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Herding dynamics and multidimensional uncertainty in equity crowdfunding: The impacts of information sources

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ABSTRACT

This study investigates the temporal dynamics of herding behavior in equity crowdfunding, and especially when herding momentum is likely to occur during a funding campaign under the influence of different information disclosures. Our results are consistent with the multidimensional uncertainty theory in which herding does not occur in the first stage of funding campaigns but arises in the later stages. We further show that information from investors' discussions may be noisier than information disclosure from project founders, and thus is more likely to bring on uncertainty and accentuate herding. Our findings highlight the importance of information resource management, in which different information sources may require different information disclosure policies.

1. Introduction

Equity crowdfunding is the most recent development in crowdfunding and perhaps the greatest potential funding source for entrepreneurs and small firms. Indeed, founders of equity crowdfunding projects are typically more established small businesses that look to raise funds from the crowd to extend and develop their companies. While the founders in equity crowdfunding projects can expect to raise a larger amount of capital than in reward-based crowdfunding, this new type of crowdfunding poses issues relatively similar to reward-based crowdfunding and other entrepreneurial financing sources, including a high level of information asymmetry between founders and investors and ambiguity about the fundamental value of the underlying business [16,17,35,37,43].

An important stream of the literature documents evidence that investors in crowdfunding tend to herd (follow others' actions). In a seminal paper, Zhang and Liu [49] show that lenders in peer-to-peer lending crowdfunding follow previous lenders to make their decisions. Further studies report evidence of herding behavior in different types of crowdfunding [6,13]. Research in operations management (OM) and information systems (IS) literature also documents different evidence of this behavior in crowdfunding (see, e.g., [12,14,24,25,27,44,45]).

While these studies widely show that herding does occur in different types of crowdfunding, they do not address the key question of when such an effect is likely to occur during funding campaigns. The question of the temporal dynamics of herding behavior in crowdfunding campaigns is relevant and important in both theoretical and practical aspects. First, given that crowdfunding campaigns typically last for a certain period,[1] it is unclear from prior literature if herding is a prevailing or intermittent phenomenon throughout funding campaigns. The implications of current studies [25,43,49] appear to suggest that herding is a prevailing phenomenon. This may not be the case, as herding theories [9,10] suggest that this phenomenon is rather unstable and time-dependent and can easily be dissolved. Herding in crowdfunding may be particularly unstable given the dynamics of the informational environment in crowdfunding campaigns [24,27,37]. Second, analysis of herding dynamics sheds further light on the investment behavior of investors in equity crowdfunding—that is, when investors are more likely to follow others. As our findings later suggest that this (herding) behavior is driven by higher level of uncertainty created by unverified information, equity crowdfunding platforms may consider adjusting their information management policies to reduce the impacts of these

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[1] The standard length of crowdfunding campaigns is 30 days though some campaigns will finish earlier when the full target is raised. Section 3 provides further information about crowdfunding campaigns.

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information sources. For instance, platforms may encourage project founders to actively provide further information disclosure to investors against unverified third party information.

This study attempts to fill this gap in the literature by examining the temporal dynamics of herding behavior in equity crowdfunding campaigns. Following key arguments from the operation management and information science (OM and IS) literature [2,24,27,45], we hypothesize that the dynamics of such behavior may be influenced by information disclosures throughout the funding campaign. Accordingly, we propose two different hypotheses. First is that an information cascade may occur from the early stages of a crowdfunding campaign [43], which will then attract investors to follow others in the cascade.[2] Information cascades are, however, generally unstable and will dissolve upon the arrival of new information. This argument is in line with that of Nguyen et al. [37] that further information disclosed by founders during a funding campaign can reduce information asymmetry and investment uncertainty and thus alleviate herding behavior. Similarly, OM studies [24,27,45] show empirically that herding's magnitude diminishes along information disclosure; hence, it tends to disappear at the later stage of a funding campaign. Accordingly, our first hypothesis is that herding behavior will concentrate in the first days of a funding campaign and disappear toward the final ones. Our second hypothesis is developed from the framework of multidimensional uncertainty theory. Avery and Zemsky [7] theoretically argue that herding may not occur when the only uncertainty in the market is value uncertainty. However, when another dimension of uncertainty, namely event uncertainty, arises, herding is more likely to occur. In this theoretical framework, we argue that herding is less likely to occur during the early days of a crowdfunding campaign, as the main uncertainty that exists at this stage is value uncertainty, that is, uncertainty about the quality of firms that are raising funds. However, when further information is disclosed throughout the funding process, for instance, via updates from the founders and discussions between investors, event uncertainty will emerge. This argument is also in line with the concept of information overload proposed by Lee and Lee [27], Jones et al. [26], and Duan et al. [19] who suggest that too much information (i.e., information overload) may not always be good and may create more uncertainty. Our hypothesis is therefore that herding behavior will most likely occur in the later stages of the crowdfunding campaign.

Using a sample of projects listed in the UK equity crowdfunding platform Crowdcube, we find empirical evidence supporting our second hypothesis and consistent with the multidimensional uncertainty theory of Avery and Zemsky [7]. Following the development of our theoretical framework, we extend our analysis to use equity offered by entrepreneurs as a proxy for value uncertainty and the number of investors' discussions as a proxy for event uncertainty. Consistent with the theory, we find that herding does not exist in the first days of a funding campaign, even among projects with a high level of value uncertainty. Event uncertainty impacts herding in the later stages of the funding process at both low and high levels of value uncertainty. Further, herding is only driven by event uncertainty among low-value-uncertainty projects. Our results are robust to using alternative measures of herding and research contexts.

Our paper makes several significant contributions to the literature. While previous studies [6,24,27,31,44,45,49] document the existence of herding in crowdfunding, our paper is, to the best of our knowledge, the first study to investigate its temporal dynamics explicitly. Given that a fundraising campaign will run for several days, examining herding's temporal dynamics provides further insight into the phenomenon and extends our understanding of crowdfunding investors' behavior. We also shed more light on the underlying motivation of such inefficient investment behavior in crowdfunding. A general assumption underlying many studies [6,43,49] is that herding behavior in crowdfunding is driven by information asymmetry and uncertainty. However, no study explicitly examines the link between uncertainty and herding within this context. Through the theoretical lenses of multidimensional uncertainty theory [7], we can point out how different dimensions of uncertainty stimulate crowdfunding herding behavior.

Our study also uniquely extends the recent thriving OM and IS literature [2,14,44,45] on the effects of information disclosure and optimal operational platform designs on herding. While these studies are conducted in reward-based crowdfunding [45] and peer-to-peer lending [24,27], we examine herding dynamics in the novel context of equity crowdfunding. More importantly, we report some unique evidence that significantly extends the previous literature about the impacts of different (sources of) information on investors' herding behavior. Particularly, while prior studies [24,27,45] view different sources of information homogenously, we argue that some sources of information (e.g., investors' discussions) may be noisier than others (updates from founders) and thus more likely to create event uncertainty. We then show that while updates from founders have similar diminishing marginal effects on herding behavior, as found in reward- and lending-based crowdfunding [24,27,45], investors' discussions actually promote herding. Our findings therefore offer novel practical implications for platforms' operational design and information disclosure policies. This suggests that (unverified) information disclosure may need to be thoroughly managed, as more (unverified) information may not always be good.

This paper is structured as follows. Section 2 discusses the prior literature in herding behavior, with particular focus on the issues of uncertainty and information asymmetry in crowdfunding markets, while Section 3 introduces our hypotheses development. All data variables and empirical methods employed to test our hypotheses are discussed in Section 4. Section 5 reports our empirical results. The paper concludes in Section 6.

2. Related literature

Herd behavior is a term implying the mimicking of trading behavior that exists among investors in the financial market, based on observation of actions and payoffs of the rest of the crowd [22]. Generally, herding behavior is caused by the presence of informational asymmetry and uncertainty in the marketplace. Under these conditions, investors are unable to determine the true value of the target projects or companies [9,10]. Thus, they intentionally tend to disregard their own private signals and follow prior investment or reactions of other investors, believing that the latter have superior knowledge and confidential information about projects or investment opportunities [40]. An extensive prior literature has reported the existence of herding behavior in financial markets (see, for example, [4,5,8,10]).

