Round-Number Bias in Investment: Evidence from Equity Crowdfunding[1]

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Abstract

We examine whether uncertainty affects the use of round numbers in investment decisions. Using unique data of more than 15,000 investments from WiSEED—the largest equity crowdfunding platform in France—for the period 2009-2016, we find that investors are more likely to invest a round number when facing greater uncertainty in equity crowdfunding campaigns. As more investors pledge funds, the perceived uncertainty is reduced, which in turn reduces the use of round numbers by follow-up investors. This finding is consistent with the round-number bias. When investors no longer know the funding status of the ongoing campaign, experience helps reduce the round-number bias. This suggests the presence of a learning-by-doing phenomenon through experience: as investors become more familiar with equity crowdfunding investments, they are less prone to behavioral bias. These findings are consistent with behavioral theories of investment.

Keywords: Round-number bias; behavioral finance; uncertainty; crowdfunding

1. Introduction

Modern finance theory posits that investors should follow a rational decision-making process (Markowitz, 1959). Investors, however, do not always conform to this normative judgment decision-making model (Kahneman, 2011). Early research by Simon (1957) shows that individuals are subject to limitations in their cognitive abilities and, as a result, rely on heuristics when making choices under uncertainty. Heuristics are a simple way of thinking that helps reduce complex tasks to simpler judgmental operations (Tversky and Kahneman, 1974). Heuristics can lie at the origin of different cognitive biases (Gilovich et al., 2002; Tversky and

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Kahneman, 1974). One of these heuristics is the use of round numbers, leading to a so-called round-number bias (Fraser-Mackenzie et al., 2015). Kuo et al. (2015) provide evidence of the use of cognitive shortcuts in the futures market, such that traders submit a disproportionate number of limit orders at round-number prices[4]. Psychological biases are magnified when there is more uncertainty (Zhang, 2006; Hirshleifer, 2001). For example, Jiang et al. (2005) contend that uncertainty exacerbates a particular psychological bias, namely overconfidence. As a result, uncertainty increases mispricing of stocks. In this paper, we assess the extent to which individuals are more likely to make round-number investments when confronted with more uncertainty about investment outcome. In other words, we investigate the relationship between uncertainty and round-number bias. We further examine whether investor experience helps reduce the round-number bias.

We evaluate the round-number bias in the context of the recently emerged equity crowdfunding market, a market characterized by a significant amount of uncertainty and risk for investors. In this market, startups raise equity finance through a specialized crowdfunding platform without the involvement of an intermediary, such as an underwriter or investment bank. Rather, the issuance occurs with light regulation, and the bulk of investors are non-professional investors (Hornuf and Schwienbacher, 2017b). Crowdfunding investment decisions are a complex task, as they involve investments in early-stage ventures with little track record and often seek finance for their R&D activities. According to Vismara (2016b), uncertainty is stronger in equity crowdfunding markets than in many other equity markets (private equity, venture capital, business angel finance) because crowdfunded projects are generally initiated by first-time entrepreneurs. Thus, we can reasonably expect that crowd investors will rely on heuristics such as investing in round numbers; that is, their investments will cluster around some salient numbers. Moreover, we examine whether a learning effect takes place and helps mitigate the use of the heuristic.

Our data come from WiSEED (www.wiseed.com/), a well-established French equity crowdfunding platform. It is also the oldest and largest platform in France. A unique feature of this platform is that it has undertaken

4 Fraser-Mackenzie et al. (2015) use the term 'round-number bias'. Others such as Kuo et al. (2015) use the term 'round-number heuristic', but also in the context of a cognitive bias. We therefore use the two terms interchangeably, depending on whether we refer to the bias or the heuristic.

an important structural change in the amount of information disclosed to investors during the campaign. Before October 17, 2014, anyone visiting the platform could see how much a startup had collected so far—something we call 'funding status', which includes information on the cumulated amount of pledges and the number of investments made so far. Thus, crowd investors could determine whether the startup was likely to achieve its funding goal, thereby reducing their uncertainty about the campaign outcome. This information can also affect perceived uncertainty (called 'information uncertainty'; see Jiang et al., 2005; Zhang, 2006; Kumar, 2009), as the participation of more investors offers a positive signal about assessments made by others regarding the investment opportunity. Our focus is particularly on this form of uncertainty, which we can measure any time during the campaign and that decreases over time with more investments being made. Since October 17, 2014, the information on the funding status is no longer available. While deletion of the information on the funding status was to avoid possible herding behavior, it also left significant uncertainty until campaign end. We explore in this paper investor behavior both before and after this period, which constitute two distinct settings for testing the presence of a round-number bias. In the first case, crowd investors receive a continuous signal about information uncertainty; in the second case, the signal remains the same throughout the campaign.

Our database contains information on 15,413 individual investments made from January 12, 2009, to September 30, 2016. The average investment size is €1,276 per investor, and most investors participate in several crowdfunding campaigns on WiSEED during the time under consideration. To evaluate whether an investment amount is 'round', we rely on the methodology Jansen and Pollmann (2001) developed in the linguistics literature. This measure converts any amount into a degree of roundness, which ranges from 0 to 4. A higher value means a higher degree of roundness. In our sample, we find that most of the invested amounts tend to cluster around specific numbers. Overall, 80% of all investments have a degree of roundness of either 3 or 4, which hints at a strong reliance on the heuristic of using round numbers by investors. By contrast, investments with an amount for which the degree of roundness equals 0 only occur 1% of the time.

Our multivariate results show that crowd investors are subject to a round-number bias. This is in line with results in the finance literature that identify a disposition of individuals to use heuristics. Thus, individual investors

are prone to behavioral biases (Barber et al., 2009), and this is true in the equity crowdfunding market as well. In particular, we document that under greater uncertainty, crowd investors rely more often on round numbers.

Moreover, we find that crowd investors benefit from their experience in mitigating the round-number bias when they do not receive an external signal in the form of information on the funding status. As their experience grows, the propensity of investors to invest a round amount is reduced in the absence of information on the status of the campaign. This suggests that a learning-by-doing effect occurs and mitigates the potential adverse effect of the round-number bias. However, experience does not matter in the presence of a signal on the behavior of other investors (i.e., when the latest funding status is disclosed), suggesting that investors are then more influenced by the external signal. This external signal reveals information on the probability of success of the campaign and the 'valuation uncertainty'. As the number of backers (or the extent to which the amount collected approaches the funding target) increases, investors perceive the investment opportunity as less uncertain. As a result, they invest a 'rounder' amount. When uncertainty is high but they receive a signal about the level of uncertainty, they behave in a non-rational way, in that they rely on heuristics, but in line with the signal perceived. When the funding status is not disclosed, investors do not have any tools to help them distinguish firms with uncertain outcomes from those with more certain outcomes. In this case, they can only rely on their own experience, which in turn mitigates the round-number bias.

