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Institutions, culture, and open source☆

Sebastian v. Engelhardt[a,*], Andreas Freytag[a,b]

[a] Friedrich-Schiller-University Jena, Department of Economics and Business Administration, Carl-Zeiss-Str. 3, 07743 Jena, Germany
[b] Stellenbosch University, Department of Economics, Private Bag x1 Matieland, 7602 Stellenbosch, South Africa

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ABSTRACT

We analyze the impact of institutional and cultural factors on the supply side of open source software (OSS). OSS is a privately provided public good: it is marked by free access to the software and its source code, and is developed in a public, collaborative manner by thousands of volunteers as well as profit-seeking firms. Our cross-country study shows that a culture characterized by interpersonal trust and self-determination/fulfillment values has a positive impact on OSS activities and the number of developers. The supply side of OSS also benefits from the enforcement of intellectual property rights. A low degree of regulation and openness towards scientific progress has a positive impact on the number of OSS developers, but the latter not on the number of active or core developers.

1. Introduction

The success of open source software (OSS) has challenged the conventional wisdom on the use of intellectual property rights (IPRs) and on the private provision of public goods. In the case of OSS, the source code—the human-readable recipe of a software program—is 'open' (disclosed). The OSS licenses grant general access to the software and its source code, as well as the right to read, modify, improve, redistribute and use it. OSS is developed by a 'community' that consists of non-paid volunteers as well as profit-seeking firms. Nowadays, OSS plays an important role in the ICT sector.[1] Thus, OSS is a successful example of the "private provision of a public good" (Johnson, 2002).

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* Corresponding author. Tel.: +49 3641 943 258; fax: +49 3641 943 252.
E-mail addresses: Sebastian.von.Engelhardt@uni-jena.de (S.v. Engelhardt), Andreas.Freytag@uni-jena.de (A. Freytag).

[1] The Apache Webserver software has a remarkable market share, see e.g., the Netcraft Web Server Survey data at www.netcraft.com. Small and medium-sized enterprises and well-known companies like Cisco, IBM, Nokia, Panasonic, Samsung, Sony, and Toshiba use OSS-based business models. Smartphones running Android and Linux-based ebook readers (e.g., Amazon's Kindle) are the most prominent examples of OSS-based products.

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However, countries differ in terms of their OSS developers per capita as well as in the level of their OSS activity (Engelhardt et al., 2013; Gonzalez-Barahona et al., 2008), and these differences cannot be satisfactorily explained by GDP or access to the Internet.

Our study shows that country-specific institutions and culture matters for the willingness to contribute to OSS. Based on the microeconomics of OSS, we test various hypotheses on how different institutional and cultural factors have an impact on OSS development. This is a relatively new approach that enables us to deepen the understanding of the phenomenon of OSS, and helps to clarify some aspects discussed or disputed in the literature. Finally, understanding how country-specific cultural and institutional factors influence OSS activities is also an important—although so far neglected—aspect for the discussion about OSS as a concept for developing countries.

We make use of own data on the worldwide allocation of activities of developers registered at SourceForge. We distinguish between registered users, active users, and core developers and have two measures of activities (postings and software uploads). We use different strategies to deal with possible country-fixed effects: ordinary least squares (OLS) regressions with regional dummies, pooled OLS regressions with regional dummies, and first-difference regressions combined with pooled OLS on the first-difference residuals for the time-invariant variables.

We find that a culture characterized by self-determination/fulfillment favors OSS activities. This is the first empirical result supporting the argument that self-fulfillment motives, which are reported by OSS developers to be important, are indeed also important for effort, i.e., for OSS activity levels. On the other hand, we cannot support the hypothesis that positive attitudes toward competition foster OSS, which would have been an indicator for the importance of extrinsic motives for OSS activities. For the number of (core-)developers, however, the importance of extrinsic motives and incentives that are linked to the existence of an ICT sector find some support, as we see a positive impact of low economic regulation. Next to self-determination/fulfillment, interpersonal trust is another strong explanatory variable. Interpersonal trust has a positive impact on the number of OSS (core-)developers as well as on the OSS activity level. This supports the branch within the OSS governance literature that emphasizes the importance of trust. The notion that OSS is a kind of anti-IPR (or IPR-less) innovation system is challenged by our findings that the de facto protection (the enforceability) of IPRs has a positive impact on OSS activities. Finally, openness to novelty—measured as a preference for new ideas and attitudes towards scientific progress—does not have a significant effect on the number of active or core developers or OSS contributions. However, scientific progress is significantly correlated with the number of registered developers.

The remainder of the article is structured as follows. In Section 2, we present the theoretical foundations and derive the hypotheses for the empirical study. In Section 3 we operationalize the variables, describe the data sources, our sample and the applied empirical methods. In Section 4, we present and interpret the regression results, before ending with the summary and outlook in Section 5.

2. Theoretical considerations and hypotheses

In general, cultural and institutional factors shape human interaction and therefore have an impact on the microeconomic level. Hence, in order to derive hypotheses about the influence of institutional and cultural factors on OSS developers and their activities, we link insights about the microeconomics of OSS with the levels of institutional and cultural factors.

The different levels that shape economic outcome are, for example, illustrated by Williamson's, 2000 framework of the four interrelated levels of social and institutional analysis—see also Fig. 1. Williamson distinguishes between four levels. The lowest level (Level 4) refers to the focus of neoclassical economics: economic agents maximize their utility, given their preferences, endowments, payoff-functions, and the rules of the game (Williamson, 2000). Most of the research on OSS focuses on this level. This comprises contributions that analyze the rationale for firms to develop OSS (e.g., Reisinger et al., 2013; Llanes and de Elejalde, 2013; Engelhardt, 2010; Henkel, 2006) or the impact of OSS on competition, resource allocation and welfare (e.g., Bitzer and Schröder, 2007; Economides and Katsamakas, 2006; Mustonen, 2003). Also, research on the motives of OSS volunteers belongs to Level 4, since it deals with preferences and incentives (e.g., Bitzer et al., 2007; Lakhani and Wolf, 2005; Ghosh et al., 2002).

On the next level up (Level 3), we find the governance structures within which the Level 4 decisions are made (Williamson, 2000). With respect to OSS, this means that research on the governance structures of OSS projects deals with Level 3 aspects; including the informal rules (e.g., Langlois and Garzarelli, 2008; Laat, 2007; Markus, 2007; Wendel de Joode et al., 2003), the way OSS projects use intellectual property law (O'Mahony, 2003), and the role, choice and rationale of the different OSS licenses (e.g., Sen et al., 2008; Polanski, 2007; Gambardella and Hall, 2006; Lerner and Tirole, 2005).

The next level (Level 2) comprises the "institutional environment" and relates to the definition and enforcement of property rights and contract laws (Williamson, 2000). Clearly, Level 2 directly affects the lower Level 3, since certain governance structures may not work, may be inefficient or simply not realizable if the higher level institutional environment is not right. Bad regulations or a lack of enforceability of (intellectual) property rights may make contracts non-enforceable and/or too costly. With respect to OSS, one relevant aspect of Level 2 is the enforceability of IPRs, since, for example, the OSS licenses are based on copyright law (Laat, 2005). However, to the best of our knowledge, no study exists that analyzes the impact of the Level 2 aspects on OSS.