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The Impact of Dynamic Feedback and Personal Budgets on Arousal and Funding Behaviour in Participatory Budgeting

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Abstract Public institutions as well as corporations seek to engage their constituents and employees in participatory processes to enhance engagement in decision-making. This paper proposes a group decision method of fusing crowdfunding and participatory budget allocation. In this approach, a central institution lets their members decide over budget allocation by endowing members with individual budgets. Participants are free to allocate their budgets to projects. A project is realized if its respective cost threshold is surpassed. We evaluate different design parameters of such mechanisms for group decisions and, based on this, the allocation of institutional budgets within a controlled laboratory experiment. The first design parameter is feedback on funding status, which can either be static (a one-shot decision, simultaneous funding) or dynamic (sequential decisions, repeated funding with continuous feedback). The second variable refers to the fraction of budget that may be kept privately by individuals and is not forfeit if not assigned to projects. Building on threshold public goods literature, we investigate how these parameters affect participants' investment behaviour, their excitement, and overall welfare. We find that mechanisms including feedback net higher welfare gains

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as well as higher levels of arousal. Higher personal budget shares drive excitement but lead to lower welfare gains.

Keywords Participatory budgeting · Threshold public goods · Laboratory experiment · Arousal

1 Introduction

Social media and the Internet have undisputedly reshaped information disbursement and processing. One area that has been impacted, yet not extensively researched is the change of public participation processes (Hentschel and Lanjouw 1996; OECD 2010). The overarching goal of civic participation yields user engagement but its implementation has distinct intricacies. Participation models have changed considerably in the era of digitalization (Boulianne 2009). This holds especially, though not exclusively, true for young(er) users (Escher 2013; Hampton et al. 2011). As such, generation Y is changing the landscape of both the political and the working environment by not only demanding flat hierarchies, but integration in collaborative, cooperative decision making processes (Eisner 2005; Harris et al. 2010). Moreover, institutions have incentives to comply with this request (Farzan et al. 2008). Even more than user engagement, empirical studies have shown that communities can promote subjective well-being and social welfare by enabling their members to participate in decision making (Franklin et al. 2009; Frey and Stutzer 2010; Hall and Caton 2016; Lisson and Hall 2016; Stutzer and Frey 2012). However, to date most institutional participation remains traditional: referendums or public discussions, which are resource-consuming and spatially bound.

Internet-based solutions have proven to work as tools to organize such participatory procedures (Klein 2012). Governments and employers alike use information and communication technologies (ICT) to bring people together online for discussions, project suggestion, and voting (Barros and Sampaio 2016). Although only a decade old, crowdfunding has been used by various institutions to transform ideas into products (Cumming et al. 2015). Through platforms such as *Kickstarter*, *GoFundMe*, or *Indiegogo*, tens of thousands of projects have already been funded and realized. In contrast, usage of crowdfunding mechanisms for group decisions to address the wish for more participation in business and in policy-making is fairly low. In this paper, we hence address the research gap of the design of participatory mechanisms for intra-organizational budget allocation. In particular, we consider how much of an entrusted budget participants are willing to provide under different funding regimes and how this behaviour translates into project realization, social welfare, and how these relations are mediated by the users' levels of arousal within the process.

This research is theoretically grounded in two streams of research. First, literature concerning participatory budgeting and (civic) crowdfunding is used for a theoretical basis of the design elements and mechanisms at work (Belleflamme et al. 2014; Kuppuswamy and Bayus 2017; Wash and Solomon 2014). Second, economic literature on (threshold) public goods informs the experimental design and economic basic principles of this work (Corazzini et al. 2015; Marks et al. 2006).

Design parameters are key to the crowd's contribution towards maximizing welfare (Bigham et al. 2014). In this paper, we consider two such parameters. First, we consider two alternatives for how the funding process is executed and how *feedback* is provided. This may either be static or dynamic. On most crowdfunding platforms, users can repeatedly invest in projects and at the same time observe other users' investments and all projects funding statuses. We transfer this dynamic feedback property to participatory budgeting processes. Second, in contrast to popular crowdfunding platforms where people bring in their own money, in institutional crowdfunding and participatory budgeting, the organizer of the overall process provides its members with a certain budget to allocate (Feldmann et al. 2013). This budget may be partly or fully bound to the purpose of funding projects or for the users to keep if they decide not to invest in any of the offered projects. Thus, *personal budget* share refers to the fraction of the provided budget which is at the participants' full disposal, that is, which can be kept privately if not invested in projects. Non-personal budgets, in contrast, can only be spent on projects and decay if not done so. Thus, personal budgets create inherent conflict between funding (public good) projects and private retention (social dilemma). While previous research does not consider personal budgets (Muller et al. 2013), we distinguish between three levels (0, 50, and 100%), the specifics of which are outlined in greater detail in the subsequent sections.

Combining our two design parameters, we consider six different treatment combinations by means of a controlled laboratory experiment with 216 participants. We investigate the effects on investment behaviour, project realization, social surplus, and how these variables are affected by the participants' arousal (Liu et al. 2013). With regard to participant's emotional experiences (arousal), Van Wingerden and Ryan (2011) found that most people take part in crowdfunding for intrinsic rather than extrinsic motivations. Previous work (to our knowledge) does not take this attribute into account. In doing so, we propose and systematically evaluate different participatory budgeting schemes under controlled and comparable conditions.

The remainder of this paper is organized as follows. In Sect. 2, we outline related work in the fields of civic crowdfunding and threshold public goods, introduce our research model and develop our hypotheses. In Sect. 3, we then present and describe the design of our experiment. We report our results in Sect. 4. Next, we discuss our results in view of implications for research and practice, limitations, and paths for future work in Sect. 5. Section 6 concludes.

2 Theoretical Background

This section outlines related work in the areas of participatory budgeting and crowdfunding and puts it into perspective of the present study. Moreover, to develop an understanding of project funding with cost thresholds, return rules, and coordination, we draw from economic literature on threshold public goods. Based on this, we develop our research model and derive our hypotheses on individual project funding behaviour in participatory budgeting.

Participatory budgeting employs the idea of letting individuals participate in decisions on budget allocation (Cabannes 2004), typically executed through voting

procedures. Participatory budgeting is a process in which constituents (and civil society organisations) have the right to participate directly in institutional budget allocation, open to all constituents and focusing on financial issues with limited resources in limited time. It also includes discussions on the budget allocation and a binding statement of the organisers on the proceeding with outcomes of the process (Sintomer et al. 2012). In contrast, crowdfunding can be categorised as a form of micro-task crowdsourcing (Stemler 2013). Civic crowdfunding is a specific way of participation in which the funding of a project benefits from private as well as government funds, assets, or sponsorship (Stiver et al. 2015).

