effects.

The descriptive statistics for the dependent and independent variables are summarized in Table 1 below to quantitatively analyze and estimate the impact of demand-driven signals on daily funding behavior. The campaigns included the raised applications. SEK 82m ranging from SEK 0,6m to SEK 21,8m with an average of SEK 2,9m per campaign. These campaigns attracted 5,965 unique backer investments, translating into an average of 213 investment decisions per campaign. Consequently, based on 1786 funding, the average daily number of investments was 3,3 compared to 6,4 in the CrowdCube study made by Kleinert and Volkmann (2019). However, the average number of investments increased to 11,2 and 10,6 during the days supported by questions and answers, respectively. This finding supports previous findings on the positive effects of demand signals (Kleinert and Volkmann, 2019; Iurchenco *et al.*, 2022) and supply-driven signals (Block *et al.*, 2018; Dorfleitner *et al.*, 2018) on discussion boards. However, to extend this research, this study focused on the content and effects of sentiment and clarity in questions and answers, respectively. The average sentiment embedded in the questions was 0,62, ranging from 0 to 1. The average clarity embedded in the answers was 60,6, ranging from 10 to 100. Hence, the questions seem to be more positive than negative, and the answers seem clearer than unclear in this sample. The average interaction effect is 37,2 and ranges from 0 0to 98, which suggests that discussions seldom include positive and clear answers during funding windows.

Table 1. Descriptive statistics

VARIBLE	MEAN	STD.DIV.	MIN.	MAX.	NO.OBS.
Investments from questions (IQ)	11,20	21,10	0,00	135,00	182
Investment from answers (IA)	10,58	18,32	0,00	142,00	233
Sentiment in question (SQ)	0,62	0,21	0,00	1,00	182
Clarity in answer (CA)	60,62	17,78	10,40	100,00	233
Interaction effect (IE)	37,20	18,77	0,00	97,52	233
Total no. of investments (NoIT)	294,96	268,15	35,00	982,00	415
Equity retention (ER)	0,11	0,07	0,02	0,40	415
Low-tech campaigns (LT)	0,41	0,49	0,00	1,00	415
Mid-tech campaigns (MT)	0,39	0,49	0,00	1,00	415
High-tech campaigns (HT)	0,20	0,40	0,00	1,00	415
Business-to-consumers (B2C)	0,72	0,45	0,00	1,00	415
Business-to-business (B2B)	0,28	0,45	0,00	1,00	415

The control variables are well-established in the literature on backer behavior, and the average values for *NoIT* and *ER* in this dataset confirm the levels from previous studies (Ahlers *et al.*, 2015; Vismara, 2018; Olsson, 2023). Additionally, because previous findings suggest that backers are more attracted to less complex campaigns or information (Lukkarinen, 2016; Shafi, 2019), it seems logical that *LT* and *MT* ventures represent approximately 80 percent of this sample of successful campaigns. This theme is further confirmed by considering the current ratio of 72/28 for the *B2C* and *B2B* business models, which is used as an alternative parameter of venture complexity.

To estimate the potential effects of sentiment in the backer questions (demand-driven signals) on investment activity (H1), a multiple regression analysis was conducted in Table 2 below. This enables

us to establish whether there are any potential instant effects to expect but also whether these potentially change based on the key control variables.

Table 2. Regression analysis, investment effects from sentiment in questions, 1 day

1-DAY INVESTMENT EFFECTS FROM QUESTIONS (IQ)								
	Mod.1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6	Mod. 7	Mod. 8
SQ	0.05 (0.79)	-0.02 (0.92)	-0.02 (0.92)	-0.02 (0.93)	-0.02 (0.93)	-0.02 (0.94)	-0.03 (0.87)	-0.03 (0.87)
NoIT (0 or 1)		1.45*** (0.00)	1.45*** (0.00)	1.45*** (0.00)	1.46*** (0.00)	1,44*** (0.00)	1,54*** (0.00)	1,54*** (0.00)
ER (0 or 1)			-0.03 (0.85)	-0.06 (0.80)	0.01 (0.98)	-0.04 (0.85)	-0.08 (0.67)	-0.08 (0.67)
LT (0 or 1)				0.04 (0.87)				
MT (0 or 1)					0.06 (0.81)			
HT (0 or 1)						-0.08 (0.72)		
B2C (0 or 1)							0.19 (0.40)	
B2B (0 or 1)								-0.19 (0.40)
Constant	1.64*** (0.00)	1.17*** (0.00)	1.19*** (0.00)	1.19*** (0.00)	1.15*** (0.00)	1.22*** (0.00)	1.33*** (0.00)	1.33*** (0.00)
Observations	156	156	156	156	156	156	156	156
R^2	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30
*p<0.1, **p<0.05, ***p<0.01								

First, regarding sentiment in the backer questions, the results are not statistically significant according to model 1-8 in Table 2 above. Hence, Hypothesis 1 was rejected. Consequently, positive sentiment in demand-driven signals (i.e. questions) on discussion boards has no positive effect on funding activities during successful ECF campaigns. Second, given the same level of sentiment, we only report positive and statistically significant instant funding activity after backer questions in more crowded campaigns versus less crowded campaigns (Model 2, Table 2). This indicates less sentiment but confirms positive funding effects from discussion boards (Kleinert and Volkmann, 2019; Iurachenko *et al.*, 2022) and potential herding during funding windows (Ahlers *et al.*, 2015).

To address potential delayed effects or learning behaviors previously confirmed among backers from supply-driven signals (Block *et al.*, 2018), the same procedure was conducted on a cumulative seven-day basis seen in Table 3 below.

Table 3. Regression analysis, investment effects from sentiment in questions, 7 days

7-DAY INVESTMENT EFFECTS FROM QUESTIONS (IQ)								
	Mod.1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6	Mod. 7	Mod. 8
Sentiment (SQ)	-0.17 (0.32)	-0.18 (0.24)	-0.18 (0.25)	-0.18 (0.25)	-0.18 (0.26)	-0.18 (0.25)	-0.18 (0.26)	-0.18 (0.26)
NoIT (0 or 1)		1,23*** (0.00)	1,23*** (0.00)	1,23*** (0.00)	1,23*** (0.00)	1,21*** (0.00)	1,21*** (0.00)	1,21*** (0.00)
ER (0 or 1)			-0,03 (0.84)	-0,03 (0.91)	0,03 (0.87)	-0,04 (0.82)	-0,02 (0.90)	-0,02 (0.90)
LT (0 or 1)				-0,01 (0.96)				
MT (0 or 1)					0,11 (0.62)			
HT (0 or 1)						-0,08 (0.69)		
B2C (0 or 1)							-0,04 (0.84)	
B2B (0 or 1)								0,04 (0.84)
Constant	3.15*** (0.00)	2.74*** (0.00)	2.76*** (0.00)	2.76*** (0.00)	2.69*** (0.00)	2.77*** (0.00)	2.73*** (0.00)	2.77*** (0.00)
Observations	178	178	178	178	178	178	178	178
R^2	0.32	0.25	0.25	0.25	0.25	0.25	0.25	0.25
*p<0.1, **p<0.05, ***p<0.01								

However, no such effects or behaviors could be confirmed based on sentiment, as the results again had no statistical significance. Instead, this study focuses on the clarity in entrepreneur answers (a demand-driven feedback loop) and its potential effect on funding activity (H2). These regressions (see models 1-9 in Table 4 below) use the same schedule described in Table 2 above but also consider potential interaction effects (from the sentiment of backer questions) on funding activity (H3).

Table 4. Regression analysis, investment effects from clarity in answers and implications from interaction effects, 1 day

1-DAY INVESTMENT EFFECTS FROM ANSWERS (IA)									
	Mod.1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6	Mod. 7	Mod. 8	Mod. 9
CA	0.010** (0.03)	0.013** (0.04)	0.013** (0.02)	0.010* (0.08)	0.011** (0.05)	0.010* (0.08)	0.011* (0.06)	0.011** (0.04)	0.012** (0.04)
IE (SQxCA)		-0.005 (0.43)	-0.006 (0.22)	-0.004 (0.45)	-0.004 (0.41)	-0.004 (0.48)	-0.005 (0.39)	-0.005 (0.32)	-0.005 (0.32)
NoIT (0 or 1)			1.378*** (0.00)	1.410*** (0.00)	1.476*** (0.00)	1.418*** (0.00)	1.429*** (0.00)	1.511*** (0.00)	1.511*** (0.00)
ER (0 or 1)				-0.313** (0.03)	-0.093 (0.66)	-0.234 (0.31)	-0.325** (0.02)	-0.411*** (0.01)	-0.411*** (0.01)
LT (0 or 1)					-0.311 (0.17)				
MT (0 or 1)						0.099 (0.67)			
HT (0 or 1)							0.149 (0.42)		
B2C (0 or 1)								0.266 (0.18)	
B2B (0 or 1)									-0.266 (0.18)
Constant	1.16*** (0.00)	1.12*** (0.00)	0.82*** (0.00)	1.07*** (0.00)	0.98*** (0.00)	0.98*** (0.00)	1.01*** (0.00)	1.23*** (0.00)	0.97*** (0.00)
Observations	204	204	204	204	204	204	204	204	204
R^2	0.02	0.03	0.31	0.33	0.33	0.33	0.33	0.33	0.33
*p<0.1, **p<0.05, ***p<0.01									

First, according to the results, clarity in answers has a positive and significant instant effect on funding activity over a day (model 1-9, Table 4). Hence, Hypothesis 2 is confirmed. Consequently, increased clarity in entrepreneurial answers is positive for funding activity during successful funding windows in ECF. Consequently, one additional level of clarity (0-100) in entrepreneur answers increased funding activity by 1 percent on the same day (Model 1, Table 4). Second, regarding the interaction effects for sentiment in questions and clarity in answers, there were no significant results to report after one day (Model 2, Table 4). Hence, Hypothesis 3 is rejected. Consequently, we cannot confirm whether a positive interaction effect for the sentiment in question (demand-driven signals) and clarity of answers (supply-driven feedback loops) on discussion boards has a positive effect on funding activity during successful ECF campaigns. Third, we report positive and statistically significant instant funding activity after backer answers in more crowded campaigns versus less crowded campaigns (Model 3, Table 4), as well as in campaigns offering less equity versus more equity (Model 4, Table 4). This confirms previous findings on backer behavior based on potential herding effects and the attraction of campaigns with low equity retention (Ahlers *et al.*, 2015; Vismara, 2018; Olsson, 2023). However, with regards to campaign complexity and funding activity, this study had no significant results.

