ARTICLE TEMPLATE

Personal Characteristics Affect Motivations on Open Source Platform

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ABSTRACT
Open source software projects are being diversified and merged under platform business model and external incentives. The external incentives affect participants with different manner through their personal characteristics, and then induces their intrinsic or extrinsic motivations. Based on personal characteristics as indications and structural equation models as research method, this paper measures personal characteristics on Open source software platform, and constructs structural model to validate the affects of personal characteristics on intrinsic and extrinsic motivations. Results on oschina.net platform shows that: 1) personal characteristics have positive effect on intrinsic and extrinsic motivations; 2) self-determination and expertise level could discern specific motivations; 3) intrinsic motivations are more complicated to be indicated. The results suggest that software project managers should consider those associations when initialize projects and design incentive strategy.

KEYWORDS
Open Source Project; Intrinsic Motivation; Extrinsic Motivation; Expertise Level; Team Attachment; Self-Determination

1. Introduction

Open business models are integrating open-source software(OSS) and proprietary software to absorb their technical advantages and crowding resources. The integration has generated valuable knowledge repository to the software industry. In another side, it also diversified participants and projects. At the beginning of open source movement, there are clear boundaries between open and close software developments, and platforms could motive their participants respectively. However, in current software projects, we have to recognize their boundary and patterns on platforms to motive their projects efficiently.

Open source software started at 1990s with mark stone of the Linux Kernel under public licence. This "open source" model quickly drove new Linux development, and later become a viable alternative to proprietary system [27,21]. Open source software was derived from advocate of free software, but essential not complete free and liberty. A simple definition of open source software is "those systems that give users free access to and the right to modify their source code" [35]. This free ideology was advocated by open source software movement with "diversity of project structures, diverse employ-

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ment arrangements, co-existence of corporations and communities and co-existence of the creative and commercial elements" [14].

Open source software projects have been studied under various aspects of business model, motivation, knowledge repository, etc. Firstly, as private-provided public goods, software company could utilize open innovation network to elevate the efficiency and quality of their development process [16]. Hence, intelligence property and protection were debated on relatively macro levels. Secondly, project mangers should analyse motivations of participants to get returns continuously. In practice, consider that how does the motivations affect contribution and software quality in open platforms [30,20]. Thirdly, the open source projects are valuable knowledge bases to support research and innovation, therefore, companies were opened their projects to attract developers as a special kind of open innovation [18].

The compounded properties of OSS platform generated novel incentive flow on participants, like figure 1 presented. With capable to be commercialized [8], open source projects have been merged into proprietary projects at multi-levels. Both company and participants are free to develop software and adsorb knowledge inner public repositories.

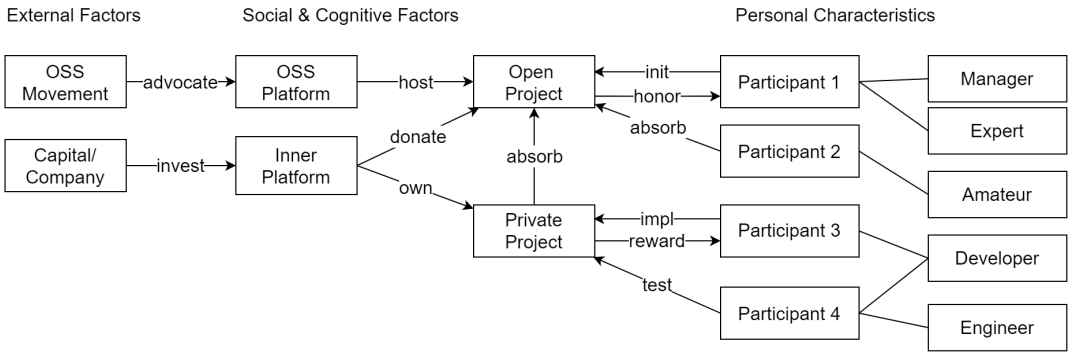

Figure 1. Merging software development with heterogeneous participants

At the left of external situation, capital and open movement are imposing a tendency of diversification and integration on platforms. When projects are being merged, the first stage of collision will inevitably diversify OSS projects, both for their procedures and participants. This stage requires company to motivate participant specifically for value absorption. When companies build their business on OSS [7], they should motivate participants to facilitate the commercialization and maintenance of the immature software. Currently, software platforms are evolving from content to collaboration. Participants are not transfer codes with hosted knowledge base or software project, but collaborate like real organization. At middle level, both company and participants could freely choose projects with their preference, demand and motivations.