2.1 From Participatory Budgeting to Civic Crowdfunding

Participatory budgeting refers to "a mechanism (or process) through which the population decides on, or contributes to, decisions made on the destination of all or part of the available public resources" (UN-HABITAT 2004, p. 20). Its objectives centre around efficient governance, sustainable resource management, and financial transactions transparency, among others (Miglietta and Parisi 2017; Shah 2007). While in most participatory budgeting campaigns the allocable budget is provided by a central institution (e.g., a company, organization, or municipality), crowdfunding draws on private contributions brought in by employees, members, or constituents. Generally, the participants of such processes come together via an online platform where they are able to propose, debate, and decide on projects (He 2011).

In between these poles there may exist hybrid forms in which both institutional budgets and private contributions co-exist and are leveraged to fund projects. In this sense, *civic crowdfunding* (as termed by Miglietta and Parisi 2017) addresses two principal objectives. First, it aims at providing financial relief from shrinking local government budgets and second, involves constituents in municipal decision making processes. As a consequence, constituents' understanding of public resource management shifts in favour of more transparent, efficient, and socially sustainable approaches (Osborne et al. 2013). Civic crowdfunding is facilitated by digital transformation of government services and supported by social media and digital technology (Bekkers et al. 2011).

Crowdfunding is different in scope from civic crowdfunding. The most significant aspect is found in the business model: whereas industrial and professional platforms (e.g., *Kiva*, *GoFundMe*, *Kickstarter*) use over-funding and provisions to further their business (models), the funds in civic crowdfunding stem from the same, static public budget. Over-funding in such a scenario has no additional merit or utility. Some platforms such as *Kickstarter* incentivize early and larger investments by allowing "pre-ordering" of products and services, as well as other small gifts (Belleflamme et al. 2014). This is also out of scope in a civic crowdfunding platform, where the focus of the funding is in social projects. Moreover, civic crowdfunding platforms offer several advantages over traditional funding mechanisms. These include the creation of social interactions within communities and the instigating of constituents to take active roles therein. Also, civic crowdfunding puts the right of allocating public resources into the hands of taxpayers and hence is often considered a viable means of direct democracy (Niemeyer 2017). Lastly, civic crowdfunding entails promises of

increasing public expenditure responsibility, transparency, and a reduction of corruption and misgovernment (Miglietta and Parisi 2017).

Civic crowdfunding represents an innovative way of participation in which the funding of a project is based on government funds, assets, or sponsorship (Stiver et al. 2015). Public infrastructure—including New York's Statue of Liberty and London's Royal Albert Hall—have been funded through such mechanisms (Harris 1986). While it is interesting to see civil society partnering with policy-makers, civic crowdfunding in its current form has some major disadvantages. Civic crowdfunding might reproduce or even widen social inequalities as wealthy neighbourhoods may benefit disproportionately from the combination of government funding and private financial support (Davies 2015). Any wider adoption of civic crowdfunding hence demands further exploring the fundamental principles of crowd mechanisms, where responsibilities are outsourced a wider range of people (Prpić et al. 2015).

Several challenges are faced in practically implementing civic crowdfunding approaches, where in particular technical feasibility remains a challenge. In this respect, the role of computer-mediated interactions, and how trust between participants unfolds in these settings is critical for successful operationalization of the mechanism (Barros and Sampaio 2016). In addition, a high degree of civil participation and mobilization is mandated which is often challenging to achieve in the short term (Margetts et al. 2011; Miglietta et al. 2013). In their review paper, Skoric et al. (2015) present a number of research that examines the correlation between the use of social media and online participation. Besides some results that do not show a link between the use of social media and online participation (Skoric and Poor 2013), others came to the conclusion that Facebook (Bode 2012; Vitak 2012), blogs, and microblogs (Chan et al. 2012; Gil De Zúñiga et al. 2009) are positively related to online participation. Still other research finds that participation is only increased at scale (+1 million users) (Margetts et al. 2011; Mukkamala et al. 2013).

Key motivators for participatory budgeting include altruism and social and economic benefits of interested constituents. Conversely, all constituents profit from the realization of projects independent of their own investment—thus increasing the risk of free-riding (Andreoni 1988). In this context of differing private utilities, transparency measures such as dynamic information and feedback provided to constituents spread a new sense of belonging and respect for common resources that can hardly be achieved when public resources expenditures management is hidden or hard to trace (Osborne et al. 2013).

First evidence suggests that crowdfunding can be applied for group decisions by employers and governments alike for the benefit of their employees or constituents. Most notably, IBM used a crowdfunding mechanism to let employees decide which projects to realize. Employees could propose projects and were then provided with a budget that they could spend on projects on an intranet-wide crowdfunding platform (Muller et al. 2013). Through collaboration across manager levels and departments, employees were able to address previously unmet needs, thereby removing some constraints of inflexible corporate processes (Muller et al. 2013).

2.2 Threshold Public Goods

Public goods are characterized by non-excludability and non-rivalry (Malkin and Wildavsky 1991). Each individual can profit from a public good and one individual can consume the good without reducing its availability for others (Ledyard 1995). For the realization of threshold public goods, a certain cost threshold must be surpassed for the good to be realized and individuals only profit if this threshold is met (Croson and Marks 2000). This theoretical description represents the foundation for civic crowdfunding. Projects of public interest, as for instance recreational parks, can be seen as threshold public goods (Corazzini et al. 2015). If a project is sufficiently funded and hence realized, the public profits, regardless of whether an individual contribution was made or not. This of course directly incentivizes free-riding where each individual's dominant strategy is to not invest at all (Isaac et al. 1984; Ledyard 1995). If, in contrast, private accounts do not exist and therefore no possibility to benefit from private budgets, there occurs no incentive to withhold investments. The resulting dominant strategy is to invest one's entire budget to the public good(s).

