

**NORMS, REWARDS, AND THEIR EFFECT ON THE MOTIVATION OF OPEN  
SOURCE SOFTWARE DEVELOPERS<sup>1</sup>**

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# **NORMS, REWARDS, AND THEIR EFFECT ON THE MOTIVATION OF OPEN SOURCE SOFTWARE DEVELOPERS**

## **ABSTRACT**

In this study, we conduct a scenario experiment testing the effect of monetary rewards on intrinsic motivation of open source software (OSS) developers. While we observe no difference in intrinsic motivation between the payment and no payment scenario, total motivation increases when a monetary reward is offered. We find that self-reported interest increases in the payment scenario when there is a norm for payment, whereas it decreases when there is a norm for no payment. We conclude that, under certain preconditions, monetary rewards may well be used in OSS development.

Keywords: open source software (OSS); motivation; crowding out; intrinsic motivation; norms about payment

# **NORMS, REWARDS, AND THEIR EFFECT ON THE MOTIVATION OF OPEN SOURCE SOFTWARE DEVELOPERS**

## **INTRODUCTION**

Agency theory argues that people being paid for engagement in activities they perform because they feel intrinsically motivated to do so introduces a disciplining effect and should make them pursue those activities all the more (e.g. Alchian & Demsetz, 1972; Fama & Jensen, 1983a, 1983b).<sup>2</sup> Psychology literature, however, clearly states that certain kinds of incentives have detrimental effects on intrinsic motivation. Especially rewards offered for completing a task (completion-contingent rewards) or rewards paid for a certain level of performance at a task (performance-contingent rewards) should undermine or “crowd out” intrinsic motivation (Deci, Koestner, & Ryan, 1999; Frey, 1994). In the context of community-based open source software (OSS), crowding out should have a particularly strong effect, intrinsic motivation being a main driver of the contribution of individuals (Hars & Ou, 2002; Lakhani & Wolf, 2005) and a crucial factor in determining OSS project success (Stewart, Ammeter, & Maruping, 2006a).

Monetary rewards, an external stimulus highly likely to induce crowding out (Deci et al., 1999), have been introduced into the domain of OSS mostly through engagement by commercial firms. According to Ghosh (2006), two thirds of all OSS software is written by individuals in their spare time and only 15 percent is contributed directly from firms. Yet, sponsorships and OSS source code releases by major corporations have constantly increased over the last years. Commercial firms spent an estimated cumulative 1.2 billion Euros for OSS development up till 2006, both indirectly by allowing or even encouraging their employees to work on public OSS projects or by directly supporting existing OSS. The latter can happen in various ways, for

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<sup>2</sup> Cf. e.g. Frey 1993 for a discussion on this.

example through provision of technical equipment or direct financial support. Businesses pay open-source developers intending to make developers better address the firm's particular needs inside projects, which by now affects one third of all OSS contributors (CED, 2006).<sup>3</sup>

Surprisingly, monetary rewards have previously been out to *not* crowd out intrinsic motivation in OSS (Hars et al., 2002; Lakhani et al., 2005; Roberts, Il-Horn, & Slaughter, 2006). Yet, no consistent and convincing argumentation for this phenomenon has so far been presented. We argue that it is the existing norm about payment (Staw, Calder, Hess, & Sandelands, 1980)—either a norm for payment or a norm for no payment—which will determine whether crowding out will happen or not.

In order to measure the effect of offering a (completion-contingent) monetary reward on OSS developers' intrinsic motivation, we conducted a scenario experiment with 229 students of computer science. The findings show that intrinsic motivation is not affected by offering such a monetary reward, while total motivation even increases for the payment treatment group. Indications for crowding out of intrinsic motivation are found when looking at the effect of the existing norm about payment: the norm for payment group shows higher self-reported interest when offered the reward, whereas a decline is observed for the group with a norm for no payment. Explanations for this phenomenon are self-selection and the meritocratic culture of the OSS community, both inducing that many developers will not perceive a shift in the locus of control—one of the main reasons for the crowding out effect to happen—when money is introduced into their domain. As long as they perceive their task to be performed autonomously, monetary rewards might even have positive effects.

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<sup>3</sup> The reasons for which commercial firms might (financially) support OSS projects and OSS development have been widely addressed by academic literature, see, e.g., Goldman and Gabriel 2005, Gruber and Henkel 2006, Hecker 1999, Henkel 2004, Lakhani and von Hippel 2003, Shah 2006, West 2003.

The remainder of this paper is organized as follows: first, we review the psychological literature to explain the concepts of intrinsic and extrinsic motivation, and the nature of the crowding out effect. Next, we highlight the importance of intrinsic motivation for OSS development. A description of data and methods follows. After the presentation of the results, we derive implications for theory and practice and discuss limitations of our study.

## **THEORY AND HYPOTHESES**

### **Intrinsic and Extrinsic Motivation**

Motivation is the energization and direction of behavior, where energy describes the needs of the individual and direction of the processes and structures that relate those needs to behavior (Deci & Ryan, 1985). Motivation consequently comprises of several factors that may explain each individual's overall motivation towards specific tasks (Amabile, 1983; Deci et al., 1985). According to Deci and Ryan's (1985) self-determination theory (SDT), three main types of motivation exist: intrinsic motivation, extrinsic motivation and amotivation. Intrinsic motivation is doing an activity just because of the satisfaction derived from it, whereas extrinsic motivation is performing a task as a means to an end or due to an obligation. Amotivation results from the dislike of accomplishing an activity or the feeling of being unable to carry it out.