Table 5, Regression analysis, investment effects from clarity in answers and implications from interaction effects, 7 days

7-DAY INVESTMENT EFFECTS FROM ANSWERS (IA)									
	Mod.1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6	Mod. 7	Mod. 8	Mod.9
CA	0,006* (0.09)	0,014** (0.01)	0,014*** (0.01)	0,012** (0.02)	0,012** (0.02)	0,012** (0.02)	0,011** (0.03)	0,011** (0.04)	0,011** (0.04)
IE (SQxCA)		-0,010* (0.06)	-0,011** (0.02)	-0,010** (0.04)	-0,010** (0.04)	-0,009* (0.06)	-0,009* (0.06)	-0,009* (0.08)	-0,009* (0.08)
NoIT (0 or 1)			1,147*** (0.00)	1,153*** (0.00)	1,156*** (0.00)	1,169*** (0.00)	1,127*** (0.00)	1,058*** (0.00)	1,06*** (0.00)
ER (0 or 1)				-0,160 (0.21)	-0,148 (0.44)	-0,073 (0.71)	-0,151 (0.24)	-0,072 (0.61)	-0,070 (0.61)
LT (0 or 1)					-0,016 (0.93)				
MT (0 or 1)						0,306 (0.13)			
HT (0 or 1)							-0,194 (0.24)		
B2C (0 or 1)								-0,254 (0.15)	
B2B (0 or 1)									0,254 (0.15)
Constant	2.78*** (0.00)	2.65*** (0.00)	2.41*** (0.00)	2.54*** (0.00)	2.54*** (0.00)	2.28*** (0.00)	2.64*** (0.00)	2.40*** (0.00)	2.66*** (0.00)
Observations	229	229	229	229	229	229	229	229	229
R^2	0.01	0.03	0.24	0.25	0.25	0.26	0.26	0.26	0.26
*p<0.1, **p<0.05, ***p<0.01									

Lastly, as an additional analysis, we ran regressions on a cumulative seven-day basis (see model 1-9 in Table 5 above) to conclude potential delayed effects or learning behaviors based on clarity in answers and the above-mentioned interaction effects. After a week, the effect of clarity remained positive and significant but decreased to 0,6 percent (Model 1, Table 5). Hence, the positive lagged effect of clarity also confirmed the learning behavior among backers based on feedback loops (i.e. answers) from demand-driven signals (i.e. questions). In addition, after seven days, there was a statistically significant negative interaction effect between reported sentiments in questions and clarity in answers (Model 2, Table 5). This suggests that, after a week, the direct effects are clouded by interaction effects. From a learning perspective, one interpretation of this could be that some backers tend to turn down campaigns after evaluating excessively positive questions from backers, although the answers from entrepreneurs might be clear. Furthermore, we confirm positive and statistically significant delayed funding activity after the entrepreneur answers in more crowded campaigns versus less crowded campaigns (Model 3, Table 5), but with a fading funding effect over the course of a week.

5. Discussion

Signals have been extensively investigated in the ECF literature because they have the potential to reduce investment uncertainty for backers when they evaluate opportunities in this domain. Current findings mainly rely on supply-driven signals from an ETB perspective (Ahlers *et al.*, 2015; Vismara, 2018; Piva and Rossi-Lamastra, 2018; Block *et al.*, 2018; Dorfleitner *et al.*, 2018; Correia *et al.*, 2019; Estrin *et al.* 2022). However, studies on demand-driven signals from a BTE perspective are lacking. ECF discussion boards offer a unique test bed for exploring these specific signals. However, only a few studies have attempted to fill this gap. Their findings depend on more traditional frameworks and seem to conflict with regard to content and funding effects (Kleinert and Volkmann, 2019; Iurachenko *et al.*, 2022). Hence, to address this situation, this study aims to unpack hidden characteristics among demand-driven signals to explore the potential funding effects for conclusions about backer behavior.

Based on Swedish data from campaign discussion boards, the findings of this study suggest that positive sentiment in questions (demand-driven signals) has less effect on funding activity during the ECF funding windows. This agrees with previous findings on news updates based on supply-driven signals (Dorfleitner *et al.*, 2018) on ECF discussion boards but contrasts with findings about backer questions based on demand-driven signals (Courney *et al.*, 2016) on RCF discussion boards. Instead, clarity in answers (the feedback loop of demand-driven signals) is of key importance. The positive funding effects

of clarity add to previous findings about its importance when it comes to evaluating supply-driven signals based on campaign characteristics such as business models, financials, teams, and products (Lukkarinen *et al.*, 2016; Shafi, 2019) released on platforms ahead of funding campaign windows. In addition, it adds to previous findings on news updates based on supply-driven signals (Block *et al.*, 2018) released during funding windows on ECF discussion boards. However, we did not find any support for the interaction effects of backer questions and entrepreneur answers (demand-driven signals and their feedback loops) that positively affected instant funding activity during funding campaigns. This finding contrasts with previous findings on supply-driven signaling (Lim and Busenitz, 2019; Estrin *et al.*, 2022).

Furthermore, the findings from the additional analysis also confirm delayed funding activity from the clarity in entrepreneur answers (feedback loops from demand-driven signals). This supports the learning behavior previously found only among news updates based on supply-driven signals (Block et al., 2018). In addition, over a week, there is a negative interaction effect of sentiment in the question and entrepreneur answers (demand-driven signals and their feedback loops) on funding activities. This expands our knowledge of the interaction effects based on demand-driven signals and delayed funding activity, which have only been studied among supply-driven signals (Lim and Busenitz, 2019; Estrin *et al.*, 2022) and instant funding activity.

Finally, these findings add to previous research on the value of demand-driven signals from discussion boards during successful funding windows (Kleinert and Volkmann, 2019; Iurchenko *et al.*, 2022). As mentioned above, this highlights the importance of high clarity in entrepreneur answers (feedback loops from demand-driven signals) for instant and delayed funding activities. This supports previous findings on the importance of discussion boards for backers when they evaluate (Moritz *et al.*, 2015; Estrin *et al.*, 2018) but also adds knowledge about potential funding effects from hidden values embedded in demand-driven signals on ECF discussion boards.

6. Conclusions

This study explored funding effects from hidden content embedded in demand-driven signals on ECF discussion boards to conclude backer behavior in the evaluation process. This is a less explored stream of the ECF literature and, to my best knowledge, the first paper that studies sentiment and clarity embedded in demand-driven signals (backer questions) and its feedback loops (entrepreneur answers).

The study Was based on 5,965 backer investments and 415 interactions during 28 successful ECF campaigns from the Swedish equity crowdfunding platform FundedByMe (2020-2021) and included two main results. First, consistent with findings based on news updates based on supply-driven (Dorfleitner *et al.*, 2018), sentiment in questions based on demand-driven signals is not important for funding activity during funding windows. Hence, ECF backers seem to neglect sentiment in all signals from discussion boards when evaluating investment opportunities during funding windows. Second, clarity in entrepreneurs' answers based on feedback loops from demand-driven signals seems important for both instant and delayed funding activities during funding windows. This is also in line with previous findings based on supply-driven signals released before and during funding windows (Lukkarinen *et al.*, 2016; Block *et al.*, 2018; Shafi, 2019). Hence, ECF backers seem to appreciate clarity in all signals when trying to reduce investment uncertainty in the evaluation process during funding windows. Furthermore, the delayed funding effects from the clarity in answers suggest a learning behavior previously found among backers based on both supply- and demand-driven signals (Block *et al.*, 2018; Kleinert and Volkmann, 2019) on discussion boards. In addition, this study confirmed the delayed negative interaction effect on funding activities. Hence, from a learning perspective, one interpretation of this could be that backers tend to turn down campaigns after evaluating excessively positive questions from backers, although the answers from entrepreneurs might be clear.

6.1 Contributions

This study makes several theoretical contributions.

First, it adds to previous research on the content and effects of ECF discussion boards based on traditional frameworks (Kleinert and Volkmann, 2019; Iurchenko *et al.*, 2022). It does so by unpacking the embedded characteristics hidden among questions and answers from the BTE perspective that are important when backers evaluate. This contribution is based on the content and funding effects of the sentiment and clarity embedded in demand-driven signals (and their feedback loops). This broadened our knowledge of these specific signal characteristics. These have previously only been explored for supply-driven signals (Block *et al.*, 2018; Dorfleitner *et al.*, 2018) in this literature stream. Hence, this is a complement to previous findings based on signals from the ETB and BTB perspectives (Ahlers *et al.*, 2015; Lukkarinen *et al.*, 2016; Block *et al.*, 2018; Vismara, 2018; Hornauf and Schwienbacher, 2018; Dorfleitner *et al.*, 2018; Shafi, 2019) to better understand the backer evaluation process.

Second, these findings broaden our knowledge of backer behavior in the investment decision-making process (Vismara, 2016; Abrams, 2018; Vismara, 2018; Wallmeroth, 2019; Åstebro *et al.*, 2023; Olsson, 2023). This contribution is linked to behaviors in the evaluation process and relies on findings based on the hidden characteristics embedded in demand-driven signals to reduce investment uncertainty. Furthermore, delayed funding effects extend previous research on learning behaviors (Block et al., 2018; Vismara, 2018; Kleinert and Volkmann, 2019) among backers when evaluating investment opportunities during ECF funding windows.

From a practical perspective, this especially emphasizes the importance of clarity in entrepreneur answers. Hence, to improve possibility of funding success, entrepreneurs need to put efforts not only to traditional parameters as financials, team, or product but also other characteristic as clarity embedded in this communication. Consequently, a clear language is important in this interaction and seem to add yet another important element for backers that evaluate investment opportunities. Furthermore, this would also encourage platforms to invest in more innovative and user-friendly tools on discussion boards to simplify writing and clarify responses from entrepreneurs to backers during funding windows. This interaction is also publicly available to others in the crowd. Hence, it has potential to also affect to reduce investment uncertainty to other backers in their evaluation processes.

Since backers pay attention to clarity in answers on discussion boards, entrepreneurs need to consider not only traditional content based on financials, team, or product/service but also other characteristics embedded in this communication. Hence, by using a clear language to improve understanding of information in this specific interaction they will improve possibility of funding success. Consequently, this also broadens the spectrum of quality elements for backers when they evaluate investment opportunities which reduce investment uncertainty in this phase of the investment decision process.

6.2 Limitations and suggestions for future research

This study had several limitations that provide avenues for future research.

First, these findings are based on group level. Hence, on an individual level, some backers might behave differently. This could imply that some backers might appreciate positive sentiment when evaluating questions and neglect clarity in answers on discussion board with potential to trigger isolated investments decisions with less or without any consideration of investment uncertainty during funding windows. Consequently, although our findings rely on unique empirics collected from a developed market, results could benefit from a larger and more detailed dataset. This would secure a more robust analysis when it comes to sentiment and clarity in demand-driven signals and perhaps also reveal different backer behaviors based on the level of sophistication during funding windows.

Second, the findings of this study rely on funding effects from the hidden characteristics embedded in demand-driven signals to extend previous research on discussion board content. However, other

characteristics could be of equal interest. According to the signaling theory, frequency is an important characteristic of a signal. The nature of the frequency is based on time or timing. Hence, to extend our knowledge of how the timing of demand-driven signals affects funding activity and backer behaviors, the timing of the question and, perhaps more importantly, the timing of responsiveness of answers might be of key importance when backers evaluate investment opportunities during funding windows.