In the context of crowdfunding, herding behavior has been examined in the OM and IS literature (e.g., [24,27,44,45]).[3] The early study by Lee

[2] The term "herding" is widely used in the literature studying behavior in crowdfunding (e.g., [49],[6],[13]; among others), except by Vismara [43], who uses the term "information cascade." These terms refer to similar observable phenomena (i.e., investors follow each other's actions) but with different unobservable beliefs; that is, investors in an information cascade tend to ignore their own private information, while this may not necessarily be true for people who herd. According to the behavioral finance literature, informational cascades can be considered a subset of herding behavior (behavioral convergence) with numerous examples in financial decision-making ([22,40,41], among other). While these terms may not be identical, in our research context, we consider them relatively similar, given that both information cascades and herding are fragile and easily dissolved upon the arrival of new information [10,24,45]. We therefore use the term "herding" throughout our research, except at places where we specifically discuss the work of Vismara [43]. We thank the editor for pointing out this subtle but important difference between the two concepts.

[3] For a review of herding in another IS context, refer to Jiang et al. [24]

and Lee [27] reports empirical evidence of herding behavior in a Korean P2P lending platform. Similar evidence was later reported by Jiang et al. [24], Jiang et al. [25], and Lu et al. [32] in different lending crowdfunding platforms. In reviewing the literature, Allon and Babich [2] suggest the need to examine the interaction between information disclosure and herding behavior in crowdfunding. This was subsequently addressed by Xiao et al. [45], who point out that information disclosure during the funding period could dynamically influence investors' herding behavior. In a recent study, Wei et al. [44] showed that the dynamics of prefunding information induces herding in reward-based crowdfunding.

Herding in crowdfunding has also been studied in the entrepreneurship and finance literature. Zhang and Liu [49] is the first study to look at this issue and report evidence of herding behavior in peer-to-peer lending crowdfunding. Following Zhang and Liu [49], other studies reported evidence of crowdfunding herding behavior [6,31,43] and reward-based crowdfunding [13,48]. Vismara [43] indicates that information cascades, a term describing late investors abandoning their own private information in order to mimic the investment behavior of early investors, arises from the initial days of the funding campaign and leads to higher success probability of project funding at the end of the equity crowdfunding period. Furthermore, Astebro et al. [6] demonstrate the existence of herding in equity crowdfunding, especially the impact of most recent pledges on a subsequent pledge, while Li et al. [31] show that the phenomenon of overfunding in equity crowdfunding campaigns is linked to early herding behavior by investors. Also, Chan et al. [13] report U-shaped funding dynamics in reward-based crowdfunding and implicitly interpret it as evidence of herding in the later stage of the funding process.

While the aforementioned studies have provided a wide range of evidence on herding behavior in crowdfunding, it is still not clear when herding is likely to occur during the crowdfunding campaign, that is, the timing of the phenomenon. In addition, prior empirical evidence using linear models is not able to show the dynamics of herding during crowdfunding campaigns. Our paper attempts to fill this gap by investigating the temporal dynamics of herding behavior in equity crowdfunding.

3. Research context and hypothesis development

Our research examines herding dynamics in the context of a leading UK equity crowdfunding platform. The context is relevant to our study of herding dynamics for several reasons. First, equity crowdfunding and crowdfunding markets are characterized by high levels of uncertainty, information asymmetry, and the presence of inexperienced investors [37,43], making them the perfect environment for investment herding behavior. Second, equity crowdfunding is a constant dynamic information environment. Indeed, besides the static listing features (project description, business plan, documentations) provided in the prefunding period, investors in equity crowdfunding are provided with all sorts of time-varying information during the funding process. More specifically, time-varying information comes from a wide range of alternative sources such as public discussions (i) among investors and (ii) between investors and entrepreneurs and (iii) updates from entrepreneurs directly through crowdfunding platforms and through other social media channels. Furthermore, significant information on the funding progress, such as the number of prior investors, the total amount of prior funding, and remaining days, is widely published by the platform. This further motivates investors to herd, as they can compare their investment activity against that of their peers. Such constant change in the information environment will occur during the entire funding campaign (i.e., 30 days), allowing us to examine the dynamics of herding in the various stages of the entire fundraising process.

3.1. Hypothesis development

Our hypotheses on the temporal dynamics of herding behavior in crowdfunding are primarily developed from prior literature that suggests that herding behavior is likely to be influenced by changes in information and uncertainty levels [2,12,19,24,27,37,43–45].

Vismara [43] argues that investors are attracted to such information cascades from the very early days of funding campaigns. Information cascades as in Vismara [43] are, however, rather fragile even with small informational shocks such as the arrival of new information or the trading of better-informed individuals [10]. The cascade will dissolve when the information contained in it may no longer be sufficient to offset the value of new information [20,38,50]. This situation is highly likely in the case of crowdfunding, as the information disclosure policy of such platforms allows founders to provide further information to investors [24,45]. Nguyen et al. [37] argue that investors may obtain more information during the funding campaigns to reduce their uncertainty about the projects. Based on signaling theory, Block et al. [11] report empirical evidence that investors may derive information from the updates issued by fundraisers over the course of their campaigns.

Altogether, it is therefore possible that herding will be formed in the early days of crowdfunding campaigns but then disappear because of the arrival of new and timely information. We therefore hypothesize that

> **H1:** Herding may occur from early days and then attenuate during the later days of crowdfunding campaigns.

Our second hypothesis is developed from the theoretical framework of multidimensional uncertainty theory by Avery and Zemsky [7]. In their study, the authors identify two dimensions of uncertainty that may impact herding behavior, which they term value and event uncertainty. Value uncertainty refers to investors' uncertainty about the actual value of the underlying investment, while event uncertainty is related to the accuracy (or lack of accuracy) of the information possessed by market participations [7,10,15]. Event uncertainty is created when further information arrives during the investment process that alters the estimate of the fundamental value of the underlying assets. As investors are unsure about the accuracy of such new information, it introduces/creates another dimension of uncertainty in addition to tvalue uncertainty. Effectively, further information leads to more uncertainty and thusn to more herding behavior. This theoretical argument is largely in line with the case of "information overload" proposed by Duan et al. [19] and Lee and Lee [27]. Duan et al. [19] emphasize that prominent information cascades stem from two big reasons: (1) information overload, where participants feel they lack knowledge and time to deal with mass amounts of information, so they decide to follow others, and (2) information popularity, which makes information cascade become more feasible and investors would decide to join. Lee and Lee [27] support Duan et al. [19]'s arguments to show that more bidders would join an auction that included more postings.

In the context of equity crowdfunding, it is possible that at the beginning of the funding campaign there is only one dimension of uncertainty, which is the uncertainty of the project's quality or the quality of the entrepreneurs (value uncertainty). However, as more information arrives during the funding process, event uncertainty may arise. This new information may create another layer of uncertainty for investors for different reasons. First, the sheer volume of information may overload investors [19,27]. Indeed, during a funding process, investors may be provided with a wide range of information including updates from founders through platforms and social media and discussions between entrepreneurs and investors and among investors themselves [11,36,42]. Furthermore, the information content may be difficult to analyze and comprehend, especially by retail investors, as it tends to be complex in terms of the language used and technical information. Block et al. [11] suggest that the complexity of language used in crowdfunding campaigns directly affects the interpretation of such information by the investors with more complex language used in crowdfunding postings

Table 1
Descriptive Statistics and Variable list.

