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An experimental study of motivations for
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Determinants of donations to scientific research: An experimental study of motivations for crowdfunding in Japan

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Abstract This study addresses the potential of crowdfunding of scientific research as a complementary source of funding to competitive government-funded research grants. Although a growing number of academic researchers expect scientific crowdfunding to support academic research that is not funded through traditional grants, few studies have investigated the motives of crowdfunding contributors. This study develops hypotheses regarding the relationship between crowdfunding and its returns or emotional motivations. The hypotheses are tested using an internet survey of 3,443 Japanese citizens regarding their willingness to contribute to academic research. We controlled two biases, disinterest and acquiescence, in the responses by applying a randomized experiment method. Our results identify two influential determinants of both an interest in donating and the willingness to contribute, namely, research that increases empathy and research that contributes to global knowledge. We also find that returns from crowdfunding, such as increasing national scientific competitiveness, do not always drive donation behavior. The results confirm the usefulness of crowdfunding in supporting various types of academic research.

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I.Introduction

Basic research at universities plays an important role in promoting innovation (Mansfield, 1991). Most of these research activities are funded by the government; in major countries, 50-80% of research expenditures are government supported¹. However, public funding is limited and cannot cover all research efforts at universities. Therefore, the governments select from among research projects when investing public money. In recent years, a particular emphasis on accountability has driven governments to prioritize research that can be easily defended in terms of the legitimacy of fund allocation, for example, a research that is related to policy issues (Guená and Martin, 2003) or that has a potential to contribute to society (Olssen, 2016). In other words, governments favor research projects that have the appropriateness, effectiveness, and validity of fund allocations. Furthermore, accountability drives motivation to support research projects that have relatively higher prospects based on the outcome of previous research (Hicks, 2012) and studies for which results are relatively easy to obtain (Guená and Martin, 2003). An empirical analysis of longitudinal Japanese research funding shows that in basic research areas, funding tends to be skewed toward a particular principal investigator, while such tendency is relatively low in applied research (Shibayama, 2011).

As a result, basic research that requires a long-term perspective is unlikely to be sufficiently funded, and therefore, diversity in academic research may be lost (Guená and Martin, 2003; Hicks, 2012). A recent empirical analysis using Japanese research funding data revealed that the quality of publications among young researchers who are considering competitive public funding is relatively low, while this trend was not found among senior researchers (Wang et al., 2018). This implies that competitive funding drives researchers who do not have a sufficiently strong reputation to commit to research projects with a high degree of certainty and limited originality. This clearly weakens the quality of the future research base. Therefore, to ensure the diversity of academic research, it is important to identify funding sources other than competitive public funding.

Aside from public money, the main sources of research funding include science-focused philanthropies, donations from alumni and citizens, and research contracts with and donations from industry. For example, in UK universities in 2014, 66% of research funding (£7.9bn) was funded by the UK government, 4% is industry funded, and 13% comes from donations (Universities UK, 2016). Even though the UK obtains less revenue from private foundations and donations than the USA (Sörlin, 2006), still these sources cover a non-trivial percentage of its

¹ According to OECD's Research and Development Statistics, Australia support 89% of research expenditure in higher education institutions, France 79%, China 64%, UK 61%, USA 56%, and Japan 52% in 2017 (note: values of Australia, France, and UK are based on 2016 data).

research expenses. As noted above, although the total amount of funding from private foundations and citizens is not large, it is essential as a funding source for research. For example, in Japan, more than 500 grant programs, including 2.3 billion yen per year from the Takeda Science Foundation, provide grants for research activities (The Japan Foundation Center, 2019).

Science philanthropies engage in a wide variety of activities and support a wide range of academic research. To illustrate, in the field of healthcare research, some foundations are dedicated to rare, intractable diseases that are not commercially viable in terms of any return on investment of research funds (Viergever and Hendrik, 2016). However, some foundations subsidize research with a high likelihood of commercialization according to the strategic objectives of the industry (Gautier and Pache, 2015), particularly in case of industry-backed foundations. In order to maintain heterogeneity in scientific research, an additional funding source other than philanthropies is needed.

Academic crowdfunding is a potential alternative funding source for scientific research. Its prominent advantage is its ability to generate timely funding (see, Dragojolic and Lynd, 2014). Researchers can seek research money through crowdfunding whenever necessary. This is not the case in the majority of public and private research grants as they restrict the periods in which grant proposals can be submitted. Wheat et al. (2013) confirmed that academic crowdfunding is suitable for raising a small amount of funding in the early stage of research. Crowdfunding can match the diverse values of individual citizens with the various research interests of researchers. Thus, it is particularly appropriate for research that is not perceived to have political or commercial value (Mitsubishi Research Institute, 2015). For this reason, academic crowdfunding is expected to play a role in supplementing public and private research funds. In fact, a questionnaire survey of Japanese researchers revealed that they view academic crowdfunding as a source of research funding that complements competitive public research grants (Ikkatai et al., 2018).

However, it is not clear that academic crowdfunding will play a complementary role to competitive public research funding. Supporters who participate in crowdfunding may have similar preference to the government, that is, an favorableness to researches with objective appropriateness, effectiveness, and validity of their investment.

The motivation that drives supporters of academic research cannot be fully explained by the studies published to date. There have only been three studies on supporters' motives: a questionnaire survey of researchers who have successfully obtained support (Byrnes et al., 2014), a qualitative analysis of descriptions of project proposals that have succeeded in raising funds (Mehlenbacher, 2017), and a quantitative analysis of the attributes of projects that have raised funds (Aminaka, 2018). All three studies are based primarily on US research projects and on specialized academic crowdfunding platforms such as Experiment. We have no insight into the

motives of supporters anywhere other than the USA or on latent motives that have not appeared on current platforms.

This study aims to clarify the motives of academic crowdfunding supporters. In particular, we explore motivations related to the nature of the projects to examine whether crowdfunding is complementary to public research grants. We use an experimental method to test our research question, focusing on academic research in Japan. The results offer implications for the potential of crowdfunding for researchers, universities, and academic crowdfunding platforms. Our contributions are also useful for science and technology policymakers.

The rest of this paper is structured as follows: Section II summarizes the current state of crowdfunding and its typology and reviews previous research on the motivation for supporting academic crowdfunding. Due to the scarcity of relevant literature, we also review the research on support motives for non-academic crowdfunding and donations to non-profit institutions. In our review process, we identified a motive that is missing from earlier studies. To complement this missing link, Section III provides the results of interviews with two organizations that operate academic crowdfunding platforms in Japan. Section IV derives our hypotheses on the motivation for supporting academic crowdfunding. Section V describes the method of our empirical analysis to verify the hypotheses, and Section VI shows the results. Section VII provides conclusions and discusses the practical and policy implications.