To facilitate high quality development toward software platform business model, we should design efficient incentive strategies motivate participants and absorb values from the project. However, the current studies hasn't resolved this issue in systematic way. In detail, there are two gaps in current studies for incentive strategies of compound open source development. Firstly, Diversified and mixed roles of participants require more explicit and compact approaches to analyse their motivations. In another word, we could not systematize the motivation for software development on China open platforms. Like table 1 listed, studies have validated diversity of the motivations

from intrinsic to extrinsic motivation. In addition, many factors are conditioned on participants, such as commitment to the ideology varies widely across developers [29]. Secondly, most current studies focused on correlations among behaviour, motivation and performances, but hasn't consider the efficient incentives at the outside. Many studies concluded that many incentive works. For example, intentions to continue with OSS development was influenced by both helping behaviour and economic incentives [34]. How the social practice and its supporting institutions mediate between individual motivation and outcome [12].

The gaps generated a problem to continuously motivate engagement of the free participants with ground measurements. Correspond to the problem, this study discovered personal characteristics which could indicate motivations significantly on China OSS platform. The rationale is as follows. If we could associate the personal characteristics to motivations, we could recognize motivation of participants, and design corresponding incentives to facilitate OSS projects. If associated, the easier measured personal characteristics could improve the incentive of open source project and increase returns of investment. Personal characteristics and team attachment are more easily be acquired by survey or query. In contrary, the motivations are usually been disguised in real situations.

The composition of this paper is as follows. Section 2 introduces the motivation theory and personal characteristics and puts forward hypotheses accordingly. Section 3 uses questionnaire method to collect data. Section 4 validate and discuses the hypothesis through structural equation models. The last two sections concluded our study and proposed implications for practitioners.

2. Theory and hypotheses

In this section, we summarize intrinsic and extrinsic motivations related on OSS projects, and specify the division of motivations. Next, we measure related personal characteristics and propose hypotheses correspondingly.

2.1. Motivations

Motivations are drive forces within a person to initiate behaviour. Under a widely accepted theme in current literatures, motivations for open source project participation have been grouped under two broad categories: intrinsic and extrinsic [16]. Both extrinsic and intrinsic motivation influence individual intentions regarding an activity as well as their actual behaviours [17]. In another side, it is immediacy that discerned the two motivation types, such that intrinsic motivation emphasize inherent satisfactions rather than their separable consequence [20].

Table 1. Components of Motivations about OSS

Study	Intrinsic Motivations	Extrinsic Motivations
Hars & Ou [9]	Self-actualization; Altruism; Community Identification	Revenue; Human Capital; Self-marketing; Peer recognition
Rossi & Bonaccorsi [23]	Creative pleasure; Altruism; Sense of belonging; Fight against proprietary	Monetary rewards; Low opportunity costs Reputation; Future career benefits; Learning; Contributions; Tech concerns; Filling an unfilled market
Bitzer & Geishecker [3]	Need for a solution; fun/play; gift culture	
Wu et al. [34]	Helping	Enhancing human capital; Career advancement; Personal need
von Krogh et al. [32]	Ideology; Altruism; Kinship; Fun	Career; Payoff
Lee & Kim [16]	Task involvement; goal identification	Good reputation; Chance of good job
Krishnamurthy et al. [14]	Fun; intellectual stimulation; personal achievement	Qualification and skill; personal status; opportunity of better job

The two motivation types have blur boundary, because they could be transformed to another [9,22]. For example, in self-determination continuum, the middle range is internalized extrinsic motivation which contains reputation, reciprocal altruism and learning [32,24].

2.1.1. Intrinsic Motivation

Intrinsic motivations focus on internal satisfaction which often are instant and instinctive [16,17,34]. In psychology, intrinsic motivations are ascribed to two sources: engagement and target identity [16,5]. Practically, we could recognize intrinsic motivations through following approaches: 1) solve issues(self-determine, expectation), pleasure and contribution [3]; 2) *VIST* of valence, instrumentality, self-efficiency and trust; 3) knowledge creation, altruism, attachment and pursue of liberty software.