Often, individual funding decisions are made simultaneously with no public feedback so that subjects are not aware of the others' actions when deciding on their contributions. This yields high potentials for under- or overfunding and thus inefficiency. Without refunding rules, simultaneous decision making in threshold public goods games incurs a coordination challenge to (i) meet the threshold while (ii) not to exceeding the threshold unnecessarily. Funding constellation exactly meeting the threshold represent Nash equilibria, as players cannot improve by unilaterally changing their strategy (Nash 1951). For underfunded projects, Isaac et al. (1989) considered how a refund rule affects investment behaviour in case the threshold is not met and found higher investments when contributions were refunded. Similarly, Wash and Solomon (2014) found significantly higher investments when using a refund rule rather than a direct donation mechanism (i.e., no refunds). Moreover, inefficiencies based on overfunding can be mitigated by refund rules that proportionally refund investments exceeding the threshold (Marks and Croson 1998). Interestingly, while affecting investment behaviour, refund rules were found to exert no influence on the number of funded projects (Marks and Croson 1998). Comparing investment behaviour between cases with one and multiple public goods, Corazzini et al. (2015) found that multiplicity implies more severe coordination problems and lower investments in general. Note that while refund rules mitigate the risk of lost investments, they do not affect the general issue of free-riding and the associated strategic consequences (i.e., the retention of funds).

The utilities of one (or multiple) goods can be homogeneous among individuals or differ between individuals. In this regard, Kölle (2015) considered heterogeneous utility schemes and found no significant difference to homogeneous distributions. For linear public goods, in contrast, Fischbacher et al. (2014) found that heterogeneous utility values result into lower investments of unconditional contributors, whereas conditional contributors did not exhibit differences as compared to those with homogeneous utility.

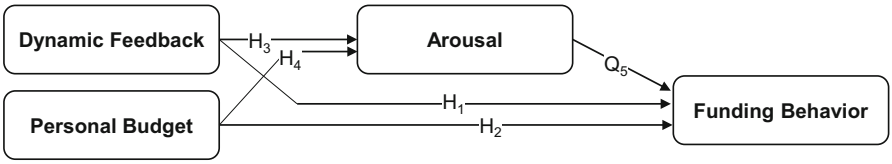

Fig. 1 Structural research model

2.3 Research Model and Hypotheses Development

The following sketches our research model and develops our hypotheses. As motivated in the proceeding paragraphs, we investigate the impact of two important design variables (dynamic feedback, personal budget) on individual funding behaviour within a participatory budgeting context. Moreover, we consider whether (and if so, how) individual arousal carries the effects between these focal variables. Figure 1 summarizes our research model.

2.4 The Effect of Dynamic Feedback on Funding Behaviour (H_1)

In static crowdfunding, participants are not provided with any information during funding decisions (one-shot and simultaneous). Only after the funding phase they receive feedback on other participants' investments and hence project status. This is tantamount to standard voting processes or threshold public goods experiments, where returns are only officially announced at the end of the voting period. With dynamic feedback, in contrast, participants receive feedback on the sum of contributions made by all other participants already during the investment phase (e.g., a progress bar). They may hence react to that information by deciding whether to provide additional funding. This is similar to platforms such as *Kiva* or *Kickstarter*.

Previous research has shown that group feedback information positively impacts the decision process and increases group performance and unity (Škraba et al. 2007). Individuals are more likely to invest when they expect that their investment will make an impact or it increases the likelihood of a project being funded (Kuppuswamy and Bayus 2017; Li and Duan 2014). As opposed to standard crowdfunding mechanisms, civic crowdfunding seeks to maximize welfare of the individual by maximizing welfare of the group. It can be expected that to maximize the total output (global welfare) of the individual, when a project is totally funded it will not be overfunded. The lack of overfunding will create lower overall investments. We hence propose:

H_1 Dynamic feedback leads to decreased funding behaviour as compared to static feedback.

2.5 The Effect of Personal Budget on Funding Behaviour (H_2)

In the context of personal budgeting, psychological biases such as the endowment effect are likely to be at play (Dommer and Swaminathan 2013). Constituents may

attribute higher value into their entrusted budget if it is theirs to keep as a private endowment. Moreover, free-riding describes the strategy of holding back budget and hoping for others to fund the public goods projects (Smith 1980). Everyone would profit from project realization—regardless of their own respective investments (Ledyard 1995). In the absence of a personal budget, free-riding is rendered meaningless since by design, unused budgets remain with the institution. In this case, the dominant strategy is to invest one's entire budget to maximize the chances project thresholds are surpassed. We hence propose:

H_2 Higher personal budget shares lead to decreased funding behaviour.

2.6 The Effect of Dynamic Feedback on Arousal (H_3)

In a static funding process, participants submit their investments quasi-simultaneously, neither knowing the investments of other participants nor the overall funding status. Participants transmit a single investment to projects (one-shot) and receive feedback only after this investment phase is completed. In contrast, in dynamic funding, the invested amounts for different projects can be repeatedly adjusted and participants receive continuous feedback. Such dynamic processes inherently bear the potential of evoking arousal and engagement due to cognitively demanding "to-ing and fro-ing" of inputs and (intermediate) results. The strategy space in dynamic processes is therefore much larger than it is in static ones which renders decisions more complex. Dynamic funding may hence evoke feelings of surprise, excitement, and engagement, which in turn are known to relate to arousal (Adam et al. 2012). Empirical evidence from related domains, for instance, auctions or competitive games support this notion (Finucane et al. 2000; Ku et al. 2005; Malhotra 2010). Moreover, dynamic funding processes enable a subtle form of social interaction among participants, offering a mode of communicating with other participants via investment-based signals. Social interactions were found to be a potent driver of hedonistic arousal within applications such as social network sites (Gosling and Mason 2015) and sharing platforms (Hawlitschek et al. 2016). This dynamic nature offers a way to express intentions and strategies, "game" the process, or try to lure others into funding one's own preferred project. We suggest that this game-like character of dynamic feedback processes causes higher levels of arousal. Our next hypothesis thus states:

H_3 Dynamic feedback leads to higher levels of arousal than static feedback.

2.7 The Effect of Personal Budget on Arousal (H_4)

As pointed out above, if personal budgets do not exist, the decision of whether and how much to invest is quite straightforward. The dominant strategy is to invest the entire budget. Higher personal budget shares lead to more complex decision scenarios given the larger viable strategy space. At the same time, the entrusted personal budget may create a perception of endowment/entitlement (Dommer and Swaminathan 2013) which has been found to be associated with arousal (Lin et al. 2006). In this sense,

high personal budgets put users into a situation of choice and internal conflict as they introduce an inherent social dilemma. Like in any public goods scenario, the dominant strategy is to invest nothing at all while the social welfare optimum is realized only if all participants invest their entire endowment. Situations of actual choice and conflict are typically considered more engaging and arousing than pseudo- or non-conflicting decisions. We hence suggest:

H_4 Higher personal budget shares lead to higher levels of arousal.