II. Background and literature

Typologies of crowdfunding and current status

The most distinctive feature of crowdfunding is that it bundles contributions from individuals who are willing to support a project but have limited funds. If bundled funds reach the level of the necessary budget, the project is successfully supported, something that none of the individuals could have done on their own. Crowdfunding is divided into five basic models: purchase model, donation model, investment model, fund type, and stock model, based on the existence and type of incentives (Table 1). The latter three models can be categorized as Finance models. Crowdfunding is widely used by various entities. Venture companies and small- and medium-sized enterprises use it for new product development or to produce movies and videogames. Non-profit organizations can use crowdfunding to cover a part of their expenditure.

Table 1 Typologies of crowdfunding

Models	Incentives	
Purchase	Products and services brought by the project	
Donation	None (in certain conditions, tax reduction)	
Finance	Investment	An interest from a lending
	Fund	A part of revenues from the outcomes of the project
	Stock	Unlisted stocks

Several crowdfunding services address academic research. “Experiment,” a private platform specializing in academic research, successfully raised funds for 852 projects between 2012 and 2018. A number of academic research projects have also successfully raised funds on “Kickstarter,” a private, general-purpose crowdfunding platform (Mehlenbacher, 2017).

Academic crowdfunding is expanding in Japan. As such, many crowdfunding platforms have popped up. Platforms that specialize in academic crowdfunding include “Academist,” launched in 2014, and “Otsucle,” a joint program between Tokushima University and Organization for People with Universities, which has been operating since 2016. In addition, the Japanese leading crowdfunding platform, “Readyfor” has set up a dedicated page to support Kyushu University and Nagoya University projects. In 2018, the National Institute of Science and Technology Policy award was given to a young scholar who studied the high-energy gamma-ray generation process in thunderclouds. His research was funded by academic crowdfunding. This shows the fairly wide diffusion of academic crowdfunding in Japan.

Motivations for supporting academic projects through crowdfunding

Byrnes et al. (2014) conducted a questionnaire survey of US researchers who successfully obtained support through the crowdfunding service “#SciFund Challenge” that was launched as an experiment to explore the factors driving successful crowdfunding for academic research. They found that the number of visits to the project description page, the number of contacts made to potential supporters via email, and the number of friends on Facebook were linked to the amount of support generated. This demonstrates the importance of communicating with potential supporters and the social relationships of the core researcher(s).

Mehlenbacher (2017), who qualitatively analyzed the descriptions of projects that successfully obtained support, found that several attributes increased the probability of successful fundraising. These include a specific research method, definitive research capabilities within the project team, and a recognizable social benefit associated with the project. This may be interpreted as an indication that certain kinds of incentives associated with the project are a motivation for support.

Aminaka (2018) used the data from the “Experiment” platform to focus on incentives and research fields, examining the motivations of supporters. He found that tangible and experience-related rewards, such as research-related goods, or the number of visits to research sites increased the number of supporters and the amount of the donation per supporter. He also discovered that research projects in biology and medicine are more likely to attract a large number of supporters. These projects often have obvious social returns, and the benefits they can bring to supporters and/or society are motivations for support.

In summary, previous studies confirm that achievement and other rewards including social benefits are the main motivations for support of academic crowdfunding.

Motivations for supporting non-academic projects through crowdfunding

In contrast to academic crowdfunding, the motivation for support of non-academic projects in purchase-model crowdfunding has been investigated from multiple perspectives. Purchase-model crowdfunding of non-academic projects focused on product innovation, services, or events has a commonality to crowdfunding of academic research. Both types of projects offer returns to both supporters and to society and therefore are expected to share the same motivations.

The core motivations for supporting purchase-model crowdfunding are to obtain a return from the project, to provide essential financial assistance, to participate in a community around the project, and to support the project owners’ advocacy or arguments (Gerber & Hui, 2013). Purchase-model crowdfunding is driven by not only a motive of seeking economic benefits but also emotional support motives. A survey of projects that raised funds via Kickstarter, a purchase-type crowdfunding platform, revealed that potential supporters are more likely to support projects that have received support from others. They tend to hesitate to support a project if they perceive that the project would fail despite their help (Kuppswamy and Bayus, 2018). Conversely, potential supporters are likely to support a project to which their help is essential. These are potential supporters who want to contribute to the owner’s success.

Other than economic returns and emotional support motivations, a social relationship between supporters and project owners affects supporters’ behavior. A project owner is more likely to raise funds successfully when he/she has many external supporters for the project and friends in his/her social networking services (Mollick and Kuppswamy, 2014). Some supporters are motivated by their relationship with the project owner. Others may respond favorably to his/her extroversion or may trust the owner. In addition, geographical proximity also affects the support decision. A study of SellaBand, a music-oriented crowdfunding platform, revealed that supporters who came from the same area as the project owner or who currently live close to where the project owner is located tend to provide early support (Agrawal et al., 2015). These supporters are less likely to be influenced by other supporters’ behavior.

The preceding studies show that, in purchase-model crowdfunding, support motivations are based on expectations of achievement or some reward from the project, as well as on emotional and social-relational reasons. Expectations of achievement have been shown to be superior to other motivations. A study of crowdfunding projects at Kickstarter shows that incremental projects that build on previously successful projects tend to be more likely to be supported than innovative projects (Chan and Parhankangas, 2017).

Motivations for supporting non-profit organizations

Supporting academic research can be equated with donating to non-profit organizations. Based on the literature reviews of Sasaki et al. (2017) and Zenkyo and Sakamoto (2017), we propose an analogy to the supportive motivation for academic crowdfunding. These reviews summarized that support motivations include emotional factors such as empathy and altruism, as well as the perception of making a social contribution through the organization.

One of the emotional factors is agreeableness or the bandwagon effect. List and Lucking-Reiley (2002), who explored the motivation for donating to a university, found that trends in other people's donation promoted other donations when the university specified the required amount of funding. This is because the amount of funds already collected is a signal of trust in the recipients and has the effect of making potential supporters feel that it is "normal" to make a donation (Sasaki et al., 2017). Reinforcing this notion, trust in the target organization has been shown to determine the trend of donations (Parsons, 2007). However, public financial support may crowd out potential supporters. A study analyzing donations to non-profit institutions in the USA reported that government subsidies tended to reduce donations (Andreoni and Payne, 2003). People perceive that their financial support is not essential when the recipient has already been given public money.