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Paper III

Backer behaviors – changing investment dynamics in equity crowdfunding markets

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Received 1 June 2022
Revised 27 October 2022
6 February 2023
29 March 2023
Accepted 3 April 2023

Abstract

Purpose – This study aims to establish the shape of investment dynamics in equity crowdfunding to better understand backer behavior.

Design/methodology/approach – This study provides insights into when backers invest in successful funding campaigns. It uses *t*-tests to compare differences in means between observation windows during successful funding campaigns. It is based on 4,938 transactions from 61 campaigns, focusing on the first and last tail ends.

Findings – In contrast to previous findings, the current investment dynamics seem more U-shaped than L-shaped. This supports previous findings about a strong start but also suggests a late collective attention effect. The strength is higher at the first tail end. However, differences in the later tail ends are statistically significant and emphasize the presence of late investment activities, especially in crowded or less complex campaigns.

Practical implications – These findings emphasize the importance of signaling during the entire funding window. This encourages platforms to invest in user-friendly functionalities that guide entrepreneurs and help backers when investing in successful campaigns.

Originality/value – This study improves the understanding of backer behavior and suggests changing investment dynamics in equity crowdfunding. In addition, this pattern contrasts with previous findings on dynamic collective attention effects in rich digitally informative markets, implying two attention effects when uncertainty is high.

Keywords Equity crowdfunding, Backer behaviors, Investment dynamics, Investment uncertainty, Collective attention effects

Paper type Research paper

1. Introduction

This study uses a signaling lens to focus on investment dynamics during successful equity crowdfunding campaigns. Dynamics are created by investment decisions based on information (signal) availability, such as finding pieces of the puzzle to see the full picture. Equity crowdfunding is an expanding financial resource in entrepreneurial finance literature. It matches capital-seeking entrepreneurs with people in the crowd (backers, that is, investors) on digital platforms during short funding windows. However, equity crowdfunding is burdened by large information asymmetry (Belleflamme *et al.*, 2014). Hence, it is difficult for backers to obtain puzzle pieces. This translates into high loads of investment uncertainty

This research was partly funded by the research school Management and IT (MIT), Uppsala, Sweden, and the research environment Governance, Regulation, Internationalization and Performance (GRIP), Kristianstad, Sweden.

(Conrad *et al.*, 2016) and affects backer investment. To reduce uncertainty, backers need information they can obtain before and during campaign windows. During the funding windows, backer investments create investment patterns. These patterns come in different shapes (Hornuf and Schwienbacher, 2018) and translate into investment dynamics, which have implications for backer behavior.

Investment dynamics based on an L-shaped curve assume that most backers invest early (Vulcan *et al.*, 2016), which translates into an initial collective attention effect (Vismara, 2018a, b). This indicates that backers pay less attention to the information available during campaign windows. By contrast, investment dynamics based on a potential inverted L-shaped curve assume that most backers invest late, which translates into a late collective attention effect. Instead, this indicates that backers can learn about objects based on the information available during funding windows. This allows backers to reduce investment uncertainty before investing and implies more sophisticated behavior (Abrams, 2017). The third option is a potential U-shaped curve, which implies a combination of the abovementioned behaviors. Hence, different shapes imply different behaviors, but existing findings conflict (Hornuf and Schwienbacher, 2018; Correia *et al.*, 2019). This raises questions about the investment dynamics in equity crowdfunding.

According to equity crowdfunding literature, signals affect backers when they invest. Signaling before campaigns enables early investments (Vulcan *et al.*, 2016; Lukkarinen *et al.*, 2016; Vismara, 2018a, b), and signaling during campaigns initiates later investments (Moritz *et al.*, 2015; Li *et al.*, 2016; Ralcheva and Roosenboom, 2016; Dorfleitner *et al.*, 2018; Block *et al.*, 2018). In addition, signaling can create collective attention effects or herding (Vismara, 2018a, b; Astebro *et al.*, 2019). Hence, signals are important for both the timing and magnitude of investments, which shape investment dynamics. However, findings regarding these dynamics differ. In a German study, Hornuf and Schwienbacher (2018) argue that dynamics are L-shaped when using the dominant first-come, first-served mechanism based on uncertainty over share supply. However, they are U-shaped when an auction-based mechanism based on uncertainty over bidding power is used. These findings suggest different backer behaviors based on the share allocation mechanism. However, in a working paper about campaign success factors, Correia *et al.* (2019) add conflicting observations about the first come, first served mechanism. This UK study confirms previous findings about strong starts and observes late-end investment activities in successful versus unsuccessful campaigns. This draws attention to the potential U-shaped curve in successful equity crowdfunding campaigns using the first-come, first-served mechanism. As prices are fixed, this hardly depends on the uncertainty of the bidding power. Thus, investment dynamics may be about to change.

Investment-based crowdfunding has matured (Wenzlaff *et al.*, 2021). It is dominated by the loan-based form (LCF), and according to data from the Cambridge Centre for Alternative Finance, this is also confirmed in Germany and the UK (SOU, 2018). However, Sweden shows a contrast, as equity crowdfunding represents over 50% of the total crowdfunding market (SOU, 2018). In addition, most equity crowdfunding platforms pre-select ventures (Kleinert *et al.*, 2022), which reduces backer investment uncertainty. However, some Swedish platforms do not. Instead, they transfer investment uncertainty to backers (SOU, 2018). Hence, this creates opportunities for conclusions about investment dynamics from a mature market dominated by equity crowdfunding and potential backer behaviors heavily affected by investment uncertainty.

The primary aim of this study is to establish the shape of investment dynamics during successful equity crowdfunding campaign windows based on a first-come, first-served mechanism. The shape depends on the investment activities in different phases of the funding window. In conclusion, this study does not intend to predict investment activities in the different phases; instead, it determines the potential deviations between them. This study statistically tests the differences between phases of investment activities during successful equity crowdfunding campaigns.

This study adds to entrepreneurial finance literature on investment dynamics and backer behavior in equity crowdfunding by examining the distribution of investments during successful campaigns in a new setting regarding geography, platform, maturity and time. In addition, it contributes to the literature on dynamic attention effects by examining the statistical differences in potential collective attention effects in terms of position, length and strength. Practically, knowledge of investment dynamics can improve platform design in terms of online functionalities for information availability during funding campaigns. This can also help entrepreneurs navigate the allocation of valuable signals to backers. This is perhaps even more interesting for backers motivated by monetary returns (Cholakova and Clarysse, 2015), equity-based backers must manage investment uncertainty accordingly. Hence, knowledge of the distribution and magnitude of investment activities can reduce uncertainty when investing.

This study uses 4,938 backer transactions from 61 successful funding campaigns (2013–2016) on the Swedish crowdfunding platform FundedByMe [1]. All campaigns had a six-week funding window, which aligns with the median duration of successful campaign windows in this selection. All transactions translate into different investment patterns and collectively show the investment dynamics for a mature equity crowdfunding market based on the first-come, first-served mechanism.

In the next section, I justify my theoretical lens, review the literature and formulate the hypotheses. The third section presents the data and methodology and then discusses the results, conclusions and suggestions for future research.

2. Theory, literature and hypothesis

2.1 Signaling and investment uncertainty in the domain of entrepreneurial finance

The signaling theory framework suggests that agents send signals to principals for decisions under uncertainty. The primary reason for this is to reduce the information asymmetry between the two parties. It helps principals reduce the risk of adverse selection or moral hazards (Akerlof, 1970). Michael Spence (1973) illustrates this in a study on labor markets. A potential employee sends signals based on educational credentials to a potential employer to increase the possibility of being hired. The key elements of this framework are signalers, signals, receivers, feedback and the environment. Signalers carry information that is unavailable to receivers (Connelly *et al.*, 2011). Signalers and receivers are on opposite sides of the environment and, to some extent, have conflicting interests. Receivers capture signals, but they may be interpreted differently depending on the receiver's characteristics (Perkins and Henry, 2005). However, we also know that when several receivers interpret signals in the same manner, it may lead to imitation by others (Connelly *et al.*, 2011).

This lens has been used extensively in the entrepreneurial finance literature. It includes the information asymmetry dilemma between entrepreneurs and investors and translates into investment uncertainty. Entrepreneurs are signalers with capital deficits, while venture capitalists (VCs) and business angels (BAs) are traditional receivers with capital surpluses in this domain. VCs and BAs firms are sophisticated investors motivated by future financial returns. Both rely on signaling to reduce and manage investment uncertainty (Sahlman, 1990; Trester, 1998). Signals come in various forms and escalate in a time-consuming due diligence process. This is part of the screening mechanism and occurs when investors absorb information from entrepreneurs before deciding to invest. Hence, sophisticated investors know how to value quality signals and manage uncertainty (Gorman and Sahlman, 1982; Kaplan and Strömberg, 2005).

In equity crowdfunding, entrepreneurs are signalers with capital deficits, and backers are receivers with capital surpluses. Backers also have financial motives (Cholakova and Clarysse, 2015) when they invest. This implies expectations of future monetary returns and an awareness of investment uncertainty, previously found among sophisticated investors. However, backers are considered less sophisticated investors. Hence, they have fewer

capabilities to investigate and evaluate startup opportunities (Ahlers *et al.*, 2015; Lukkarinen *et al.*, 2016). This raises questions about backer behavior and investment dynamics.

2.2 Backer behavior and investment dynamics in equity crowdfunding

Equity crowdfunding literature has examined entrepreneurial success factors during successful campaigns (Moritz *et al.*, 2015; Li *et al.*, 2016; Dorfleitner *et al.*, 2018; Block *et al.*, 2018; Correia *et al.*, 2019; Cicchiello *et al.*, 2021) and regulatory issues concerning investor protection and the implementation of laws (Chen, 2017; Cicchiello and Leone, 2020). From the backer's perspective, this can be considered a quality signal to reduce investment uncertainty. The presence of investment uncertainty triggers different backer behaviors. This has been studied regarding motives, evaluations and backer types (Cholakova and Clarysse, 2015; Moysidou and Spaeth, 2016; Gunther *et al.*, 2015; Hornuf and Neuenkirch, 2017; Abrams, 2017; Olsson, 2021; Cicchiello and Kazemikhasragh, 2022). However, few studies have been conducted on the implications of investment dynamics.

Hornuf and Schwienbacher (2018) initiated this discussion based on a collection of investments from 89 successful and unsuccessful campaigns on four German platforms (2011–2014). They argued that this depends on the share allocation mechanism. If the entrepreneur offers shares on a platform using a first-come, first-served mechanism, the share price is fixed. In this case, backers invest early to secure a stake in a new firm before reaching the funding target. This translates into an L-shaped curve during funding windows, implying uncertainty over the supply of shares. If an entrepreneur turns to a platform using an auction-based mechanism, the price is not fixed. In this case, some backers invest late to reduce the risk of late bidding or sniping, which is often seen at Internet auctions (Ariely *et al.*, 2005). Instead, this translates into a U-shaped curve, implying uncertainty over bidding power and more available information before some investments. Hence, information and timing may be important to some backers. This suggests different backer behaviors based on the platform design (allocation mechanism). However, there was early investment activity in both cases.