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Insert Figure 1 about here

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Figure 1 gives an overview about Deci and Ryan's motivation continuum, which depends on self-determination and regulatory styles. While more intrinsically motivated people are satisfied through the exploring, challenging, playful, novel, spontaneous and/or creative nature of the task itself, individuals who are getting tangible and/or intangible benefits through external

intervention in order to achieve a certain outcome are said to be more extrinsically motivated (Deci et al., 1985; Frey, 1994). However, an individual is not either solely motivated intrinsically or solely motivated extrinsically. As Amabile (1983) states, factors from both dimensions may be present at the same time for a particular task one is working on.

In their cognitive evaluation theory (CET), a subtheory of SDT, Deci and Ryan (1985) explain influence factors affecting intrinsic motivation. Underlying psychological needs—the need for competence, autonomy, and relatedness—are shown to determine intrinsic motivation. Thus, any external factor affecting one or more of these needs either may undermine or enhance intrinsic motivation.

### **Crowding In and Crowding Out**

In the business world, external influence factors such as incentives are expected to boost effort and performance of workers, that is, reinforce motivation and intrinsic motivation in particular. Conversely, in psychology, most external influence is seen as having an opposite effect on motivation. External intervention in the form of a reward or a regulation is expected to “crowd out”, that is, diminish, intrinsic motivation, leading to reduced effort in the corresponding activity (Frey, 1994). Regarding the underlying psychological needs, in particular self-confidence, which comprises of the needs for autonomy and competence, is compromised (Bénabou & Tirole, 2003).

Still, not every external influence factor necessarily undermines intrinsic motivation: the nature and way of presentation of a reward also influences its effect on intrinsic motivation (Deci et al., 1999; Deci et al., 1985; Staw et al., 1980). An external reward conceived as purely informational by the individual may positively influence motivation. Moreover, positive performance feedback can boost people’s feeling of competence and thus enhance their intrinsic

motivation, while in contrast expected performance-contingent rewards undermine their intrinsic motivation (Deci et al., 1999).

Task-contingent rewards like for example paying someone for successfully finishing a task (“completion-contingent”) or even just for performing a certain task (“engagement-contingent”) may undermine intrinsic motivation. This is due to the fact that those rewards are more likely to be perceived as controlling rather than informational (Deci et al., 1999). The perceived locus of control shifts to outside oneself, that is, individuals feel that their behavior is controlled externally (Deci et al., 1999; Frey, 1994).

An important prerequisite for applying Deci and Ryan’s CET is the intrinsic interest of an activity (Deci et al., 1985). For uninteresting tasks, CET cannot be applied and a task-contingent reward may well increase performance on a task (“crowding in”) while, however, the total level of intrinsic motivation remains small (Bénabou et al., 2003). The more interesting an action is perceived to be, the more external intervention crowds out intrinsic motivation (Frey, 1994).

Summarizing, if the individual perceives the outside reward as controlling, it can be expected to undermine intrinsic motivation whereas rewards supposed as an indicator of competence are likely to enhance intrinsic motivation (Deci et al., 1999).

### **Norms about Payment**

Specifically looking at monetary rewards, an inhibitory effect on intrinsic motivation also depends on the normative information whether one should be paid for a certain task or not, the “norm about payment”.

In case a “norm for payment” exists, Staw et al. (1980) have shown that intrinsic motivation should usually not be inhibited by monetary rewards. Instead, a positive reinforcement effect may take place, as the monetary reward will be perceived informational rather than controlling. Deci and Ryan (1985) criticized that the crowding in effect measured by

Staw et al. when administrating the reward is that of fulfillment of the expectation (i.e., satisfaction) of the monetary reward. The positive effect captured by Staw et al. has thus to be considered as an increase in satisfaction rather than an increase in intrinsic motivation. The effect, namely higher self-reported interest in the task (i.e., a self-reported measure on fun and enjoyment derived from fulfilling the task) is, however, the same.

Although it is not easy to pre-determine norms towards specific tasks, voluntary activities for which it is socially accepted to have no payment are more likely to demonstrate some inhibitory effect (Staw et al., 1980). In an extensive series of interviews with community members of the open source project KDE, Allen et al. (2007) have shown that, if fundamental ideologies are followed rigidly in an open source project, the respective community has a “norm for no payment”, and external rewards can be expected to crowd out intrinsic motivation.

### **The OSS movement**

*Intrinsic motivation.* Lakhani and Wolf (2005) found that enjoyment-based intrinsic motivation is the strongest driver for OSS contributors. Most often, the inherent interest in OSS programming itself lets people join such projects. While coding, they experience a “flow state” (Csikszentmihalyi, 1975, 1990), which is a mixture of joy, creativity and challenge. One may experience such a state through selecting projects that match one’s skill level with task difficulty (Lakhani et al., 2005). A form of self-organization is applied through “meritocracy”: the more a member has already contributed to a particular project the more he or she can determine what features are built into the application next and in general control the future direction of the project (Roberts et al., 2006). Additionally, helping each other (“altruism”) may be another internal factor to join a project without any apparent benefit for oneself (Hars et al., 2002). Likewise, OSS ideology may play a strong role for the participant, that is, keeping software source code open and providing it for free to everyone (Hertel, Niedner, & Herrmann, 2003;



Stewart & Gosain, 2006b). Closely related to this is this give-and-take attitude of the OSS community (“reciprocity”) (Raymond, 2001). In this sense, strong OSS ideologists may also view their contribution as a gift to the community (“gift benefit”) which they feel obliged to give since they both use OSS themselves and benefit from the extension others did to the software (Bitzer, Schrettl, & Schröder, 2007; Wu, Gerlach, & Young, 2007).