Our contribution to the literature is threefold. First, while other studies have evidenced the existence of a tendency of investors to invest in round numbers (e.g., Kandel et al., 2001; Ikenberry and Weston, 2007), they explain this bias instead with cognitive factors (Aerts et al., 2008; Kuo et al., 2015). To the best of our knowledge, we are the first to study a causal relationship between uncertainty and the round-number bias for investors, in which uncertainty induces the round-number bias. Binder (2017) also examines this relationship but takes a different point of view. Her objective is to construct a proxy for uncertainty about inflation expectations. To achieve this goal, she builds on round numbers and approximation behavior to infer uncertainty. She quantifies the uncertainty with the use of round numbers inform a survey: the more often people use round numbers in their responses, the more uncertain is the economic environment. She relies on the *round numbers suggest round interpretations* (RNRI) principle, which is

a different perspective of our meaning of round numbers. RNRI posits that the use of round numbers suggests high uncertainty. We show that the round-number bias is exacerbated under conditions of greater uncertainty and affects investment decisions by increasing the likelihood of investing in round numbers. This is in line with the finance literature showing that uncertainty can increase cognitive biases. Second, we characterize roundness of numbers in a more precise way than other studies in the literature on the round-number bias. Building on the seminal work of Jansen and Pollman (2001) in the field of linguistics, we measure precisely the degree of roundness of amounts invested by individuals (crowd investors) in small, early-stage ventures. In contrast with other studies in finance (see, e.g., Kuo et al., 2015; Ikenberry and Weston, 2007), we do not rely on a binary approach to measure roundness. This measure can be easily implemented and used in other contexts and with other datasets. Third, we provide further evidence on how the learning process of individual investors influences investments, by assessing this relationship in the context of equity crowdfunding. Other studies have focused on different markets. For example, Seru et al. (2009) and Kuo et al. (2015) document that stock traders in the financial market benefit from their experience. Moving to the equity crowdfunding market—a microcap market—we show that more experienced crowd investors exhibit a lower tendency to invest in round numbers and, thus, to be subject to the behavioral bias.

The remainder of the paper proceeds as follows: Section 2 reviews the literature and develops our research hypotheses. Section 3 describes the data and the empirical setting and details how we measure roundness and uncertainty. Section 4 begins with summary statistics and then turns to multivariate analyses. Section 5 concludes.

2. Literature review and development of behavioral hypotheses

2.1. Equity crowdfunding

Our empirical setting is the emerging equity crowdfunding market. Though still nascent, this market has quickly attracted interest by researchers in entrepreneurial finance and management. One early strand of literature focuses on regulation, as equity crowdfunding, in contrast with other forms of crowdfunding, involves the issuance of financial securities, something

that is highly regulated in any country (Hornuf and Schwienbacher, 2017b). While equity crowdfunding was for a long time forbidden in the US for non-accredited investors, it has developed more easily in the European Union because of the existence of a wide range of exemptions to the prospectus regulation (the Directive 2003/71/EC of 4 November 2003 and the updated Directive 2010/73/EU of 24 November 2010), which allowed small firms to issue shares to the general public without the need for a formal prospectus approved by national regulators. Follow-up regulations at the national levels have further propelled the development of this market, though at the cost of largely segmenting the European market into national markets.

Other strands of literature examine investment behavior of crowd investors and determinants of campaign success in equity crowdfunding. It is especially important to assess equity crowdfunding separately from other forms of crowdfunding because crowd investors make investment decisions while backers of reward-based crowdfunding generally make consumption decisions (Vismara, 2016b). The first study on the topic is that by Ahlers et al. (2015), who shows that quality signals affect investor behavior and ultimate outcome of the campaign. For example, social networks and social capital play a role in these markets (Colombo et al., 2015; Vismara, 2016a). Entrepreneurs gain from mobilizing their own personal networks (mainly through social networks such as Facebook and LinkedIn), which can be especially valuable during the first campaign days. Vismara (2016b) documents informational cascade effects resulting from early contributions. The timing of investments is also affected by the way platforms structure the campaign; Hornuf and Schwienbacher (2017a) find that within-campaign dynamics follow an L-shape pattern when shares are allocated to crowd investors on a first-come, first-served basis but a U-shaped pattern under a price auction mechanism. Signori and Vismara (2017) examine what happens after an equity crowdfunding campaign and find that one-third of firms are able to pursue further equity issuance, especially if the equity crowdfunding was quickly successful and generated less dispersed ownership. Most crucially, they find that an important success factor is the initial participation of professional investors.

2.2. Use of round-numbers and cognitive biases

The round-number bias has been examined in different contexts, leading to different explanations for its occurrence. The propensity to use round

numbers has been investigated in many markets such as the used-car market (Lacetera et al., 2012); the housing market (Pope et al., 2015); consumer durables, consumption goods, and housing markets (Yan and Pena-Marin, 2017); and the deposit market (Kahn et al., 1999; Ashton and Hudson, 2008). Some strands of literature argue that round numbers either make bargaining easier or result from collusive behavior of vendors. In different contexts (Pope et al., 2015; Yan and Pena-Marin, 2017; Hukkanen and Keloharju, 2015; Harris, 1991), results show that the use of round numbers helps simplify the negotiation process. Moreover, in a financial context, Christie and Schultz (1994) were the first to identify the existence of collusive behavior of brokerage firms on the NASDAQ. There, market makers do not quote odd-eights in some stocks to extract a higher spread per share. These results led to highly publicized litigations and a payment of more than $1 billion of fines by 30 brokerage firms.

By contrast, Simon (1957) views individuals as limited information processors. That is, individuals have limitations in their cognitive abilities and, consequently, are subject to cognitive shortcuts. Faced with complex tasks, they tend to use heuristics to simplify their decision-making processes. Biases and heuristics constitute efficient means to explain how and why individuals deviate from a rational decision-making process. In finance, evidence on the existence of behavioral biases abound. Daniel et al. (2002) and Subrahmanyam (2007) offer detailed surveys of the presence of such biases and show that they affect not only retail investors but also professional investors, security analysts, and CEOs of large companies.

Individuals are more prone to heuristics when facing complex decisions because heuristics provide an efficient way to reduce a complex decision to a simpler one (Bazerman and Moore, 2009). Assessing a venture's future perspectives of success is a complex task; even professional investors such as venture capitalists can exhibit psychological biases when making such judgments (Franke et al., 2006). In the context of equity crowdfunding in which individuals are confronted with early-stage investments, the decision to invest can be particularly complex. As Ahlers et al. (2015) argue, crowd investors are small, non-professional investors. They do not have the experience that venture capitalists generally have and thus are less likely to have adequate capabilities to evaluate such investment opportunities. Therefore, the evaluation of an equity-crowdfunded startup and the ultimate decision of how much to invest constitute a highly complex task for crowd investors. As a result, crowd investors should be prone to use heuristics.

2.3. Development of hypotheses: Round-number bias, uncertainty, and learning behavior

Rosch (1975) describes one type of heuristic related to numbers. She shows that individuals do use cognitive reference points in their decision-making processes. With regard to numbers, she identified that multiples of 10 act as reference points for integer numbers in a decimal number system. Kuo et al. (2015) advocate that the use of round numbers by investors comes from this reference points heuristic. Broadly speaking, all round numbers can be viewed as reference points (Bhattacharya et al., 2012). This echoes the intuition of Niederhoffer (1966), who suggests that psychological variables are at play in explaining stock price clustering. The clustering of asset prices at round numbers is a well-documented empirical regularity on the financial markets (Kuo et al., 2015)[5].