Variable name	Description	Mean	Median	Std. dev.	Min	Max
Measure herding momentum						
DailyInvestors	The number of individual investors contributing to a campaign on each day	4.90	2	12.79	0	261
LogDailyInvestors	Logarithm of number of DailyInvestors					
LagInvestors	The accumulated number of investors contributing to a campaign from initial to the day	66.15	46	69.18	0	640
LogLagInvestors	Logarithm of number of LagInvestors					
DailyRaised	The total monetary amount raised by a campaign on each day	9950.71	450	50,660.92	0	1670,988
LogDailyRaised	Logarithm of number of DailyRaised					
LagRaised	The accumulated total monetary amount raised by a campaign from initial to the day	142,834	72,770	219,529	0	1898,172
LogLagRaised	Logarithm of number of LagRaised					
Time-varying information						
Discussions	The accumulated number of discussions posted in platform	10.67	9	8.04	0	51
Twitter	The accumulated number of Twitter posts in campaign's official Twitter account	22.28	6	53.23	0	652
Facebook	The accumulated number of Facebook posts from campaign's official Facebook account	51.32	27	27	0	913
Campaign-specific controls						
Days Available	(Duration – Number of Day Passed)/ Duration (%)	53.57	55.17	27.6	0	98.44
Patent	Dummy variable =1 if the campaign listing or documentation mentions a patent (pending); 0 otherwise	0.10	0	0.10	0	1
Management	Logarithm of number of nonexecutive managers or board members mentioned by name in the campaign listing	0.79	0.69	0.63	0	2.3
Equity Offered	The percentage of equity in the business offered by the campaign founders in return for the target sum (%)	12.46	11.12	6.37	2.71	40
Fin Snapshot	Dummy variable =1 if the campaign listing or documentation mentions a financial snapshot; 0 otherwise	0.73	1	0.44	0	1
Target	Logarithm of total amount that the founders of the crowdfunding campaign seek to raise	12.33	12.43	0.80	10.82	14.46
Tax	Dummy variable =1 if Seed Enterprise Investment Scheme (SEIS) tax relief is available for investors; 0 otherwise	0.18	0	0.386	0	1
Tech	Dummy variable =1 if the campaign is listed in the technology category; 0 otherwise	0.10	0	0.3	0	1
Dividends	Dummy variable =1 if the financial snapshot shows dividends have been paid to shareholders; 0 otherwise	0.05	0	0.21	0	1
Sophisticated	Dummy variable =1 if the campaign listing or documentation mentions the involvement of an angel or VC; 0 otherwise	0.25	0	0.43	0	1
London	Dummy variable =1 if the business is based in London; 0 otherwise	0.32	0	0.466	0	1
IPO	Dummy variable =1 if the campaign listing or documentation states an IPO as the target exit strategy; 0 otherwise	0.27	0	0.44	0	1
Positive Sales	Dummy variable =1 if the financial snapshot shows positive revenue in the previous accounting year; 0 otherwise	0.66	1	0.47	0	1
Active Campaign	The aggregate number of active campaigns hosted on the Crowdcube platform on a given date	23.74	25	6.14	6	33
FTSE Volatility	The standard deviation of FTSE returns over a rolling 20-day period up to and including a given date	0.013	0.012	0.004	0.006	0.02

been negatively related to funding participation. This is also supported by Zacharakis and Meyer [47], who show that, for the case of the venture capitalists, excessive data points during new venture screening could lead to information overload. Moreover, if the continuous stream of excess information provided during the funding process cannot be verified easily for accuracy (ambiguity), they can further increase project uncertainty.

Hence, following the framework of multidimensional uncertainty theory, we argue that herding may be less intensive during the early days of funding campaigns when the main uncertainty is value uncertainty and information on projects is constrained. However, as the volume of new information provided during the funding process increases, we should expect herding behavior to increase too, due to time processing constraints on behalf of the decision-maker (crowdfunding participant) and potential information overload. Our hypothesis is therefore

H2: Herding behavior increases toward the later days of crowdfunding campaigns.

4. Data and methodology

4.1. Data

To collect data on equity crowdfunding projects, we acquired daily data from the UK equity crowdfunding platform Crowdcube from August 2015 to February 2016. We could obtain some basic project features such as project description, valuation, pricing, management, and financial documents through the information included on the platform. Detailed information about the management team of the projects iwas collected from the UK Companies House, the United Kingdom's official database, which registers company information and makes it available to the public.

From over 114 campaigns collected from Crowdcube, we removed all projects with missing information on daily funding. Furthermore, following our empirical methodology in calculating herding momentum and event uncertainty, we also removed projects that raised funds in less than 5 days or more than 100 days.[4] Our final sample size consists of 104 campaigns and 2680 daily observations, similar to the data sample used by Nguyen et al.'s [37] study on equity funding behavior and the number of projects used in the study on information cascades of Vismara [43]. We do not include overfunding periods in our analysis, as herding

[4] In the case of short campaigns lasting less than 5 days, the subperiods (first and second stages) may consist of fewer than 2 funding days. Conversely, excessively long-duration campaigns exceeding 100 days typically include numerous days without investments and updates. Thus, this characteristic may introduce distortions in the measurements of herding and event uncertainty. We thank an anonymous reviewer for inquiring about this explanation.

Table 2
Correlation Matrix.

	LogDailyInvestors	LogLagInvestors	Twitter	Facebook	Discussions	DaysAvailable	Patent	Management	EquityOffered	FinSnapshot	Target	Tax	Tech	Dividends	Sophisticated	London	IPO	PositiveSales	ActiveCampaign	FTSEVolatility
LogDailyInvestors	1.000																			
LogLagInvestors	0.158	1.000																		
Twitter	0.127	0.400	1.000																	
Facebook	−0.014	0.136	0.221	1.000																
Discussions	0.065	0.495	0.122	0.079	1.000															
Days Available	0.208	−0.430	0.048	−0.224	−0.533	1.000														
Patent	0.027	0.070	−0.011	−0.122	0.100	0.001	1.000													
Management	0.101	0.177	0.119	0.132	0.054	0.080	0.030	1.000												
Equity Offered	−0.082	−0.073	0.066	0.048	−0.039	−0.084	0.037	−0.155	1.000											
Fin Snapshot	0.112	0.272	0.227	0.068	0.130	0.051	0.091	0.213	−0.023	1.000										
Target	0.222	0.312	0.204	0.062	0.154	0.062	0.058	0.154	0.003	0.583	1.000									
Tax	−0.082	−0.139	−0.161	0.030	−0.047	−0.027	−0.132	−0.180	−0.048	−0.539	−0.533	1.000								
Tech	−0.044	0.032	−0.001	0.002	−0.002	−0.021	0.159	0.054	−0.176	−0.092	0.002	0.133	1.000							
Dividends	0.009	0.007	−0.122	−0.178	0.040	0.010	−0.073	0.016	0.053	0.022	0.079	0.023	−0.075	1.000						
Sophisticated	0.024	0.140	0.171	0.090	0.092	0.034	0.188	0.350	−0.053	0.220	0.287	−0.216	0.074	−0.130	1.000					
London	−0.007	0.053	0.051	0.132	0.032	0.003	−0.004	−0.091	0.001	−0.002	0.048	0.007	0.134	−0.152	0.081	1.000				
IPO	0.068	0.045	0.061	−0.099	−0.056	−0.011	0.091	0.074	−0.065	0.203	0.374	−0.148	0.061	0.008	0.032	0.024	1.000			
Positive Sales	0.120	0.212	−0.083	−0.071	0.081	0.034	0.060	0.212	−0.257	0.453	0.321	−0.305	0.056	0.107	0.258	−0.140	0.115	1.000		
Active Campaign	−0.028	0.040	0.100	−0.045	−0.141	0.148	0.011	0.041	−0.095	0.068	0.082	−0.057	0.106	0.095	−0.024	0.106	−0.029	0.020	1.000	
FTSE Volatility	−0.076	0.036	0.287	0.049	−0.011	0.020	0.021	0.000	0.089	0.211	0.023	−0.061	0.081	−0.081	−0.024	−0.044	0.118	−0.119	0.130	1.000

behavior in these periods may be different (from the main funding process).