***Extrinsic motivation.*** Hars and Ou (2002) show that—besides intrinsic interest in an activity—OSS contributors may also be extrinsically motivated: for example, one may need a fix to an existing bug or to include a missing feature or an add-on in a piece of existing software (“use need”). Sharing code and knowledge with the community may also result in others being more easily willing to give something in return (CED, 2006). “Signaling incentives” may be another reason for participating in a specific OSS project (Hars et al., 2002; Lerner & Tirole, 2002): developers may be driven by gaining reputation through the contribution inside the OSS community (“peer recognition”) or the ability to demonstrate their talent to possible employers, thus using the contribution to boost their future career development (“professional status enhancement”). Coders may also enhance their programming expertise (“skill enhancement”) through receiving constructive feedback from the community by peer reviews on their contributions (Lakhani et al., 2005). To avoid wasting effort, extrinsically motivated developers will thus only select to participate in OSS projects that they think will provide any benefit for them either immediately or in the future (Lerner et al., 2002; Stewart et al., 2006b).

## **Hypotheses**

The OSS movement is well suited to fulfill the before-mentioned requirements to measure the effect of payment on intrinsic motivation. In OSS projects, collaboration is done usually on a voluntary basis without receiving direct payment (Ghosh, 2006; Hars et al., 2002; Hertel et al., 2003), yet there are instances in which this is happening. Two research questions

arise from this, namely (1) is there an effect of payment on developers' motivation, and (2) what is the role of the existing norm about payment in this context?

Following SDT, monetary intervention should crowd out intrinsic motivation (Deci et al., 1999; Deci et al., 1985). However, as Frey (1994) states, extrinsic motivation should grow: assuming the level of crowded out intrinsic motivation is compensated by a higher level of extrinsic motivation, those who are paid for their OSS contribution may even show a higher level of total motivation than their volunteering counterparts. Furthermore, another effect that cannot be clearly separated from the first one exists: OSS developers can self-select the projects in which they participate. Consequently, OSS developers who are more extrinsically motivated (e.g. looking for status and reputation enhancement) *to begin with* will rather work on projects in situations in which these needs are satisfied:<sup>4</sup> in a study on firm-hosted user communities, Jeppesen and Frederiksen (2006) have shown that one of the main drivers of individuals to join such communities is the desire to be recognized by the firm hosting the community.

***Crowding out of intrinsic motivation.*** Some of the external factors presented above, such as use need, reputation enhancement, or signaling, may have been partially internalized by the individual (Roberts et al., 2006) and thus cannot be clearly identified as intrinsically or extrinsically motivating (Amabile, 1983). However, when choosing payment as a completion-contingent reward there should be a distinguishable and measurable inhibitory effect on intrinsic motivation: offering a monetary reward for completing the task should undermine intrinsic motivation (Deci et al., 1999; Deci et al., 1985).<sup>5</sup>

*H1: Developers offered a completion-contingent monetary reward for working on an OSS project have lower self-reported interest than developers not offered any reward.*

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<sup>4</sup> And vice versa for more intrinsically motivated developers.

<sup>5</sup> Addressing the afore-mentioned criticism by Deci and Ryan on the Staw et al. study, we will use the term self-reported interest for our hypothesis to describe that part of intrinsic motivation that can actually be measured in our experiment generation.

*Moderating effect of norms about payment.* Following Staw et al. (1980), the existing norm about payment moderates the effect of an external reward on intrinsic motivation. Thus, when a completion-contingent reward is offered to OSS developers there should be different levels of intrinsic motivation measurable for each group, depending on the existing norm about payment, and the application of a monetary reward.

Hars and Ou (2002) found salaried and contract programmers to be more strongly motivated by self-determination and personal need. Although the higher level of self-determination was unexpected for the paid group, they then correlated negatively with effort, which would acknowledge motivation crowding theory. However, Stewart, Ammeter, and Maruping (2006a) in their study on organizational sponsorship showed that, in contrast, organizational sponsorship increased interest in the respective OSS projects.

Lakhani and Wolf (2005) showed that developers receiving money in any form—second only to the level of intrinsic motivation—spend more time working on OSS than their peers and that being paid has no negative impact on intrinsic motivation, meaning that no crowding out happens. The authors argued that project contributors may have already “internalized” extrinsic motivation and that interplay between extrinsic and intrinsic motivation hinders dominant motives from crowding out each other.

Another survey from Roberts et al. (2006) found no crowding out of intrinsic but of internalized extrinsic motivation—such as use need, reputation, and signaling incentives—and thus suggests OSS communities to be open for commercial sponsors. However, it was also recommended to further examine the various effects by an experiment.

In this study, we will conduct such an experiment based on the research of Staw et al. (1980), who showed that an important moderating factor on the effect of a monetary reward of intrinsic motivation is the existence of a norm for or against payment. Consequently, we only

expect an inhibitory effect on intrinsic motivation—as measured by self-reported interest—through completion-contingent rewards when there is a norm for no payment. Thus comparing individuals who receive a monetary reward with a control group, self-reported interest should decrease for developers having a norm for no payment.

*H2a: Self-reported interest of developers with a norm for no payment will decrease when they are offered a completion-contingent monetary reward for working on an OSS project.*

*H2b: Self-reported interest of developers with a norm for payment will increase when they are offered a completion-contingent payment offered for working on an OSS project.*

Frey (1994), in his explanation of the outcomes of external intervention, states that two effects, an incentive or disciplining effect and a crowding effect of the reward, may determine how overall motivation looks like. If crowding out caused by an external reward is greater than the disciplining effect, overall motivation is reduced to a level even smaller than the initial level of intrinsic motivation. If crowding in of payment follows the direction of the disciplining effect and adds to intrinsic motivation, overall motivation increases. Besides these combinations, other ways of aggregation are possible as well: for example, the crowding out effect of an external reward may be lower than the disciplining effect, causing overall motivation to be higher than intrinsic motivation. In this case, developers who are offered payment may well show higher overall motivation to carry out the task than those who are not offered a monetary reward.