All agree on the importance of early investments (Vulcan *et al.*, 2016; Lukkarinen *et al.*, 2016; Vismara, 2018a, b). This behavior is triggered by entrepreneurs (signalers) who try to build early campaign momentum among backers (receivers) before campaigning starts. This phase is called the private phase (Åstebro *et al.*, 2019). The key receivers in this process are potential lead backers (anchors), family and friends. These are important because they transform from receivers to signalers to other backers when investing. During this phase, entrepreneurs use social media and investor events to push signals to backers. It can signal management competencies, venture stage, risk factors, USPs, equity retention, funding targets and minimum investments (Brem and Wassong, 2014; Ahlers *et al.*, 2015; Lukkarinen *et al.*, 2016; Zunini *et al.*, 2017).

Hence, early investment momentum depends on signaling before the funding window opens and is an important element of the L-shaped curve. This type of dynamic is based on investments when windows are open, suggesting that backers pay less attention to additional quality signals released during funding windows, with the possibility of reducing investment uncertainty. This phenomenon can be established by comparing the first phase (early investment activity) with the second phase (post-early investment activity) of the funding window. We tested this using the following hypotheses:

H1. Early investment activities are higher than post-early-investment activities in successful campaign windows using the first-come, first-served mechanism.

In a more recent study, Correia *et al.* (2019) focused on success drivers on platforms using a first-come, first-served mechanism. This study was based on 1,256 campaigns (2015–2018) conducted in the UK. They observed that the backers were more active during the first and last days of the campaign window. They translated this into a possible U-shaped curve based on

the investment amount and the total number of investors, arguing that the effect might be more pronounced in successful campaigns. This contrasts with previous findings on successful campaigns based on the first-come, first-served mechanism (Hornuf and Schwienbacher, 2018). While the working paper by Correia *et al.* (2019) has not yet been peer-reviewed, and the data have not been statistically tested, it raises important questions about dynamics and behaviors.

During funding windows, entrepreneurs and backers have opportunities to interact on the platform before investing. Regarding entrepreneur-to-backer interplay, Li *et al.* (2016) and Dorfleitner *et al.* (2018) argued for the importance of project updates. Block *et al.* (2018) support this view, suggesting that these signals have a significant effect on the number of investments and investment amounts. In addition, they argued that there are positive effects when updates have easy language; however, they play down the importance of length. Hence, the understandability of a product or service is an important signal. This was supported by Lukkarinen *et al.* (2016), who suggested that less complex campaigns have a higher probability of success than more complex campaigns. To succeed, entrepreneurs should be active and present less complex information during funding windows. Regarding backer-to-backer interplay, Moritz *et al.* (2015) and Ralcheva and Roosenboom (2016) suggested that third-party communications (other backers or experienced backers) are also quality signals to invest or not. Consequently, quality signals are important; however, these findings indicate less about the distribution of investments during funding windows.

However, the composition of the crowd seems to be an important aspect with the potential to affect backer behaviors. Wallmeroth (2019) argued that more strategic backers (strong personal wealth) invest less frequently but in higher amounts. They also tended to be more selective than less strategic backers (weak personal wealth). However, this stream of the literature also suggests differences in investment dynamics. After the US legislation regarding unaccredited investors, Abrams (2017) argued that more sophisticated backers (experts from the financial sector) seemed to crowd out less sophisticated ones. More importantly, they tended to be more active at the end of the campaign.

This translates into an inverted L-shaped investment pattern for more sophisticated backers and implies behavior based on the need for information availability. These findings focus on late-end investment activities, which can be detected by comparing the last phase (late-end investment activity) with the second to the last phases (semi-end investment activities) of the funding window. This has not been statistically tested before, and we address this potential late-end investment activity in successful campaigns on platforms with first-come, first-served mechanisms with the following hypothesis:

H2. Late-end investment activities are higher than semi-end investment activities in successful campaign windows using the first-come, first-served mechanism.

The L-shaped and inverted L-shaped investment curves suggest strong investment activities at either the early or late tail ends during successful funding windows. However, the U-shaped curve suggests strong investment activity at both tail ends. This raises questions about its strengths. To be fully U-shaped, the magnitude of the investment activities should be equally strong. This calls for a strong start and end. In the UK study by Åstebro *et al.* (2019), based on 22,615 backers, 21% of the total amount was accumulated during the first day, and 75% of the amount was accumulated during the first week in successful campaigns versus failed campaigns that never took off. In addition to this observation of magnitude, the authors also discussed the effect of size. A large investment is considered a quality signal. This is affected by the size of the most recent pledge; however, the correlation fades over time. This suggests a similarity among backers (receivers) regarding signal interpretation during funding windows, translating into imitation or herding behavior (Gali, 1994). According to this stream of literature, backers with a public profile or area expertise (Kim and Viswanathan, 2016; Vismara, 2018a, b) are important to other backers who follow them based on these characteristics. However,

herding has so far only been confirmed in the early phases of equity crowdfunding funding windows (Vismara, 2018a, b; Åstebro *et al.*, 2019).

These findings are reflected in separate literature. Collective attention effects are used to better understand consumer behavior in rich and informative digital markets (Wu and Huberman, 2007; Falkinger, 2008). In this stream of literature, Hodas and Lerman (2013) argued that old stories are just as appealing as new stories, but people pay more attention to new ones because they are easier to find. Today, this literature focuses on the dynamics of collective attention effects, which have a close bearing on magnitude. In a longitudinal study based on datasets from several domains, Lorenz-Spreen *et al.* (2019) suggested accelerating dynamics in collective attention effects. Today's collective attention spikes are higher but fade away more rapidly as the production and consumption of content increases. Equity crowdfunding is a context that fits this description as entrepreneurs compete with others to gain more attention during funding windows. Based on the findings on early investments and herding, this implies only one high single collective attention effect in successful funding windows. This translates into an L-shaped investment pattern and backer behavior that pays less attention to signals during funding windows.

However, Correia *et al.* (2019) suggest that during successful funding windows, 27% and 13.3% of all backers invested in the first and last weekly tail ends, respectively. This finding emphasizes the value of signaling and raises questions about the strength of the first tail end during successful funding windows. If there is more than one collective attention effect in this context, it affects investment dynamics. In addition, balanced magnitudes would instead support a U-shaped investment pattern. To clarify this issue further, we test the differences in the first and last tail ends of successful funding windows using the first-come, first-served mechanism with the following hypothesis:

H3. Late-end investment activities are greater than early investment activities in successful campaign windows using the first-come, first-served mechanism.

3. Data and methodology

3.1 Equity crowdfunding globally and in Sweden

Crowdfunding is gaining momentum worldwide. According to the Cambridge Centre for Alternative Finance (2021), the global online alternative finance market was worth 113 billion (+24%) in 2020 (excluding China). In this market, CF is offered in four forms: (a) donation-, (b) reward-, (c) loan- and (d) equity-based. LCF is the most popular form (49.6 billion USD), but the equity-based alternative has grown significantly, worth approximately 2.2 billion USD (+47%) in 2020. Sweden represents a minor part of this market. It was worth 7 million USD in 2015 but also grew substantially and was worth approximately 30 million USD in 2018. However, unlike other countries, it is dominated by equity crowdfunding (SOU, 2018).

In addition, some Swedish platforms do not pre-select ventures. Instead, entrepreneurs independently decide on the content and financial terms according to the platform structure of the investment memorandums. They are then offered the service to present this information in investment meetings and newsletters to specific backers during the private phase. If it is received positively, the campaign is accepted and launched on the platform before the funding window opens (SOU, 2018). Hence, without platform screening, all investment uncertainties are transferred to backers. Without face-to-face meetings, platforms instead provide a tool for signaling (the discussion board), which is managed by entrepreneurs and backers during campaign windows (Moritz *et al.*, 2015; Estrin *et al.*, 2018; Kleinert and Volkmann, 2019; Iurcenhko *et al.*, 2022). Funds are then raised during a six-week funding window according to an "all or nothing" model and close as soon as the funding target is met.

3.2 Data source and collection procedure

This study was based on data from the Swedish crowdfunding platform FundedByMe using the first-come, first-served mechanism. This platform does not pre-select ventures and offers reward-, debt-, or equity-based models. Entrepreneurs have raised approximately 0.75 billion SEK on this platform, attracting over 250,000 backers. The dataset includes 4,938 investments from 3,584 backers based on the equity crowdfunding model. Investments were made in 61 successful campaigns and 11 sectors during a restricted period (2013–2016). These funding campaigns were worth approximately 125 million SEK. Information was published voluntarily from the backers' perspectives. Publicly available investments are tagged with campaign names, sector identifications, backer names and timestamps. This enables the creation of investment patterns for 61 successful funding campaign windows.

To create patterns, all the data were translated into panel datasets. All investments were distributed and accumulated based on the percentage of time spent (1–100%) on all unique campaign windows. This means that if a campaign window is 100 days, the first day represents one percent and the last day 100%, and the number of transactions is aggregated accordingly. This enables comparability between and among campaigns, in line with the models used by Hornuf and Schwienbacher (2018) and Correia *et al.* (2019) for equity crowdfunding. According to the data, the median campaign duration was 50 days. This aligns with platform recommendation and investment dynamics studies in this stream of literature. The median number of unique investments in each funding window was 83, and multiple transactions from the same backer were excluded during unique campaigns. Only the first investment (of a series of investments) from a unique shareholder is counted to reduce the risk of false conclusions regarding investment activity or attention effects during a campaign window. On the FundedByMe platform, live campaigns have sorting options based on popularity and campaign duration (newest or oldest live campaigns). This is the standard procedure crowdfunding platforms use to identify or initiate attention effects.

3.3 Data analysis procedure

According to the literature review, investment dynamics are either L-shaped or U-shaped (Hornuf and Schwienbacher, 2018; Correia *et al.*, 2019). Hence, it seems logical to look at both tail ends during funding windows to draw conclusions about investment dynamics in the main analysis. All previous studies have used weekly funding windows to detect and report findings on attention effects or investment activities. This study has the same intention but instead uses two window perspectives to make this process more robust.

To test the different tails statistically, all campaign patterns were divided into four (25% perspective) and ten part (10% perspective). All parts or sub-windows include the aggregated numbers of unique backers. This enabled the identification of potential early or late attention effects in both tail ends by comparing the first sub-window (win1) with the second (win2) and the third sub-window (win3) with the fourth (win4) based on the 25% funding window perspective. The same procedure was also performed for the other perspective: the first sub-window (win1) was compared to the second (win2), and the ninth sub-window (win9) was compared to the tenth (win10) based on the 10% funding window perspective. This translated into differences between campaign windows based on backer investments at the early and late tail ends. These differences were used not only to find evidence of potential attention effects but also to argue for relative magnitudes in this market. Differences in means were also tested for statistical significance.

In addition to investment dynamics, backer behavior also depends on investment evaluations and backer type. Hence, to ensure the robustness of the findings, this study controls for potential impacts on the dynamics through additional analysis. This included one-way ANOVAs for differences in means in the last tail ends with post-hoc tests (sidak).