III. Insights from interview surveys

Design of interview surveys

From the literature review, we can glean direct and indirect insights on the general determinants of support via crowdfunding platforms; however, we may still overlook specific determinants for academic crowdfunding. In contrast to purchase-model crowdfunding, the results obtained from crowdfunding academic research have strong externalities. Put differently, outcomes will not offer returns exclusively to supporters. Also, unlike the activities of non-profit institutions, scientific research often does not make an immediate contribution to society. Under these conditions, potential supporters may not be seeking any direct rewards and may not expect any

specific outcomes. Instead, emotional motivations highlighted in the research works on purchase-model crowdfunding and non-profit organization institution can be effective. Therefore, we conducted an interview survey with managers of academic crowdfunding to investigate unique support motives in this area, with a particular focus on emotional motives.

The interviewees are from Academist Co., Ltd., and Organization for People with Universities. Both organizations operate academic crowdfunding platforms. Interviews took 1.5 hours each and were conducted from September 2017 to May 2018. Additional questions and confirmations were sent via email after the interviews. Interviewees have agreed to make the interview results open.

Interview survey results

In the interview with the managers from Academist, we were given the results of a questionnaire survey they had given to their supporters. They asked whether the motivation for supporting academic research is “interest in a research theme,” “attractiveness of the researcher,” or “incentive (rewards).” The number of supporters who had selected “incentive (rewards)” as their motivation was the smallest. This suggests that supporters of academic crowdfunding may place more emphasis on emotional motivations rather than on external incentives. According to an interview with the managers from Organization for People with Universities, many projects have difficulty offering direct incentives because of the length of time needed to obtain research outcomes and the uncertainty of outcomes. Thus, they emphasize the empathy the supporter has toward the researcher or the research project. They also shared several feedback comments from supporters, which showed their empathy drove them to support a research project. Table 2 illustrates these comments.

Table 2 Comments of supporters in Otsucle

Research theme: Tooth regeneration therapy using dental pulp cells
Comments from supporters: “A long time ago, my relative died from an infection of bacteria that had migrated from the alveolar pyorrhea to the stent embedded in the blood vessel. I hope that this new therapy will be widely available and cheap.” “I regret having missed dental care, as I would like to get healthy teeth back if I could start over. By all means, I support the regenerative therapy research.”
Research theme: Drug discovery to prevent side effects of anticancer drugs by drug repositioning
Comments from supporters: “Last year, my mother had breast cancer and experienced taxane anticancer treatment. The anticancer drugs and molecular targeted drugs were effective in treating the cancer, so her therapeutic performance was very good and she was thankful for the treatment. However, I observed her torture during the anticancer drug treatment. If the research team could reduce the side effects of anticancer drugs, it would benefit countless patients and families.” “I am currently receiving cancer treatment. I work hard to defeat my cancer and receive anticancer drug treatment, but sometimes I want to stop treatment because the side effects are too torturous. I think many people will be freed from such suffering as this research progresses.”
Research theme: Nationwide diffusion of back pain treatment with 8mm endoscope
Comments from supporters: “In April 2015, my mother received an operation to fix lumbar stenosis. Since then she has been able to travel twice a year. I am really thankful to the doctor [a project leader]. She needed to receive a large-incision, around 18 cm, which was difficult. But this new method only requires an 8 mm incision. I am surprised this is possible and I support this project to increase patients who will enjoy traveling after the operation.” “I myself have low back pain, and my father has been hospitalized about three times for it. My father is very elderly. If he is hospitalized again for back pain, I want him to be treated using this operation. I wanted to support the efforts to reduce patient suffering as much as possible.” “I am grateful for the benefits of cheap and good medical care. I know that the development of medical technology is expensive. I will support them in some small way.”
Research theme: Study for prevention of baseball elbow
Comments from supporters: “My son, who was a pitcher in sixth grade in elementary school, is currently regretting that he has been unable to participate since July due to a ban on pitching and batting because of osteochondritis dissecans. He had been required to pitch more than 200 balls a day by his baseball coach. I will

support this project to show the reasons for preventing this to such a coach.”

“I know the bitterness of not being able to play baseball from my own experience. In order to keep other children from such a experience, and to expand participation in baseball, I will support the activity even in a small way.”

“My son was found to have osteochondritis dissecans in a medical examination in the sixth grade of elementary school. Thanks to that early discovery, he is currently enjoying baseball at junior high school without getting worse. I think that this project is absolutely necessary so that children can continue to enjoy baseball for many generations. I support the project with my best effort.”

The University Support Organization of Japan emphasized that emotional factors such as empathy for the research themes are motives for support in academic crowdfunding. In addition, it has been revealed to us by Academist that some supporters appear to be relatives or friends of a project leader. They analyzed the number of visits to the project website, words of mouth in social networks, and timing of support and found several unique supporters who supported a project or called for support of the project immediately after it began to seek donations. These interviews revealed that both platforms recognized there are multiple factors in successful fundraising.

IV.Hypotheses

The reviews of previous studies and insights from our interviews suggest that there are emotional and social support motives for crowdfunding, as well as expectations of outcomes and rewards. We summarize the factors (shown in Table 3) that can be considered as support motives.

Table 3 Project attribution-related motivations of donations

	Literature on academic crowdfunding	Literature on purchase-model crowdfunding	Literature on donations to non-profit organizations
<i>Expectations of outcomes and rewards</i>			
Rewards	+: Aminaka (2018)		
Certainty of outcomes (research capability)	+: Mehlenbacher (2017)		
Social benefit from the project	+: Mehlenbacher (2017)	+: Gerber & Hui (2013)	+ (see Zenkyo and Sakamoto, 2017)
<i>Emotional factors</i>			
Empathy to the project	+: Interview survey result	+: Gerber & Hui (2013)	+ (see Zenkyo and Sakamoto, 2017)
Altruism from the project			+: Sasaki (2016)
Essential nature of the funding from potential supporters		+: Kuppswamy and Bayus (2018)	-: List and Lucking-Reiley (2002)
Trust in the project owner			+: Parsons (2007)
Participation to the project community		+: Gerber & Hui (2013)	
<i>Social factors</i>			
Social network of the core member of the project	+: Byrnes et al. (2014); interview survey result	+: Mollick and Kuppswamy (2014)	
Geographical proximity to the project members		+: Agrawal et al. (2015)	
<i>Communications between potential supporters and project owners</i>			
Communications between potential supporters and project owners	+: Byrnes et al. (2014)		

Legend: + Positive motivations. - Negative motivations

Among these, the motivations classified as emotional factors have not been explored in studies of academic crowdfunding. The studies of purchase-model crowdfunding and donation behavior to non-profit organizations suggest that emotional motivation is significant. Therefore, this study focuses on emotional motivation in crowdfunding of academic research. In particular, the aspects of empathy with the research theme and altruistic behavior through supporting research projects, which were suggested in our interview survey, have not been explored in previous research. In this study, taking the various aspects of empathy described in the previous sections together, we define empathy as “empathy with the project contents, or the vision, or advocacy of the project owner.”