Depending on the respective norm about payment, payment will positively (norm for payment group) or negatively (norm for no payment group) affect intrinsic motivation while exerting a positive effect on extrinsic motivation. As past studies have not shown a significantly negative effect of payment on intrinsic motivation, we can assume that the overall effect of the administration of payment on total motivation is significantly positive. More specifically, we expect to see a positive and significant effect for the norm for payment group. For the norm for

no payment group, the external reward should at least offset the negative effects on intrinsic motivation.

*H3a: Total motivation of developers will increase when they are offered a completion-contingent reward for working on an OSS project.*

*H3b: Total motivation of developers with a norm for no payment will not decrease when they are offered a completion-contingent reward for working on an OSS project.*

*H3c: Total motivation of developers with a norm for payment will increase when they are offered a completion-contingent reward for working on an OSS project.*

## DATA AND METHOD

### Method

In our study, we combined an online survey with a scenario experiment. The online survey asked for demographic information as well as general and motivational questions about previous and current OSS project experience.

To realize the experiment, participants were randomly assigned to one of two versions of the survey which differed in only one question presenting the scenario. Pretests had been carried out with a rather generic OSS scenario but participants indicated that a more specific scenario design was necessary which was then again pretested and found to be valid. The final scenario described a fictional Voice over IP (VoIP) OSS project, for which interest was assumed to be high among the participants. The two scenarios in the two versions of the survey contained the same basic description, but only in one were participants offered a payment upon successful project completion (completion-contingent reward). The exact wording is displayed in Table 1.

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Insert Table 1 about here

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Additionally, we controlled for the existing norm about payment for each participant (see below). Combining treatment and norm about payment resulted in a 2 x 2 design similar to the one used by Staw et al. (1980), which allowed us to analyze between-subject effects and, in particular, the interaction effect between norm about payment and the administration of payment.

### **Sample**

The survey was conducted between February 5 and March 6 2007 and resulted in 229 valid responses. Computer science departments of several technical universities in Austria, Germany and Switzerland were requested to forward or post an invitation email for the OSS survey on their students' mailing list or newsgroup. Out of the 229 respondents, 90 had previously engaged in OSS projects and the remaining 139 were strongly familiar with the topic.

To minimize social desirability bias with respect to our research questions, the survey was advertised to be about programmer's experiences with OSS. Those who chose to answer the survey were randomly assigned to either the treatment or the control group. Whereas a problem of self-selection inherent to this type of survey remains, comparing our sample with that of previous studies showed no significant differences.<sup>6</sup> Furthermore, we conducted two informal interviews with industry experts who confirmed the validity of our scenario, sample, and the design of the norm about payment.

### **Dependent Variables**

After presenting all our survey participants a fictional OSS project from the field of VoIP, we asked them to indicate their agreement on several statements measuring their motivation operationalized on 1 (strongly disagree) to 5 (strongly agree) Likert scales. Our focus

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<sup>6</sup> In the samples by Hertel et al. and Lakhani and Wolf approximately 40 percent of the contributors were paid to participate in a particular OSS project. In this study, 38 percent of the 90 contributors had received payment for their contributions. The average age was 30 years in all three studies of Hars and Ou, Hertel et al. and Lakhani and Wolf, thus compared to the present study's mean of 26 years, those participants were four years older on average. This is attributable to the fact that the main target group in this survey was students. Results for gender are similar: compared to 89 percent male participants in this study, in previous studies 95 percent (Hars and Ou, Hertel et al.) and 98 percent (Lakhani and Wolf) were male.

was the measurement of intrinsic motivation through self-reported interest consistent with SDT and the Intrinsic Motivation Index (Ryan, 1982). This was achieved through the respective items “I would have fun working on this project” and “Participating in this OSS project would be enjoyable”. Additionally, we included a statement measuring individuals’ total motivation by directly asking whether they could imagine working on this project (“I could imagine working for this project”). Descriptive statistics on the respective variables are given in Table 2. To minimize social desirability, we placed different questions around and between these statements.

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Insert Table 2 about here

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### **Grouping Variables in the Scenario-based Questions**

***Treatment and control group.*** As described above, individuals were randomly assigned to either the treatment or the control group. The fictional OSS project was presented to both groups, however, the treatment group was also promised a financial reward upon completion of their project.

***Norm about payment.*** The operationalization of the norm about payment depended on whether individuals had previously engaged in OSS projects or not.<sup>7</sup>

For people who had previously engaged in OSS projects, we asked how often they had received any kind of monetary compensation for this. If this number was larger than zero, we assumed a norm for payment existed, that is, that those people thought it was OK to receive a

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<sup>7</sup> Controlling for differences between the two groups (worked on OSS project before, never worked on OSS projects before), we found that people who had not worked on OSS projects before showed slightly higher scores on the enjoyment measure, which is consistent with previous studies (Hertel, Niedner and Herrmann 2003).

monetary reward for working on OSS. Those people who had participated in OSS projects without receiving monetary compensation were assumed to have a norm for no payment.<sup>8</sup>

For people that had not previously participated in OSS projects, the fictional project we had presented to them would logically have been their first contribution to an OSS project ever. Consequently, we operationalized the norm about payment based on the reply to the statement “I think it is OK if people get paid for working on OSS projects” which was coded on a 1 (strongly disagree) to 5 (strongly agree) Likert scale. A norm for payment was assumed for people who strongly agreed to this statement, a norm for no payment for all others. The sample split according to our grouping variables is shown in Table 3.