The explanation of this tendency to use round numbers lies in the saving of cognitive energy. Price clustering results from a psychological phenomenon. Ikenberry and Weston (2007) and Kuo et al. (2015) validate this influence of behavioral factors in the stock market. Similar conclusions are obtained by Lucey and O'Connor (2016) for the gold market, Aerts et al. (2008) with dividend policy, Kandel et al. (2001) for IPO markets, and Clarkson et al. (2013) and Roger et al. (2018) for financial analysts. The general phenomenon underlying this cognitive process is that numbers that are easier to recall are those for which the clustering effect is greater (Kahn et al., 1999; Ashton and Hudson, 2008). Thus, the more salient a number is, the more it is easily recalled and used as a reference point. Such an argumentation is also consistent with the availability heuristic of Tversky and Kahneman (1974): round numbers are used because they come easily to mind.

So far, this behavioral explanation of the use of round numbers for asset prices has not taken into account the uncertainty surrounding the assets under consideration, whereas all the assets studied are, by nature, subject to a high degree of uncertainty. In the context of stock market investments, Zhang (2006) and Hirshleifer (2001) argue that psychological biases tend to increase with uncertainty, leading to greater mispricing of stocks. Kumar (2009) argues that high uncertainty (at either the security or the market level) implies that investors will exhibit more overconfidence.

5 Readers interested by this literature can find a long list of references in Kuo et al. (2015).

Jiang et al. (2005) obtain similar findings. In the context of entrepreneurship, Baron (1998) identifies theoretically that uncertainty is a condition that increases susceptibility to cognitive biases. Busenitz and Barney (1997) empirically show that entrepreneurs are more subject to overconfidence and representativeness biases than managers in large organizations, which they attribute to the fact that entrepreneurs make decisions in environments surrounded by greater uncertainty. This suggests that the higher the uncertainty, the more people are inclined to exhibit cognitive biases.

Given this mounting evidence, we posit that uncertainty exerts a positive influence on the occurrence of behavioral biases in general. Little is known, however, about how the round-number bias is related to the amount of uncertainty that individuals face. Investing in round numbers is a case of anchoring on salient numbers with which investors are familiar. In the field of psychology, Quinn (2000) shows that particularly salient stimuli— reference points—function as anchors. He hypothesizes that reference points derive their saliency from their psychological separation from other points on the continuum. Along this perspective, Bhattacharya et al. (2012) show that stock traders use round numbers as cognitive reference points. Kuo et al. (2015) find the same results for futures traders, though without making a direct link to differences in uncertainty.

Mussweiler and Strack (2000) advocate that the degree of uncertainty has a positive effect on anchoring. Mussweiler and Englich (2003) document an anchoring effect resulting from uncertainty following the introduction of the euro in Germany. Because the round-number bias appears as an anchoring on reference points, we expect that this bias will also be increased by uncertainty. This view is consistent with what Shiller (2000, p. 137) puts forth in a context of high uncertainty (valuation of the level of stock prices) when stating that an "*anchor may be the nearest milestone of a prominent index such as the Dow, the nearest round-number level, and investors' use of this anchor may help explain unusual market behavior surrounding such levels*".

Equity crowdfunding is characterized by high uncertainty, and uncertainty varies according to the project/firm under scrutiny (Ahlers et al., 2015; Vismara, 2016b). Along this perspective, we expect that uncertainty motivates the use of the round-number heuristic by equity crowd investors. More precisely, we expect that greater uncertainty increases the propensity of crowd investors to rely on the round-number heuristic when choosing how much to invest. Some numbers can be deemed 'more round' than others.

This leads us to conjecture that crowd investors will invest an amount with a higher (lower) degree of roundness when uncertainty is greater (lesser). We summarize this prediction in our first hypothesis:

Hypothesis 1: The greater the uncertainty, the higher is the degree of roundness of the investment amount.

The literature has long debated the learning effect in investing, which finds its roots in the works of Arrow (1971). The main idea is that learning results from experience. In the stock market, investors could benefit from a learning-by-doing effect and improve their capability to invest over time. Some studies provide evidence of improved performance due to investor experience (Feng and Seasholes, 2005; Seru et al., 2009; Kuo et al., 2015). Yang et al. (2009) show that venture capitalists benefit from experience and that their selection and valuation capabilities improve over time; they learn from their experience.

In the context of equity crowdfunding, no study examines the learning phenomenon in investment. Crowd investors are, for the most part, unsophisticated investors, and they likely have much to learn about investing, especially in this newly emerging market. Thus, we expect that crowd investors become more knowledgeable over time, when they invest more. Accordingly, learning may result from a rational learning process, which we formulate as follows:

Hypothesis 2: The experience of crowd investors mitigates investments in round amounts.

3. Data, empirical setting, and description of variables

We begin with a description of our dataset (Section 3.1), followed by our empirical setting, which is based on the French equity crowdfunding platform WiSEED (Section 3.2). Next, we turn to the description of our variables (Section 3.3). There, we present our measure of roundness, which comes from the field of psychology, and also our measures of uncertainty. Finally, we describe our measures of investor experience.

3.1. Data source

Our data comprise all investments made on the WiSEED platform from January 12, 2009, to September 30, 2016, which represent the full

population of investments made since the start of the platform. In total, 15,413 investment decisions were made. For each campaign, we have information on the entire set of investments made, including the exact date of investment, the amount invested, and the individual who made the investment. We also have detailed information on investors, including gender and age. We are able to track all individuals over time, even when they invest in different startups. For each startup that runs a campaign, we have the minimum ticket size, its year of incorporation, industry classification, and desired funding goal.

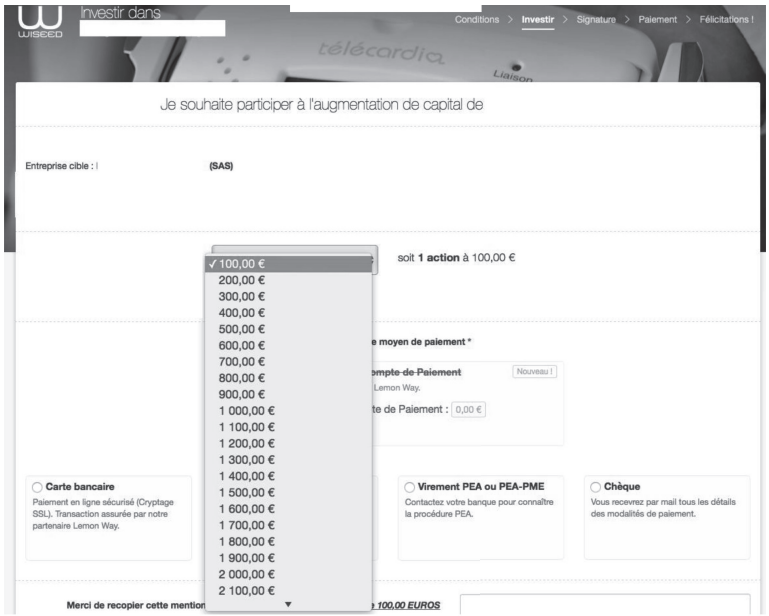
3.2. WiSEED: Our empirical setting

The purpose of the WiSEED platform is to provide entrepreneurs—generally at an early stage of their development—with equity funding. A typical fundraising campaign lasts between one and three months. The duration of a campaign depends on the funding goal set by the entrepreneur and on the perception of the opportunity by investors. The funding model is a hybrid one, mixing the all-or-nothing with the keep-it-all model (Hervé et al., 2017): if funding reaches a minimum threshold, funds are paid out to the firm; otherwise, all pledges are cancelled. However, this minimum threshold is well below the announced funding goal. Firms that do not achieve their funding goal nevertheless received the money pledged (as long as at least the minimum threshold is reached), following a keep-it-all funding model.