2.1.2. Extrinsic Motivation

In open source platforms, participants also pursued future rewards which are successive from an external objects [16]. In broad sense, the reward included monetary reward, reputation and career enhancement. As a consequence and incentive, we could motivate participants directly with different formants of reward, compensation, bounty [34]. In addition, we also support participants through community and social network [35], which motivate participants with awarded reputation.

The extrinsic motivations include reputation and career development, which are substrates of payoff and self actualization. Pursue high quality software will bring reputation to the participants, and, as stable external objects, the reputation and pursuit will evoke extrinsic motivations. And, as consequence, accumulate social capitals and skills to enhance new job opportunity [34]. Many studies validated that reputation and career development are primary motivations in open source projects [15,34,22]. Most peripheral participants are relatively attracted by extrinsic motivations. That is, novice members may have a strong motivation to participate in the virtual community, often driven by some specific task orientation, such as needing to solve a problem or seeking particular information [30].

2.1.3. Relate to Incentives

Motivations are associated with incentives with two sides. In one side, reward is a specific kind of extrinsic motivations. In another side, incentive could evoke motivations, but its consequences may exceed expectations with diversities. Many studies reported that several incentives may negatively affect motivation of participants. In essence quality of openness, opening one side of a proprietary platform may lower incentives to invest in platform quality [28]. For monetary rewards, many studies examined the degree of participation and its link to financial motives, but may cause different acceptance level [32,14]. In special aspect, organizations financial-based incentives may discourage rather than encourage knowledge sharing if employees perceive that knowledge sharing will hinder their distinction [33].

Those diversified reactions suggest that we should careful to design open and incentive strategy. Incentives and strategies should be applied differently to make a project succeed and achieve higher beneficial and continuous improvement.

2.2. Personal Characteristics

In our hypothesis, personal characteristics are measured from self-determination, expertise level and team attachment. In open source projects, participants are obviously belonged to different roles, such as project leader, active developer and bug reporter [7,35]. Whence technical supremacy being appreciated, high level developers will acquire reputation through their expertise and contributions.

Table 2 listed evidences of our hypotheses which extracted from current studies. Several evidences could directly support our hypotheses, but many are in-direct and relatively weak. This is a reason we study the association of personal characteristics and motivations for empirical validations.

Table 2. Evidences of Structural Model

Construct	Intrinsic	Extrinsic
SDT	Internalize through psychological needs: "Psychological growth is typically manifested by intrinsic motivation"(++)[31]. In self-determination continuum, when individuals are autonomously motivated, they engage in a particular behavior because of its inherent satisfactions.	SDT differentiates needs from what might be referred to as desires(-)[31].
EXP	when people are confident of their ability, they tend to be more motivated to do so through EKRs(+)[13]. Students and hobby programmers seem to be more strongly motivated by altruism and community identification(-)[9].	programmers (rather than bug fixers, or managers) were motivated through peer reputation(++)[32]. members experience levels positively moderate the relationship between we-intentions and contribution behaviors[30]. pragmatic motives should be mainly relevant to users which have basic programming skills[11]. New members are attracted to an OSS community because the system can solve one of their own problems(-)[35,29].
TEAM	According to the social practice view, motivation is intimately linked with a membership of OSS(+). The pro-social motive is a type of intrinsic motivation(+)[32]. Higher levels of adherence to freedom beliefs negatively impacted communication quality, cognitive trust, and team effort[29].	collective empathy positively affects team learning, speed-to-market and less development cost(+)[1]. Group norms affects behavioural desires(+)[30]. Members close to the centre of the community enjoy better visibility and reputations than do peripheral members(+)[35].

2.2.1. Expertise level

A definition of expertise level is: the amount of acquired knowledge regarding the development of programs, so that the ability to analyse and create programs is improved[27]. It associates to motivations through self-efficacy and recognition in community. Firstly, In open source platform, sophisticated programming skills are most essential factor to improve software quality. Hence, expertise implied self-efficacy for achieve high-level of actualization and internalized motivations. According to flow channel segmentation model, perceived requirements have to be in balance with the persons ability level[19]. Secondly, pursue pleasure or reputation require the proper expertise level. For example, from the individuals point of view, if students are not familiar with a subject or topic being talked about, they simply do not have much to say, therefore accounting for their limited interest in sharing[6]. The need to exhibit expertise in an environment populated by other experts is likely to make reputation a stronger and more direct determinant of contributors' careers[20].

