

Incentive Structure on Open Source Software Community: Case Study of GitHub

Ryo Suzuki *

Version: July 10, 2014 †

Abstract

This paper provides a simple model that shows how open source software development will change if the developers can reveal their software development skills through open source project. We present the quality of the software and the number of the developers who join the open source community will increase if their abilities can be observed in the labor market. This implies that the existence of the place that evaluate programmers' skills with open source projects provides better result not only to each programmer but also to the community and the society itself. Finally, we discuss the limitation of our model and suggest the possible future works.

1 Introduction

Open source software (OSS) has many varieties, but common features are that code is freely available and contributions are made by a diffuse set of programmers often working as volunteers. Well-known success stories include Linux, Apache, which dominates the market for web servers, and PERL and PHP, which are leaders in scripting software.

The open source software development have a long time history but development of OSS accelerated rapidly after success of Linux in 1990s. Now it is common for even the famous software company to use open source software. For example, Google recommends its software engineers to use and develop open source software.

1.1 Motivations of open source software development

The phenomenon of open source software movement have attracted not only computer scientist but also economists. Actually, this phenomenon attracts some economists in that why developers work to create and maintain OSS

*University of Tokyo Graduate School of Economics, Email: ryoopan@gmail.com

†This is preliminary version of working paper. Please do not circulate it or cite it.

project for free. There are a lot of related literature about incentives of OSS development and these papers discuss there are several possible incentives which explain why people develop open source software for free.

First explanation is programmers have altruistic or intrinsic motivations for software development. In empirical studies, Hars and Ou (2002) [3] and Chakravarty et al (2007) [1] investigates the motivations of OSS in this point of view.

On the other hand, Lerner and Tirole (2000) [6] argue that developers of open source projects acquire a reputation, which is eventually rewarded in the job market. They call it "career concerns motivation", and they says the framework used in labor economics can explain the reason why they helps each other for free and they argue the incentive of OSS development is not only altruistic motivations. In empirical studies, Hann, Roberts, and Slaughter (2002) [4] examine the Apache HTTP Server Project and find that contributions are not correlated with higher wages, but a higher ranking within the Apache Project is indeed positively correlated with higher wages.

Harhoff, Henkel and von Hippel (2003) [2] argue that end users of open source benefit by sharing their innovations. Moreover, Johnston (2002) [5] develops a model of open source software as voluntary provision of a public good.

Summarizing these related literature, we can find there are various motivations to develop open source software, but in this paper we focus on the altruistic or intrinsic motivation and the career concerns motivation.

1.2 GitHub and SourceForge

In April 2008, a website which helps and encourage programmers to develop OSS projects was launched. Now it has over 5 million users and 10 million projects and is growing more and more rapidly now. The website calls GitHub¹, which is currently the most famous open source repository hosting website.

There is another old and famous website of open source software called SourceForge². GitHub and SourceForge provide different services and GitHub is not alternative to SourceForge. The most important difference between GitHub and SourceForge is that GitHub is the place for developers while SourceForge is the place for users. GitHub provides the place to "build software better, together"³ and developers can develop their projects with other developers easily. SourceForge provides project hosting service and end users can download open source product.

Though there were SourceForge before GitHub came out, the appearance of GitHub definitely changed the environment around open source software communities. Let us explain about how the situation changed with GitHub.

As we said, SourceForge is the place for end users rather than developers. Before 2008, a developer can publish their own open source projects but SourceForge does not feature who contributes the projects.

¹<https://github.com>

²<http://sourceforge.net>

³Service concept of GitHub, Inc

Now we can see such an information on GitHub. We can see at a glance how popular the project is, who develops the project, and how good programmer he or she is. For example, the page of "Ruby on Rails", which is the software for web application framework used in Twitter, Groupon, and Cookpad and one of the most popular open source project can be seen in its project page⁴, and you can see how many users like this project with the number of stars, watchers and forks. Software programmer usually regard this stats as a quality or reliability of the software. (In fact, there are some websites like The Ruby Toolbox⁵, which compare the quality of software, and they use these data to calculate.)

Moreover, you can also see how good a programmer is with their contributions. For example, the creator of Ruby on Rails can be seen in his profile page⁶ and you can see the list of open source software projects he contributes with its popularity.

This means, GitHub allows programmers to reveal their ability of software development. A lot of software company look for the excellent programmers on GitHub and the programmers look on their GitHub profile page as a resume of a programmer. In practice, recruiting activities has been took place on GitHub. In analogy of academic field, the number of stars and forks will be the number of citation of the paper, and the profile page on GitHub will be CV of the researcher.

Therefore, we think GitHub changed not only the way but also the incentives to develop open source software, that is, our hypothesis is the career concerns motivation becomes much stronger with GitHub than ever before.

In this paper, based on this hypothesis, we provide the model that explain how the number of developers and the quality of software will change, when they can reveal much more information with GitHub and the career concerns motivation will be stronger with it.

2 The Model

Suppose there are N players and each player has different skill and altruistic motivation. Let each skill and altruistic motivation for player i be $s_i \in \{s_L, s_H\}$ and $\alpha_i \in \{\alpha_L, \alpha_H\}$ ($\alpha_L, \alpha_H \geq 0$). In labor market, their skills cannot be observed so if they want to reveal their skills, they have to develop open source software.