All members of the platform are individuals; institutional investors are not allowed to become members. The minimum ticket for investing in any startup is at €100 per share, and the minimum number of shares that can be bought is 1. This ensures that almost anyone can participate. Accordingly, WiSEED provides a dropdown menu for investors to choose the amount they want to invest, as shown in Figure 1. The menu begins with €100 and continues by increments of €100 up to €100,000. Thus, investors can choose any amount that is a multiple of €100, with a set limit at €100,000.

Until October 17, 2014, WiSEED included up-to-date information on the status of the funding process on the website of the campaign. Thus, members interested in investing could see how much other members had already pledged (as an aggregate amount) to that startup to date. This provided valuable information to investors on the progress of the funding and, thus, on the uncertainty about whether the funding goal could be

Figure 1. Screenshot of investment menu for a startup on the WiSEED platform



achieved. Since then, WiSEED no longer reports this information, with the outcome of the funding process only revealed at the end of the campaign. The platform wanted to offer a setting in which investors make their own decisions without being influenced by others.

3.3. Definition of main variables

3.3.1. Measurement of the degree of number roundness

Work in the field of psychology (Baird and Noma, 1975; Dehaene and Mehler, 1992) finds that individuals prefer some numbers to others and that these numbers appear at a much higher frequency than others. In the field of quantitative linguistics, Jansen and Pollmann (2001) argue that the frequency of a number's occurrence depends on its 'roundness'. They propose qualifying the roundness of a number as a function of specific criteria as a way to quantify it. They evaluate approximation in different texts extracted from major newspapers in France, Germany, and England, which allows them to identify round numbers in the different languages. Approximation is based on the use of an approximation word followed directly by a number

(e.g., 'environ' in French, 'etwa' in German, and 'about' in English). They observe strong correlations between the frequencies of the round numbers used in different languages. They argue and empirically validate that in a system of decimal numbers, roundness depends on four n-ness conditions: 10-ness, 2-ness, 5-ness and 2½-ness. A number has:

- 2-ness if it is contained in the set $[2 \times (1 - 9 \times 10^n)]$
- 2½-ness if it is contained in the set $[2.5 \times (1 - 9 \times 10^n)]$
- 5-ness if it is contained in the set $[5 \times (1 - 9 \times 10^n)]$ and
- 10-ness if it is contained in the set $[1 \times (1 - 9 \times 10^n)]$ with $1 - 9$ ndicating number varying from 1 to 9 and n always ≥ 0 except for 10-ness where $n > 0$ [6].

The greater the number of conditions that a number meets, the higher is its degree of roundness. Jansen and Pollmann (2001) explain this phenomenon by the ease of halving and doubling numbers, which are in conformity with the n-ness conditions.

Garmaise (2015) examines the reporting of personal assets by individuals and finds that behavioral theories are at play. He quotes (p. 455) Jansen and Pollman (2001) as follows: "*In societies using a decimal number system, powers of 10 and integer multiples of these powers are considered most prominent*". In the area of marketing, Coulter and Roggeveen (2014) use the roundness definition of Jansen and Pollman (2001) to investigate the effects of approximation sequences on the behavior of consumers. They show that a promotional offer leads to a higher purchase intention if the regular price, the discount, and the discounted price share the same degree of roundness. Given this empirical evidence, we also take the approach of Jansen and Pollman (2001) to identify the degree of roundness of investment amounts. As we have four conditions, the measure of roundness takes values from 0 to 4.

In our setting, investors can choose any amount between €100 (minimum ticket) and €100,000, in multiples of 100. We apply the roundness criteria of Jansen and Pollmann (2001) to this range and obtain our dependent variable, the degree of roundness, which we denote by *Roundness*. Implementation of these criteria leads to the assignment to each number in the range [€100;

6. According to Jansen and Pollman (2001, p. 198), a number "has 2-ness when dividing it by 2, 20, 200, 2000, etc. [and] results in 1, 2, 3, 4, 5, 6, 7, 8, or 9". For example, 4,000 can be divided by 2,000, which results in a value of 2; therefore, it has 2-ness. The same applies for the other criteria of roundness.

€100,000] a degree of roundness varying from 0 to 4 according to how many roundness conditions a number meets. Our dependent variable *Roundness* therefore varies from 0 (no roundness condition fulfilled) to 4 (all four conditions of roundness simultaneously satisfied)[7].

3.3.2. Measures of uncertainty

Uncertainty in the current context is similar to the information uncertainty of Jiang et al. (2005) and Zhang (2006) or to what Kumar (2009) refers as 'valuation uncertainty'. Uncertainty does not result from information asymmetry; rather, it embodies the difficulty of valuing a given firm. A firm with a high level of information uncertainty is difficult to value. Uncertainty originates from two sources: (i) the volatility of a company's fundamentals and (ii) poor quality of information (Zhang, 2006). Following this definition of uncertainty, high uncertainty will lie at the origin of behavioral biases and especially the round-number bias. Indeed, as uncertainty grows, information becomes sparser, the complexity of the task increases, and, as a result, investors are more prone to behavioral biases (Kumar, 2009).

In the context of equity crowdfunding, we cannot build on the findings of Jiang et al. (2005), Kumar (2009) or Zhang (2006)[8]; instead, we need to take into account that no trading takes place during the campaign, only investments. Jiang et al. (2005) and Kumar (2009) use trading volume as a proxy of uncertainty, a measure that we can transpose in the context of an equity crowdfunding campaign. The idea is to use a related measure that reflects the number of securities traded. In our context, we approximate this by the number of investors purchasing shares. Thus, we rely on three alternative measures: the number of backers (the variable *Nbr. Backers*), the amount already collected (*Amount Cumulated*), and the funding ratio (the ratio of the amount pledged so far to the funding goal, denoted *Funding Ratio*). These measures can be calculated in our setting at any time during the campaign because we have the exact time (in seconds) of each investment. The replication of the volume measure is not exactly the same as in the equity crowdfunding context, because investors cannot sell their shares

7 For example, 100 has a degree of roundness of 4 because it satisfies the four conditions, 500 has a roundness degree of 3 (10-ness, 5-ness, and 2.5-ness, not 2-ness), 300 has a degree of 2 (5-ness and 10-ness only), 700 has a degree of 1 (10-ness), and 1100 has a degree of 0 (no condition met).