2.8 The Association of Arousal and Funding Behaviour (Q_5)

Civic crowdfunding has been primarily facilitated through online platforms with computer-mediated interactions between constituents underlying the budgeting process (Citizinvestor 2017; Ioby 2015). In online citizen interactions, the nature of the interaction is relatively short-term (duration of decision process may be within the magnitude of few minutes to several days), leaving fewer time for deliberation. Prior research has shown that low decision time tends to increase the reliance on emotional processes in budgeting (and other) decisions and increases heuristic-based thinking over deliberative cognitive processes (Gigerenzer and Gaissmaier 2011). For participatory contexts, positive emotions and social interaction have shown to fuel citizen engagement, even more readily than community feeling or trust in the institution (Mannarini et al. 2010). It has also been shown that goods which inspired joy are more preferred than goods which are utilitarian in nature (Dhar and Wertenbroch 2000).

Importantly, as prior research has established that arousal is well-capable of affecting behaviour, the effect of feedback type (dynamic or static) and personal budget share on social surplus may be (partly) mediated via the path of emotional arousal (Adam et al. 2015; Teubner et al. 2015). It is an open question, however, which effect arousal (per se) has on behaviour in this regard, as the literature on arousal-induced behaviour in public goods experiments is not conclusive (Mitkidis et al. 2015).

3 Method

To evaluate the proposed research model and hypotheses, we conducted a laboratory experiment. In the following, we outline the experiment's task, session and treatment design, measurement instruments, as well as the overall procedure (Niemeyer et al. 2016).

3.1 Project Funding Task

We model a threshold public goods scenario with four goods (i.e., projects), six participants, and heterogeneous funding thresholds and utility values. Our design's parameters for players, periods, endowments, project thresholds, and utility values are guided by the study design of Wash and Solomon (2014). The experiment comprises 24 periods of consecutive project funding. In every period, each participant is randomly assigned to one of the six player types (see Table 1). A player *i* is aware of

Table 1 Individual utility values for player type (1–6) and project (A–D)

Player	Budget	Project			
		A	B	C	D
		Cost			
		100	200	300	400
Type 1	150	200	150	100	50
Type 2	150	50	200	150	100
Type 3	150	100	50	200	150
Type 4	150	150	100	50	200
Type 5	150	200	100	150	50
Type 6	150	50	150	100	200

their own player type but not of the types of the other players (private information). Each player is endowed with an initial budget of $b = 150$ monetary units (MU) and may allocate their budget to one or multiple of the four projects $j = \{\text{A, B, C, D}\}$. The budget allocation from player i on project j is denoted z_{ij}. A project j is realized if its cost threshold c_j is met (or surpassed) by the total of all players' contributions to that project ($\sum_{i=1}^{n} z_{ij} \geq c_j$). If a project is realized, each player receives a utility value u_{ij} where different player types value the projects differently. All cost thresholds, budgets, and utility values are summarized in Table 1.

Note that the sum of all utility values across the different columns (i.e., projects; $\Sigma = 750$) and rows (i.e., player types; $\Sigma = 500$) is constant. In other words, each project generates the same overall utility across player types and each player type can obtain the same overall utility across projects. Importantly, however, the cost thresholds of the four projects vary from $c_A = 100$ MU to $c_D = 400$ MU. Also note that the sum of all individual budgets is not sufficient to fund all projects ($\sum b_i = 900 < 1000 = \sum c_j$).

The investment phase lasts 60 s. After completing the investment phase, a result screen displays a summary of projects, contributions, and the player's outcome in this period. An exemplary result screen is displayed in Fig. 2. After all players have clicked an okay-button, the next period begins.

3.2 Experimental Session Design

Each experimental session comprises 12 participants. In each of the 24 periods, these are randomly grouped into two cohorts of six participants which then enter the project funding task. In order to avoid learning and sequence effects, for each period new groups are formed so that participants engage with different combinations of other participants throughout the experiment (stranger matching). Note that the other participants cannot be identified and always appear as player type "1" through "6" in the experiment.

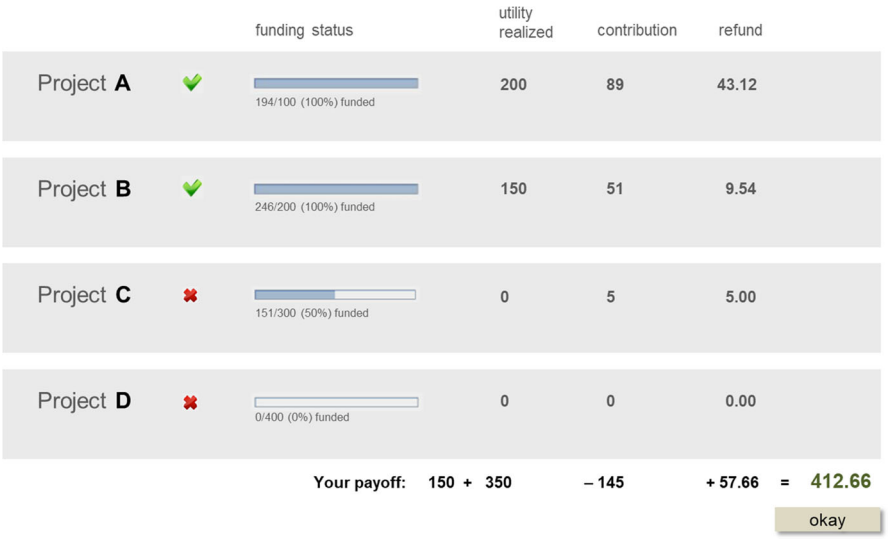

Fig. 2 Exemplary result screen

Table 2 Treatment design (number of participants in each condition)

Feedback\Personal Budget	0%	50%	100%
Static	$3 \times 12 = 36$	$3 \times 12 = 36$	$3 \times 12 = 36$
Dynamic	$3 \times 12 = 36$	$3 \times 12 = 36$	$3 \times 12 = 36$

3.3 Treatment Design

With the experiment, we investigate the two main design variables *feedback* (static/dynamic) and *personal budget* (0/50/100%) by means of a 2 by 3 full factorial between-subjects design. This means that in each of the resulting six treatment combinations, different participants took part and that each participant took part in exactly one of the conditions. As illustrated in Table 2, each treatment cell comprises 3 sessions à 12 participants, yielding a total of 216 participants.

First, in the static conditions, feedback on the projects' funding status is provided only after all participants have made and confirmed their funding decisions. In the dynamic condition, in contrast, participants are continuously informed about each project's funding status and are able to provide additional funding at any time. Note that it is not possible to withdraw any MUs once contributed. On most crowdfunding platforms, users may repeatedly invest in projects and observe the projects' funding progresses as well as other users' investments. In this sense, the dynamic conditions represent the more practical design while the static condition serves as a theoretical benchmark.