4.2. *Measuring herding momentum and modeling approach*

In line with prior literature [24,27,45], we measured herding on crowdfunding through the sequential correlation (or herding momentum) of the number of investors. The information of total earlier investors is available on the platform, so investors would easily know how the crowd interacted with each project. Accordingly, if herding exists, then investors will tend to support projects that already attract more investors, ceteris paribus. Thus, and in line with Zhang and Liu [49], the relation between (logarithm of) daily number of investors and (logarithm of) total number of earlier investors may be used as a "naïve" measure for herding.

Following our discussion on the selected herding measure, and in line with extant studies by Xiao et al. [45] and Jiang et al. [24], we define our dependent variable as the log of the daily number of investors at time t, while the primary independent variable is the log of the number of accumulated investors from the beginning of the campaign and up to day *t-1*.[5] The baseline empirical specification for the examination of herding behavior is

$$\text{LogDailyInvestors}_{j,t} = a_0 + \beta \text{LogLagInvestor}_{j,t-1} + \gamma X_{j,t} + e_{j,t}, \quad (1)$$

where j is the number of listed projects, $t = 2,\ldots,T$, and $X_{j,t}$ includes a number of campaign-specific variables.

As the goal of our study is to examine the temporal dynamics of herding in crowdfunding, we adapt specification 1 in two separate ways. The first follows Jiang et al. [24] and Chan et al. [13] and adds the square of the number of investors to specification 1. This specification 2 is algebraically formulated as

$$\text{LogDailyInvestors}_{j,t} = a_0 + \beta_1 \text{LogLagInvestor}_{j,t-1}$$

$$+\beta_2 \text{LogLagInvestor}^2_{j,t-1} + \gamma X_{j,t} + e_{j,t}. \quad (2)$$

Our second approach is to divide the funding period into two subperiods in which the first covers from the first day to the middle day of the fundraising campaign and the second is from the middle day to the last day. We then run specification 1 for each subperiod. We use robust standard errors exclusively for all our estimations.

Following these two approaches, it is expected that if herding only occurs in the first set of days and then dissolves (thus, accepting H1), then β_2 should be negative and significant across the entire period under examination (Specification 2), and β is positive and significant only in the first subperiod (Specification 1). Conversely, if herding intensifies toward the final stage of the funding process (thus, accepting H2), then just β_2 will be positive and significant across the full period and β is positive and significant only in the second subperiod.

Further to the main independent variables, we provide a set of campaign-specific factors to control the model, consistent with Vismara [43] and Nguyen et al. [37]. For instance, we use *size of the management team* to capture ta project's human capital, while the dummy variable *patent* indicates the existence of a patent in the project documents and is used as a proxy for projects' intellectual capital. The variable *active campaign* encompasses parallel projects that raise funds at the same time, which potentially lead to less daily crowdfunding investment in target projects. Some empirical findings indicate that parallel projects diminish support from investors in equity crowdfunding [43] and lenders within lending platforms [18] as well as backers in reward-based

[5] The number of previous investors will not decrease over time, as we do not have any days with negative numbers of investors in our database. Our Table 1 shows that the minimum daily number of investors is zero (non-negative). We thank the editor for his/her comment on this point.

Table 3
Herding dynamics in equity crowdfunding (random effect).

DV= LogDailyInvestors	Model 1 Whole funding process Curvilinear (Negative binominal)		Model 2 First stage (Negative binominal)		Model 3 Last stage (Negative binominal)		Model 4 Whole funding process Curvilinear (OLS)		Model 5 First stage (OLS)		Model 6 Last stage (OLS)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Main independent variables												
LogLagInvestors	−1.420	0.065***	−0.318	0.029***	0.987	0.071***	−1.188	0.047***	−0.283	0.027***	0.716	0.047***
$LogLagInvestors^2$	0.244	0.011***					0.202	0.008***				
Time-varying information												
Twitter	0.022	0.016	0.087	0.023***	−0.009	0.023	0.023	0.011**	0.079	0.017***	−0.002	0.016
Facebook	0.077	0.017***	0.104	0.022***	0.063	0.025**	0.050	0.011***	0.084	0.016***	0.021	0.016
Discussions	0.136	0.041***	0.300	0.046***	0.111	0.074	0.060	0.028**	0.222	0.037***	−0.052	0.047
Campaign-specific controls												
Days Available	0.017	0.001***	0.042	0.003***	0.018	0.002***	0.011	0.001***	0.029	0.002***	0.012	0.001***
Patent	0.207	0.084**	0.175	0.113	0.329	0.121**	0.124	0.057**	0.160	0.085	0.207	0.079**
Management	0.033	0.040	0.131	0.054**	−0.106	0.060	0.008	0.029	0.120	0.042**	−0.105	0.040**
Equity Offered	0.002	0.004	−0.014	0.006**	0.009	0.006	−0.004	0.003	−0.013	0.004**	−0.004	0.004
Financial Snapshot	0.041	0.083	−0.291	0.106**	0.184	0.127	−0.131	0.053**	−0.250	0.076***	−0.168	0.075**
Target	0.201	0.044***	0.645	0.054***	−0.053	0.068	0.161	0.032***	0.535	0.043***	0.032	0.044
Tax	0.038	0.087	0.126	0.115	−0.035	0.128	0.047	0.054	0.149	0.078	−0.090	0.074
Tech	0.020	0.087	−0.241	0.114**	0.083	0.127	−0.043	0.057	−0.122	0.082	−0.175	0.079**
Dividends	0.231	0.116**	0.132	0.151	0.028	0.173	0.230	0.080**	0.236	0.116**	−0.018	0.112
Sophisticated	−0.020	0.061	−0.213	0.079**	0.086	0.088	−0.064	0.043	−0.185	0.063**	−0.092	0.059
London	−0.159	0.054***	−0.027	0.071	−0.269	0.080***	−0.047	0.036	0.005	0.053	−0.068	0.050
IPO	−0.181	0.060***	−0.180	0.078**	−0.111	0.091	−0.048	0.041	−0.103	0.059	0.000	0.057
Positive Sales	0.295	0.064***	0.653	0.082***	−0.010	0.098	0.195	0.043***	0.392	0.062***	0.021	0.061
Active Campaign	−0.007	0.004*	0.013	0.006**	−0.010	0.005	−0.008	0.003**	0.004	0.005	−0.008	0.004**
FTSE Volatility	−23.775	5.848***	−23.052	7.248**	−40.943	9.729***	−9.791	3.990**	−16.234	5.567**	−10.457	6.209
Constant	−0.947	0.564*	−9.918	0.690***	−4.132	0.728***	−0.296	0.399	−7.462	0.522***	−2.272	0.497***
Pearson Chi-Square	4405		1761		2635		1765		918		852	
Number of observations	2680		1320		1360		2680		1320		1360	

Note: *, **, *** denotes 10 %, 5 % and 1 % levels of significance. Standard errors are clustered at the campaign level. We divide the funding period into two subperiods in which the first stage covers from the first day to the middle day of the fundraising campaign and the second stage is from the middle day to the last day.

crowdfunding [51]. Table 1 provides detailed definitions and descriptive statistics for all variables used.

Regarding the number of key statistics in Table 1, on the average, projects attract about 5 investors and raise nearly £10,000 daily. While the daily average number of investors in equity crowdfunding is comparable to that in other types of crowdfunding markets, such as reward-based crowdfunding [45] or lending-based crowdfunding [24,49], their daily fundraising volume is much higher. This indicates the important and potential role of equity crowdfunding in providing capital to young entrepreneurs. Our sample statistics are, to a large extent, consistent with samples of equity crowdfunding projects from other papers [23,42,43].

We provide a correlation matrix among independent variables in Table 2. The correlation coefficients satisfy the condition of no multicollinearity in the model. We have no pair of variables that are highly correlated.