8 Jiang et al. (2005) measure uncertainty with firm age, trading volume, duration, and return volatility. Zhang (2006) uses firm age, firm size, analyst coverage, dispersion in analyst forecasts, return volatility, and cash-flow volatility. Finally, Kumar (2009) uses firm age, trading volume, and idiosyncratic volatility. In our setting comprising early-stage firms, the only relevant measure we can compute is firm age because all the other proxies are not applicable to small, private firms.

owing to the private nature of the offer. However, these variables measure the number of securities bought by crowd investors and, as the volume measure does, reflect the attention of investors to a particular security. This way of measuring uncertainty transcribes the uncertainty perceived by crowd investors at the time they make an investment. In turn, this uncertainty influences their behavior.

In the context of equity crowdfunding, Colombo et al. (2015) show that the number of early backers and the percentage of early capital raised during the campaign reflect uncertainty. They argue that observational learning, word of mouth, and crowdsourcing underlie these proxy measures. Vismara (2016b) makes similar arguments and shows that a high percentage of early backers causes late investors to take part in an equity crowdfunding campaign, as significant participation in the first days generates information on valuations by others (because they are willing to invest at the proposed price). Hornuf and Schwienbacher (2017a) find that investor participation increases after the funding goal is achieved, an effect they attribute to reduced risk and positive feedback from other investors. In sum, these studies evidence that a high number of backers and a high funding ratio reflect high interest of investors and, as a result, reduce the uncertainty of the investment. Stanko and Henard (2017) hypothesize that the number of backers is a good predictor of the success of the firm in the future. They validate this empirically and show that as the number of backers grows, so does the product-market performance. Bapna (2017) argues that a high funding ratio resolves uncertainty because it is a social proof of the relevance of investing in a given equity crowdfunding project. However, all these studies are at the campaign level and not at the investor level. We adapt these measures to fit our settings because we have multiple investments at different dates during a campaign, and the measures proposed by Colombo et al. (2015) or Vismara (2016b) are only known at a given time and do not vary over time during a given campaign. The intuition is that at any given point in time, a high number of backers and a high level of capital raised (either in absolute terms or as a fraction of the funding goal) reflect lower uncertainty.

3.3.3. Measures of investor experience

To assess the experience of a given crowd investor, we build on the work of Seru et al. (2009), who examine the effect of experience on investments in stock markets and use the cumulative number of past trades as a proxy

variable for investor experience. In our setting, we can easily replicate this measure. We can compute the cumulative number of investments made by a given crowd investor at any time, as we have the entire history of each member on the platform. The cumulative number of investments reflects the capability of investors to learn by observing the result of their investment and his or her understanding of how the platform works (i.e., a learning-by-doing effect). In the empirical section, we use the number of previous investments made (the variable *Ln(Investor's Past Investments+1)*) and a binary transformation that captures whether it is the investor's first investment (the variable *Investor's First Inv.*).

An alternative measure of experience is the investor's membership length, as measured by the number of years between the actual investment and the date of registration. In our setting, however, this alternative measure is likely to do a poor job at determining the experience effect, because investments are clearly less frequent than in trading. The mean number of past trades in Seru et al.'s (2009) study is 15.4, while in our sample, the mean number of investments in the different campaigns is merely 7.1 (with a median value of 3). However, this number does not reflect the average per investor, as it is calculated for the full sample, and thus investors who made more than one investment are over-represented in that calculation; the true investor-level value is significantly lower. In addition, about one-quarter of the crowd investors make only one investment; they do not make a second one at a later point in time. Moreover, because only a few investment opportunities are provided every month, the time length between investments can be long. The sporadic and private nature of equity crowdfunding investments likely yields a weaker learning-by-observing effect because the feedback is infrequent and the valuation of the startups is difficult.

We use other variables as controls in our econometric analyses. First, we control for individual characteristics of investors (gender and age). Second, we control for the effect of the time elapsed since the beginning of the campaign (the variable *Time Since Start*). The intuition is that as time goes by, crowd investors may expect that some other investors would have participated, especially when no further information on the funding status is provided by the platform. Third, we also control for the invested amount (*Amount Invested*), as the likelihood that a round number close to the desired amount exists is reduced for larger amounts. In other words, when the invested amount is high, there are fewer possibilities to invest in

round amounts. The numbers shown in Table 1 illustrate this mechanical fact. We do not include any startup characteristics, because we include various fixed effects (industry, startup, and year) that make them redundant. All our variables (independent, dependent and control) are detailed in Appendix Table 1.

4. Results

We begin with a presentation of descriptive evidence of a round-number bias and of the influence of uncertainty on its occurrence (Section 4.1). We next discuss the results from a multivariate analysis of the influence of uncertainty on round-number bias (Section 4.2). Finally, we provide an analysis of the effect of experience on the behavioral bias (Section 4.3) and some robustness checks (Section 4.4).

4.1. Summary statistics

Table 1 presents all the numbers in the range [€100; €100,000] that have a degree of roundness equal to 1 and higher; all other numbers fulfill none of the conditions and thus have a degree of roundness of 0. The last columns show the top 20 values with *Roundness* = 0. Table 1 further shows the distribution of the two variables *Roundness* and *Amount Invested* by presenting the number of investments in our sample for each value of *Roundness*. An examination of its distribution shows that crowd investors predominantly invest in round amounts. There are clear spikes at the rounder amounts, especially €100, €200, €500, €1000, €2000, €5000, and €10,000. All these numbers also have a high degree of roundness (values of either 3 or 4) following the methodology adopted. This observation is consistent with the presence of a round-number bias. In other words, 80% of all investments (i.e., 12,311 of 15,413 investments) have a value of *Roundness* of either 3 or 4, which is broadly in line with the findings of Coulter and Roggeveen (2014). Similarly, values with *Roundness* = 0 are rare. These univariate statistics suggest the prevalence of a round-number bias among investors in the equity crowdfunding market.

Table 2 provides summary statistics for the full sample and for two sub-samples before and after October 17, 2014, the date on which the fundraising status of ongoing campaigns was removed. Taking the full sample first (Panel A), we observe that the average investment amounts to

Table 1. Investment amounts and number of investments in our sample for different degrees of roundness

For *Roundness = 0*, we provide only the top 20 investment amounts represented in our sample due to space limitation.