Extrinsic motivations are necessary trigger to enact expertise of participant. Essentially, an individual has innate pursue to pleasure and exploration which could transform to commitment[33]. From immerse theory, appropriate levels of capacity and challenge will sustain that commitment. However, if involved judgement of expertise, participant will consider utilities to engage project, or the engagement will be ascribed to self-determination which are associated with intrinsic motivation. Ex-

cept the self-judgement, participant may virtualize observer effect and social learning practice, i.e., virtual external attentions will increase performance when participant has quite well expertise level. This is because people tend to like to do things they think they are good at, since the more skill oriented a task is, the more relevant competence-assessment feedback should appear [25].

Low expertise level participants, tend to access open source project as career and learning enhancement. But it also associated intrinsic motivation of altruism and universalism [9]. Plus the actualization from expertise level, we hypothesize that the mixed affects cause negative association between expertise level and intrinsic motivations.

H1: Expertise level of participants have positive effect on extrinsic motivation.

H2: Expertise level if participants have positive effect on intrinsic motivation.

2.2.2. Team attachment

Attachment could be described as lasting psychological connectedness between human beings. Except the original requirement of belonging, attachment are widely associated to other factors in later developments, also include motivations on OSS platforms [32].

Team attachment associates to intrinsic motivations through competence utterance and collective empathy. Programmers as motivated by the feelings of competence, satisfaction, and fulfilment [9]. Here, the feelings of competence is a special motivation compare to participation of content provision like Wikipedia codification. Collective Empathy as feeling of kindness to other members in a group [1,29]. This emotional comprehension and reaction of an individual are correlated to knowledge share and team cooperation. Hence, team attachment is derives from desire of reputation and implicit reward of an individual that build on the collective empathy.

Team attachment also associate to extrinsic motivations through identification and social capitals. Identification with the OSS community will positively impact an individuals level of support for corporate engagement [2]. Social integration is defined as the extent to which an individual perceives himself/herself to be trusted and accepted by the other FOSS community contributors [4]. It could be suggested that those with poor social connectedness are more likely to use the Internet for a social purpose, however they do not necessarily receive psychosocial benefits for doing this. common sense that contribute and sustain a group at long stage will require an external motivation as foundation.

H3: Team attachment have a positive effect on intrinsic motivation

H4: Team attachment have a positive effect on extrinsic motivation

2.2.3. Self-Determination

The intrinsic motivation includes ideology, pleasure and self actualization which all associated to intrinsic motivations respectively.

Ideology is the tenet of open source software, which is nourishing other motivations, like pleasure and reputation. Ideology is defined as norm, belief and value [32,29]. This ideology should be sufficiently sustained by self-determination, otherwise, the open project will be suspended.

According CET theory, individual's intrinsic motivation will be evoked in an competitive situation [24]. Several factors, like appropriate competitive level, positive feedback and autonomy, will sustain the evoked intrinsic motivation. increase individuals perceived competence at an activity should increase his or her level of intrinsic motivation for the task [22]. On platform, strong autonomy and goal orientation will evoke

intrinsic motivation of participant [5].

The long process of actualization require a solid condition of self-determination. Self-determined behaviour are antecedent to seek out novelty and pervasive fun [24]. In contrary, external factors may act negatively, such that people typically do not experience well-being when they have a strong need for concepts such as power or wealth [31]. If the commitment are sustained continuously, then, participant will get bonus of self actualization which founded on high quality of software [32]. Obviously, the high quality is depended on the commitment as a equilibrium of the open ecology. Under the evoked actualization, participants will achieve a stability to develop and exceed themselves which primarily rely on intrinsic motivation.

H5: Self determination have a positive effect on intrinsic motivation

3. Methods

3.1. Data Sources

The aim of this research is to explore personal characteristics which could indicate motivations of open project participants. Accordingly, we surveyed participants of oschina.net, a China open source platform. From profile page of participants, we extracted their email addresses, and send questionnaire to them through the emails.

We received 105 questionnaire and kept them all, since online participants are objects to be motivated, i.e., potential developer to mixed software project. 90% participants are engaging works about software development, and majority were interacted with platform through initiate project, commit code, report bugs, etc.