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Insert Table 3 about here

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## RESULTS

Using Stata 9.2, we ran t-tests, ANOVA, and MANOVA to measure between-subject effects.<sup>9</sup> Our results are shown in Tables 4 to 9, Table 10 gives an overview.

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Insert Tables 4 to 10 about here

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<sup>8</sup> At first glance, the classification of individuals who worked on OSS projects in the past might be problematic. For example, while most people will have deliberately self-selected on a project fitting their norm about payment, some of the people who have not yet worked on paid projects might just not have had the opportunity to do so, but well have a norm for payment. However, by working on a non-paid project, that is a project with a dominant norm for no payment, those individuals will come in contact with others having a norm for no payment, which will influence their normative beliefs and weaken their norm for payment (Ajzen 2005, Fazio and Zanna 1981, Fazio, Zanna and Cooper 1978).

<sup>9</sup> T-tests were used when we were comparing two groups (i.e., one grouping variable), (M)ANOVA when we had four groups (i.e., two grouping variables).



With respect to H1, as shown in Table 4, the fun and the enjoyment measure as well as the index for self-reported interest constructed out of the two items show no significant differences between the treatment and the control group. Payment does not seem to cause a significant crowding out effect on intrinsic motivation. H1 can thus not be accepted.

Hypotheses H2a and H2b analyze the interaction effect between the norm about payment and the administration of payment. For our analysis, we used ANOVA and MANOVA. The results are shown in Table 5. When looking at the interaction effect for the measures for self-reported interest, all four specifications are significant at the 5%-level, the fun measure and the index even at the 1%-level. As shown in Tables 6 to 8 and illustrated in Figure 2, self-reported interest decreases if a developer is promised payment in the form of a completion-contingent reward and has a norm for no payment. Thus, H2a is accepted. For developers who have a norm for payment, self-reported interest increases when promised money. Consequently, H2b is also accepted.

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Insert Figure 2 about here

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H3 analyzed the effect of payment on total motivation as measured by the statement “I could imagine working for this project.” As shown in Table 9, total motivation significantly increases when introducing the monetary reward, thus lending support to H3a. Splitting the sample depending on the norm about payment, we do not find a negative effect of the completion-contingent reward on the no-payment group as predicted by H3b. A significant positive effect is found in the group with a norm for payment as hypothesized in H3c. As a result, H3a, H3b, and H3c are all accepted.

## DISCUSSION AND IMPLICATIONS

### Effects of Payment and Norms on Intrinsic Motivation

Our first hypotheses asked whether payment generally affected the motivation of a developer. The promise of a completion-contingent reward does, on average, not reduce developers' intrinsic motivation to participate in this project. This corresponds to the findings of previous studies on OSS developers' motivation by Lakhani and Wolf (2005) and Roberts et al. (2006), who could not find any crowding out effect on intrinsic motivation either.

Our second set of hypotheses analyzed the effect of both monetary reward and the existence of a norm for or against payment, which we have theorized to be the explanation why no crowding out had been observed in previous studies. Looking at H2a and H2b, our results are similar to those found by Staw et al. (1980). As hypothesized, we find an interaction effect between the two variables: people with a norm for no payment show a decline of self-reported interest when offered a monetary reward, crowding out thus taking effect. This is consistent with our considerations regarding OSS ideology: people strongly believing in ideological concepts around OSS will reject monetary rewards and perceive them as highly intrusive, and, thus, negatively affecting the need autonomy and competence.

Looking at the increase of self-reported interested in the norm for payment group, we find two explanations why the reward may have been perceived as informational rather than controlling, leading to the observed increase in satisfaction: self-selection and meritocracy.

Concerning self-selection, when looking at extrinsic motivational factors (see Table 11), people with a norm for payment are significantly more motivated by "professional status enhancement" ( $p < 0.01$ ) and "reputation enhancement" ( $p = 0.02$ ). The existence of a norm for payment can thus be taken as a general indicator for high receptivity to external stimuli.

Similarly, for those survey participants who had already contributed to OSS projects in the past

and have a norm for payment, we find that they already had significantly higher extrinsic motivation than their peers regarding “professional status enhancement” at a 5%-level (see Table 12). Developers with a norm for payment are thus more likely to join projects with an organizational sponsor than their peers, and they will do so for career concerns, that is, they specifically self-select into projects where they can signal their competence to the organizational sponsor of the project.

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Insert Tables 11, 12 about here

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For another group of developers joining sponsored OSS projects, in the context of the meritocratic OSS culture, these people will more strongly see the external reward as a indicator of competence—independent of their norm about payment.<sup>10</sup> This might even go as far as people attributing the external reward with cue value characteristics (Harackiewicz, 1979; Harackiewicz, Manderlink, & Sansone, 1984). While cue value is usually associated with performance-contingent rewards, this may well apply in the general context of OSS: getting a piece of source code accepted requires individuals not only to finish a task but to do so in a way the community acknowledges to match certain performance requirements.

### **Effects of Payment and Norm on Total Motivation**

Looking at overall motivation, we find that the administration of a monetary reward has a positive effect on our sample. For the subsample with a norm for no payment, there is no significant change whereas a significant increase in the level of overall motivation for the norm for payment group is observed. Overall, this shows the administration of a monetary reward will

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<sup>10</sup> As an indicator for this, when comparing agreement of the respective group (norm for payment, treatment) with the rest of the sample for the question “Participating in this project would give me a feeling of competence” in a t-test, we see a significant difference ( $p = 0.08$ ).

increase the likelihood that a random developer will join an OSS project if this project offers monetary compensation, the reason for this being that the positive effects of the external reward either outweigh the negative effects on intrinsic motivation as in the case of developers with a norm for no payment, or, naturally, add to the positive effects on satisfaction as in the case of developers with a norm for payment.