Dilution and herding are issues in evaluation (Hornuf and Neuenkirch, 2017). Campaigns with low levels of equity retention (dilution) imply that entrepreneurs give away less power. It is seen as a quality signal that reduces uncertainty for backers based on long-term entrepreneurial commitment (Vismara, 2016). In addition, herding is more likely to occur during campaign windows with high levels of participation (Åstebro *et al.*, 2019). This is viewed as a quality signal for backers to reduce uncertainty based on imitation (Gali, 1994). This study controls for dilution effects (above or below 10%) and the number of new shareholders (0–50, 51–150 and 150+).

Finally, regarding backer type, it would have been of great value to control for levels of sophistication or backer strategic profiles (Abrams, 2017; Wallmeroth, 2019). Unfortunately, the data do not provide this information. However, backers prefer campaigns with less complexity (Lukkarinen *et al.*, 2016). This is seen as a quality signal for backers to reduce uncertainty based on the level of complexity and has been used in a study on gender (Mohammadi and Shafi, 2018). Hence, campaigns were clustered into levels of technical complexity (1–3) based on the Swedish Standard Industrial Classification (SNI) segment distribution. The complexity level was graded according to the following schedule: Low- and high-tech firms have low and high investment uncertainty, respectively.

(1) Food and beverages, sport, fitness and others (low-tech)

(2) Consumer products, service and fashion (mid-tech)

(3) Finance, media, technology and healthcare (high-tech)

4. Results and discussion

In addition to the main analysis, this section presents descriptive data. The main analysis then includes the results from the *t*-tests of all three hypotheses to establish the shape of the investment dynamics. This section concludes with an additional analysis based on a one-way ANOVA for differences in means at the important last tail end to ensure the robustness of the findings.

According to the descriptive statistics (Table 1), 61 successful campaigns had a mean funding value of 1.9 million SEK. Entrepreneurs offer as much as 31.5% of a firm's voting power to new shareholders, but the mean dilution effect is close to 10%. This aligns with previous findings on successful equity crowdfunding campaigns and emphasizes that high dilution reduces the attractiveness of investment opportunities (Vismara, 2016). The mean campaign window absorbed 83 new backers over a mean campaign duration of 50 days.

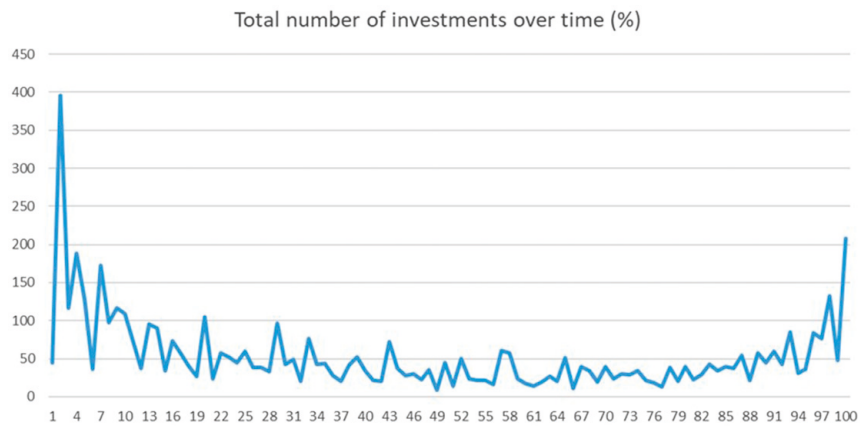
Backers invested 125 million SEK in 11 sectors with different technological maturity complexities.

The distribution over the entire time horizon (Figure 1) for all campaigns indicated high activity at the beginning and end. This provides less support for previous findings on an

Campaigns	Observations	Mean	Std. Dev	Min	Max
Market cap (MSEK)	61	85.9	495.9	2.0	3,891.0
Funding (MSEK)	61	1.9	2.3	0.2	11.8
Dilution	61	10.3%	7.1%	0.0%	31.5%
No. of new shareholders	61	83.4	72.5	7.0	386.0
Duration	61	49.7	18.6	11	90

Source(s): Table created by author

Table 1. Summary of descriptive statistics, ECF campaigns



Source(s): Figure created by author

Figure 1. Distribution of total investments during a successful campaign funding window in equity crowdfunding

L-shaped investment dynamic using the first-come, first-served mechanism (Hornuf and Schwienbacher, 2018). Instead, it suggests a more U-shaped curve, in line with the investment dynamics previously observed in the working paper by Correia *et al.* (2019) for successful equity crowdfunding campaign windows. However, this illustration provides no statistical support for the changes in investment dynamics. Hence, for the main analysis, I tested the differences in both tail ends from the 10 and 25% funding window perspectives.

Skewness and kurtosis supported the choice of the model and according to the *t*-tests (Table 2), there were differences in both tail ends. The results were statistically significant from both perspectives ($p < 0.05$ in the first tail end and $p < 0.001$ in the last tail end). The findings indicate that there was at least twice the investment activity (measured as the number of backers) at both tail ends compared with both post-early and semi-end investment activities. This implies less investment activity in the middle but higher investment activity at both tail ends. First, this confirms H1: Investment activity is high at the beginning of a successful campaign. This supports previous findings on the importance of early investment (Vulcan *et al.*, 2016; Lukkarinen *et al.*, 2016; Vismara, 2018a, b; Hornuf and Schwienbacher, 2018; Correia *et al.*, 2019). Second, it confirms H2: investment activity is high at the end of a successful campaign. This supports previous findings from Abrams (2017) regarding the growing interest in late-end investment activities (the author refers to sophisticated behaviors). As prices are fixed, there is hardly any concern regarding bidding power. Instead, this implies backer behaviors that enable the possibility to benefit from signals in the entrepreneur-to-backer and backer-to-backer interplay (Moritz *et al.*, 2015; Gunther *et al.*, 2015; Li *et al.*, 2016; Block *et al.*, 2018; Åstebro *et al.*, 2019).

However, the aggregated results of H1 and H2 provide less support for the L-shaped or inverted L-shaped curves in successful campaigns. Instead, this implies a U-shaped curve. This indicates that some backers invest early, while others invest late; however, they tend not to invest in the middle of these funding windows. This supports behaviors based on uncertainty over share supply at the first tail end (Hornuf and Schwienbacher, 2018) but also suggests potential behavior based on investment uncertainty over adverse selection or moral hazards (Akerlof, 1970) during campaigns. Hence, backers who invest early ensure they do not miss investment opportunities. However, backers who invest late have all the available information, which reduces the uncertainty of making the wrong investment. This emphasizes the importance of additional transparent and user-friendly functionalities on platforms to guide entrepreneurs and help backers signal during the entire funding window.

Statistics	10% perspective Win 1 and 2	10% perspective Win 9 and 10	25% perspective Win 1 and 2	25% perspective Win 3 and 4
Observations	61	61	61	61
Means	12.7	−6.8	21.3	−9.8
Skewness	5.9	1.7	4.6	1.0
Kurtosis	41.8	5.8	28.0	4.4
Two sample *t*-tests				
First tail end	**Observations**	**Means**	**Std. Error**	**Std. Dev**
Win 1 (10%)	61	23.1	6.7	52.3
Win 2 (10%)	61	10.4	1.6	12.3
	Diff	*12.7*	Ha: diff > 0, Pr (T > *t*) = 0.0335	
Win 1 (25%)	61	37.4	7.4	58.3
Win 2 (25%)	61	16.1	2.5	19.7
	Diff	*21.3*	Ha: diff > 0, Pr (T > *t*) = 0.004	
Last tail end	**Observations**	**Means**	**Std. Error**	**Std. Dev**
Win 9 (10%)	61	6.3	1.1	8.4
Win 10 (10%)	61	13.1	1.9	14.7
	Diff	*−6.8*	Ha: diff < 0, Pr (T < *t*) = 0.001	
Win 3 (25%)	61	11.8	1.3	10.5
Win 4 (25%)	61	21.6	2.7	20.8
	Diff	*−9.8*	Ha: diff < 0, Pr (T < *t*) = 0.0007	

Source(s): Table created by author

Table 2. *t*-test for differences of means in both tail ends (10 and 25% perspectives)

This study also considered the magnitude of investment activities. The results for H1 and H2 imply superior investment activities at both tail ends. Comparing these sub-windows based on strength further reveals the investment dynamics. Consequently, the differences in the means between the tail ends are tested from the 10 and 25% funding window perspectives.

Skewness and kurtosis once again supported the choice of the model, and the *t*-tests suggested that early-end investment activities were higher than late-end investment activities (Table 3) from both perspectives. This difference was statistically significant ($p < 0.1$ and $p < 0.05$). Hence, H3 is rejected. Late-end investment activities are not stronger than early-end activities. However, this test shows investment activities in both windows, which provides less support for the L-shaped and inverted L-shaped investment curves. Late-end activities in the last sub-window represent as much as 57% of the early-end activities in the first sub-window from both the 10 and 25% perspectives. This is significantly higher than that previously observed in the literature (Astebro *et al.*, 2019; Correia *et al.*, 2019) and provides additional support for a U-shaped curve, in contrast to previous findings on the L-shaped curve (Hornuf and Schwienbacher, 2018).

The results of H1 and H2 suggest collective attention effects at both tail ends of successful funding windows using the first-come, first-served mechanism. This implies that investment

Two sample *t*-tests Perspectives	Observations	Means	Std. Errors	Std. Dev
Win 1 (10%)	61	23.1	6.7	52.3
Win 10 (10%)	61	13.1	1.9	14.7
	Diff	*10.0*	Ha: diff > 0, Pr (T > *t*) = 0.08	
Win 1 (25%)	61	37.3	1.3	10.5
Win 4 (25%)	61	21.6	2.7	20.8
	Diff	*15.7*	Ha: diff > 0, Pr (T > *t*) = 0.02	

Source(s): Table created by author

Table 3. *t*-test for differences of means between tail ends (10 and 25% perspectives)

dynamics in this domain support two collective attention effects but with slightly reduced strength over time (H3). This conflicts with previous findings on dynamic collective attention effects (Lorenz-Spreen *et al.*, 2019), suggesting only a single high spike and then no activity. This dataset offers little insight into backer characteristics (retail or sophisticated backers). This is important for understanding herding behaviors (Vismara, 2018a, b), previously found only in the early phases of funding windows. Although we do not know who follows who, these results also imply potential herding behavior in the last tail end during successful campaign windows.

Regarding the robustness of the findings, this study provides an additional analysis of investment dynamics based on the late attention effect. This included one-way ANOVAs for the differences in means in the last tail ends. They were controlled for static factors with post hoc tests (sidak): the four static factors were sector complexity, technological complexity, dilution and the number of new shareholders. All these are well-established quality signals that affect backer behavior (Brem and Wassong, 2014; Ahlers *et al.*, 2015, Lukkarinen *et al.*, 2016; Zunini *et al.*, 2017; Vismara, 2018a, b; Åstebro *et al.*, 2019).