5. Empirical results

5.1. Main analysis of herding

Table 3 reports the results from our different panel regressions on the presence of herding dynamics in equity crowdfunding. Model 1 shows the results from curvilinear regression (specification 2), while models 2 and 3 report the outcomes of the linear regression in the first and last periods of the crowdfunding campaigns (specification 1). As the dependent variable of the *daily number of investors* is a non-negative integer, we first use random-effect negative binominal panel regressions in models 1–3 to control for overdispersion. Furthermore, following Xiao [45], we replicate models 1–3 in models 4–6 using random-effect OLS regressions with natural log of daily number of investors as the dependent variable. To confirm the robustness of the results, we also run model 4–6 using fixed-effect regressions. The results appear to be consistent.

As the outcomes are consistent between these two econometric approaches, our discussion is based on the results from models 1–3. At a first glance, having established that herding momentum may occur only at a certain stage of a funding campaign, we investigate the dynamics of herding in the three models. The results from the curvilinear specification in model 1 lend support to our Hypothesis 2. The negative coefficient of the first component and the positive coefficient of the squared term suggest that herding occurs in the later stage of the funding campaign. Results from model 1 are further confirmed by models 2 and 3, where we find that the coefficient of prior number of investors is only positive and significant in the final subperiod of the funding campaign (model 3). The magnitude of herding is also significant. Particularly, model 3 shows that 1 % increase in total prior number of investors will, on the average, lead to a 0.987 % increase in the daily number of investors.

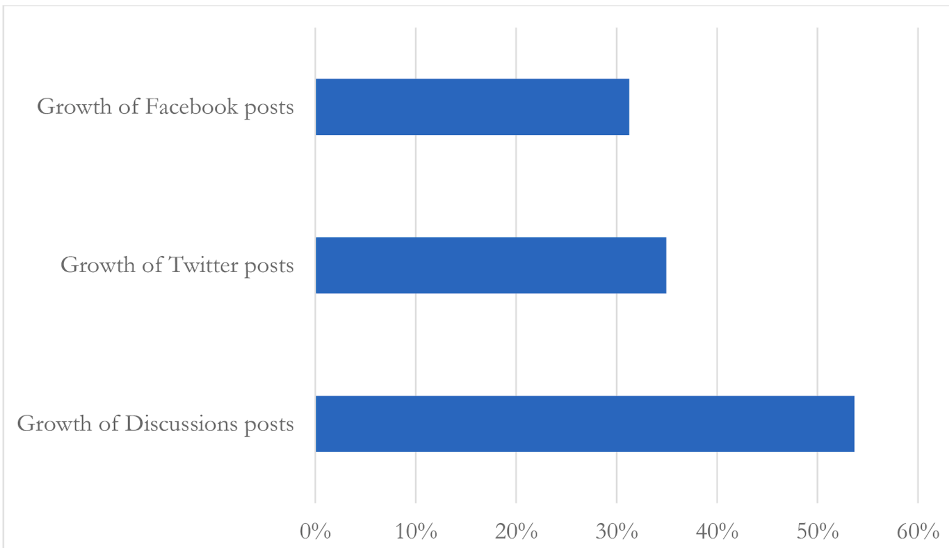
Altogether, the results from our main analysis support our hypothesis 2 and therefore are consistent with the multidimensional uncertainty theory of Avery and Zemsky [7]. An important implication of our results is that information disclosure during a crowdfunding campaign may actually create more uncertainty for investors. This contrasts with previous literature [24,45].

The next section extends our analysis under the theoretical framework of multidimensional uncertainty theory to examine the impact of different uncertainty dimensions on crowdfunding herding behavior.

Table 4
Number of posts from three information sources by period.

	At the end of first stage					At the end of last stage					T- statistics of difference in means	Wilcoxon p value
	Mean	Median	Std	Max	Min	Mean	Median	Std	Max	Min		
Number of Twitter posts	29.00	11.00	59.85	444.00	0.00	39.13	14.00	81.20	652.00	0.00	4.09***	<0.0001***
Number of Facebook posts	57.28	31.00	100.19	898.00	0.00	75.18	45.50	108.88	913.00	0.00	7.11***	<0.0001***
Number of Discussions posts	10.57	9.00	7.70	46.00	0.00	16.24	14.00	9.46	51.00	0.00	12.98***	<0.0001***

Note: *, **, *** denote 10 %, 5 %, and 1 % levels of significance.



Graph 1. Growth rate of information sources.

6. Further analysis of herding

6.1. Value and event uncertainty

Our first step is to follow the theoretical framework of multidimensional uncertainty theory and define proxies for value and event uncertainty. In detail, value uncertainty is defined as investors' uncertainty about the actual value of the underlying projects, in line with Avery and Zemsky [7]. We use different proxies for value uncertainty. Our first proxy is the variable *equity offered*. According to Ahler et al. [1], when entrepreneurs keep a greater percentage of firms' equity (offer less equity to investors), they signal their confidence about their projects; hence investors can be more assured about the quality of the listed projects. Low equity offered may, therefore, indicate low value uncertainty, and vice versa. Second, we use patent ownership by a project as a proxy for technological capabilities and hence low value uncertainty of the project [28,30,34,39].[6] Our rationale aligns with the literature in entrepreneurial finance [33], which asserts that technological capabilities serve as an effective signal of greater startup quality. Patent ownership is a reliable proxy for technological capabilities because it demonstrates the development of novel technologies by startups [29] and the ability to convince a third-party, such as the patent office, of the merit of their technologies [39]. We also measure projects' value uncertainty through different characteristics of their founders. More specifically, we use founders' working experience, founders' educational level, and founders' number of followers on social media (number of followers in founders' Linkedln accounts) as proxies for the value uncertainty of the campaigns. The first and second proxies are based on the argument that founders with more working experience or higher education level will possess greater human capital, knowledge, and skills, and thus may be better at managing companies [1,3,21]. Meanwhile, founders' numbers of social media followers may represent the founders' social capital, and thus may impact projects' value uncertainty [1]. Projects with founders with more working experience (measured by number of working years) or higher educational level will have lower value uncertainty than those with less experienced or less educated founders. For projects with multiple founders, we use the working years of the most experienced founder, the degree of the most educated founder, and the number of followers of the founder with the largest number of LinkedIn followers as the proxies for the projects. Using these proxies, we can separate projects into low and high value uncertainty in three different ways. More particularly, we consider projects with founders' working experience larger (smaller) than the sample median, projects with founders' highest education level higher (equal to or lower) than a bachelor's degree, and projects with number of LinkedIn followers larger (smaller) than the sample median as low (high) value uncertainty projects.[7]

Event uncertainty refers to uncertainty created when further information arrives during the investment process. In the specific context of our research, *equity crowdfunding*, following the time-invariant information provided to investors at the beginning of the project, those economic agents will be provided with subsequent information about the project during the rest of the funding campaign period. This additional information is disclosed through two main channels. The first channel consists of updates that come directly from the entrepreneurs through social media platforms including Twitter and Facebook, while the second contains the discussions among investors and between investors and entrepreneurs on the equity crowdfunding platforms. For

[6] We thank an anonymous referee for suggesting these proxies.

[7] We thank an anonymous referee for suggesting this proxy.

Table 5
Herding dynamics in equity crowdfunding with uncertainty dimensions.