We thus see that, under the condition of an existing norm for payment, there is no case in which the monetary incentive has a negative effect on total motivation of overall sample. Still, while monetary rewards for tasks for which a norm for payment exists positively affect satisfaction at short-term, at long-term the expected payment may lose its effect (Bénabou et al., 2003).

### **Limitations**

Although sample size is by far large enough to guarantee statistical validity, the choice of sample population might have affected the outcomes of the study. Students might differ from “real” OSS developers and/or full-time programmers with respect to their experience with OSS, level of intrinsic and extrinsic motivation, their valuation of payment, and the importance of the existing norm about payment. However, as Henkel (2006) stated, people in the academic or educational field are significantly more enthusiastic about OSS, and should thus be more intrinsically motivated than others. Furthermore, Amabile et al. (1994) showed that professionals who had worked several years in the same position are less motivated by the enjoyment they derive from their work. Yet, if intrinsic motivation towards OSS is stronger in the academic field than amongst professional software developers, crowding out should have therefore been observable all the more in our study, which is not the case.

Also concerning the sample, our participants were mainly from one geographical area with rather similar culture (Hofstede, 2001) which may have again influenced participants’ level

of intrinsic and extrinsic motivation, their valuation of payment, and the importance of the existing norm about payment. Furthermore, this study has focused merely on the administration of payment on motivation. We have seen that the administration of payment increases the likelihood that a random programmer will contribute to an OSS project. However, what we cannot measure is the effect on contribution *quality*, that is, both the skill level of the contributor and the quality of his or her contributions, which might also be affected.<sup>11</sup> To address these concerns, one should try to conduct a similar study with an internationally active, large-scale OSS project.

### **Implications for Theory and Practice**

Our results lead us to maintain that, given a norm for payment, an external reward will not be perceived as controlling but rather as informational and, thus, does not have to undermine intrinsic motivation and creativity. We have identified two reasons underlying this phenomenon, (1) individuals with a norm for payment can—in accordance with their generally higher level of extrinsic motivation—self-select on projects that have organizational sponsors, and (2) the meritocratic OSS culture that may associate monetary rewards with cue value characteristics. On the other hand, individuals with a norm for no payment who do not associate the monetary reward with cue value characteristic will try to not select themselves into projects with organizational sponsors. If they cannot freely choose to not work on such projects—for example, if monetary rewards are introduced to an existing project on which those individuals are already working—the intrinsic motivation of those individuals will decrease, and crowding out may well be observed.

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<sup>11</sup> If individuals can self-determine how to carry out tasks, no negative effects on creativity of the solutions is to be expected (Amabile 1993). Yet, there are indications showing that people with a more hobbyist nature might more likely be a source of valuable innovation (Constant, Sproull and Kiesler 1996, Jeppesen and Frederiksen 2006, Lakhani, Jeppesen, Lohse and Panetta 2007). Similarly, posting a higher wage for a vacancy in firms increases the probability of it being filled, whereas expected average quality of applicants declines because less motivated workers are induced to apply (Delfgaauw and Dur 2007).

Our findings confirm those of Staw et al. (1980), again showing the importance of existing norms when looking at the effect of external rewards on intrinsic motivation, and shed light on the coexistence of intrinsic and extrinsic motivational factors of OSS developers. More generally, we feel that, consequently, the effect of a norm about payment should always be taken into account when analyzing crowding out phenomena. Furthermore, while we have shown the effect of rewards and norms for completion-contingent rewards, we feel that our results will hold for performance-contingent rewards, too, as those will act even more competence-enhancing under the precondition that individuals can decide how they carry out the tasks.

By offering a monetary reward in a specific project, organizations that think about sponsoring OSS efforts may successfully attract skilled developers to work on their specific needs: while our data show that the attracted developers will be more strongly extrinsically motivated than their peers, no difference in intrinsic motivation, and no detrimental effect of reward on total motivation is observable. On the contrary, the likelihood that a developer will start working on this project—expressed by total motivation—significantly increases. Yet, organizations should refrain from sponsoring projects that are follow fundamental ideologies, as—with a rather strong norm for no payment—the detrimental effects of rewards might easily outweigh their positive effects here.

Contrary to popular belief, a norm for payment will widely exist in the OSS world as, in many areas of OSS development, commercial firms and professional development are well established. Henkel (2006) has shown that most contributors in the field of embedded Linux are salaried or contract developers working for commercial firms. Amongst a majority of developers in this area, thus, a norm for payment is likely to exist.

Moreover, arrangements such as the Google Summer of Code<sup>12</sup> will succeed in attracting both intrinsically motivated developers who see the tasks presented as a challenge as well as extrinsically motivated ones who want to advertise their skills to Google as a potential employer,<sup>13</sup> and may consequently well be used for reputation-enhancing or recruiting purposes. Yet, while this study has shown that the administration of such rewards can make sense from a motivational point of view, organizational sponsors of OSS projects will need to evaluate whether the administration of rewards is also economically advantageous, in particular with respect to the quality of contributions by extrinsically motivated participants and, more generally, the level of skill of these individuals.

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<sup>12</sup> Participants in the Google Summer of Code receive \$4,500, the OSS project they work for receives an additional \$500 (Google 2007).

<sup>13</sup> In this extreme case, the prospect of possibly being employed by Google will probably even weigh more strongly than the direct financial reward administered by Google to participants of the Summer of Code.