From a 10% perspective (Table 4), there were statistically significant ($p < 0.05$) differences in the means for campaigns with less technological complexity (14.0) and moderate technological complexity (3.3). This finding suggests a higher late-attention effect for campaigns with less technological complexity versus those with mid-technological complexity. This adds to previous findings on backer attraction for less complex ventures (Lukkarinen *et al.*, 2016). Regarding the dilutions, there were no statistical differences in the means reported. Instead, tests for campaign participation from both 10 and 25% perspectives were conducted. From the 10% perspective (Table 4), there were statistically significant differences in means ($p < 0.1$) in campaign windows with more than 50 and fewer than 150 new backers compared to campaigns with fewer than 50 backers. From the 25% perspective, the results were stronger ($p < 0.001$). This suggests stronger differences for campaigns with more than 150 new backers than those with fewer than 50 backers. Hence, the late attention effect is higher in campaigns that attract more new backers. This adds to previous findings on the potential herding effects (Vismara, 2018a, b; Åstebro *et al.*, 2019) at the early and late tail ends of successful equity crowdfunding campaigns.

One-way ANOVA, last tail end

Technological complexity (10%)	**Campaigns**	**Means**	**Std. Dev**
Less	16	14.0	17.5
Mid	28	3.3	8.6
More	17	5.9	13.8
Total	61	6.9	13.4
	Comparison Mid to Less: 10.7, 0.032		
No. of new shareholders (10%)	**Campaigns**	**Means**	**Std. Dev**
>50	27	2.7	3.4
50–150	23	11.0	14.0
<150	11	8.2	23.1
Total	61	9.7	18.2
	Comparison > 50 to 50–150: 8.3, 0.086		
No. of new shareholders (25%)	**Campaigns**	**Means**	**Std. Dev**
>50	27	1.9	7.5
50–150	23	12.0	18.2
<150	11	24.1	26.6
Total	61	9.7	18.2
	Comparison > 50 to < 150: 22.2, 0.001		

Source(s): Table created by author

Table 4. One-way ANOVA, differences of means, technological complexity, and number of new shareholders in late tail ends (10 and 25% perspectives)

5. Concluding discussion

5.1 Theoretical implications

This study focuses on the investment dynamics during successful funding windows in equity crowdfunding. This domain is burdened with information asymmetries that translate into investment uncertainty (Belleflamme *et al.*, 2014; Conrad *et al.*, 2016). Investment uncertainty affects investment dynamics and the findings in the literature conflict. According to the main analysis, the data support Hypotheses 1 and 2. Hence, investment activities are high at the beginning and end of successful funding campaigns. However, the data rejected Hypothesis 3, indicating that investment activities are not stronger at the late end compared to the early end of these funding windows. However, compared with previous studies (Åstebro *et al.*, 2019; Correia *et al.*, 2019), the magnitude of late-end investment activities cannot be ignored. This translates into the second collective attention effect and potential herding. According to additional analysis, the late-end collective attention effect is statistically significant in less technologically complex or crowded campaigns. Thus, the findings imply that the current investment dynamics are more U-shaped than L-shaped during successful funding windows.

This finding provides less support for previous findings of an L-shaped curve during successful funding windows (Hornuf and Schwienbacher, 2018). Instead, it suggests changing investment dynamics in equity crowdfunding. These findings support the importance of early investments (Vismara, 2018a, b; Hornuf and Schwienbacher, 2018; Correia *et al.*, 2019) but also suggest a growing interest in late-end investment activities in successful funding campaigns (Correia *et al.*, 2019). Hence, some backers invest early and some invest late, but they do not invest in the middle in mature markets dominated by equity crowdfunding using the first-come, first-served mechanism.

The change in investment dynamics during funding windows implies different behaviors on platforms that use this mechanism. Previously, backers mainly relied only on signaling (Spence, 1973) ahead of campaign funding windows to reduce investment uncertainty. According to the L-shaped curve, backers invested early and were influenced only by uncertainty over share supply and herding (Hornuf and Schwienbacher, 2018; Åstebro *et al.*, 2019). However, today, some backers invest later. This behavior has been identified among more sophisticated backers (Abrams, 2017). They have all available signals released during campaign windows. When more information is available, investment uncertainty is further reduced. Hence, today's U-shaped curve seems to also include behaviors previously identified among more sophisticated backers.

These findings increase our understanding of less technologically complex and crowded campaigns. Backers not only prefer campaigns that are less complex (Lukkarinen *et al.*, 2016); but some also seem to invest late during these funding windows. In addition, herding in the first tail-ends (Vismara, 2018a, b; Åstebro *et al.*, 2019) also seems to have the potential to occur in the late tail-ends, especially in more crowded campaigns.

Furthermore, the U-shaped curve translates into two collective attention effects during a successful funding window. This conflicts with existing findings on the dynamics of collective attention on rich informative digital platforms (Lorenz-Spreen *et al.*, 2019) and is a useful piece of knowledge when adding a context of high uncertainty to this separate literature.

5.2 Practical implications

From a practical perspective, this finding contributes significantly to various perspectives. For platforms, it suggests additional investments in transparent and user-friendly functionalities to facilitate and encourage signaling between entrepreneurs and backers during the entire funding window. In addition, it encourages entrepreneurs to keep pushing quality signals to backers during funding campaigns and backers to learn about the object based on signals released during funding windows that reduce investment uncertainty.

5.3 Limitations and suggestions for further research

The data in this study are updated and based on a mature market dominated by equity crowdfunding, unlike previous research on investment dynamics (Hornuf and Schwienbacher, 2018). It uses data from a platform that does not pre-select campaigns and increases the depth of findings based on observations from newer datasets (Abrams, 2017; Correia *et al.*, 2019). However, it would benefit from data on unsuccessful campaigns with the potential to detect alternative behaviors. This method relies on the same approach used in previous studies, with a high focus on the first day or week of the funding window. This study expands the approach to 10 and 25% observation windows but also increases the area of attention to the late end of the funding window. This approach absorbs all investment activities when using the 25% observation window but loses some when using the 10% observation window.

Furthermore, the findings regarding the dynamics are based on conclusions at the aggregate level. This provides fewer opportunities to draw strong conclusions at the individual level; however, more data and research can provide insights into the composition of the crowd as a potential moderator of investment dynamics over time. Who invests early and late? This would also strengthen the understanding of herding in investment dynamics. Who is the leader, and who is the follower? In addition, going from platform to backer data enables an understanding of how they seek and manage information before investing. These questions relate closely to different backer behaviors and point to avenues for future research on investment dynamics.

Notes

1. Currently, FundedByMe is incorporated into the Swedish crowdfunding platform Pepin AB. Hence, this unique dataset is no longer publicly available. In contrast to FundedByMe, all ventures on PEPIN are screened and pre-selected using the platform.

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Paper IV

Backer behaviours: an explorative study of investor types in equity crowdfunding

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Abstract: Equity crowdfunding (ECF) is a new source of early-stage finance where ordinary people are the investors. In this context, investors are called backers, and their behaviours are less well understood. The contribution of this paper is to explore differences between backer investment behaviours. This is important, as it further positions backers when it comes to behaviour of different investor types, but also enables a discussion of attitudes and management of uncertainty from a portfolio theory perspective. The data include 4,938 backer transactions collected from FundedByMe.com during 2012–2016. Most backers invest in single campaign portfolios (single-portfolio backers) and seem less attracted to uncertainty. However, 16% of the crowd invest in multiple campaign portfolios (multi-portfolio backers). They seem more attracted to uncertainty and most of them diversify to manage the portfolio uncertainty. Hence, a minority of the crowd seem to care about uncertainty and manage it in a professional manner.

Keywords: early-stage finance; equity crowdfunding; ECF; backer behaviour; investor behaviour; investment patterns; portfolio management; diversification; specialisation; management of uncertainty.

Reference to this paper should be made as follows: Olsson, O. (2021) 'Backer behaviours: an explorative study of investor types in equity crowdfunding', *Int. J. Entrepreneurship and Small Business*, Vol. 42, Nos. 1/2, pp.156–168.

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This paper is a revised and expanded version of a paper entitled 'Backer behaviours – an explorative study of equity crowdfunding' presented at MIT, Lund, Sweden, 12–14 March 2018.

1 Introduction

This paper focuses on investor behaviours in equity crowdfunding (ECF). ECF is a less mature financial mechanism within entrepreneurial finance (EF), but has started to gain momentum during the last few years (Wallmeroth et al., 2018). Investors in this context are called backers. Backers with cash surpluses seek early-stage equity investments and use online platforms to identify and support new and low-valuated ventures with growth potential and cash deficits (Ahlers et al., 2015; Vismara, 2018). However, information asymmetries in this domain are high, and near-term exit opportunities are rare. This translates into a system with high loads of uncertainty and investments must be managed accordingly. This paper explore whether there are different backer behaviours based on investment patterns in this system.

The majority of current ECF research focuses on the venture or the institutional perspective. It mainly addresses how ventures behave to reduce uncertainty about funding campaigns (Ahlers et al., 2015; Moritz et al., 2015; Piva and Rossi-Lamastra, 2017; Ralcheva and Roosenboom, 2016) or the importance of regulations to reduce uncertainty about this financial mechanism (Chen, 2017; Conrad et al., 2016; Cumming and John, 2013; Hornuf and Schweinbacher, 2017). However, we know less about behaviours from the investor perspective, although this aspect seems important, as new ventures depend on backers to be funded. Research in ECF backer behaviour indicates that they are motivated by potential financial return (Belleflamme et al., 2014). This stream of research also argues that backers are positively affected by investment information from ventures or comments and investment decisions of other backers to go ahead with an investment and accept the attendant uncertainties (Cholakova and Clarysse, 2015; Hornauf and Neuenkirch, 2017; Vismara, 2018). However, we know very little about investment behaviours among different investor types.

A great way to gain knowledge of a new phenomenon is to observe behaviours. If one investor puts all savings in a bank account and another invests solely in shares, their behaviours suggest differences regarding expectations of risk and return. The first investor can get access to the same amount of money (plus interest) whenever desired. However, the second investor hopes for strong share performance (plus dividend) but must accept the risk of default. This risk can be measured based on possibilities of future outcomes. However, when these possibilities are unknown, we instead talk about uncertainty. Uncertainty for early-stage finance is fundamental within EF. This research includes behaviours of professional venture capitalists (VCs) and business angels and how they manage this burden using contract mechanisms (Gompers, 1995; Sahlman, 1990; Wong et al., 2009) and investment strategies (Knill, 2009; Norton and Tenenbaum, 1993; Patzelt et al., 2009).

In ECF, there are no such professionals but ordinary people in the form of backers. Like professionals, backers are motivated by financial return. But scholars also suggest that backers are less well equipped with respect to experience, networks, resources and skills (Agrawal et al., 2014; Bapna, 2019). This is problematic when it comes to investment decisions, as backers try to avoid adverse selection or moral hazard in a domain with a high level of uncertainty. It is also disturbing when it comes to exit possibilities, as there are no secondary markets. In addition, scholars also argue that VCs and business angels now try to reduce their load of uncertainty and suggest that backers go first (Gregson et al., 2013) in early-stage finance. This raises questions about

non-professional investor behaviours and the implications for management of uncertainty.