Second, the personal budget share represents the proportion of individual financial endowments that may (at most) be pocketed privately by the participants. In the 100%

condition, the entire budget (150 MU) is granted to the participants. They can then freely decide on how to allocate it between projects or keep it privately. In the 0% condition, in contrast, participants are endowed with 150 MU as well, whereas now, this budget is not theirs to keep. They may freely decide on how to allocate the budget between projects but any unused amount is retracted. Similarly, in the 50% condition, participants can allocate the 150 MU budget across projects, whereas now, half of what is not used for funding projects can be kept privately, while the other half is retracted. (Note that this is technically identical to a situation in which participants are endowed with 75 MU and project investments are doubled-up by the experimenter.)

3.4 Refund Rules

The experimental rules include the refunding of MU allocated to projects that did not reach the cost threshold and were hence not realized (*under-funding*). Moreover, if investments exceed the cost threshold, the resulting *over-funding* is also refunded proportionally to the individual contributions (Marks and Croson 1998). The last case is best illustrated by an example. Consider a project with a threshold value of 100 MU and contributions from three players A = 50, B = 60, and C = 70. The total contributed amount is 180 MU, exceeding the project's threshold by 80 MU. These are now proportionally returned to the players according to their investments (rounded to the full unit). Thus, player A receives $80 \times 50/180$ MU = 22 MU, player B receives $80 \times 60/180$ MU = 27 MU, and player C receives $80 \times 70/180$ MU = 31 MU.

3.5 Payoffs

For the 100% personal budget conditions, a player's overall payoff comprises the initial budget b_i and the associated project utility values u_{ij}, minus contributions z_{ij} plus adding refunds from overfunding:

$$\Pi_i = b_i + \sum_{j=\mathrm{A}}^{D} \left(u_{ij} - z_{ij} + \frac{\sum_{i=1}^{n} z_{ij} - c_j}{\sum_{i=1}^{n} z_{ij}} z_{ij} \right) \mathrm{I_j} \tag{1}$$

with $\mathrm{I_j} = 1 \Leftrightarrow \sum_{i=1}^{n} z_{ij} \geq c_j$, $\mathrm{I_j} = 0$ otherwise. In the 50% personal budget treatment, participants actively decide on half of the initial budget b_i. This one half is at the participants' full disposal, that is, it can be invested or kept privately. Importantly, in this treatment condition, each investment will be doubled by the institution (with the second half of the budget). This implies constant financial spending power as in the other treatments. Formally, payoff is:

$$\Pi_i = \frac{1}{2} b_i + \sum_{j=1}^{m} \left(u_{ij} - z_{ij} + \frac{\sum_{i=1}^{n} 2z_{ij} - c_j}{\sum_{i=1}^{n} 2z_{ij}} 2z_{ij} \right) \mathrm{I_j} \tag{2}$$

Last, in the 0% personal budget condition, none of the budget b_i can be kept privately. The budget b_i can only be invested in the project and falls back to the institution otherwise. Refunding rules are not relevant here:

$$\Pi_i = \sum_{j=1}^{m} u_{ij} \mathrm{I_j} \tag{3}$$

Note that in all three conditions (0, 50, and 100% personal budget), the participants' funding power, that is, the amount of money which can be allocated to projects, is identical. This treatment dimension merely varies how much of their budget they may effectively keep and enjoy privately.

3.6 Measurements

Our main dependent target variable is funding behaviour. This variable captures a players' average investment (across all projects) over the course of the 24 periods. Since each player is endowed with a budget of 150 MU in each period, the funding variable ranges from 0 to 150 MU. Moreover, we surveyed the participants' perception of arousal (7-point Likert scale) and several demographic and control variables after the experiment, including age, gender, individual risk aversion, and experience with crowdfunding (Holt and Laury 2002; Liu et al. 2013).

3.7 Procedure

The experiment was conducted at the Karlsruhe Institute of Technology (KIT). In total, 216 participants were recruited using the Online Recruitment System for Economic Experiments (Greiner 2015) and were mostly students of economics and industrial engineering. Overall, 60 participants were female. Average participant age was 22.4 years (ranging from 18 to 39 years). The experiment was implemented using the software environment *Brownie* (Hariharan et al. 2017). Written experiment instructions were handed out to all participants and were read out aloud at the beginning of each session. Participants answered 10 quiz questions to assure task comprehension. Sessions took 75 min on average. Average payoff was 14.60 EUR per participant.

4 Results

4.1 Funding Behaviour

Average funding behaviour across treatment conditions and over time is summarized in Fig. 3. As can be seen from these illustrations, (a) static feedback is consistently associated with increased funding behaviour; (b) higher personal budgets are associated with decreased funding behaviour; and (c) the treatment difference due to static/dynamic feedback increases for higher personal budgets. Moreover, we observe a slight but steady overall trend in funding behaviour over the course of the 24 periods.

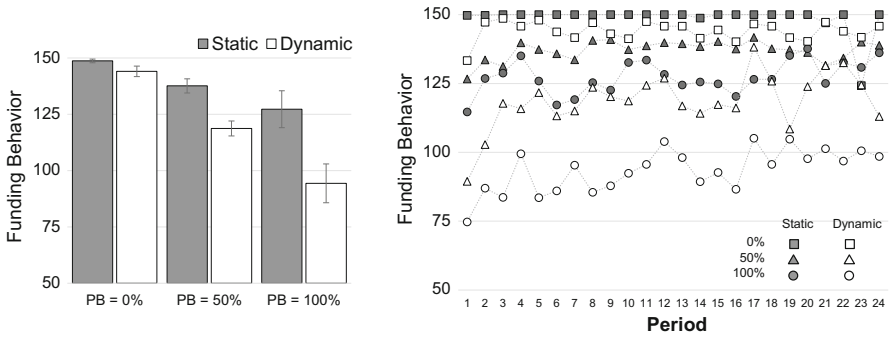

Fig. 3 Average funding per treatment (left) and treatment/period (right); error bars indicate 95% confidence intervals

We corroborate this first visual assessment by means of a generalized least squares (GLM) regression with subject random effects. Based on the behaviour of all 216 subjects over the course of all 24 periods (n = 216 × 24 = 5184), Table 3 summarizes four regression models with funding behaviour as the dependent variable and varying sets of independent variables. Specifically, we use a treatment interaction effect between Dynamic Feedback and Personal Budget Share in Models 3 and 4 (DF × PBS) and a set of control variables in Models 2 and 4 (gender, age, crowdfunding experience). Overall, the regression models suggest highly robust treatment effects. As can be seen from Models 3 and 4, controlling for the treatment interaction yields a non-significant effect of the dynamic feedback dummy and a significant interaction term. This means that the difference due to dynamic feedback is marginal for the PBS = 0% condition, whereas it significantly increases (toward larger negative values) for the 50 and 100% conditions. Hence, the overall effect of dynamic feedback as indicated in Models 1 and 2 is particularly driven by these conditions of high personal budgets. Note that using two dummy variables to capture the three levels of personal budget (0, 50, 100%) yields very similar results. Next, we see that period has a consistently significant and positive effect on funding behaviour. Last, none of the control variables have significant effects.