Clearly, such a state of empathy is in accordance with personal interests and intentions. Interest in a research theme may create sympathy and lead to support (Hypothesis 1). In addition to the comments from interviews mentioned above, other elements that lead to solutions of social issues are “to prevent children from thinking like that” and “development of medical technology.” Addressing social issues also involves the outcome of support. Since the expectation of achievement and emotional motivation may combine to create empathy, we assume that solutions to social issues also lead to sympathy and support (Hypothesis 2). Furthermore, as shown in Gerber & Hui (2013), support motivation through purchase-type crowdfunding, there is also a motivation to support researchers’ activities beyond individual themes. Hypothesis (3) states that major contributions to the development of science and technology also lead to empathy. Solutions to social issues and the developments in science and technology are altruistic and thus may be easier to support. To some extent, empathy, altruism, and social benefits are inseparable.

Some science and technology developments gain direct interests from a specific perspective, such as national interests from the taxpayers’ perspective. These interests may motivate support for academic research (Hypothesis 4a). On the other hand, potential supporters may expect that such research projects will have limited altruistic aspect and will receive government support. As a study of non-profit institutions (Andreoni and Payne, 2003) has shown, willingness to support them declines when state support is expected. With these conflicting views, there is a possibility that research for the advancement of science and technology and research aiming to serve the national interest may not be a strong motivation for support (Hypothesis 4b).

This paper focuses on these factors and chooses not to investigate other motivational factors, such as the essentiality of the funding from the potential supporters, trust in the project owner organization, and participation in the project community, or other social and communicational factors. These factors depend on the method of funding through crowdfunding and are beyond the scope of our research question.

In summary, this study addresses the following hypotheses.

Hypothesis 1: Interest in the research theme has a positive effect on a supporter’s decision to support the research.

Hypothesis 2: The possibility that research results could solve social issues has a positive influence on a supporter’s decision to support the research.

Hypothesis 3: Factors related to scientific progress have a positive effect on a supporter’s decision to support the research.

Hypothesis 4a: Factors related to national interests in science and technology have a positive influence on a supporter’s decision to support the research.

Hypothesis 4b: Factors related to national interests in science and technology have no positive effect on support decision-making by supporters.

V.Methodology

Identification strategy

To test the above hypotheses, we conducted a questionnaire survey of Japanese citizens and two challenges were faced. Firstly, many citizens are not interested in scientific research and are even less interested in crowdfunding. Asking such individuals directly about their individual motivations for crowdfunding can lead to inaccurate answers. Second, some give compliant responses that they believe are desired by the questioner; therefore, the answer includes a bias.

To minimize these biases, we adopt a randomized experiment method in our questionnaire. We present cases in which the conditions that could affect support behavior for each respondent were changed at random and estimated the effects of factors related to individual support motivations from multiple responses using multivariate analysis. We implemented this using an internet survey, a method used in analyzing donation behaviors toward non-profit institutions (Zenkyo and Sakamoto, 2017).

Respondents

The survey targeted internet users between the ages of 18 and 69 in Japan. The subjects were selected from those registered on the monitor of INTAGE Co., Ltd., to match their residence, age, and gender to the distribution of Japanese society as much as possible. We asked 14,360 people over the period from March 9, 2018, to March 13, 2018, and received responses from 3,443 (a response rate of 24.0%). Internet surveys can also include dishonest answers. To detect these trends, a similar question was asked using different approaches and a method was used to verify the consistency of the answers. Specifically, in the first and last questions, we asked “Do you care about science and technology news and topics?” Both were asked using a five-point Likert scale, but the order of the scales was reversed. Seventy-four respondents who differed by at least three points in the scale were excluded because of their dishonest or careless responses.

Question items

In the survey, sample research projects in the following nine fields were created based on actual research examples collected from press releases from universities in Japan and from information from scientific research grant applications. The descriptions included the characteristics of the research team, the social impact of the research, the time it would take for the research to have an impact, the amount of time invested in the research project, and the funding needed. The description of a research team consists of (1) whether the principal investigator belongs to an international research university or a regional university, and (2) whether there is a domestic

university, an overseas university, a major domestic company, or a regional company connected to the research. The period and funding are set at 120 million yen (approximately 1 million USD) for five years in each case. However, in the case of industry-academia collaborations, there are separate cases where 8% and 83% of the expenses are funded by companies.

Table 4 Options for attributes in sample projects

Attribution	Options
Capability of a project owner's institution	Internationally renowned university / Regional university
Composition of a research team	Alone / Jointly with a domestic university / Jointly with an overseas university / Jointly with a major domestic company (8% of research expenses funded by the company) / Jointly with a major domestic company (83% funded by the company) / Jointly with a local company (8% funded by the company) / Jointly with a local company (83% funded by the company)

One of the cases is presented below. Those marked with [] indicate where the conditions differ depending on the respondents.

“The research team of Professor X at [internationally famous university A] has been working on the following research. However, it was difficult to transmit ultra-high-resolution image data captured by artificial satellites to earth instantly due to power and transmitter problems. The research will take about five years with the aim of developing electronic components and enabling micro-satellites to play the same role as large-scale satellites. If successful, in 5 to 15 years it is expected that meteorological observation satellites and communication satellites will be much cheaper than ever before. The expected research expenses are 120 million yen over 5 years. [Aiming to utilize in business, Company Y will be responsible for 10 million yen.] [100 million yen] will be applied to the national research expenses for research.” (Case 4)

The fields covered in the cases are shown in Table 4, and respondents were asked to review three cases, one for each of the three groups. As a result, the number of valid responses to the sample cases is $(3,443-74) * 3 \text{ cases} = 10,047$ answers.

Table 5 Types of cases presented to respondents

Groups	Cases
Medical cases	Development of anticancer drugs with few side effects (Case 1)
	Study on the cause of amyotrophic lateral sclerosis (Case 2)
	Development of early detection method for gastric cancer (Case 3)
Engineering and agricultural cases	Development of ceramics that store heat (Case 4)
	Development of high-speed communication technology for small satellites (Case 5)
	Research on analytical methods to identify the characteristics of new varieties of fruits (Case 6)
Basic science and social science cases	Space telescope development (Case 7)
	Research on how to increase elementary and junior high school students' interest in arithmetic and mathematics (Case 8)
	Research on human communication that enhances the performance of R&D organizations (Case 9)

For each case, a comprehensive evaluation was asked using a five-point Likert scale, and factors that were evaluated as favorable and unfavorable were selected from the options presented. Afterward, the questionnaire indicated that there is a shortage of research funds and asked respondents' intention to make a contribution through crowdfunding, in which the incentive is a report on the research progress and a tax deduction for donations. Their contribution intentions are measured by 10 scales: unknown, 0, 500, 1,000, 5,000, 10,000, 50,000, 100,000, 500,000, and 500,000+ yen².