DV= LogDailyInvestors	Low value uncertainty projects						High value uncertainty project					
	Model 1 Whole funding process Curvilinear (Negative binominal)		**Model 2 First stage (Negative binominal)**		**Model 3 Last stage (Negative binominal)**		**Model 4 Whole funding process Curvilinear (Negative binominal)**		**Model 5 First stage (Negative binominal)**		**Model 6 Last stage (Negative binominal)**	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Panel A: Equity offered as value uncertainty proxy												
Main independent variables												
LogLagInvestors	−0.860	0.223***	−0.455	0.073***	0.169	0.447	−1.199	0.158***	−0.294	0.060***	0.814	0.246***
LogLagInvestors^2	0.113	0.051**					0.238	0.035***				
Information interaction variables												
LogLagInvestors * Twitter	−0.068	0.085	−0.018	0.030	−0.009	0.060	−0.123	0.051**	−0.035	0.020	−0.002	0.030
LogLagInvestors^2 * Twitter	−0.001	0.013	0.009	0.007								
LogLagInvestors * Facebook	0.007	0.064	0.025	0.022	−0.053	0.067	0.103	0.054	0.029	0.021	−0.089	0.040**
LogLagInvestors^2 * Facebook	0.005	0.011					−0.021	0.009**				
LogLagInvestors * Discussions	−0.288	0.105**	−0.037	0.035	0.315	0.125**	−0.177	0.085**	0.045	0.032	0.236	0.087**
LogLagInvestors^2 * Discussions	0.056	0.019**					0.032	0.014**				
Panel B: Patent ownership as value uncertainty proxy												
Main independent variables												
LogLagInvestors	0.244	0.560	−0.616	0.137***	−2.056	1.529	−1.245	0.135***	−0.320	0.050***	0.842	0.221***
LogLagInvestors^2	−0.257	0.159					0.238	0.030***				
Information interaction variables												
LogLagInvestors * Twitter	0.030	0.175	0.056	0.059	0.992	0.302***	−0.109	0.046**	−0.028	0.016*	0.011	0.027
LogLagInvestors^2 * Twitter	0.002	0.033	0.006	0.007								
LogLagInvestors * Facebook	−0.189	0.162	−0.071	0.056	−0.044	0.146	0.072	0.042*	0.025	0.015*	−0.052	0.032*
LogLagInvestors^2 * Facebook	0.037	0.028					−0.012	0.007*				
LogLagInvestors * Discussions	−0.630	0.244***	−0.099	0.104	−0.201	0.414	−0.141	0.066**	0.005	0.023	0.120	0.070*
LogLagInvestors^2 * Discussions	0.111	0.051**					0.024	0.011**				
Panel C: Founder Experience as value uncertainty proxy												
Main independent variables												
LogLagInvestors	−1.197	0.184***	−0.298	0.063***	0.530	0.347	−1.187	0.189***	−0.437	0.069***	0.722	0.306**
LogLagInvestors^2	0.207	0.043***					0.238	0.040***				
Information interaction variables												
LogLagInvestors * Twitter	−0.182	0.085**	−0.036	0.030	0.018	0.047	−0.110	0.052**	−0.032	0.019*	0.051	0.036
LogLagInvestors^2 * Twitter	0.014	0.012					0.008	0.008				
LogLagInvestors * Facebook	0.111	0.069	0.044	0.024*	−0.047	0.057	0.116	0.053**	0.006	0.019	−0.053	0.045
LogLagInvestors^2 * Facebook	−0.014	0.011	−0.024	0.009***								
LogLagInvestors * Discussions	−0.147	0.089*	−0.040	0.032	0.196	0.095**	−0.258	0.096***	0.096	0.035***	0.251	0.118**
LogLagInvestors^2 * Discussions	0.031	0.016**					0.044	0.017***				
Panel D: Founder Education as value uncertainty proxy												
Main independent variables												
LogLagInvestors	−0.732	0.272***	−0.365	0.090***	0.100	0.521	−1.340	0.151***	−0.406	0.056***	1.002	0.242**
LogLagInvestors^2	0.109	0.066*					0.252	0.033***				
Information interaction variables												
LogLagInvestors * Twitter	−0.054	0.080	−0.016	0.032	−0.017	0.057	−0.133	0.055**	−0.020	0.019	0.042	0.032
LogLagInvestors^2 * Twitter	0.001	0.012					0.011	0.008				
LogLagInvestors * Facebook	0.003	0.077	−0.034	0.028	−0.084	0.077	0.115	0.050**	0.038	0.018**	−0.071	0.038*
LogLagInvestors^2 * Facebook	−0.004	0.014	−0.020	0.008**								
LogLagInvestors * Discussions	−0.463	0.139***	0.126	0.059**	0.561	0.146***	−0.096	0.071	−0.303	0.084***	0.032	0.073
LogLagInvestors^2 * Discussions	0.095	0.025***					0.015	0.226				
Panel E: Founder social followers as value uncertainty proxy												
Main independent variables												
LogLagInvestors	−1.378	0.181***	−0.312	0.063***	0.797	0.308***	−0.788	0.195***	−0.405	0.073***	0.257	0.361
LogLagInvestors^2	0.294	0.041***					0.126	0.045***				
Information interaction variables												
LogLagInvestors * Twitter	−0.058	0.055	−0.043	0.019**	−0.066	0.035*	−0.224	0.086***	0.001	0.030	0.120	0.060**

(*continued on next page*)

Table 5 (*continued*)

DV= LogDailyInvestors	Low value uncertainty projects						High value uncertainty project					
	Model 1 Whole funding process Curvilinear (Negative binominal)		**Model 2 First stage (Negative binominal)**		**Model 3 Last stage (Negative binominal)**		**Model 4 Whole funding process Curvilinear (Negative binominal)**		**Model 5 First stage (Negative binominal)**		**Model 6 Last stage (Negative binominal)**	
LogLagInvestors^2 * Twitter	−0.003	0.008	0.026	0.013*								
LogLagInvestors * Facebook	0.070	0.052	0.009	0.019	−0.106	0.045**	0.060	0.066	0.027	0.025	−0.010	0.058
LogLagInvestors^2 * Facebook	−0.014	0.008	−0.013	0.012								
LogLagInvestors * Discussions	−0.198	0.089**	0.040	0.032	0.209	0.107**	−0.297	0.102***	0.009	0.036	0.347	0.118***
LogLagInvestors^2 * Discussions	0.016	0.016					0.074	0.018***				

Note: *, **, *** denote 10 %, 5 %, and 1 % levels of significance. All control variables are similar to those in Table 3. Control variables and regression statistics are omitted for brevity. Standard errors are clustered at the campaign level. We divide the funding period into two subperiods in which the first stage covers from the first day to the middle day of the fundraising campaign and the second stage is from the middle day to the last day.

social media, each campaign possesses designated accounts for social media channels (i.e., Facebook and Twitter). These social media accounts serve as official pages where startups share all relevant information pertaining to their fundraising campaigns. In terms of discussion updates, the campaign, rather than individual founders, provides updates and interacts with investors through the discussion section in the platform. Thus, the issue of multiple founders does not arise when social media and public discussions are considered in this particular context, since information is communicated through accounts of campaigns, not individual founders.

While posts on Facebook and Twitter come directly from campaigns, they will be quite formal, clear, and generally positive. Investors' discussions, on the other hand, include all sorts of issues, questions, or even complaints related to the project among investors and between investors and entrepreneurs. According to Xu and Chau [46], discussions may also contain some cheap talk and unverified information. Altogether, it is likely that investors' discussions will bring higher event uncertainty about the true value of projects. We quantify these sources of information by the number of posts on each channel and use investors' discussions as a proxy for event uncertainty.

To illustrate the dynamics of these information sources throughout the funding process, Table 4 presents different statistics (mean, median, max, min) on the number of discussions and of Facebook and Twitter posts at the end of the first stage and the last stage of the funding cycle. Further to Table 4, Graph 1 shows the average growth rate of number of posts from these sources. The growth rate for each project is calculated as

$$\text{Growth rate} = \frac{\text{Number of discussions, Facebook and Twitter posts at the end of the last stage}}{\text{Number of discussions, Facebook and Twitter posts at the end of the first stage}} - 1.$$

Table 4 and Graph 1 show clearly the dynamics of the information environment in equity crowdfunding. More specifically, the table shows that investors need to process an increasing volume of information in later stages of the funding cycle. The mean and median numbers of discussions and Facebook and Twitter posts are significantly larger in the final stage than in the first one. All the differences (in mean and median) of all three sources (discussions, Facebook, and Twitter) between last and first stages are statistically significant at the 1 % level. Graph 1 suggests that discussions are the most dynamic source of information, with the number of posts increasing on the average by 50 % in the final stage. Importantly, these dynamics of information sources may illustrate the development of event uncertainty dimensions that may be driven by the arrival of new information, particularly of "unverified" information status.