4.2 Model Evaluation (H_1–H_5)

After this first general assessment of the main treatment variables, we now consider *how* their effects on funding behaviour are conveyed specifically. The model was validated using Partial Least Squares (PLS), conducted in SmartPLS 3.0 (Ringle et al. 2015). PLS-SEM was chosen for the approach's broad scope and flexibility of theory and practice (Richter et al. 2016) as well as its flexibility with regard to handling binary and single-item variables without any additional requirements or constraints (Hair et al. 2012, 2017). With regard to the requirements of sample size, G* power analysis suggests that for our model a sample size of n = 145 is sufficient to detect minimum R^2 values of 10% with a 1% probability of error (Cohen 1992; Faul et al.

Table 3 GLM regression results for funding behaviour

	(1)	(2)	(3)	(4)
Dynamic feedback	− 15.876***	− 15.620**	− 1.242	− 1.367
	(4.786)	(4.801)	(7.474)	(7.489)
Personal budget (%)	− .361***	− .352***	− .214**	− .210*
	(.059)	(.059)	(.082)	(.082)
DF × PBS			− .293*	− .285*
			(.116)	(.116)
Period	.221***	.221***	.221***	.221***
	(.047)	(.047)	(.047)	(.047)
Gender (female)		− .573		− .423
		(5.441)		(5.377)
Age		− .485		− .513
		(.871)		(.861)
Experience with CF		7.953		7.455
		(4.888)		(4.834)
Intercept	130.328***	137.122***	123.011***	130.812***
	(4.509)	(19.692)	(5.312)	(19.628)
#Observations	5184	5184	5184	5184
R^2	.014	.014	.015	.016

Standard errors in parentheses; ***$p < .001$; **$p < .01$; *$p < .05$

2007; Hair et al. 2017). With 216 observations, our data set should hence be large enough to detect existing effects with sufficient certainty.

The reflective construct of arousal satisfied all conventional thresholds of construct reliability (Cronbach's alpha, > .70; Composite Reliability > .70) (Bagozzi and Yi 1988; Nunnally and Bernstein 1994) and Composite Reliability. Also convergent validity was established (Average Variance Extracted, AVE > .50). In terms of overall model fit, the standardized root mean square residual (SRMR) is .035, which is below the conservative threshold of .05 (Byrne 2008).

4.3 Structural Model and Hypotheses Testing

The structural model was evaluated with PLS bootstrapping (5000 samples, no sign changes, complete bias-corrected and accelerated bootstrapping, two-tailed hypotheses testing). All path coefficients and significance levels are provided in Fig. 4. As can be seen, all but one of the hypothesized effects were confirmed by the data at the conventional 5-percent level. First, as hypothesized, both treatment variables dynamic feedback (H_1, $\beta = -.172$, $p < .01$) and personal budget (H_2, $\beta = -.364$, $p < .001$) have significant and negative effects on funding behaviour. Overall, 19.8% of the variance of this main target variable are explained. Next, as hypothesized, we find that both dynamic feedback (H_3, $\beta = .291$, $p < .001$) and personal budget (H_4, $\beta = .139$, $p < .05$) have positive effects on the participants' arousal ($R^2 = .104$). Lastly, we find that the

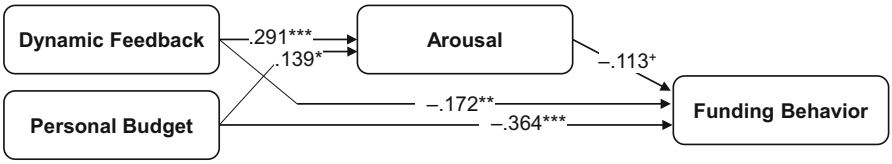

Fig. 4 PLS research model testing results ($^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$; $^{+}p < .1$)

association between arousal and funding behaviour is only marginally significant (i.e., at 10-percent level; H_5, $\beta = -.113$, $p = .073$).

The Stone–Geisser criterion (Q^2) was used to evaluate the structural model. All Q^2 measures exceeded the threshold of 0, hence meeting the criterion for predictive validity (Chin 1998; Geisser 1974; Hair et al. 2017; Stone 1974).

4.4 Control Variable Analysis and Multi-group Analysis

To assess the outlined results' robustness, we conduct a control variable analysis comprising the variables gender (male = 0, female = 1), experience with crowdfunding (no = 0, yes = 1), age (in years), and individual risk aversion (Holt and Laury 2002). This analysis reveals that none of the factors had a significant impact on any of the dependent constructs in the model (i.e., arousal and funding behaviour). Importantly, when including the control variables in the model, the original relations remain constant in terms of sign, magnitude, and significance. Thus, the study's results are not altered by participants' age, gender, experience, or individual levels of risk aversion. Overall, control variable analysis hence suggests that the findings and conclusions derived from this study are robust.

As a next step and given the relative imbalance of female (27.8%) and male (72.2%) participants in the sample, we conducted a multi-group analysis (MGA) to explore these groups' difference in greater detail—that is, not only considering gender effects on constructs but also on relations between them (Sarstedt et al. 2011). This MGA reveals that only one significant path difference occurs between male and female participants (see Table 4). Specifically, the effect of personal budget shares on arousal is exclusively driven by female participants ($\beta = .305$, $p < .01$) whereas this path is insignificant for male participants ($\beta = .064$, *n.s.*). Besides such demographic (i.e., visible) sample heterogeneity, we investigate unobserved sample characteristics in the following section.