Variables

In general, a decision on whether or not to make a donation and a decision on how much the donation should be made are made independently. Therefore, the dependent variables are a dummy variable (crowdfunding intention dummy) that takes a value of 1 if the respondent wants to provide funding in crowdfunding and six-level³ categorical variables (0, 500, 1,000, 5,000, 10,000, and 50,000 or more) of willingness to contribute for funding along with a "no idea" option.

² The question is as follows: "As the project team proceeded with this research, the government research funding ran short by 10 million yen, and the team decided to raise donations online. If you can donate to this research, how much would you donate? If you make a donation, you will receive a tax deduction and a simple report that is clearly written to stimulate the public understanding of the research results."

³ In the question, there were 10 levels but since few people chose 10,000 yen or more, they were converted into 6 levels for the analysis.

For the purpose of robustness checks, we used four categories (0, 500, 1,000, 5,000 yen or more). In this process, 2,705 “no idea” answers were excluded.

Our independent variables represent perceptions of favorable and unfavorable factors listed in Table 6. The majority of factors are presented as both favorable and unfavorable. In our model design, favorable factors take a value of 1, and unfavorable ones take a value of -1; otherwise the variable takes a value of 0. Other factors are shown as “either aspect” and treated as a dummy variable because of the difficulty in converting them into a two-sided measurement.

Since we assume that some motivational factors have subordinate concepts and interact with some of the other factors, factors presented as favorable and unfavorable do not match perfectly with the theoretical determinants shown in Table 3. First, regarding social benefits and national interests, we specify two items, one from the viewpoint of Japan’s competitiveness and the other related to global competitiveness. Second, we clarify trust in research institutes by separating trust in the project team from trust in the university. Third, to assess the interaction between social benefits and altruism, we present options focused on contributions to human wisdom and the global impact of achievements. Finally, regarding the intersection of altruism, national interests, and social benefits, we construct an item indicating that the project would result in an outflow of research results overseas. The outflow of research results overseas has a negative social benefit from the viewpoint of national interests, but it is altruistic in terms of humanity as a whole. We believe this will help to indicate whether altruism or national interests were dominant.

In addition, altruism may refer to a situation in which the project does not benefit both the supporter and the supportee. Therefore, we added an item representing the benefit to the supportee, that is, the private interest of the project stakeholders.

Therefore, our survey includes twelve items to evaluate the respondent’s perception of a research project.

Table 6 Independent variables

Classifications of motivations	Motivational factors	Items [Individual factors]	Sides asked
Expectations of outcomes and rewards (A)	Rewards	Outcomes benefit me and my relatives [Personal benefit from outcomes]	Both sides
	Certainty of outcomes (research capability)	The team is expectable [Promising team]	Both sides
		Social benefit from the project	Outcomes contribute to the economy [Economic contribution]
			Outcomes improve Japan's scientific and technological competitiveness (Hypotheses 4a, 4b) [National scientific competitiveness]
Emotional factors (B)	Interest in the research theme	The theme interests me (Hypothesis 1) [Interest in the theme]	Both sides
		Altruism in the project	The project gives the private interest of the project stakeholders [Private interest of the stakeholders]
	Trust in the project owner	The team is not trustworthy [Untrustworthy team]	Unfavorable side only
		I have a favorable impression on every kind of academic research [Favorable view of academia]	Both sides
Interaction between (A) and (B)	Social benefit and altruism	Outcomes contribute to solving social problems [Social problem solving] (Hypothesis 2)	Both sides
		The project contributes to human wisdom [Human wisdom] (Hypothesis 3)	Both sides
		Outcomes can be used globally [Global impact] (Hypothesis 3)	Favorable side only
		Outcomes will flow overseas [Knowledge outflow] (Hypotheses 3, 4a, 4b)	Unfavorable side only

In addition, the respondents' level of education (with or without master's or doctoral degree), age, and annual income were used as control variables. This is because studies have shown that income level and education affect behavior when donating to non-profit institutions (see Zenkyo and Sakamoto, 2017). We also analyzed the effects of gender, occupational categories, and household income, but our analysis showed only retired employees had a negative effect on crowdfunding in each occupational category. Household income was less explanatory than individual income.

Descriptive statistics

Figure 1 shows the willingness to contribute via crowdfunding for each case, and Figure 2 presents the willingness to contribute based on the respondents' attributes. In research projects related to healthcare (cases 1, 2, and 3), the majority of respondents (excluding respondents who answered "no idea") were positive toward crowdfunding (Figure 1). On the other hand, for other projects, the rates were around 40%. In case 9 (research on human communication that enhances the performance of R&D organizations), only 27.3% are supportive. By age group, teens (aged 18 and 19) have a positive attitude toward crowdfunding. We found no statistically significant difference between university students and others. Across all cases, the percentage of those who are willing to support academic research is 44.8%. Among them, the average willingness to contribute is 11,316 yen. However, it should be noted that this questionnaire survey does not require payment and does not necessarily lead to actual support actions.

Table 7 shows descriptive statistics of variables used in the empirical analysis.