3.2. Data features

The questionnaire was queried several basic attributes of participants, as table 3 presented.

Table 3. Descriptive Statistics

Trait	Proportion	Trait	Proportion
Gender		**Interaction**	
male	93.33%	initiate project	22.86%
female	6.67%	commit code	47.62%
Education		report bug	40%
$\leq$ college	19.05%	ask question	56.19%
under-graduate	62.86%	answer question	65.71%
$\geq$post-graduate	18.1%	**Engaging in software jobs**	
		Yes	89.52&
		No	10.48%

Most responders are male, and only 6.7% responders are female. Of educational level, the median is under-graduate that are most probably hired by software development vocation. That is, mos responders are engaging in software jobs. As the interaction indicated, the responders are relatively active to initiate project and commit code.

3.3. Survey Design

The questionnaire can be divided into three parts: 1) demography information, 2) personal characteristics and 3) motivations. Table 3 counted their demography distribution. Table 4 listed the typical questions and sources of personal characteristic and motivations. We modified part of questions to adapt our study. Most questions are 7-level Likert scale, and supplied with several discrete questions.

Table 4. Questionnaire to evaluate personal characteristics and motivations

Item	Wording	Measurement Sources
Expertise Level (1: no experience, 7: experienced)		
EX-1	n a scale from 1 to 10, how do you estimate your programming experience?	Siegmund et al.[27]
EX-1	How do you estimate your programming experience compared to experts with 10 years of practical experience?	Sepehr & Head[26], Wu et al.[34]
EX-2	How do you estimate your programming experience compared to your classmates or colleague?	Wu et al.[34]
Team Attachment		
TA-1	I enjoy sharing my knowledge with colleagues.	Lin[17], Lakhani & von Hippel[15]
TA-2	I intend to share knowledge with my colleagues	
TA-3	Team members conducted frequent informal communications	Akgn et al.[1].
TA-4	embers of the team have a sharing relationship with each other. We can freely share our ideas, feeling and hopes.	Stewart & Gossain[29]
Self-Determination		
PC-1	I always feel like I choose the things I do.	
PC-2	I choose to do what I have to do.	
PC-3	I do what I do because it interests me.	
PC-4	I am free to do whatever I decide to do.	
Intrinsic motivations (1: very dis-agree, 7: very agree)		
IDE-1	I believe that source code should be open.	Krishnamurthy et al.[14]
IDE-2	Open source programmers should help each other out.	Hars & Ou[9]
JOY-1	I enjoyed doing this activity very much.	Krishnamurthy et al.[14]
ACH-1	Participating in the project gives me a feeling of accomplishment.	Hars & Ou[9]
ACH-2	Participating in the project gives me a feeling of effectiveness.	Hars & Ou[9]
Extrinsic Motivations		
CAR-1	Working on an open source project gives me the chance to attain a recognized skill.	Krishnamurthy et al.[14].
CAR-2	Dedicate to OSS development advanced my skill level of programming.	Oreg & Nov[20], Hars & Ou[9], Wu et al.[34]
CAR-3	Develop open software is critical for my business or my work.	Hars & Ou[9], Wu et al.[34]
FAM-1	Working on an open source project enhances my professional status.	Krishnamurthy et al.[14]
FAM-2	Participate OSS helped me build up my reputation as an expert.	Oreg & Nov[20], Krishnamurthy et al.[14]

3.3.1. Independent Variables

Along the hypothesis, we selected three personal characteristics predict the motivations of participant. Firstly, expertise level measure the experience and programming skill of participants. It has objective aspects to count the activities(AC), such as commit code and answer question. In another side, we asked the participants to assess their level by compare to experts or colleagues(PC). Secondly, team attachments are the willing to join and contribute to group and community. Participants may have several bonds to a community with psychological and cogntive factors. Thirdly, we applied questionnaire of self-determination theory with selected questions from awareness of self(AS) and perceived choice(PC).