6.2. *Uncertainty dimensions and herding dynamics in equity crowdfunding*

To examine the impact of these two dimensions of uncertainty on herding dynamics, we conduct the following analysis. First, we use the median equity offered ratio (12.9 %), patent (binary variable), and founder experience (binary variable) of all campaigns in the sample as a cutoff point to separate them into two subsamples of high- and low-value-uncertainty campaigns. Second, we follow Xiao et al. [45], Jiang et al. [24], and Zhang and Liu [49] to adjust our specifications (1) and (2) as the specifications (3) and (4) below, in which we include the interactions of entrepreneurs' information channels and investors' discussions as proxies of event uncertainty and the accumulated number of investors. This is mathematically formulated as

$$\text{LogDailyInvestors}_{j,t} = a_0 + \beta_1 \text{LogLagInvestors}_{j,t-1} + \beta_2 \left(\text{LogLagInvestors}_{j,t-1} \times \text{Event uncertainty}_{j,t}\right) + \gamma Z_{j+} e_{j,t} \tag{3}$$

and

$$\begin{aligned} \text{LogDailyInvestors}_{j,t} = {} & a_0 + \beta_1 \text{LogLagInvestors}_{j,t-1} + \beta_2 \text{LogLagInvestors}^2_{j,t-1} \\ & + \beta_3 \left(\text{LogLagInvestors}_{j,t-1} \times \text{Tweet}_{j,t}\right) + \beta_4 \left(\text{LogLagInvestors}^2_{j,t-1} \times \text{Tweet}_{j,t}\right) \\ & + \beta_5 \left(\text{LogLagInvestors}_{j,t-1} \times \text{Facebook}_{j,t}\right) + \beta_6 \left(\text{LogLagInvestors}^2_{j,t-1} \times \text{Facebook}_{j,t}\right) \\ & + \beta_7 \left(\text{LogLagInvestors}_{j,t-1} \times \text{EventUncertainty}_{j,t}\right) + \beta_8 \left(\text{LogLagInvestors}^2_{j,t-1} \times \text{EventUncertainty}_{j,t}\right) + \gamma X_{j,t} + e_{j,t}. \end{aligned} \tag{4}$$

Table 6
Day interaction model.

DV= LogDailyInvestors	Model 1 Day interaction model (Negative binominal)		Model 2 Day interaction model (OLS)	
	Coeff.	Std. Error	Coeff.	Std. Error
Main independent variables				
LogLagInvestors	1.347	0.082***	0.739	0.054***
Day interaction variable				
LogLagInvestors * Days Available	−0.018	0.001***	−0.010	0.001***
Time-varying information				
Twitter	0.063	0.016***	0.051	0.012***
Facebook	0.080	0.017***	0.052	0.012***
Discussions	0.193	0.040***	0.104	0.030***
Campaign-specific controls				
Days Available	0.087	0.004***	0.051	0.002***
Patent	0.298	0.086***	0.193	0.061**
Management	0.072	0.041	0.061	0.030**
Equity Offered	−0.010	0.004**	−0.012	0.003***
Fin Snapshot	−0.269	0.086**	−0.289	0.05+***
Target	0.426	0.043***	0.359	0.032***
Tax	0.072	0.090	0.082	0.057
Tech	−0.253	0.089**	−0.233	0.060***
Dividends	0.087	0.117	0.114	0.085
Sophisticated	−0.153	0.060**	−0.187	0.045***
London	−0.113	0.055**	0.014	0.038
IPO	−0.179	0.061**	−0.079	0.043*
Positive Sales	0.344	0.065***	0.250	0.046***
Active Campaign	−0.008	0.004	−0.007	0.003**
FTSE Volatility	−23.323	5.868***	−9.853	4.221**
Constant	1.347	0.082***	−7.057	0.383***
Pearson Chi-Square	4856		1974	
Number of observations	2680		2680	

Note: *, **, *** denote 10 %, 5 %, and 1 % levels of significance. Standard errors are clustered at the campaign level.

where event uncertainty is proxied by the number of posts in discussions, Z_j captures various time-varying information, and $X_{j,t}$ controls for campaign-specific variables.

We then replicate Table 3 of the main analysis with the specifications (3) and (4) in the subsamples of high- and low-value-uncertainty campaigns with three panels corresponding with the three proxies (equity offered, patent, founder experience).[8] We also use alternative econometric methods as in Table 3 but only report results for the random-effect negative binominal panel regressions. This is because our results are largely consistent among all methods.

According to Table 5, the impact of alternative uncertainty dimensions on herding dynamics is consistent with multidimensional uncertainty theory. Specifically, the results show that value uncertainty alone does not induce herding momentum among investors. Indeed, models 1 and 2 (*low-value-uncertainty projects*) and models 4 and 5 (*high-value-uncertainty projects*) do not show evidence of herding in the first period of funding campaigns, even among the campaigns with high value uncertainty.

The interaction term of event uncertainty (number of discussions) and accumulated number of investors is consistently positive and significant in models 1 and 3 (except model 3 of panel B) for low value uncertainty, and models 4 and 6 for high-value-uncertainty projects, suggesting that event uncertainty has a significant impact on herding behavior. Interestingly, for cases of both low and high value uncertainty, event uncertainty (number of posts in discussions) mostly impacts herding in the final stage of the funding campaign, when investors already must absorb and manage a large amount of information.

Altogether, the results from our further analysis are mostly consistent with the theoretical framework of multidimensional uncertainty. More specifically, using different measures of value uncertainty, we show minor impact of founders' information disclosure on herding. Herding dynamics is mostly driven by event uncertainty caused by new and "noisy" information.

6.3. Robustness tests

We ran a series of different tests to confirm the robustness of our analysis. First, we constructed an interaction variable between the logarithm forms of lag investors and days available, which measures the number of days remaining in a funding campaign. We replicate the main analysis using this new interaction term in negative binominal and OLS specifications. Models 1 and 2 of Table 6 show that the interaction term is negative and statistically significant, suggesting that herding momentum is more prevalent toward the final days of the funding campaign (i.e., the number of days available is getting smaller). These results are consistent with our previous findings.

We also replicate our main analysis using an alternative measure for herding, which is the momentum of daily funding amount and total prior funding amount, as used in the prior literature [24,45]. These measures are considered to be good alternative proxies, as information on funding amounts is publicly available in crowdfunding platforms, so as investors can use it in their funding decision-making. Indeed, as discussed in Zhang and Liu [49], investors may herd to solve two key questions of whether they should invest or not and if so, how much they should contribute. Table 7 replicates our main analysis from Table 3 using funding amount momentum as an alternative measure of herding behavior. The results from the robustness checks are largely consistent with the main finding that herding only occurs in the last stages of those funding campaigns. The results from replicating Table 3 using an alternative measure of herding are also robust.

Finally, we extend our main analysis to another important UK equity platform—Seedrs. We replicate our main tests in a sample of 80 projects, listed in Seedrs during 2017–2018, as a method for assessing the validity of our main findings with out-of-sample data. Using a smaller set of control variables than for the Crowdcube projects, our results, illustrated in Table 8, suggest similar herding dynamics among Seedrs projects, with herding momentum appearing strongly in the final stage of the funding campaigns, and confirm our original findings.

7. Conclusions

Our study reports evidence that herding in equity crowdfunding tends to occur in the last stages of the crowdfunding campaign. The results add to a major line of studies in the OM and IS literature [2,14,24,27,44,45] and the finance and entrepreneurship literature [6,43,49], which investigates the existence of herding in crowdfunding activity. We also report evidence that herding dynamics in equity crowdfunding is influenced by multiple dimensions of uncertainty, as suggested by the multidimensional uncertainty theory of Avery and Zemsky [7].