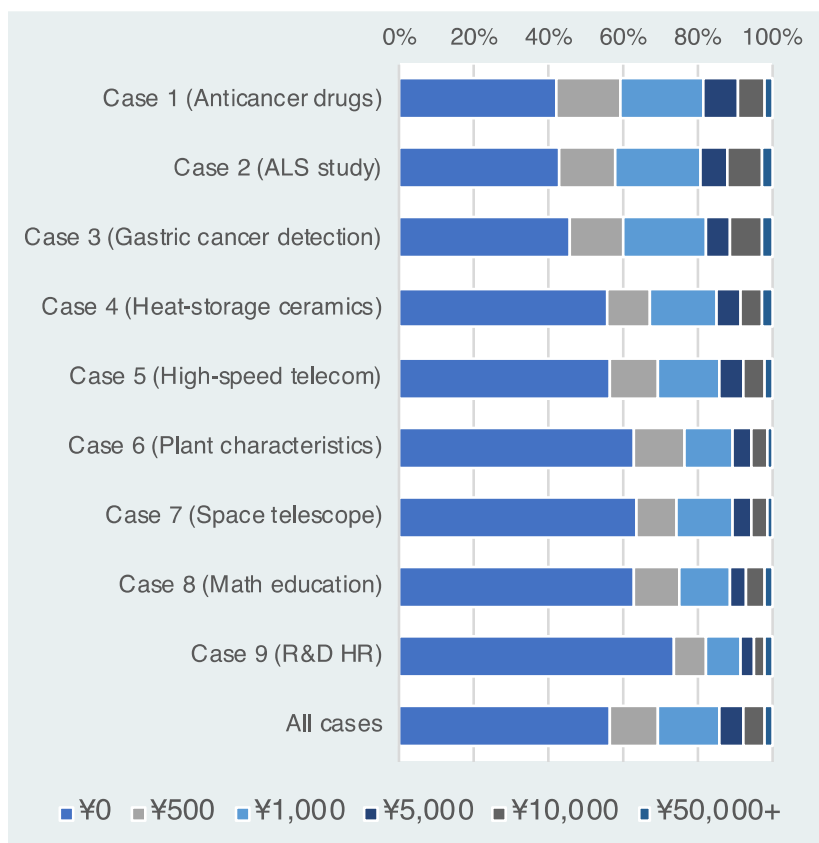


Figure 1 Willingness to contribute to the project by case

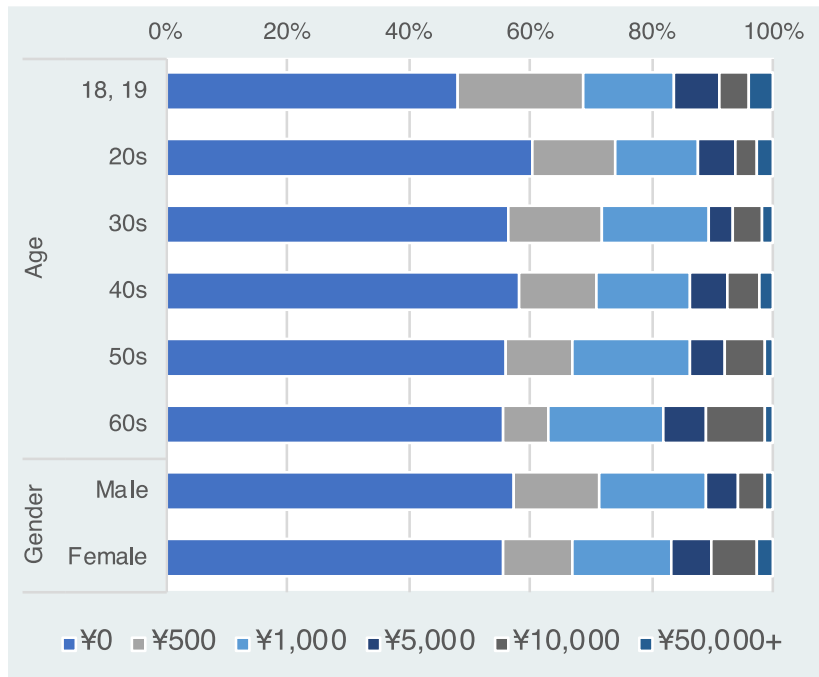


Figure 2 Willingness to contribute to the project by age and gender

Table 7 Descriptive statistics

Variables	Avg.	Std. dev.
Crowdfunding intention dummy	0.44	0.50
Willingness to contribute (6 scales)	0.99	1.36
Personal benefit from outcomes	0.03	0.34
Promising team	0.00	0.39
Economic contribution	0.12	0.45
National scientific competitiveness	0.14	0.42
Interest in the theme	0.08	0.45
Private interest of the stakeholders	0.10	0.30
Untrustworthy team	0.06	0.24
Favorable view of academia	0.04	0.27
Social problem solving	0.26	0.52
Human wisdom	0.23	0.47
Global impact	0.25	0.43
Knowledge outflow	0.07	0.26
Comprehensive evaluation (5 scales)	3.43	0.82
Intra-university collaboration dummy	0.29	0.45
University-industry collaboration dummy	0.57	0.49
Research university dummy	0.50	0.50
Interest in science (5 scales)	3.27	1.02
Master's degree	0.04	0.19
PhD degree	0.01	0.10
Household income (7 scales)	2.19	1.45
Age (6 scales)	3.75	1.61

Estimation method of crowdfunding intention and willingness to contribute

As described above, this study estimates the effect of independent variables on the crowdfunding intentions and the willingness to contribute. We estimate the crowdfunding intention by logit regression (Estimation A). Regarding the willingness to contribute (Estimation B), a control of statistical biases is essential. Many empirical studies on donation behavior struggled to remove a bias from people who are not willing to donate regardless of the nature of the target activity. Some papers excluded those who have no intention of donating (e.g., Yen, 2002) and some use Tobit estimation and Heckman two-step estimation together (e.g., Smith et al., 1995; Rooney et al., 2001). A majority of the studies, which consider a sampling bias, do not display large differences between the results of Tobit estimation and Heckman estimation, but Rooney et al. (2001) note the Tobit estimation requires homogeneity of determinants between donation intentions and willingness to contribute.

As shown in the descriptive statistics, the majority of respondents do not have any intention to contribute support. Since there is much censorship of the intention to contribute (particularly on no intention), sampling bias must be taken into account. In particular, we can assume that in general academic crowdfunding intentions are influenced by the respondents' income and interest in science, while the willingness to contribute is affected by project-specific factors. Thus, it is appropriate to use econometric methods, removing sampling bias, such as Heckman's two-step estimation. However, this approach has several disadvantages (Puhani, 2002). First, if the variables that have a significant effect in the estimation of the first step also have a significant effect in the second step, multicollinearity exists between the variable and the inverse Mills ratio, causing a bias in the results. Puhani (2002) recommends using subsampled estimates in such cases. Second, since OLS is used for the second-stage estimation, another estimation bias occurs when the estimation error is not normally distributed. In this survey, the amount of support is specified in the form of a choice of items. Given this, we can expect non-normality in the error term.

Therefore, in accordance with the suggestion in Rosenbaum and Rubin (1983), we adopt a subsample analysis that limits respondents to those who meet a certain minimum score on the probability of donation intention. We calculate a propensity score of crowdfunding intention, drop responses that show a low propensity score, and estimate willingness to contribute using ordered logit regression. Our threshold value for the propensity score is 0.5, which is in line with the actual ratio of those who showed an intention to donate. We exclude respondents whose scores are less than 0.5. As a robustness check, we perform the same analysis using subsamples of respondents with scores of at least 0.45 (reported) and 0.55 (results not reported). We also perform Heckman's two-step estimation. These robustness checks verify the reliability of the sign and significance level.

VI. Results

Estimation A: Crowdfunding intention

Table 8 shows the results of a logit regression using the dummy variable of whether or not to provide support as the dependent variable. The respondents were divided into two groups based on the degree of interest in science. One group, “High Science Interest,” is composed of those who answered “Interested” or more in “Somewhat interested”—— upper two scales in our five Likert scales——in two questions about science. Another group, “Low Science Interest,” is composed of the remaining responses.