	Amounts for which *Roundness* = 4	Number of Investors	Amounts for which *Roundness* = 3	Number of Investors	Amounts for which *Roundness* = 2	Number of Investors	Amounts for which *Roundness* = 1	Number of Investors	Amounts for which *Roundness* = 0	Number of Investors (Top-20)
	€100	3,531	€400	366	€300	1,137	€700	157	€1,100	25
	€200	1,827	€500	2,659	€600	214	€900	25	€2,200	14
	€1,000	2,058	€4,000	139	€800	143	€1,200	78	€1,300	13
	€2,000	912	€5,000	564	€1,500	414	€1,400	12	€2,100	9
	€10,000	201	€40,000	3	€2,500	165	€1,600	15	€6,500	7
	€20,000	41	€50,000	10	€3,000	349	€1,800	10	€1,700	6
	€100,000	0			€6,000	37	€3,500	30	€2,800	6
					€8,000	25	€4,500	10	€5,500	6
					€15,000	26	€7,000	21	€2,700	4
					€25,000	7	€7,500	8	€11,000	4
					€30,000	21	€9,000	4	€2,300	3
					€60,000	3	€12,000	12	€3,200	3
					€80,000	0	€12,500	2	€3,300	3
							€14,000	1	€5,300	3
							€16,000	4	€2,400	2
							€17,500	0	€2,600	2
							€18,000	3	€2,900	2
							€22,500	1	€3,600	2
							€35,000	0	€3,800	2
							€45,000	0	€4,200	2
							€70,000	0		
							€75,000	0		
							€90,000	3		
Total		8,570		3,741		2,541		396		165

€1,276 (the median value is €500), though with a strong variation around this mean. The average value of *Roundness* is 3.3, with a median value of 4 (the higher possible value). This confirms the intuition that the bulk of the investments are made in round numbers. The average investor is 43 years of age, and 92% are men. Moreover, 27% of all investments were made by first-time investors. Investor characteristics are not very different between the two sub-samples (Panels B and C), as we obtain similar values in investor age and gender. At the beginning of the period (Panel C, which corresponds to investments before October 17, 2014), newcomers are more frequent, which is consistent with the novelty of the equity crowdfunding in France and the commencement of the platform. Another significant difference between the two periods is the average (and median) amount invested, which is lower during the second period (Panel B).

Startups are young (median age is 3 years), consistent with the popular view that these ventures have short track records. This further suggests that the startups in our sample are typically at the early stage of their development[9]. The variables *Amount Cumulated*, *Nbr. Backers*, and *Funding Ratio* are not immediately interpretable, because they are calculated at the time investments take place, not at the end of the campaign. Thus, differences may also be attributed to differences in dynamics over time, not only the increasing popularity of equity crowdfunding, and to the development of a regulatory framework that facilitated the expansion of equity crowdfunding in the most recent years (Hornuf and Schwienbacher, 2017a).

Table 3 presents difference-in-mean tests in which we compare the sub-sample of investments with *Roundness* > 2 with the remaining sub-sample of investments (*Roundness* ≤ 2). We do so again for the full sample (Panel A) and the sub-samples before and after the deletion of the information status (Panels B and C). Doing so provides us with first insights into our hypotheses testing. We first discuss the results for the whole sample (Panel A). As Table 1 shows, the average amount invested is smaller when *Roundness* is large. This may be due in part to smaller amounts having more 'round numbers', which confirms the need to control for the invested amount in the multivariate setting. Turning to our variables on uncertainty, we find that only *Funding Ratio* on the date of investment is significantly higher for less round amounts. This observation fits well with the idea that

9 In Jiang et al.'s (2005) and Zhang's (2006) samples, the mean age of firms is 18.67 and 18, respectively. This is in line with the public nature of the firms in their study.

Table 2. Summary statistics

Variables	No. Obs.	Mean	Median	Std. Dev.	Min	Max
Panel A: Full sample						
Roundness	15413	3.308	4	0.909	0	4
Investor's First Inv. (1=yes)	15413	0.267	0	0.442	0	1
Investor's Past Investments	15413	7.157	3	12.176	0	113
Amount Cumulated (€)	15413	145605.5	91900	160023	0	1087600
Funding Ratio	12140	0.379	0.285	0.355	0	3.66
Nbr. Backers	15413	156.295	105	153.524	0	831
Investor Age (years)	15359	43.162	42	12.216	10	89
Investor Gender (1=man)	15413	0.919	1	0.273	0	1
Amount Invested (€)	15413	1276.01	500	3246.62	100	90000
Time Since Start (days)	15413	41.264	35	32.491	0	120
Funding Status (1=yes)	15413	0.148	0	0.355	0	1
Funding Goal (€)	12140	413760	400000	173893.1	11111	750000
Startup Age (years)	15413	3.910	3	3.028	0	17
Panel B: Sample with funding status = 0						
Roundness	13138	3.338	4	0.894	0	4
Investor's First Inv. (1=yes)	13138	0.254	0	0.435	0	1
Investor's Past Investments	13138	7.306	3	12.054	0	110
Amount Cumulated (€)	13138	161183.6	108700	166937.6	0	1087600
Funding Ratio	10714	0.389	0.292	0.357	0	2.662
Nbr. Backers	13138	178.091	134	155.994	0	831
Investor Age (years)	13091	43.170	42	12.241	10	88

Variables	No. Obs.	Mean	Median	Std. Dev.	Min	Max
Investor Gender (1=man)	13138	0.921	1	0.270	0	1
Amount Invested (€)	13138	1040.531	400	2615.075	100	90000
Time Since Start (days)	13138	42.413	36	32.268	0	120
Funding Status (1=yes)	13138	0	0	0	0	0
Funding Goal (€)	10714	445976.9	400000	155300	11111	750000
Startup Age (years)	13138	3.973	3	3.098	0	17
Panel C: Sample with funding status = 1						
Roundness	2275	3.132	3	0.969	0	4
Investor's First Inv. (1=yes)	2275	0.341	0	0.474	0	1
Investor's Past Investments	2275	6.299	2	12.827	0	113
Amount Cumulated (€)	2275	55642.63	42500	55307.72	0	466600
Funding Ratio	1426	0.308	0.220	0.324	0	3.66
Nbr. Backers	2275	30.426	25	23.857	0	103
Investor Age (years)	2268	43.113	42	12.074	21	89
Investor Gender (1=man)	2275	0.909	1	0.288	0	1
Amount Invested (€)	2275	2635.868	1000	5455.364	100	90000
Time Since Start (days)	2275	34.627	25	32.986	0	120
Funding Status (1=yes)	2275	1	1	0	1	1
Funding Goal (€)	1426	171704.1	150000	99192.38	100000	500000
Startup Age (years)	2275	3.547	3	2.557	0	11

lower uncertainty leads to a lower propensity to invest in round numbers. *Nbr. Backers* presents no significant differences in means. Finally, investor experience influences the roundness of the amount to invest in (significant

difference-in-mean test for the variable *Investor's Past Investments*), though in the opposite sign than expected. More experienced investors are also likely to invest larger amounts, which hints at the need to test our hypotheses in a multivariate setting. Finally, the binary view of roundness does not reflect the full range of possibilities that we explore in our study.

When we consider the tests by sub-samples (Panels B and C of Table 3), the picture is slightly different. In both periods, the measures of uncertainty are generally significant, though not always. However, they have the expected sign whenever statistically significant. These results are consistent with the idea that uncertainty increases the round-number bias. Finally, experience plays a different role depending on whether the funding status of a campaign is known or not. The results are generally similar to those observed in the full sample (Panel A).