4.5 Participant Heterogeneity

To assess whether there exists unobserved heterogeneity in the data, we conduct a finite mixture analysis (FIMIX; Hair et al. 2016; Sarstedt and Ringle 2010). Such FIMIX approaches to clustering assume that the data originates from more than one latent segments of the population (Sarstedt and Ringle 2010). The approach attempts to capture unobserved heterogeneity within the inner model, that is, *among the relationships between latent variables*. Specifically, we test segmentations of 2–6 clusters

Table 4 Summary of multi-group and FIMIX analyses

	ALL (100%)	Sig.	Multi-group analysis				FIMIX analysis		
			Male (72.2%)	Female (27.8%)	|Δ|	Sig.	Cluster 1 (50.2%)	Cluster 2 (26.3%)	Cluster 3 (23.5%)
Arousal ⟶ funding	−.113	+	−.118	−.088	.030	*n.s.*	−.112	−.033	−.002
Dynamic ⟶ arousal	.291	***	.263	.350	.088	*n.s.*	.391	.102	.402
Dynamic feedback ⟶ funding	−.172	**	−.230	−.010	.221	*n.s.*	−.359	.947	−.995
Personal budget ⟶ Arousal	.139	*	.064	.305	.241	*	.243	.061	−.166
Personal budget ⟶ funding	−.364	***	−.309	−.516	.206	*n.s.*	−.157	−.079	−.009

*$p<.05$; **$p<.01$; ***$p<.001$

with 10 repetitions each. Both Bayesian Information Criteria (BIC) and Consistent Akaike's Information Criterion (CAIC) suggest an optimal segmentation into three clusters (see Table 4). The first cluster comprises 50.2% of all participants. Within this cluster, none of the path estimates exhibits large differences from the overall sample. In the second cluster (26.3%), in contrast, the path estimate for the relation between dynamic feedback and funding behaviour is .947 (as compared to − .172 in the overall sample). Hence, this specific type of participant appears to invest almost their entire budget when dynamic feedback is provided, whereas others exhibit a rather opposite tendency. This type of participant may be referred to as *hedonistic spenders* as they tend to fund projects only in the interactive process (and when they do, they go all in). The third cluster (23.5%) exhibits three distinct characteristics, distinguishing them from the overall sample. First, this type's relation of personal budgets and arousal is much lower than that of the rest of the sample and also the presence of personal budgets is not related to funding behaviour. Moreover, this cluster's relation between dynamic feedback and funding behaviour is almost perfectly inverse (− .995). This type may hence be referred to as *Spocks*—acting fully rational, emotionless, and self-interested.

4.6 Social Surplus

Given the social dilemma character of the considered crowdfunding mechanisms, we now assess how the individual behaviour translates into a common group outcome. As a measure for this, we draw on the overall welfare generated, or *social surplus* (Franklin et al. 2009). In line with economic standard theory, we define social surplus as the overall realized utility from funded projects minus the projects' respective costs. Thus, social surplus (per period) ranges from 0 (no project realized) to $4 \times 750 - (100 + 200 + 300 + 400) = 2000$ (all four projects realized). Table 5 reports the results from an OLS regression on session level with social surplus as dependent and the treatment dimensions as independent variables. We find that social surplus is significantly higher for the dynamic as compared to the static feedback conditions ($b = 104.07$, $p < .01$). Moreover, social surplus is inversely related to personal budget shares. Specifically, we used two dummy variables to capture this treatment dimension's three levels (0, 50, 100%). The results show that the 0% level yields significantly higher social surplus than the 50% level ($b = 162.33$, $p < .001$) whereas the 100% level yields significantly lower social surplus ($b = -173.61$, $p < .001$). Overall, social surplus is well-explained by the treatment variables, reflected in an R^2 value of 91%.

Table 5 Regressions results for realized social surplus

Social surplus	Coef. (Std. Dev.)
Feedback (dynamic)	104.07 (24.70)**
Personal budget (0%)	162.33 (30.25)***
Personal budget (100%)	− 173.61 (30.25)***
Intercept	1294.85 (24.70)***
R^2	.910

*$p < .05$; **$p < .01$; ***$p < .001$

5 Discussion

5.1 Summary of Results and Theoretical Implications

In this paper, we investigated the emerging concept of participatory budgeting by means of a laboratory experiment, examining the fundamental design variables *feedback* and *personal budget*. Our results show that dynamic feedback promotes participants' arousal while it has a mitigating effect on funding amounts committed. The mitigating effect is due to improved coordination in project funding. At the same time, the presence of dynamic feedback results in higher overall welfare gains (social surplus).

Individual payoffs are higher when participants receive dynamic rather than static feedback. This is a clear indicator for better coordination, since participants manage to fund more projects with less investments. Importantly, this result is independent of the level of personal budget. Moreover, we find that personal budgets are associated with even higher levels of arousal and but decreased project funding levels. The different levels between investments due to dynamic feedback are more pronounced, when participants keep part of the budget privately. Most importantly, higher personal budget shares yield *lower* social surplus. Free-riding behaviour is most pronounced with 100% personal budget, where participants have full access to the budget and free-riding is more "profitable." Hence, whereas personal budgets appear to tempt users to withhold funding at the expense of social surplus, dynamic feedback enables a more efficient allocation of the (limited) funds. From a global perspective, a lower share of personal budget is preferred when it comes to welfare gains. With lower personal budgets, overall welfare can be realized through the projects. This is a goal of public institutions and corporations alike.

With regard to arousal, the opportunity to invest multiple times and react on other group members' investments expands the strategy space leading to a more complex decision process and interaction between participants. Dynamic feedback, hence, seems to create a situation that is more exciting and engages participants with the decision making process. The interaction created by dynamic feedback during the funding as well as the possibility to fund multiple times is perceived to be more exciting. Participants with higher shares of personal budget, however, report higher levels of arousal when asked at the end of the experiment. The ability to withhold personal budget makes the process and act of investing feel more exciting. If perceived arousal is aimed for when looking back on the process, specifically corporations may choose to implement personal budget withholdings. This distinction is driven by the reality that public institutions will rarely have a legal framework from which to refund public funds to some but not all individuals without overhauling their tax structures.

Since this is a driver for motivation, constituents are more likely to participate again. Being entrusted with a personal budget that constituents can keep privately leads to a higher perception of fun. Self-reported emotional arousal is also higher for those being able to keep the budget. Constituents are more excited about the funding with personal budget *ex post* than they are during the process. In contrast, constituents are as excited while investing budgets that they cannot keep but experience it less exciting

ex post. From a global perspective social surplus should generally be more relevant than small differences in self-reported arousal.