As shown in Table 8, a project is likely to be supported when (i) the respondent expects a personal benefit from outcomes, (ii) the respondent has an interest in the theme, (iii) the project is related to social problem solving, (iv) outcome has a global impact, (v) the project increases human wisdom or (vi) outcome involves knowledge outflow. The likelihood of support is also affected by the respondents’ favorable view of academia. In particular, perceptions of interest in the theme and expectations for knowledge outflow strongly increase the probability of support. The estimated odds ratios of these factors are 1.69 and 1.76, respectively (Figure 3). In contrast, the perception of an economic contribution slightly increases the probability of support only from the High Science Interest group. This perception does not have a significant impact on donation intentions among the Low Science Interest group.

Table 8 Estimation A: Crowdfunding intention (logit regression)

	(1) All	(2) High Science Interest	(3) Low Science Interest
Personal benefit from outcomes	0.304*** (0.0764)	0.192* (0.0969)	0.488*** (0.128)
Promising team	-0.0112 (0.0666)	-0.0412 (0.0813)	0.0687 (0.119)
Economic contribution	0.174** (0.0591)	0.194** (0.0718)	0.120 (0.107)
National scientific competitiveness	-0.0497 (0.0641)	-0.103 (0.0761)	0.147 (0.124)
Global impact	0.302*** (0.0649)	0.264** (0.0802)	0.378*** (0.114)
Interest in the theme	0.527*** (0.0627)	0.385*** (0.0747)	0.906*** (0.121)
Private interest of the stakeholders	0.0901 (0.0851)	0.0231 (0.103)	0.240 (0.156)
Untrustworthy team	-0.187 (0.115)	-0.0743 (0.141)	-0.391 (0.208)
Social problem solving	0.229*** (0.0541)	0.172** (0.0662)	0.378*** (0.0980)
Human wisdom	0.248*** (0.0566)	0.261*** (0.0690)	0.314** (0.103)
Knowledge outflow	0.566*** (0.0996)	0.569*** (0.121)	0.537** (0.178)
Favorable view of academia	0.350** (0.107)	0.397** (0.127)	0.478* (0.205)
Comprehensive evaluation	0.719*** (0.0430)	0.745*** (0.0539)	0.691*** (0.0759)
Interest in science	0.244*** (0.0293)	0.0867 (0.0829)	0.746*** (0.0915)
Case dummies	Yes	Yes	Yes
Project team dummies	Yes	Yes	Yes
Respondent attributes dummies (academic degree, income, age)	Yes	Yes	Yes
Constant	-3.730*** (0.214)	-3.262*** (0.402)	-4.693*** (0.396)
Observations	7,097	4,340	2,751
Pseudo-R ²	0.177	0.159	0.192

Note: *** p<0.001, ** p<0.01, * p<0.05. Cluster-robust standard error by cases (in parentheses)

Estimation B: Willingness to contribute

Table 9 shows the estimation results for willingness to contribute through crowdfunding. Our ordered logit regressions indicate that people are likely to donate more money to projects in which respondents (i) expect a personal benefit from outcomes, (ii) expect a global impact, (iii) have an interest in the theme, (iv) expect the project to expand human wisdom and (v) possibilities of knowledge outflow. A favorable attitude toward academic research also increases the willingness to contribute independently. Its estimated odds ratio indicates that those who have a favorable view of academia are likely to donate 1.6 times more than those who do not (Figure 3). Its impact is the largest among individual factors, followed by the possibility of knowledge outflow which shows the next highest odds ratio of 1.4.

Table 9 Estimation B: Willingness to contribute (ordered logit regression)

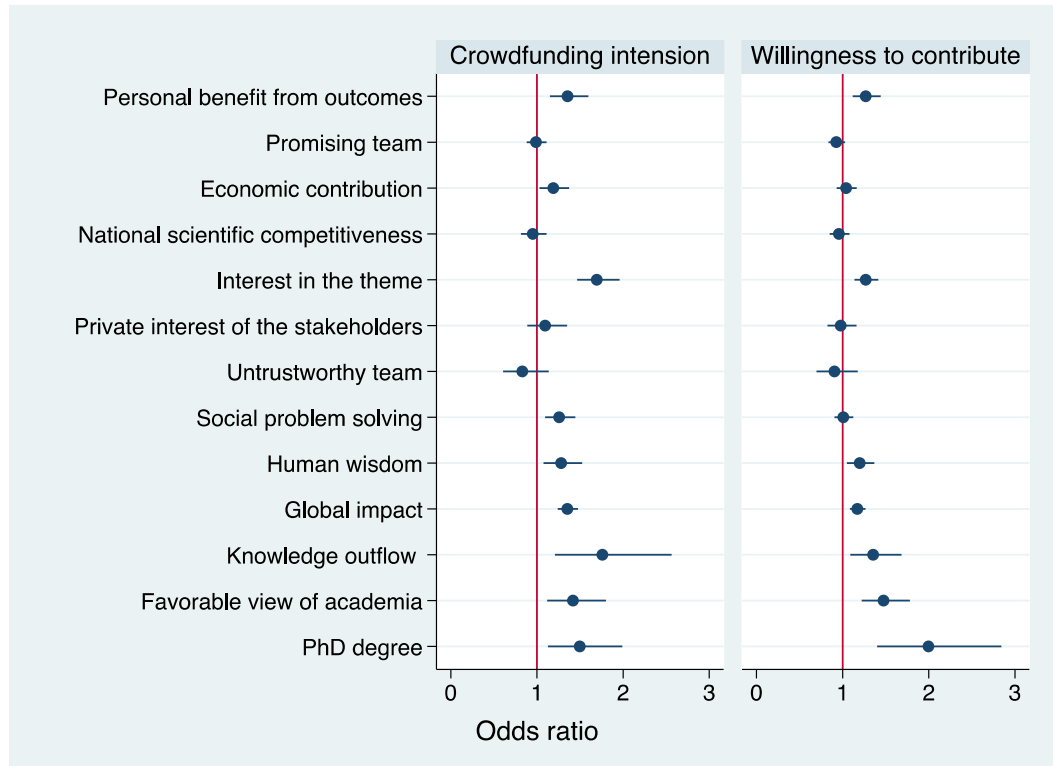
	(1) Propensity Score > 0.5: 6 Scales	(2) Propensity Score > 0.45: 6 Scales	(3) Propensity Score > 0.5: 4 Scales
Personal benefit from outcomes	0.238*** (0.0650)	0.223*** (0.0565)	0.244*** (0.0648)
Promising team	-0.0758 (0.0533)	-0.0624 (0.0570)	-0.0814 (0.0547)
Economic contribution	0.0397 (0.0574)	0.0470 (0.0541)	0.0317 (0.0593)
National scientific competitiveness	-0.0434 (0.0610)	-0.0361 (0.0573)	-0.0251 (0.0672)
Global impact	0.238*** (0.0557)	0.250*** (0.0559)	0.242*** (0.0515)
Interest in the theme	-0.0223 (0.0876)	-0.00672 (0.0963)	-0.0195 (0.0849)
Private interest of the stakeholders	-0.0998 (0.133)	-0.116 (0.144)	-0.124 (0.128)
Untrustworthy team	0.00921 (0.0550)	0.0337 (0.0559)	0.00599 (0.0585)
Social problem solving	0.181** (0.0674)	0.190** (0.0642)	0.194** (0.0684)
Human wisdom	0.158*** (0.0393)	0.169*** (0.0452)	0.148*** (0.0339)
Knowledge outflow	0.303** (0.111)	0.327** (0.111)	0.301* (0.119)
Favorable view of academia	0.388*** (0.0965)	0.327*** (0.0945)	0.401*** (0.0911)
Comprehensive evaluation	0.511*** (0.0511)	0.541*** (0.0590)	0.510*** (0.0499)
Interest in science	0.220*** (0.0369)	0.223*** (0.0317)	0.213*** (0.0362)
Case dummies	Yes	Yes	Yes
Project team dummies	Yes	Yes	Yes
Respondent attributes dummies (academic degree, income, age)	Yes	Yes	Yes
Observations	4,204	4,514	4,204
Pseudo-R ²	.031	.034	.035