3.3.2. Dependent Variables

Dependent variables are motivations which have been described in section 2.1. In the questionnaire, we queried participants: 1)intrinsic motivations of ideology(IDE), pleasure(JOY) and actualization(VAL); 2) extrinsic motivations of reputation(FAM) and career development(CAR). We applied the following factors to indicate the ideology: liberty of software and information, sharing and help each other. Those activities of share and help may derive from pure altruism like gift culture[34], or more widely be ascribed to reciprocal altruism. Those platform-related motivations with be regressed on personal characteristics. To validate the hypothesis on the various evidences in table 2, we will construct latent variables and explore if they could be indicated by personal characteristics significantly.

4. Results and discussion

4.1. Reliability and validity of questionnaire

Table 5 presented discriminant validity of constructs. Elements in diagonal are average variance extracted which calculated from new criteria[10]. Other elements are means, standard variance and square of correlations. According to the table, we could ensure that variance shared by construct and its items are greater than that of other constructs[14].

Table 5. Discriminant validity of the constructs of interest.

	MEAN	STD	AC	EX	TA	AS	PC	IM	EM
AC	0.91	0.62	0.68						
EX	16.26	5.46	0.19	0.93					
TA	14.13	2.32	0.06	0.08	0.92				
AS	9.13	3.94	0.04	0.16	0.01	0.93			
PC	9.04	1.79	0.00	0.00	0.15	0.02	0.83		
IM	32.62	6.49	0.13	0.06	0.26	0.01	0.12	0.86	
EM	25.02	5.10	0.04	0.04	0.15	0.04	0.04	0.43	0.91

In the table 5, intrinsic motivations are primarily associated with awareness of self and team attachment. Extrinsic motivation are associated with team attachment, but hasn't shown association on other personal characteristics. The intrinsic and extrinsic motivations are positively correlated as well, since they distributed on self-determination continuum[24], and shared team attachment in our questionnaire.

4.2. Regression analysis

We apply python package *statsmodels* to perform linear regression. The effects between personal characteristics and special motivations were evaluated toward the above hypotheses testing. The fit were assessed by coefficient significances and explained variances (R^2). As depicted in table 6, The proposed model explained a certain proportion of the specific motivations (ranging from 0.23 to 0.35).

Table 6. Regression Models

	IM_IDO	IM_JOY	IM_VAL	EM_FAM	EM_CAR
AC	0.412*	0.175	0.098	0.233	-0.014
	0.216	0.269	0.248	0.279	0.234
EX	-0.064	0.059	0.113*	0.176***	0.190***
	0.050	0.063	0.058	0.065	0.055
TA	0.392***	0.330***	0.481***	0.240*	0.412***
	0.110	0.137	0.126	0.142	0.119
AS	0.010	0.097	0.145*	0.226***	0.193***
	0.064	0.080	0.073	0.083	0.069
PC	0.133	0.275***	0.116	0.308***	0.114
	0.103	0.129	0.118	0.133	0.112
const	7.327***	3.713	2.461	-0.032	1.883
	1.883	2.343	2.157	2.426	2.038
AIC	518.473	564.308	546.973	571.622	535.026
BIC	534.397	580.231	562.897	587.546	550.949
R-squared	0.251	0.233	0.306	0.296	0.349
Note:					*p<0.1; **p<0.05; ***p<0.01

From the regression coefficients and t values, hypothesis H1 was weakly supported, and H2 was supported. That is, expertise level could weakly affect ideology and achievement, but strongly affect reputation and career of participants. This should be observer effect that in dominance, in which expertise was impose participants to sustain their skill level and reputation. Hypothesis H3 and H4 were supported, as the related study proposed, engaging a community must imply a purpose, whatever solve problem of freshmen or achieve reputation of experts. In detail, team attachment affect all constructs of motivation, only a bit weak on reputation. H5 was weakly supported. But interestingly, the awareness of self(AS) and perceived choice(PC) are act separately, and both are failed to distinguish the intrinsic motivation from the desire[31].

4.3. Confirmatory analysis

We also applied python packages *semopy* to perform structural equation model (SEM). Results of the SEM analysis are presented in table 7. Generally, all effects in the structural model are significant, except the association between count the activities(AC) and intrinsic motivation. This exception confirmed the table 6, where, the AC has weak effect on ideology. For external validity of the structural model, CFI(0.94) is higher than benchmark 0.90, and the RMSEA(0.079) is not in acceptable range which less than 0.07[14]. In addition, the NFI(0.86) is in moderate acceptable level.