Table 3. Difference-in-means tests

Variables	Round > 2 (Mean)	Round ≤ 2 (Mean)	Diff-in-Mean (value)	Diff-in-Mean Test (p-value)
Panel A: Full sample				
Roundness	3.696	1.766	---	---
Investor's First Inv. (1=yes)	0.264	0.275	–0.011	0.220
Investor's Past Investments	7.497	5.807	1.690	0.000
Amount Cumulated (€)	143301.5	154749.4	–11447.9	0.000
Funding Ratio	0.372	0.406	–0.034	0.000
Nbr. Backers	155.591	159.089	–3.498	0.257
Investor Age (years)	42.882	44.269	–1.387	0.000
Investor Gender (1=man)	0.918	0.925	–0.007	0.190
Amount Invested (€)	1048.038	2180.754	–1132.716	0.000
Time Since Start (days)	41.197	41.529	–0.332	0.611
Funding Status (1=yes)	0.142	0.169	–0.027	0.000
Funding Goal (€)	413723.3	413906.8	–183.5	0.963
Startup Age (years)	3.929	3.833	0.096	0.113
Panel B: Sample with funding status = 0				
Roundness	3.716	1.789	--	---
Investor's First Inv. (1=yes)	0.252	0.260	–0.007	0.449
Investor's Past Investments	7.595	6.119	1.476	0.000

Variables	Round > 2 (Mean)	Round ≤ 2 (Mean)	Diff-in-Mean (value)	Diff-in-Mean Test (p-value)
Amount Cumulated (€)	158055.8	173995.8	–15940	0.000
Funding Ratio	0.382	0.415	–0.033	0.000
Nbr. Backers	176.383	185.086	–8.703	0.011
Investor Age (years)	42.922	44.182	–1.260	0.000
Investor Gender (1=man)	0.920	0.923	–0.002	0.703
Amount Invested (€)	850.085	1820.636	–970.551	0.000
Time Since Start (days)	42.294	42.899	–0.605	0.394
Funding Status (1=yes)	0	0	0	---
Funding Goal (€)	444932.4	450231.1	–5298.7	0.160
Startup Age (years)	4.002	3.850	0.153	0.025
Panel C: Sample with funding status = 1				
Roundness	3.575	1.653	---	---
Investor's First Inv. (1=yes)	0.338	0.353	–0.016	0.511
Investor's Past Investments	6.905	4.273	2.632	0.000
Amount Cumulated (€)	54320.7	60060.01	–5739.31	0.037
Funding Ratio	0.297	0.346	–0.050	0.017
Nbr. Backers	30.198	31.189	–0.991	0.404
Investor Age (years)	42.640	44.695	–2.056	0.001
Investor Gender (1=man)	0.901	0.935	–0.034	0.016
Amount Invested (€)	2241.862	3952.481	–1710.619	0.000
Time Since Start (days)	34.579	34.790	–0.212	0.898
Funding Status (1=yes)	1	1	0	---
Funding Goal (€)	172302.2	169586	2716.2	0.669
Startup Age (years)	3.487	3.748	–0.262	0.040

4.2. The influence of uncertainty

In Table 4, we present the results from the multivariate analysis. We estimate an ordered probit for the two sub-periods (with and without the funding status reported) separately, because we expect them to induce very different investment behavior due to differences in information availability. Coefficients presented are marginal effects to enable economic interpretation. We introduce fixed effects to control for years, industries,

and campaigns. While this means that various characteristics that are constant across campaigns (and, thus, startups, such as firm age) will drop, the advantage is that we can control for any other year, industry, and campaign characteristics for which we cannot otherwise.

In Panel A of Table 4, we present the results for the period when the funding status was provided, such that investors knew at any time the status of the funding process; in Panel B, we show the results during the more recent period when this information is only revealed when the campaign is over. The split into these two sub-periods offers a unique opportunity to observe whether investors rely on alternative signals in the presence of different information sets. Our expectation is that the behavior of the crowd investors should differ when information of the current funding status is provided, because the context is different due to the way investors can infer the level of uncertainty. In the absence of a signal of uncertainty (i.e., information on the funding status), investor experience will be more important to alleviate the prevalence of the round-number bias. In Panel A, crowd investors observe a precise signal of the uncertainty. Again, they precisely know, at any time, whether a project is perceived as valuable by the crowd. The more individuals have already invested in the campaign, the more they have concluded the investment is valuable, and thus the lower the perceived risk. In Panel B, members can hardly infer this information on the popularity of the investment when looking at the website of WiSEED. On the platform website, commentaries do appear, but these offer only an imprecise signal of popularity and investor commitment.

Following our predictions, we should observe that investors are less prone to the behavioral round-number bias when uncertainty decreases. Our results support this prediction, as the coefficients for *Nbr. Backers* and *Funding Ratio* are significantly negative (Table 4, Panel A). The third measure *Amount Cumulated* is also negative but only significant at the 10% level. When the information on funding status is omitted (Panel B), individuals are not able to extract a precise signal of uncertainty, and thus our measures of uncertainty (*Amount Cumulated*, *Nbr. Backers*, and *Funding Ratio*) become non-significant (Panel B). When the information is suppressed, these values are not directly observable by investors or only very imprecisely through investors' comments. The lack of a significant impact is therefore consistent with our expectation.

4.3. The effect of investor experience

We now turn to the effect of investor experience. Our measures of experience are the dummy variable *Investor's First Inv.* and the continuous variable *Ln(Investor's Past Investments + 1)*. If experience reduces the use of round numbers, we expect a positive coefficient for the first measure but a negative coefficient for the second. In Table 4, we find that when information on the funding status is provided (Panel A), experience does not play any role in mitigating the behavioral bias. Both measures are non-significant throughout all the specifications. However, when the information is suppressed (Panel B), experience negatively affects the use of round numbers. This result is supported by both measures of experience.

In summary, we find that when investors obtain a signal of uncertainty through precise information on the popularity of an investment, greater uncertainty magnifies the behavioral bias of using round numbers, while investment experience has no effect. By contrast, when the information is not made available, experience plays a role in mitigating the round-number bias, which is not the case of uncertainty (as the information necessary to infer changes in uncertainty is not provided). In other words, we observe some form of substitution effect between uncertainty and investor experience. When individuals obtain no signal from the behavior of other investors, they rely on their own experience. If they receive an external signal of the risk associated with the given firm (through the behavior of other investors), they base their investment decision on this obtained information, which in turn affects the use of round numbers. A reduction in uncertainty as the crowdfunding campaign unfolds mitigates the use of the heuristic. This heuristic is at the origin of the round-number bias.

These findings should be taken with caution, because the number of investments during the first period is lower than the number of investments during the second period (which is also the period when the market has become more mature than the early years of the platform). As a whole, however, we find that uncertainty plays a crucial role in the adoption of a heuristic and in the prevalence of the round-number bias. At the same time, investment experience influences the prevalence of the round-number bias, as it compensates for the lack of signal about the level of uncertainty.

Table 4. Determinants of investing in a round number

The dependent variable used in all the specifications in Panels A and B is *Roundness*, which measures the degree of roundness of investments. Given that the dependent variable is a categorical variable, we use ordered Probit regressions. All the variables are defined in Appendix Table 1. Robust standard errors are used. Significance level: * < 10%; ** < 5%; *** < 1%.