Each player decide to join or not at each time. Player's action is $a_{i,t} \in \{0, 1\}$ and 0 represents "not join" and 1 represents "join". Next, we consider N_t as the set of player who join open source developer community at time t , that is $N_t = \{i \in N | a_{i,t} = 1\}$. Then, the value of software is given by this.

$$V_t = \sum_{j \in N_t} s_j$$

⁴<https://github.com/rails/rails>

⁵<https://www.ruby-toolbox.com>

⁶<https://github.com/dhh>

And let the deadline of the project be T and if $N_T < N$ then the project will be failed, that is $V_T = 0$. To simplify the model, we suppose $T = 1$ in the followings.

2.1 If GitHub does not exist

If GitHub does not exist, open source software developers cannot reveal their skills to the labor market. Then, player's utility is given by this.

$$u_{i,t} = \begin{cases} wE[\frac{1}{|N_{t+1}|}V_{t+1}|V_t] + \alpha_i - c_i & \text{if } a_{i,t} = 1 \\ 0 & \text{if } a_{i,t} = 0 \end{cases}$$

where w represents the wage and he or she gain wage of their skills based on value of open source software. And we consider c_i as the opportunity cost for development and if the player has high ability to develop the opportunity cost will be higher.

Here we assume $c_i = ws_i$ to simplify the model, then the utility is given by this.

$$u_{i,t} = \begin{cases} wE[\frac{1}{|N_{t+1}|}V_{t+1}|V_t] + \alpha_i - ws_i & \text{if } a_{i,t} = 1 \\ 0 & \text{if } a_{i,t} = 0 \end{cases} \quad (1)$$

If there is no developer at time 0 $N_0 = \emptyset$, then $V_0 = 0$, then player i join the community if

$$\begin{aligned} & wE\left[\frac{1}{|N_1|}V_1|0\right] + \alpha_i - ws_i \geq 0 \\ \Leftrightarrow & \alpha_i \geq w\left(s_i - E\left[\frac{1}{|N_1|}V_1|0\right]\right) \end{aligned}$$

Consider the player i has (s_H, α_L)

$$\alpha_L \geq w\left(s_H - E\left[\frac{1}{|N_1|}V_1|0\right]\right) \geq 0$$

So if α_L does not satisfy the above condition, the software will not be completed and project will be failed, that is $V_T = 0$.

2.2 If GitHub exists

Equation (1) represents the situation where players' skills cannot be revealed and only their action can be seen in labor market. We consider this situation as the world where GitHub does not exist. On the other hand, we can also consider the situation where the labor market can observe not only players' action but also their skills if they join the open source software community.

Under the second condition, player's utility is given by this.

$$u_i = \begin{cases} wE \left[\frac{s_i}{\sum_{j \in N_t} s_j} V_{t+1} | V_t \right] + \alpha_i - c_i & \text{if } a_{i,t} = 1 \\ 0 & \text{if } a_{i,t} = 0 \end{cases}$$

In this case, we can observe how they contribute to the open source project, so the wage is Now we assume $V_t = \sum_{j \in N_t} s_j$ and $c_i = ws_i$, so the utility is simply given by this.

$$u_i = \begin{cases} \alpha_i & \text{if } a_{i,t} = 1 \\ 0 & \text{if } a_{i,t} = 0 \end{cases}$$

This means all of the players join the open source community and the value of software will be $V_T = \sum_{j \in N} s_j$.

3 Conclusion

This paper provides the simple model to show how open source software projects change if the developer's skill is revealed from the point of view of developer community and software quality. In our model, we shows that programmers are eager to develop open source softwares much more if their skills is revealed, as a result, open source project will be successful and its community will be bigger. The result implies that if the software developers can reveal their ability more to labor market through open source software development, the social welfare will be higher. Therefore, the existence of GitHub lead a better result not only for each users but also for society.

Our model we provide in this paper is too simple to investigate difference of probability to succeed or the effect of participation of high skilled players. For the possible future works, we suggest to investigate the effect in the following three point of view: the first one is how probability distribution of succeed and the quality of software will change, the second one is how the speed of development will change, and the third one is how the number of participants who join the community and the distribution of their skills will change. We will try to answer the questions above in the future.

References

- [1] Sujoy Chakravarty, Ernan Haruvy, and Fang Wu. The link between incentives and product performance in open source. *Global Business and Economics Review*, 9(2):151–169, 2007.
- [2] Dietmar Harhoff, Joachim Henkel, and Eric von Hippel. Profiting from voluntary information spillovers: how users benefit by freely revealing their innovations. *Research Policy*, 33:1753–1769, 2003.

- [3] Alexander Hars and Shaosong Ou. Working for free? motivations for participating in open-source projects. *International Journal of Electronic Commerce*, 6(3):25–39, 2002.
- [4] Il horn Hann, Jeff Roberts, Sandra Slaughter, and Roy Fielding. An empirical analysis of economic returns to open source participation. *Mimeo*, 2004.
- [5] Justin Pappas Johnson. Open source software: Private provision of a public good. *Journal of Economics and Management Strategy*, 11(4):637–662, 2002.
- [6] Josh Lerner and Jean Tirole. The simple economics of open source. *NBER Working Paper*, 2000.