Hence, this study is important as it sheds additional light on different backer types in a domain with high uncertainty and enables a discussion of how uncertainties are managed among non-professionals. It will address the following questions:

1 How are backer transactions and portfolios distributed in this system?

2 Do backers invest in one project or do they invest in many?

3 Are there different investment patterns within ECF, and can they be compared to professional investment strategies used in early-stage finance?

These questions will be answered with an explorative analysis of data from the crowdfunding (CF) platform FundedByMe.com. Backer transactions will be clustered into industries and portfolios with respect to relative uncertainties. In addition, the paper uses a portfolio theory perspective as a tool to better understand the different investment behaviours of backer types and to discuss investment patterns and management of investor uncertainty.

First, the paper will address the literature and try to explain why portfolio theory is an appropriate theoretical framework for this theme. Second, method and empirics will be scrutinised. Third, conclusions will be presented as well as suggestions for future research.

2 Literature and theory

CF was worth approximately USD 34 billions (+100%) in 2015 (Massolution, 2015) and offers multiple financing forms (donation, equity, loan and reward-based). It is a relatively new financial mechanism in early-stage finance (2006) but is starting to be an attractive alternative for entrepreneurs. It can be used as a first resort to evaluate market acceptance of new, innovative solutions or products (like the first smart watch Pebble Time™ in 2012) but also as a last resort for those that have been turned down by banks, VCs or even business angels because uncertainty is expected to be too high (Bruton et al., 2014; Bryan, 2013; Gregson et al., 2013).

The CF literature has emerged during the last decade (Mollick, 2014), but the ECF literature took-off only a few years ago. This paper adds to this literature stream with a specific focus on backer behaviour among investor types. While we still know very little about the composition of the crowd, Mochkabadi and Volkmann (2018) argue that backers play a crucial role in ECF and support the need of additional understanding of backer behaviour. Backer behaviours seem to differ pending on gender. Women are more risk averse compared to men and invest less frequently in younger or high tech ventures expected to carry relatively high loads of uncertainty (Mohammadi and Shafi, 2018). We also know that women prefer to invest in ventures led by other women (Vismara et al., 2017) and that communication with the entrepreneur and other backers has a positive effect on female investment behaviour (Herve et al., 2017). Hence, women seem to be less interested in investments with higher risk/reward potential and favour social interactions to address investment uncertainties in this system. Backer behaviours also seem to depend on geographic distance. According to Guenther et al. (2018), home-country backers are more connected to home bias compared to overseas backers,

who ignore the effect of distance when they invest. The home bias effect is also supported by Hornuf and Schmitt (2016) for backers investing large sums. This suggests that local backers and backers who invest relatively large amounts of money use the possibility of absorbing additional information (excluded from the CF platform) to manage investment uncertainty with the help of close distance. For example, it is both easier and cheaper to meet the founder, monitor the development, see or test the product or service in real-life and perhaps also grasp the local demand when the investment is done close by. Hence, there seem to be different behaviours among ECF backer types and also close similarities between ECF and other financial mechanisms when it comes to gender or distance. Women tend to allocate more pension funds to bonds than to equity, based on risk aversion (Jianakopolos and Bernasek, 1998; Sunden and Surette, 1998), and professional VCs tend to invest in nearby equity opportunities (new ventures close to their headquarters) instead of the opposite (Coval and Moskowitz, 1999; Grinblatt and Keloharju, 2001). This suggests that women have less aggressive investment behaviour than men and that distance is important for home-country investors, no matter the financial domain.

Wallmeroth (2016) also supports the home bias effect but adds to this stream of ECF research by dividing backers into more or less strategic investor types based on private wealth. According to this study, 20% of the investments represent approximately 80% of the funds raised on the CF platform Companisto. Strategic backers are more selective and invest less frequently but with much higher investment amounts. He also argues that strategic backers have a higher probability when it comes to the selection of successful investments. In addition, Abrams (2017) claims that regulatory changes have increased the share of sophisticated backers (experts from the financial industry) in the USA and argues that they enter late during funding campaigns. Hence, we know that the crowd is heterogeneous based on background characteristics like wealth and experience. However, we know little about the composition of the crowd based on investment patterns and nothing based on portfolio configurations. One way to observe this phenomenon with respect to uncertainty is to use a portfolio theory lens.

This framework is based on the seminal work of Markowitz (1959), where rational investors use diversification to optimise a portfolio with respect to expected risk and return by using the benefit of low correlations of future returns between portfolio investments. It ignores market risk but assumes that all investors are risk averse and always go for the alternative with the best risk/reward ratio. Hence, investors are able to reduce their load of company-specific uncertainty by creating bundles of multiple investments with different probabilities of future cash flow distributions. The diversification effect comes in different aspects (industry, size/market capitalisation, maturity/stage, region) but are all considered by professional portfolio managers as a way to manage the load of company-specific risk (Knill, 2009; Norton and Tenenbaum, 1993). In the financial industry, the discussion has emerged as two separate strategies and can be either horizontal (diversification) or vertical (specialisation), but both are active ways to manage portfolio uncertainty. Scholars have made a significant contribution in this literature to understanding diversification and specialisation for VCs. Professional VCs have a tendency to specialise in industries, regions and stages (Bygrave, 1987; Gupta and Sapienza, 1992; Norton and Tenenbaum, 1993; Sahlman, 1990). On the other hand, Bertoni et al. (2015) suggest in a study of investment patterns in Europe that specialisation varies among VCs both compared to the USA and also compared to

different VC investor types. When it comes to diversification, Bartkus and Hassan (2009) suggest that VCs diversify across company development stage and have a greater exit rate than other strategies. However, Gupta and Sapienza (1992) argue that larger VCs in the USA prefer industry diversity, and Cressy et al. (2012) instead say that VCs in the UK prefer to diversify by geography. The conclusion is that behaviours differ for this type of investor. However, all papers indicate that professionals use these strategies to manage uncertainty in this domain. But what about non-professionals? This paper will be able to respond to this discussion, and to the best of my knowledge, there are no papers using this lens to address different behaviours of backer types based on investment patterns in this domain.

3 Method and data collection

This is an exploratory empirical study, and the goal of this paper is to find evidence of differences in ECF backer behaviour. This will shed light on backer types in this new literature and enable a discussion of management of investment uncertainty in this domain. In response to the literature review, this method seems appropriate, as the study targets an increasing interest in this new literature, which has the opportunity to support future progress of theory creation (Eisenhardt, 1989). Hence, I will not use formal hypothesis testing, but rather try to explore descriptive data from backer transactions to make conclusions that add to current research.

Backer behaviour will be explored in relation to the distribution of backer transactions and portfolios. In addition, portfolios will be clustered in a portfolio table according to backer type, based on all investment patterns with respect to options included but also to relative uncertainty. Some groups will then be linked to investment strategies based on the current literature in this domain to enable a discussion of management of uncertainty. The data sample was collected from the website FundedByMe.com, which focuses on the reward, debt and equity-based alternatives. As of today, entrepreneurs have raised approximately SEK 500 million by using this platform, which attracts over 100,000 different backers. I used this platform because the study focuses on ECF and due to the fact that the data were publicly accessible. The data sample includes a collection of 4,938 transactions (worth app. SEK 125 million) from 70 successfully first-round financed projects within 16 industries and 11 countries. The transactions have been made by 3,584 unique backers signed to the platform during the period 2012–2016. On the website, documents and descriptions can be found for all campaigns that have succeeded in their financing rounds. Included are country of origin, industry, and dates and values of the campaign as well as the dilution effect and the number of new shareholders received. In respect of backers, transaction activities of members are presented on a voluntary basis. Investment time and investment frequencies, but not the value of each pledge, from each backer transaction is recorded for all financing rounds. This made it possible to distribute backer transactions into unique portfolios for the discussion of individual behaviour and backer type.

The problem of predicting probabilities of future cash distributions raises questions as to why backers invest. A key reason is the opportunity to enter a potential growth story at a low price level. Hence, it can be seen as an ‘all or nothing’ approach that is equal to a financial call option. Scholars in early-stage finance have used this approach as a way to understand investor behaviour and the management of investor uncertainty (Admati

and Pfleiderer, 1994; Amit et al., 1998; Gompers, 1995; McGrath, 1997; Neher, 1999; Pindyck, 1993; Trester, 1998; Sahlman, 1990; Wang and Zhou, 2004). The rationale of options is that the owner has the right and not the obligation to act on an investment decision. This offers the opportunity to withdraw from a project or to keep it alive by additional funding in the next financing stage. This behaviour means that investors continue to choose whether they want to be able to reap the fruits of future cash flows (Chi and Nystrom, 1995; Folta and O'Brien, 2004; Trigeorgis, 1995) by adding a new premium. In this paper, I will use options as a method to identify uncertainty. In the study, an ECF investment is seen as a financial option with a premium in line with the average investment based on the project valuation at the current round. Hence, if a campaign is worth SEK 1 million and attracts 100 backers, the average investment is SEK 10,000. In other words, this will equal the premium of an option that gives the backer the right to invest in the next financing round. Financial options can also help us to determine levels of uncertainty in the underlying asset. In the absence of a secondary market, crowdfunded firm shares offer no time series, which means that price volatility or uncertainty cannot be identified. Hence, I will try to leverage the seminal work of Black and Scholes (1973). They show that price volatility of the underlying asset is a very important factor when deciding the value of a financial call option. This implies that when the premium of an option is relatively high versus others options, the volatility or uncertainty in the ECF investment can also be expected to be relatively high versus other ECF investments. This creates an opportunity to distribute backer investments according to the relative grade of uncertainty, and the average premium in this entire selection is SEK 18,021.

Bertoni et al. (2015) used the distribution of transactions as a method to understand investor behaviours for different VC types. I instead use the distribution of portfolios (based on options) included as a method to understand the individual backer behaviour for different types of backers. All options are coded to unique backers. This process distributes 4,938 backer transactions into 3,583 backer portfolios. The options included are then equally weighted into the backer portfolios and determine the average value of the portfolios. Hence, if one backer portfolio includes one option with a premium of SEK 10,000, the average value of the portfolio is SEK 10,000. However, if one backer portfolio includes two options with premium values of SEK 10,000 and SEK 20,000, respectively, the average value of the portfolio is SEK 15,000. Portfolios with one option are called single-portfolios and portfolios with more than one option are called multiple-portfolios. Hence, a portfolio with an average value below SEK 18,021 is considered to carry less uncertainty than a portfolio with an average value above that level. To be able to present descriptive data, a backer portfolio table is created based on four clusters:

1 single-portfolios with an average value above the average investment level

2 single-portfolios with an average value below the average investment level

3 multiple-portfolios with an average value above the average investment level

4 multiple-portfolios with an average value below the average investment level.