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## FIGURES & TABLES

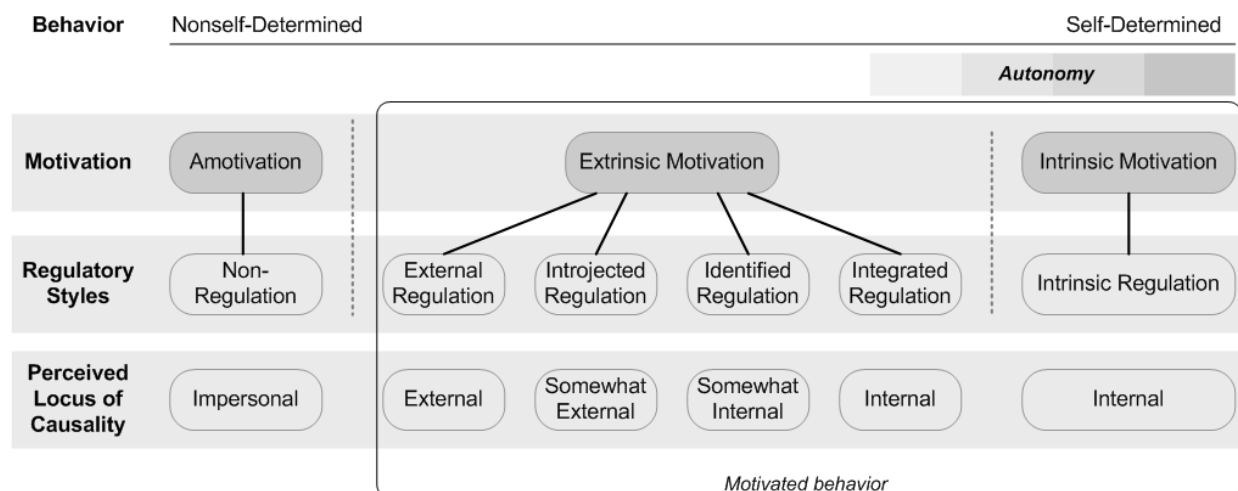
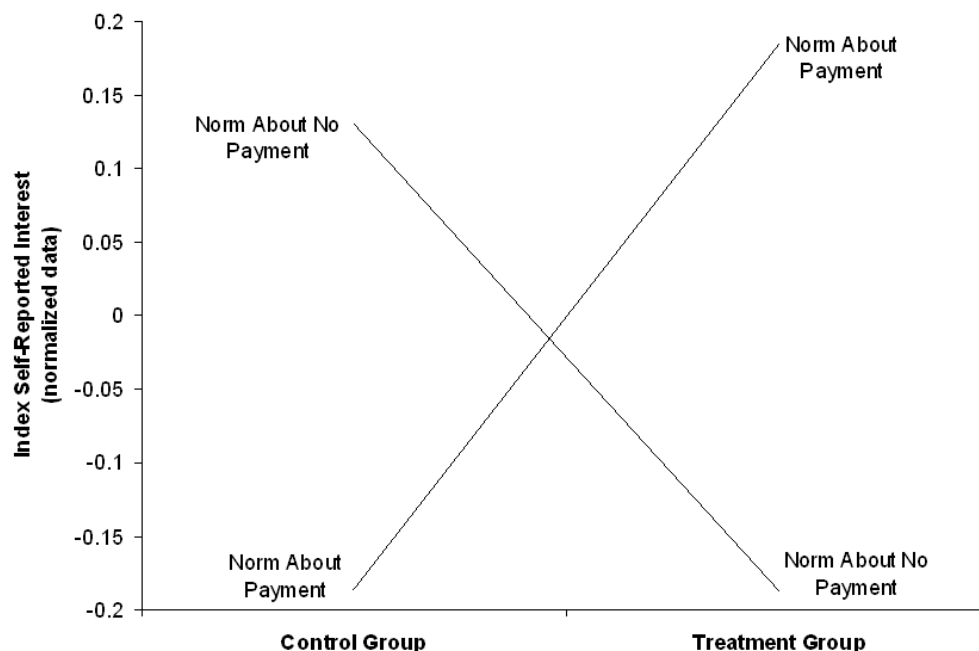


Figure 1: Types of Motivation Depending on Regulatory Style (Ryan & Deci, 2000)



**Figure 2: Interaction Effect of Monetary Reward and Norm about Payment (using the Normalized Index for Self-Reported Interest)**

<b>Standard Scenario Text</b>	<p>Imagine the following situation:</p> <p>You have received an email of the project leader of a newly created OSS project in the area of Voice over IP (VoIP). As VoIP is something you have been interested in for a long time, you know that no competing OSS project exists.</p> <p>The project leader is inviting you to participate in the project. In his mail, he describes a set of tasks that would most likely be assigned to you in case you accepted. He also estimates that the project will be completed in six months time.</p> <p>After reading the list of tasks, you realize that those tasks are challenging but feasible with your level of programming skill. They would require you to spend an average of 5 hours per week on the project (No matter your current situation, please imagine you could easily spend this much time on the project).</p>
<b>Treatment Supplement</b>	<p>Additionally, the project manager tells you that all project team members who complete their tasks within the six month timeframe will be <u>awarded \$2,500</u>. The money is provided by an organizational sponsor of the project.</p>

**Table 1: Scenario Text**

Variable	N	Med.	Mean	Std. Dev.	Min.	Max.	Share 4&5
I would have fun working on this project (Fun)	227	4	4.07	0.77	1	5	80.18%
Participating in this OSS project would be enjoyable (Enjoy)	229	4	4.04	0.8	2	5	78.60%
Index (Fun, Enjoy)	229	4	4.06	0.73	1.5	5	73.36%
I could imagine working for this project (Total motivation)	229	5	4.34	0.84	2	5	88.21%

Table 2: Descriptive Statistics for the Dependent Variables

Sample Split	Treatment	Control	Total
Norm for Payment	58	47	105
Norm for no Payment	57	67	124
<b>Total</b>	115	114	229