Panel A: Sample with continuous information on funding status								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Investor's First Inv. (1=yes)	0.00157	0.000526	0.0582	0.00426				
Ln(Investor's Past Investments + 1)					0.0278	0.0274	0.0187	0.0193
Amount Cumulated (€)		–0.00000134*				–0.00000133*		
Funding Ratio			–0.491***				–0.483**	
Ln(Nbr. Backers)				–0.131***				–0.131***
Investor Age (years)	–0.00102	–0.00116	0.000740	–0.00152	–0.00129	–0.00142	0.000383	–0.00171
Investor Gender (1=man)	–0.220**	–0.226**	–0.151	–0.140	–0.226**	–0.231**	–0.161	–0.148
Ln(Amount Invested)	–0.232***	–0.230***	–0.178***	–0.198***	–0.227***	–0.225***	–0.173***	–0.195***
Time Since Start (days)	–0.000236	0.00126	0.00254*	0.00398**	–0.000409	0.00108	0.00226	0.00382**
Campaign/Startup FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Sector FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	2268	2268	1422	2210	2268	2268	1422	2210
Pseudo-R2	0.0583	0.0589	0.0442	0.0542	0.0586	0.0591	0.0441	0.0544

Panel B: Sample without continuous information on funding status								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Investor's First Inv. (1=yes)	0.0737***	0.0735***	0.0758***	0.0771***				
Ln(Investor's Past Investments + 1)					–0.0211**	–0.0212**	–0.0219**	–0.0252**
Amount Cumulated (€)		–0.000000180				–0.000000184		
Funding Ratio			–0.118				–0.120	
Ln(Nbr. Backers)				–0.0135				–0.0152
Investor Age (years)	0.00278***	0.00276***	0.00228**	0.00271***	0.00288***	0.00287***	0.00240**	0.00284***
Investor Gender (1=man)	–0.00170	–0.00144	0.0159	0.0165	–0.00361	–0.00329	0.0138	0.0172
Ln(Amount Invested)	–0.502***	–0.502***	–0.491***	–0.500***	–0.503***	–0.503***	–0.491***	–0.500***
Time Since Start (days)	–0.000525	0.0000906	0.000366	–0.0000902	–0.000550	0.0000782	0.000356	–0.0000553
Campaign/Startup FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Sector FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE incl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	13091	13091	10674	13030	13091	13091	10674	13030
Pseudo-R2	0.1025	0.1026	0.1000	0.1015	0.1024	0.1025	0.0998	0.1014

4.4. Robustness checks

We performed two more robustness checks that provide support for our conclusions. First, one possible concern is that the increased uncertainty leads crowd investors to reduce the amount they will invest. Proportionately more 'round' numbers in the range between €100 and €1,000 may mechanically lead them to invest more often in round numbers. In this case, this choice would not be driven by their incentive to invest in round number per se but simply because more round numbers are clustered around smaller amounts. To rule out this possibility, we subtracted €100 from each investment (now excluding those with an amount of €0) and then re-ran the different analyses. As expected, our measures of uncertainty all turn statistically non-significant except one. This goes against the view that our established relationship between uncertainty and choosing round numbers is purely mechanical.

A second robustness check is to exclude investments made at the minimum amount of €100, as these investments are constrained while being a round number with *Roundness* equal to 4. Crowd investors interested in pledging only a very small amount of money are constrained by this minimum amount and thus automatically invest in a round number without necessarily being interested in selecting a round number. For example, a crowd investor who would have preferred investing €90 would be forced to invest €100. We therefore re-ran the analyses without the sample of €100 investments. The results on the uncertainty measures remain similar, indicating that our results are robust to any impact of the minimum threshold of €100.

5. Conclusion

The paper investigates whether uncertainty affects the appearance of a behavioral bias, namely the use of round numbers in investment decisions. Using unique data from a large equity crowdfunding platform, we document that investors are more likely to invest in round numbers when confronted with greater uncertainty. Moreover, investor experience plays a significant role in alleviating the round-number bias when there is no information on the status of the funding process, which could provide a signal to investors on the valuation made by others. These results are in favor of the learning-by-doing phenomenon through platform experience. As investors become more experienced with crowdfunding investments, they are less subject

to behavioral bias. These findings are in line with a behavioral theory of investment and a substitution effect between signals about firm uncertainty and investor experience.

From a general standpoint, our results are of practical importance. If uncertainty is alleviated, investors are less prone to behavioral bias, which can be beneficial for the economy as a whole. Bhattacharya et al. (2012) estimated the costs associated with the use of round numbers by stock traders on the NYSE to a wealth transfer of $813 million a year. If the use of round numbers by crowd investors were to lead to under-funding of some startups, this could have similar effects resulting from the misallocation of resources in the economy. Under-funded startups may go bankrupt only because their funding is not sufficient to achieve their goal. Thus, this bias can be directly prejudicial to entrepreneurs. A related question pertains to the performance of crowd investors who rely more often on the round-number heuristic. Kuo et al. (2015) conclude that the round-number bias is hazardous to performance. These questions on whether the round-number bias eventually leads to inefficient allocation of resources and their impact on startups and investors alike were not directly addressed in this study but could be explored in the future when the ultimate outcome of these startups become known. In the coming years, we hope to obtain more information on the success and failure of equity crowd-funded firms, which leaves opportunity for future research in that direction.

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Appendix

Table 1. Definition of Variables

Variable	Definition
Degree of roundness	
Roundness	In line with Jansen and Pollman (2001), *Roundness* measures the degree of roundness by counting the number of n-ness conditions that are satisfied. It is therefore a categorical variable, ranging from 0 to 4. Section 3.3 provides more details on these conditions. (Source: WiSEED; own calculation)
Measures of uncertainty	
Amount Cumulated (€)	Sum of all individual investments made in a given campaign, measured on the time of a particular investment. Thus, this variable increases over time during the campaign. (Source: WiSEED; own calculation)
Funding Ratio	Ratio of 'Amount Cumulated' to 'Funding Goal', measured on the time of a particular investment. Thus, this variable increases over time during the campaign. (Source: WiSEED; own calculation)
Nbr. Backers	Total number of backers that participated in a given campaign, measured on the time of a particular investment. Thus, this variable increases over time during the campaign. (Source: WiSEED; own calculation)
Measures of experience	
Investor's First Inv.	Dummy variable that takes the value of 1 if it is the investor's first investment on the platform (Source: WiSEED; own calculation)
Investor's Past Investments	Number of times the invested member has invested in other projects between the time of registration on the platform and the date of the particular investment (Source: WiSEED; own calculation)
Control variables	
Funding Status	Dummy variable that takes the value of 1 if the investment was made before October 17, 2014, and 0 otherwise (source: WiSEED)
Investor Gender (1=man)	Dummy variable that takes the value of 1 if the member is a man, 0 otherwise (Source: WiSEED)
Investor Age	Age of the investor (in years) at the time of the investment (Source: WiSEED; own calculation)

Variable	Definition
Time Since Start	Number of days between the beginning of the campaign and the date of the investment (Source: WiSEED; own calculation)
Amount Invested (€)	Amount in euros invested by a given investor in a given campaign (Source: WiSEED)
Funding Goal (€)	The desired funding of the startup in euros. Because all the campaigns are run under the keep-it-all model, this value is not the minimum required but the targeted funding level. (Source: WiSEED)
Startup Age	Age in years of the startup at time of investment (Source: WiSEED; own calculation)