While it provides various significant contributions to the literature, there are limitations in our research that would benefit from future studies. First, our research is conducted in an equity crowdfunding context, so it would be useful to generalize it to other crowdfunding contexts. Zhang and Liu [49] document herding in the first few days of lending crowdfunding projects but do not investigate the whole process. Chan et al. [13] implicitly report herding in a later stage of reward-based crowdfunding. It is interesting to see if herding dynamics in other types of crowdfunding is different from our findings. Second, Xiao et al. [45] show that information from entrepreneurs can attenuate herding in reward-based crowdfunding, but they do not investigate the impacts of "informal" information provided from/to investors. Our study shows that this source of information may impact investors differently by

[8] In addition to subsamples, we also use a dummy variable (one for high value uncertainty and zero for low value uncertainty) to interact with the main independent variables of the model. The results are consistent with the analysis using subsamples. We thank the editor for suggesting this analysis.

Table 7
Herding momentum by funding amount.

DV= LogDailyRaised	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Whole funding process Curvilinear (Negative binominal)		First stage (Negative binominal)		Last stage (Negative binominal)		Whole funding process Curvilinear (OLS)		First stage (OLS)		Last stage (OLS)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Main independent variables												
LogLagRaised	−0.676	0.084***	−0.211	0.022***	0.988	0.089***	−1.418	0.099***	−0.264	0.032***	1.192	0.114***
LogLagRaised^2	0.041	0.007***					0.095	0.008***				
Time-varying information												
Twitter	−0.031	0.032	0.092	0.047	−0.078	0.048	0.023	0.043	0.137	0.062**	−0.048	0.061
Facebook	0.015	0.036	−0.036	0.045	0.160	0.054**	0.146	0.043***	0.129	0.058**	0.203	0.059***
Discussions	0.181	0.082*	0.274	0.092**	0.245	0.133	0.474	0.105***	0.433	0.128***	0.98	0.167***
Campaign-specific controls												
Days Available	0.012	0.002***	0.035	0.006***	0.020	0.004***	0.034	0.003***	0.076	0.008***	0.038	0.005***
Patent	0.415	0.171**	−0.013	0.230	1.101	0.260***	0.384	0.224	0.224	0.307	0.414	0.310
Management	0.018	0.086	−0.038	0.114	−0.100	0.125	0.159	0.110	0.139	0.151	0.149	0.152
Equity Offered	0.004	0.009	−0.015	0.011	0.031	0.013**	−0.005	0.011	−0.022	0.015	0.024	0.015
Fin Snapshot	0.052	0.174	−0.196	0.217	0.325	0.273	−0.009	0.205	−0.246	0.274	−0.040	0.293
Target	0.709	0.106***	1.003	0.104***	−0.111	0.154	0.333	0.139**	1.503	0.155***	−0.392	0.186**
Tax	0.231	0.167	−0.092	0.220	0.451	0.250	0.149	0.208	0.264	0.282	0.023	0.288
Tech	0.305	0.179	0.020	0.221	0.594	0.270	0.273	0.220	0.293	0.297	0.226	0.308
Dividends	0.249	0.240	0.235	0.311	0.346	0.377	0.284	0.313	0.789	0.422	−0.279	0.439
Sophisticated	−0.072	0.120	0.225	0.159	−0.036	0.177	−0.386	0.168**	0.014	0.229	−0.564	0.232**
London	−0.154	0.112	0.035	0.145	−0.281	0.163	−0.366	0.141**	−0.397	0.194**	−0.246	0.195
IPO	−0.380	0.124***	0.005	0.157	−0.526	0.185**	−0.356	0.159**	−0.381	0.214	−0.069	0.222
Positive Sales	0.151	0.133	0.384	0.167**	−0.272	0.205	0.757	0.167***	0.952	0.223***	0.572	0.233**
Active Campaign	0.009	0.008	0.041	0.012***	0.003	0.011	0.020	0.011	0.035	0.018	0.021	0.014
FTSE Volatility	−7.198	12.029	−12.274	15.243	−24.227	20.598	−22.513	15.575	−59.511	20.218**	−8.173	24.300
Constant	0.709	1.404	−5.877	1.400***	−3.647	1.582**	1.227	1.768	−17.591	1.898***	−8.872	1.900***
Pearson Chi-Square	3776		1474		2043		26,906		12,102		13,039	
Number of observations	2680		1320		1360		2680		1320		1360	

Note: *, **, *** denote 10 %, 5 %, and 1 % levels of significance. Standard errors are clustered at the campaign level. We divide the funding period into two sub-periods in which the first stage covers from the first day to the middle day of the fundraising campaign and the second stage is from the middle day to the last day.

Table 8
Herding in alternative context—Seedrs platform.

DV= LogDailyInvestors	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Whole funding process Curvilinear (Negative binominal)		First stage (Negative binominal)		Last stage (Negative binominal)		Whole funding process Curvilinear (OLS)		First stage (OLS)		Last stage (OLS)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Main independent variables												
LogLagInvestors	−2.019	0.081***	−0.453	0.048***	0.871	0.066***	−1.497	0.045***	−0.290	0.030***	0.440	0.030***
LogLagInvestors^2	0.280	0.011***					0.200	0.006***				
Campaign-specific controls												
Funding needed	−0.020	0.001***	−0.025	0.003***	−0.014	0.002***	−0.009	0.001***	−0.015	0.001***	−0.004	0.001***
Days Available	0.021	0.001***	0.039	0.004***	0.004	0.003	0.009	0.001***	0.025	0.002***	0.000	0.001
Target	0.088	0.188	1.202	0.336***	−0.326	0.258	0.065	0.092	0.512	0.155***	−0.185	0.121
Equity Offered	−0.011	0.021	−0.107	0.038***	0.039	0.029	−0.007	0.010	−0.042	0.017**	0.019	0.013
Valuation	−0.175	0.193	−0.892	0.349**	0.212	0.267	−0.085	0.094	−0.354	0.160**	0.161	0.123
Tax	−0.252	0.067***	−0.066	0.120	0.008	0.092	−0.093	0.032***	−0.055	0.055	0.038	0.042
Tech	−0.253	0.058***	−0.279	0.107***	−0.137	0.081*	−0.049	0.027*	−0.140	0.046***	0.018	0.035
Constant	5.369	0.935***	0.733	1.686	−2.818	1.279**	3.578	0.457***	0.205	0.775	−1.732	0.581***
Pearson Chi-Square	4036.510		2751.890		1923.530		1717.300		1219.670		749.250	
Log Likelihood	12,279.960		6964.450		5568.700		7230.640		4182.490		3433.750	
Number of observations	3486		1743		1743		3486		1743		1743	

Note: *, **, *** denote 10 %, 5 %, and 1 % levels of significance. Standard errors are clustered at the campaign level. We divide the funding period into two subperiods in which the first stage covers from the first day to the middle day of the fundraising campaign and the second stage is from the middle day to the last day.

creating more uncertainty. It is also important to investigate if investors in other types of crowdfunding are influenced in the same way as in our case, equity crowdfunding. Finally, our study is only able to use the number of discussion posts and Facebook and Twitter updates as a proxy for event uncertainty. Future studies may collect and analyze the content of these conversations as in Xiao et al. [45] to improve such a measure.

8. Author statement

My co-authors and I would like to thank yourself and the review panel for giving us the opportunity to revise our manuscript entitled 'Herding dynamics and multidimensional uncertainty in equity crowdfunding: the impacts of information sources' (INFMAN-d-22–00546R2). The comments we received were valuable and we believe offered us the insight necessary to substantially improve the manuscript relative to the previous submission.

In light of the recommendations and suggestions offered by the second reviewer, we have taken the time to clarify remaining issues of the paper. In addition to a revised version of the manuscript and the associated tabled and figures, we also supply a document detailing the changes we have made in response to all of the comments and concerns of the reviewer. We hope you agree that the revisions to the manuscript are satisfactory in terms of addressing these comments and that the piece now demonstrates sufficient quality to be considered for publication in the Information & Management. We look forward to hearing from you regarding the suitability of the revised manuscript at your earliest convenience.

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