Note: *** p<0.001, ** p<0.01, * p<0.05. Cluster-robust standard error by cases (in parentheses)

Table 10 Summary of estimation results

Individual factors	Classifications		Results	
	Expectations of rewards	Emotional factors	Funding intentions	Willingness to contribute
<i>Project-related factors</i>				
Personal benefit from outcomes	Yes	No	+ *1	+
Promising team	Yes	No	n.s.	n.s.
Economic contribution	Yes	No	+	n.s.
National scientific competitiveness	Yes	No	n.s.	n.s.
Interest in the theme	No	Yes	+	+
Private interest of the stakeholders	No	Yes	n.s.	n.s.
Untrustworthy team	No	Yes	n.s.	n.s.
Social problem solving	Yes	Yes	+	n.s.
Human wisdom	Yes	Yes	+	+
Global impact	Yes	Yes	+	+
Knowledge outflow	Yes	Yes	+	+
<i>Other factors</i>				
Favorable view of academia	N/A	N/A	+	+
PhD degree	N/A	N/A	+	+

*1 Not significant in High Science Interest group



Note: A dot indicates the estimated odds ratio and bars around the dot represent its intervals

Figure 3 Estimated odds ratio

VII. Discussion and conclusion

Discussion

A summary of the results is shown in Table 10. The respondents' interest in the research theme had a relatively strong positive influence on both the intention to support a specific project and the willingness to contribute via crowdfunding. These results however do not reject Hypothesis 1. The potential of a project to address social issues increases the probability of support but does not increase the willingness to contribute. We note that the increase in the probability of support is confirmed only in the Low Science Interest group. A lack of robustness checks raises doubt about Hypothesis 2. Several factors between social benefit and altruism, such as the perception of increasing human wisdom and the potential for knowledge outflow, increase both crowdfunding intentions and the willingness to contribute. These results are consistent with Hypothesis 3.

We obtained intriguing results regarding the motive of national interest. Perceptions of contributions to national scientific competitiveness do not constitute a motivation for supporting research projects. As discussed above, social problem solving projects also do not always motivates potential supporters. These factors have been associated with the perception that there is the possibility of publicly funded support, reducing the motivation for private support (see Andreoni and Payne, 2003). In line with their findings, the willingness to contribute is shown to be positively affected by the perception of knowledge outflow abroad, which potentially undermines the legitimacy of spending public funds on the project. These results are not only consistent with Hypothesis 4b but also suggest that global externality is a driving factor of support.

In conclusion, our experiment revealed that emotional factors that constitute empathy toward a research project affect the decision to support the project. Moreover, there were no significant effects from factors associated with negative emotions, such as projects that benefit the private interests of the stakeholders or an unreliable team composition that would not justify public support. These findings show that academic research crowdfunding complements competitive public research funding, which is inevitably affected by expectations for results and perceived legitimacy.

Academic contributions, practical implications, and limitations

This study's main contribution is to clarify that empathy, in other words a match between one's interests and the overlap between social benefits and altruism, is an important support motivation. Focusing on the magnitude of the impact, a match with respect to interests had a greater effect than perceived personal benefits for respondents and their families. Other emotional motivations had an effect similar to those associated with personal benefits, indicating that

emotional motivation dominates in academic research crowdfunding. Most of the expectations of outcomes and rewards, such as the Promising team, do not have a statistically significant effect. The result contrasts with the insights regarding purchase-model crowdfunding (Chan and Parhankangas, 2017). Therefore, this study identifies one of the differences between academic crowdfunding and purchase-model crowdfunding.

The study also presents insights on how universities and academic scholars can use academic crowdfunding effectively. First of all, we must note that in most cases, academic crowdfunding accounts for a small percentage of research expenditures. The average amount of funds raised per project remains at around 1 million yen (9,000 USD), so this funding source only complements a competitive research grant. However, its advantage lies in the flexibility in the timing of fundraising (Shibato, 2015). Academic crowdfunding can be a small source of research funding in accordance with research serendipity. Linking this with our main finding, that is, that empathy constitutes a major motive for support, crowdfunding may be particularly effective for feasibility research for new ideas or additional experiments that are beyond the scope of the research grant. This study also suggests that in order to effectively obtain funding, scholars and research managers should place emphasis on conveying an empathetic appeal and effectively communicating the value of the project. Further research is needed on the specific approaches to this type of communication.

This study has two main limitations. First, our experimental research is not evidence of actual behavior. Some of the potential supporters who responded to our survey may not actually donate money to a scientific research project. In addition, several excluded factors, such as external conditions of a crowdfunding platform and tax deductions associated with contributions, will affect the support decision. Nevertheless, we believe our contribution in identifying several potential motives for supporting academic research through crowdfunding is significant. Another limitation is in the construction of emotional factors. Our approach is not sophisticated in terms of organization, and improvements will be needed for future research.

Avenues of future research

This paper does not discuss any implications of academic crowdfunding other than as a source of research funding. Ikkatai et al. (2018) clarified the potential of an approach to stimulate public understanding of academic research and to collaborate with citizens. Moreover, academic crowdfunding may attract other types of funding because of a priming effect. To illustrate, Dragojolic and Lynd (2014) found that several basic research efforts focused on cancer and rare diseases successfully verified their scientific approaches with funds obtained from crowdfunding, and as a result, they were able to reduce uncertainty, a major risk in research, which strengthened their competitiveness in the public research grant proposal process and

attracted investment from pharmaceutical companies. These effects are also important and should be explored in the future.

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