According to the literature review, investment patterns are used to understand investor behaviour when it comes to portfolio management and management of uncertainty in this domain (Bartkus and Hassan, 2009; Bertoni et al., 2015; Bygrave, 1987; Gupta and

Sapienza, 1992; Knill, 2009; Norton and Tenenbaum, 1993; Sahlman, 1990). However, findings are not homogeneous, and the methods of deciding the grade of diversification or specialisation differ. The Herfindahl index or the entropy measure, used to track the development of grades in portfolios over time (Knill, 2009; Li and Chi, 2013), is not an available option with this data sample. The Baressa index (Bertoni et al., 2015), used to understand the diffusion of transactions to relative grade differences between pre-formulised VC types, is also not appropriate, as I will have a discussion of differences of backer behaviours based on portfolios to determine backer types. Hence, I instead use the results from a study by Bartkus and Hassan (2009) of specialisation and diversification among VC firms. They suggest that VC funds have a mean concentration of 42% and 29% on industry and stage, respectively. In this ECF backer context, stage seems less important, as all projects are all first-round activates. As a consequence, I focus only on industry specialisation and diversification among backer portfolios and also increase the level of specialisation to 60%. Hence, if a backer portfolio includes two options for projects from different industries (50/50), it is not considered as specialised but instead diversified. But if the portfolio includes three options and two are for projects from the same industry (67/33), the portfolio is considered to be specialised and not diversified. This mean that groups three and four on the backer portfolio table are also analysed on the basis of specialisation or diversification, which opens up for a discussion over management of uncertainty.

4 Results

The distribution of backer transactions in this sample shows that consumer goods (26%), food and beverages (17%) and services (9%) represent more than half of the transactions made (Table 1). Most money in this platform is absorbed into consumer goods campaigns (SEK 36 million) and technology campaigns (SEK 30 million). As the values of the campaigns as well as the number of new shareholders are included in the sample, I also measured the average investment in each of all the 70 financing rounds. The average level of all these average investments is SEK 18,021. Healthcare (SEK 43,736), retail (SEK 38,369) and technology (SEK 26,771) came out on top (Figure 1). Hence, premiums for options in these industries are relatively higher compare with options in consumer goods (SEK 12,652), food and beverages (SEK 16,509) or sport (SEK 16,400) and fitness (SEK 10,627). This behaviour implies that a majority (66%) of all transactions are made in options with low premiums (low uncertainty), and they represent 52% of funds raised on this platform during 2012–2016. In addition, only 10% of the transactions are made in options with the top three premiums (very high uncertainty) and represent 26% of funds raised. Hence, these findings do not support that a minority of transactions represent the majority of funds raised (Wallmeroth, 2016). However, it adds to previous research that a minority of transactions seem to be allocated in high uncertainty territory.

The distribution of 4,938 options into backer portfolios can be seen in Table 2. In total, there were 3,583 portfolios, and 84% of them (3,011) were portfolios with only one option (single-portfolios). Consequently, 16% of them (572) were portfolios with more than one option (multiple-portfolios).

Table 1 Distribution of backer transactions – industry

Industry	*Freq.*	*Percent*	*Cum.*
Consumer goods	1,290	26.12	26.12
Food and beverages	860	17.42	43.54
Services	443	8.97	52.51
Media and entertainment	415	8.40	69.36
Finance	417	8.44	60.96
Fashion	402	8.14	77.50
Technology	368	7.45	84.95
Others	322	6.52	91.47
Sport	121	2.45	93.92
Energy	99	2.00	95.93
Healthcare	91	1.84	97.77
Fitness	82	1.66	99.43
Retail	28	0.57	100.00
Total	4,938	100.00	

Figure 1 Average investment – industry (see online version for colours)

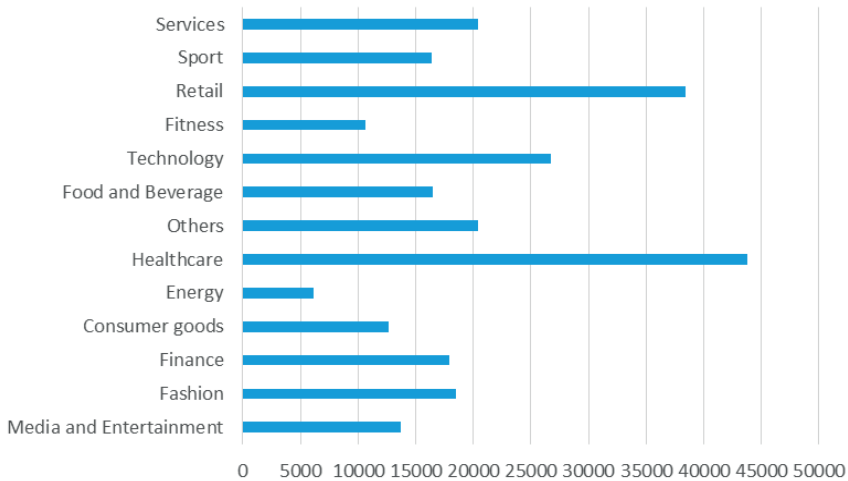

Table 2 Backer portfolios and average value

Group 1	*One project, > ave. invest. value*	*Group 3*	*> One project, > ave. invest. value*
Number	984	Number	382
Share	27%	Share	11%
Group 2	*One project, < ave. invest. value*	*Group 4*	*> One project, < ave. invest. value*
Number	2,027	Number	190
Share	57%	Share	5%

Note: Total no. of portfolios, 3,583 and average investment, SEK 18,021.

In a vertical perspective, the majority of the backers (84%) have an investment behaviour that ends up with only one single investment (single-portfolio backers). According to the literature (Wallmeroth, 2016), strategic backers invest less frequently, but this is hardly the behaviour of single-portfolio backers. Abrams (2017) argues that less sophisticated investors (family and fools) enter campaigns early, but this result does not tell us when single-backer portfolios enter campaigns. Instead, I focus on investment behaviour connected to portfolio configurations and uncertainty. It is not easy to find evidence that single-portfolio backers, represented by groups one and two, focus a lot on uncertainty. However, according to their investment behaviour, two out of three single-portfolios had an average value below the average investment value of SEK 18,021. This implies that the majority of the single-portfolio backers were less reluctant to create a portfolio with an option in a campaign with relative high uncertainty (2,027 versus 984). Hence, the majority of single-portfolio backers have a behaviour that indicates less attraction to uncertainty, which connects to previous research about women (Mohammadi and Shafi, 2018). The minority of the backers (16%) have an investment behaviour that creates multiple-portfolios (multiple-portfolio backers). They are represented by groups three and four, and their situation is the opposite. Two out of three multiple-portfolios had an average value above the average investment value of SEK 18,021. This indicates that the majority of these backers were more reluctant, on average, to create portfolios of options in campaigns with relatively higher uncertainties (382 versus 190). Hence, the majority of multiple-portfolio backers have a behaviour that suggests more attraction to uncertainty, in line with previous research about men (Mohammadi and Shafi, 2018).

In a horizontal perspective, 62% of the backers (2,027 + 190 = 2,217) have portfolios with an average value below the average investment value, and only 8% of these (190 multiple-portfolio backers) managed this uncertainty with a portfolio strategy used by professionals. On the other hand, 38% of the backers (984 + 382 = 1,366) had portfolios with an average value above the average investment value, and almost 28% of them (382 multiple-portfolio backers) managed this uncertainty with a portfolio strategy used by professionals. Thus, according to these investment behaviours, the majority of all backers seem to be less aggressive, in line with previous research about women (Mohammadi and Shadi, 2018), but out of the more aggressive minority I see a higher degree multiple-portfolio backers. Looking at portfolio configurations, no doubt, backers behave differently. However, findings not only connect to previous ECF research when it comes to investor types but also suggest some similarities among a minority of non-professionals and the majority of professionals (Knill, 2009; Norton and Tenenbaum, 1993) when it comes investment behaviour in this domain.

In total, there are 572 multiple-portfolios. All those backers are able to enjoy the possibility of reducing uncertainty with the help of portfolio diversification or specialisation (Table 3).

According to this study, 13% of them (40 + 36 = 76) have portfolios with an industry concentration of options above 60% (specialists). Consequently, 87% of them (342 + 154 = 496) have portfolios with an industry concentration of options below 60% (diversifiers). When it comes to portfolio management strategy, diversification is superior in this sample. This is a more skewed distribution compared to previous research for VCs, but the literature argues that portfolio strategies vary among investor types (Bertoni et al., 2015; Gupta and Sapienza, 1992). Hence, backers are obviously no exception. However, this suggests that the level of specialism in the crowd is low, although one could argue that the level of industry concentration is set too high.

Table 3 Multiple portfolio backers and investment strategy

Group 3	*> One project, > ave. invest. value*	*Specialists*	*Diversifiers*
Number	382	40	342
Share	67%	7%	60%
Group 4	*> One project, < ave. invest. value*	*Specialists*	*Diversifiers*
Number	190	36	154
Share	33%	6%	27%

Notes: Total no. of portfolios, 572. Specialist = more than 60% of total no. investments in the same industry.

As a consequence, I will only focus on the behaviour of multiple-portfolio backers/diversifiers. This result indicates that two out of three (342 versus 154) diversified portfolios had an average value above the average investment value of SEK 18,021. This implies that they were more reluctant to create a portfolio of options with a relatively high value. The majority (69%) of all multiple-portfolio backers use diversification to manage their more aggressive investment behaviour. This further clarifies the similarity among the minority of non-professionals and professionals when it comes to investment behaviour and strategy to manage uncertainty.

5 Conclusions and suggestions of future research

In this paper, I explore different backer investment behaviours in ECF. This is important, as it not only supports this new literature when it comes to investor types but also enables a discussion over how uncertainties are managed in early-stage finance. Findings suggest heterogeneity in investment behaviour but also that the majority make only one investment (single-portfolio backers). They have a less risk-taking attitude, and this is in line with previous research on women (Mohammadi and Shafi, 2018) in this literature. On the other hand, a minority invests more frequently (multiple-portfolio backers) and with a more risk-taking attitude, which is in line with previous research on men (Mohammadi and Shafi, 2018). This non-professional minority (multiple-portfolio backers) has an investment behaviour similar to professional VCs (Knill, 2009; Norton and Tenenbaum, 1993) when it comes management of uncertainty in this domain. However, these backers seem to prefer portfolio diversification ahead of specialisation. This raises questions about the role of the specialist in ECF. A final remark is that I find no support for the notion that a minority of backer investments represent a majority of funds raised on this platform (Wallmeroth, 2016).

The findings add to previous research in ECF regarding the behaviour of investor types (gender) and risk-taking attitudes (Mohammadi and Shafi, 2018; Vismara et al., 2017) and also supports previous research in the EF literature when it comes to management of uncertainty (Bertoni et al., 2015). In a practical perspective, they also add to the understanding of different backer types, which new ventures depend on when raising money on CF platforms.

This paper has, of course, several limitations. With an extended dataset of transaction values, it would have been possible to further address portfolio configuration issues. In addition, it would have been great to add more colour to the backer types with data on

background characteristics. We have much to learn about the behaviour of backers in ECF based on their experience, networks and resources. These points to the important role of specialists as a potential avenue of future research in this domain with a high level of information asymmetry.

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