Table 3: Sample Split According to Grouping Variables

Variable		Treatment Group (N=114)	Control Group (N=115)
<b>Fun</b>	Mean	4.01	4.13
	Std. Dev.	0.73	0.81
	Median	4.00	4.00
	T-test (p-value)	0.11	
<b>Enjoy</b>	Mean	4.04	4.04
	Std. Dev.	0.82	0.79
	Median	4.00	4.00
	T-test (p-value)	0.50	
<b>Index Self-Reported Interest</b>	Mean	4.03	4.08
	Std. Dev.	0.72	0.73
	Median	4.00	4.00
	T-test (p-value)	0.29	

Table 4: Effect of Treatment on Self-Reported Interest

Variable	Treatment (T)	Norm about Payment (N)	T x N
<b>Fun</b>	0.35	0.59	<b>0.01**</b>
<b>Enjoy</b>	0.92	0.49	<b>0.04*</b>
<b>Index Self-Reported Interest</b>	0.73	0.85	<b>0.01**</b>
<b>MANOVA (Fun, Enjoy)</b>	0.45	0.39	<b>0.02*</b>

Table 5: Effect of Treatment and Norm about Payment

† p < .10

\* p < .05

\*\* p < .01

<b>Fun</b>		<b>Treatment Group (T)</b>	<b>Control Group (C)</b>
<b>Norm for Payment</b>	Mean	4.12	3.94
	Std. Dev.	0.78	0.94
<b>Norm for no Payment</b>	Mean	3.89	4.27
	Std. Dev.	0.67	0.67

Table 6: Descriptive Statistics for Fun Measure by Groups

<b>Enjoy</b>		<b>Treatment Group (T)</b>	<b>Control Group (C)</b>
<b>Norm for Payment</b>	Mean	4.19	3.96
	Std. Dev.	0.80	0.93
<b>Norm for no Payment</b>	Mean	3.89	4.10
	Std. Dev.	0.82	0.68

Table 7: Descriptive Statistics for Enjoyment Measure by Groups

<b>Index Self-Reported Interest</b>		<b>Treatment Group (T)</b>	<b>Control Group (C)</b>
<b>Norm for Payment</b>	Mean	4.16	3.95
	Std. Dev.	0.73	0.88
<b>Norm for no Payment</b>	Mean	3.89	4.18
	Std. Dev.	0.69	0.60

Table 8: Descriptive Statistics for Index on Self-reported Interest by Groups

<b>Total Motivation</b>	<b>Treatment Group (T)</b>	<b>Control Group (C)</b>	<b>T, Norm for No Payment</b>	<b>C, Norm for No Payment</b>	<b>T, Norm for Payment</b>	<b>C, Norm for Payment</b>
<b>Mean</b>	4.44	4.23	4.39	4.24	4.50	4.21
<b>Std. Dev.</b>	0.79	0.88	0.84	0.87	0.73	0.91
<b>Median</b>	5.00	4.00	5.00	4.00	5.00	4.00
<b>T-test (p-value)</b>	<b>0.03*</b>		0.83		<b>0.04*</b>	

Table 9: Effect of Monetary Rewards on Total Motivation

† p < .10  
 \* p < .05  
 \*\* p < .01

#	Hypothesis	Result
<b>H1</b>	Developers offered a completion-contingent monetary reward have lower intrinsic motivation than the ones not offered any reward.	rejected
<b>H2a</b>	Intrinsic motivation of developers with a norm for no payment will decrease when there is a completion-contingent monetary reward offered in an OSS project.	accepted
<b>H2b</b>	Intrinsic motivation of developers with a norm for payment will increase when there is a completion-contingent payment offered in an OSS project.	accepted
<b>H3a</b>	Total motivation of a developer will increase when a completion-contingent payment is promised in an OSS project.	accepted
<b>H3b</b>	Total motivation will not decrease for developers with a norm for no payment when there is a completion-contingent payment promised in an OSS project.	accepted
<b>H3c</b>	Total motivation will increase for developers with a norm for payment when there is a completion-contingent payment promised in an OSS project.	accepted

**Table 10: Overview of Hypotheses**

Variable		Norm for Payment	Norm for No Payment
<b>Status Enhancement</b>	Mean	4.17	3.89
	Std. Dev.	0.89	0.78
	Median	4.00	4.00
	T-test (p-value)	<b>0.01**</b>	
<b>Reputation Enhancement</b>	Mean	3.80	3.59
	Std. Dev.	0.94	0.90
	Median	4.00	4.00
	T-test (p-value)	<b>0.04*</b>	
<b>Index Extrinsic Motivation</b>	Mean	3.99	3.74
	Std. Dev.	0.73	0.69
	Median	4.00	3.50
	T-test (p-value)	<b>0.01**</b>	

**Table 11: Norms about Payment and Extrinsic Motivation**

† p < .10

\* p < .05

\*\* p < .01

Variable		Did OSS, Payment (N=34)	Did OSS, No Payment (N=56)
<b>Status Enhancement</b>	Mean	3.82	3.41
	Std. Dev.	1.16	1.31
	Median	4.00	3.00
	T-test (p-value)	<b>0.06†</b>	
<b>Reputation Enhancement</b>	Mean	3.12	2.85
	Std. Dev.	1.34	1.19
	Median	3.00	3.00
	T-test (p-value)	0.17	
<b>Index Extrinsic Motivation</b>	Mean	3.47	3.15
	Std. Dev.	1.07	1.04
	Median	3.50	3.00
	T-test (p-value)	<b>0.08†</b>	

**Table 12: Motivational Factors in Past Projects**

† p < .10  
 \* p < .05  
 \*\* p < .01