Table 7. Structural Model

	lval	op	rval	Estimate	Std. Err	z-value	p-value
0	IM	~	AC	0.178	0.141	1.264	0.206
1	IM	~	TA	0.268	0.081	3.330	0.001
2	IM	~	PC	0.161	0.073	2.195	0.028
3	EM	~	EX	0.190	0.052	3.673	0.000
4	EM	~	TA	0.458	0.108	4.249	0.000
5	EM	~	AS	0.205	0.069	2.984	0.003
6	IM_IDO	~	IM	1.000	-	-	-
7	IM_JOY	~	IM	1.580	0.212	7.443	0.000
8	IM_VAL	~	IM	1.393	0.193	7.213	0.000
9	EM_FAM	~	EM	1.000	-	-	-
10	EM_CAR	~	EM	1.019	0.112	9.072	0.000
11	EM	~~	EM	7.825	1.531	5.112	0.000
12	IM	~~	IM	3.075	0.828	3.714	0.000
13	IM_VAL	~~	IM_VAL	4.791	0.993	4.823	0.000
14	IM_IDO	~~	IM_IDO	5.102	0.821	6.213	0.000
15	EM_FAM	~~	EM_FAM	5.027	1.288	3.904	0.000
16	IM_JOY	~~	IM_JOY	3.138	1.024	3.064	0.002
17	EM_CAR	~~	EM_CAR	0.492	1.129	0.436	0.663

The results indicated the significant effects between motivations and personal characteristics. The motivations are induced to latent variables of intrinsic and extrinsic motivations, and the personal characteristics are measured by constructs from recent studies, as the table 4 presented. All constructs and variables are selected and adjusted toward OSS platforms which are diversified and merged in current platform business paradigm. Except the openness and diversification, those platforms also developed novel incentives to absorb external resources which include both crowd intelligence and spillover of proprietary software. Those incentives are primary reason of weak external validity of our model, since the incentive involved cognitive factors in an artefact and intricate situation of software development. In nutshell, our model, have practice meaning, but require further distinguish between motivations and exclude other factors.

5. Implications for practitioners

Personal characteristics have positive effects on motivations. Software project managers should consider those effects when initialize projects and design incentive strategy. At initiative stage, manager or initiator have to analyse and motivate participants when resort OSS platforms. It's quite obvious that intrinsic and extrinsic motivations could affect participants to contribute and seek rewards. At developing stage, manager should record and approval personal characteristics of participants design corresponding incentive strategies. Those characteristics could be estimated from user profiles and surveys. Different to proprietary software development, diversifying platform and participants require heterogeneous and broader incentives compare to uni-culture organizations. Primarily, the incentives could be designed along the specific motivations. For example, we could award sophisticated developers with reputation and career opportunity, or, improve development situations to elevate joyful of self-determined and independent developers. In addition, all the detail of design could refer to questionnaire on related studies.

In practice, those implications are more suitable to open organization with lower trust level. An open organization usually difficulty to measure motivation in real practices, because the members are intended to hide their demand and purpose. Therefore, we should step back to indicators of the motivations, like our studied personal characteristics. If personal characteristics are measured, we could infer their specific motivations as table 6 indicated. In contrary, mature organization could measure the motivations directly with daily experiences.

6. Conclusions

OSS platform is a valuable repository to develop software and improve software quality. However, those participants are not directly and uniformly motivated, since the open situation are being diversified toward external demands. To analyse the motivations on under platform business paradigm, we measured personal characteristics and discovered their effects on motivations. With survey on participants of *oschina.net*, we modelled regressed motivations on specific personal characteristics, and further constructed their structural model. This study has partially explained motivations on China OSS platform. The results showed that: 1) personal characteristics have positive effect on intrinsic and extrinsic motivations; 2) self-determination and expertise level could discern specific motivations; 3) intrinsic motivations are more complicated to be indicated. In addition, we described profiles of current China OSS participants, and proposed implications to develop software on the compounded platforms.

Our study also has obvious limitations. That is, the complicated platforms decreased the external utility of our models. The complexity require us to discern motivations more prudently, and then adjust the constructs and participants, other than select participants randomly from the platform. Also, the questionnaires should be more specific toward social norms or rewards. In the future, we will conduct more surveys under control variables to discover the effects more stable and consolidation.

Disclosure statement

No potential conflict of interest was reported by the authors.

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