5.2 Practical Implications

Our findings provide several valuable starting points for the designers of participatory budgeting processes. When aiming for social surplus and user engagement through arousal, the application of dynamic feedback will positively affect both measures. Systems for participatory budgeting should hence mimic the status bars found in commercial crowdfunding platforms. Governments and corporations can likewise adapt the concept of crowdfunding mechanisms to have budgets allocated by their constituents or employees. They may do so by simply providing regular feedback on funding status of the projects, but they may also prompt users more actively, for instance, by an e-mail notification like eBay does when one is over-bidden by another bidder (Teubner et al. 2015). The provision of dynamic feedback appears expedient as it alleviates coordination among users and increases social surplus even though overall contributions are smaller. Dynamic feedback results in overall higher welfare gains, representing a major goal of enterprises and governments (Hall and Caton 2016). Dynamic feedback mechanisms address and fulfil these requirements, satisfying the call of Generation Y for being integrated in collaborative and cooperative decision-making processes. We therefore recommend dynamic over static feedback mechanisms in participatory budget processes when focusing on overall welfare.

With regard to personal budgets, our findings suggest that the retention of budgets is associated with losses in welfare and that from an overall perspective, budgets should not be available for personal use. This may, however, have unintended consequences on user engagement and participation, as also arousal (a potential stimulator in this regard) is positively associated with personal budget shares. Process design may attempt to compensate this loss of involvement by appealing to a psychological budget ownership ("See which projects your budget was used to realize…"). Platform designers can also phase in and out personal budgets to increase the desirability of the participation mechanism.

While the aforementioned implications are based on the design variables' overall effects, it is important to keep in mind that there exist different user types with varying design sensitivity. While our main findings are well-suited to describe about half of the sample, we also see that there emerge other, quite intricate user types. Specifically, *hedonistic spenders*, in contrast to all other users, exhibit greatly increased funding behaviour in the presence of dynamic feedback. This user type appears particularly interesting for the operators of participatory budgeting campaigns as they are likely to greatly support project realization. Targeting this exact type by suited marketing and network analysis should hence create the basis of successful budgeting campaigns even before the actual process starts. The other distinct user type, that is, the fully rational and rather unemotional *Spocks* appears to work in a complimentary way. An attractive attribute of dynamic feedback is that with less overall contribution more social surplus is gained: such a combination is generally attractive to rational bidders. In this sense,

our analysis supports practitioners in "tapping the right crowd" (Belleflamme et al. 2014).

Another potential path to extend participatory budgeting is civic crowdfunding. In civic crowdfunding, a public institution or NGO asks private donors to support a public project (i.e., budgets are fully personal by design) (Davies 2015; Stiver et al. 2015). This increases the transparency of financial transactions and constituents' sensitivity towards public budgeting (Miglietta and Parisi 2017). Yet, while it is interesting to see civil society partnering with sovereign players, civic crowdfunding in its current form has some major drawbacks. As mentioned, it might widen social inequality as wealthy neighbourhoods could benefit disproportionately from the combination of government funding and private financial support (Davies 2015)—especially when the distribution of private funds decides on the allocation of public budgets, as would be the case for double-up funding regimes. It is generally accepted, however, that a democratic society should counteract plutocratic tendencies to guarantee equal chances for participation and equal rights of co-determination, regardless of financial power.

5.3 Limitations and Future Work

There are several limitations to this study. First, lab experiments necessarily create an artificial environment. In particular, inducing specific utility values for blinded projects certainly limits our results' generalizability. Expected project values can usually not simply be measured and the individual utility scores for potential supporters are blurry, even—or especially—to them (see Mateos et al. (2015) a work on incomplete preferences). It has also been found that funding likelihood is directly related to subjective assessments of quality (Kuppuswamy and Bayus 2017; Mollick 2014). This suggests the need for experiments with actual projects (e.g., the provision of cold drinks to all participants as a "project") or field experiments (e.g., for on-campus projects). Second, considering that the process of crowdfunding can be emotional and value-laden, self-assessments of arousal have inherent and obvious limits due to a potential lack of objectivity. Future work may draw on psycho-physiological measures to assess participants' emotional states in a more objective manner (Hall and Caton 2017; Niemeyer 2017). This would also imply the possibility of investigating emotional states continuously and in high temporal resolution. Third, there is an unknown factor considering gender dynamics in the effect of personal budget shares on arousal (Marom et al. 2016). Given the structural difference in female and male participants, this could be an artefact of the sample distribution or a factor at play which deserves additional study. In future work, this limitation should be addressed by mandating balanced gender samples.

Other future works should consider the application of these findings to real projects and live systems. The abstract level of the laboratory experiments allowed to understand the mechanism and the investment behaviour with high internal validity. However, laboratory experiments always create an artificial environment and hence limit generalisability as private utilities for real public projects will be different and not observable. Arousal levels, too, cannot be generalised easily. When funding projects with real involvement, participants' emotions towards the content might interfere with

the emotions caused by the mechanism. The consequent next step is to take this understanding in the field and test its external validity with real projects. This extends the controlled setting of given preferences by insights on the investment behaviour based on personal preferences. The interaction of stakeholders, institution, individuals, and online platform need to be further evaluated to gain a complete picture of online participation.

6 Conclusion

This work has shown that both social welfare and participants' excitement, two essential objectives, can be increased significantly by introducing dynamic feedback. This central conclusion is also reflected in the current trend of progressing digitalisation and drastically increased information flow. Therefore, on the basis of this work, future participatory processes may be optimised, thus helping to prosper social welfare both in municipal communities as well as enterprises. Participatory processes need to adapt to future developments in information and communication technologies and corresponding effects on society. With the theoretical framework introduced within, the evaluation process will nevertheless stay the same but the recommended choice for policy makers or enterprises will vary.

Public institutions and corporations can adapt crowdfunding mechanisms to allocate budgets in a group, such as citizens or employees. Constituents will therefore be more intrinsically motivated to participate in such participatory processes. At the same time, dynamic feedback stimulates the funding of projects and results in overall higher welfare gains. Institutions focussing their decision on these target variables rather than other strategic considerations should design crowdfunding mechanisms with dynamic feedback properties for participative budget allocation. Maximising welfare and constituents' contentment represent two main goals of enterprises and governments (Lindner et al. 2015). Dynamic feedback mechanisms address and fulfil these requirements, satisfying the desire of Generation Y for being integrated in collaborative and cooperative decision-making processes (Eisner 2005). Therefore, dynamic feedback mechanisms are recommended over static feedback in participatory budget processes.

The decision on the share of personal budget must be made carefully, since a larger share of personal budget leads to more excitement but constituents can keep it privately rather than reinvesting in the project funding. In a multi-round system these two elements could reasonably be combined. While participants may be more eager to join the process when personal budgets shares may be maintained, if and when the overarching design goal is social surplus then personal budget should be avoided. In particular, enterprises can decide on the share of personal budget to increase arousal at the cost of lower welfare. Nevertheless, with changing laws and progressing trends in society, personal budget will find its way into participatory budgeting processes of public institutions.

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