PUBLIC POLICIES IN THE SOFTWARE MARKET: REGIONAL ISSUES CONCERNING OPEN SOURCE SOFTWARE

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Abstract. A topic recently discussed in the literature about software markets concerns government policies supporting open-source software, the purpose of such an intervention being the prevention of failures in that market and ultimately increase social welfare. Possible interventions include mandated adoption and information campaigns. Our study investigates the relationship between FOSS (free and open source software) prevalence on the one hand, and economic and human development indicators on the other, across about 130 countries. We find that FOSS prevalence is related to education rather than to economic well-being, which is largely in line with findings reported in the scientific literature obtained using approaches different from ours. Furthermore, clustering our sample of countries with respect to several indicators permits insight into how governments have already implemented policies in public agencies, and leads to suggestions about possible future policies.

1 Introduction

Regional differentiation is seldom undertaken appropriately in studies regarding online communities, such as those in open source software. However we believe that development of better IT policies which employ Free and Open Source Software (FOSS), in public or private domain, requires a better understanding of how FOSS adoption interacts with various aspects of society. While the growing body of research on FOSS focuses on community, governance, and coordination of production activity [7, 5], or relations to wider software industry [3, 13], studies on relation of FOSS with broader developments in society and factors which affect its adoption are seldom [1, 2], with some underlining importance of offline social settings on online communities [12].

In this paper we present results of a preliminary investigation of such relations and reflect on international differences among clusters of countries. We first address how FOSS adoption is related to economic and human development indicators of different countries, as such relations are the setting against which

public IT policies to be developed. A look at correlation of FOSS adoption levels and various indicators from United Nations [11] point to relative significance of non-economic factors in FOSS adoption. The analysis is also extended with clustering of countries especially to track down whether consistent patterns are found in public policies. Finally correlation with software piracy and the rest of variables were investigated.

The next section summarizes the quantitative results of our analysis. Adoption of FOSS in a country is operationalized as the number of results in the country-specific Google search of the keyword "open source". This variable will obviously be correlated with the size of a country in terms of its population. To refine the analysis we have attempted to relate it to a classification of countries we have developed on the basis of cluster analysis. Subsequently deficiencies in policies involving proprietary software is examined through analysis of piracy data for countries in relation to development indicators. For this purpose piracy rate data published by BSA was checked for its relation with human development, economics and transparency indicators.

Building on our results and research elsewhere, we then discuss policy choices accounting for economic reality in the following sections. We support the claims that public promotion of FOSS through information campaigns can indeed be effective [1]. Furthermore, we argue that given the economic conditions in relatively less developed countries, public intervention in the software market through promoting open source is not only favorable [2], but possibly inevitable if sensible conditions in the software market (such as reduced piracy) and innovation are desired. On the other hand lack of consistent public policies indicates a lack of awareness among policy makers towards the potential of open source software, in effect disengaging large communities from enjoying its benefits.

2 Towards Policy Making — Some Empirical Facts

2.1 Our approach

Our starting point for suggesting and discussing public policies concerning FOSS is an analysis of

– FOSS adoption, operationalized as the number of results in the country-specific Google search of the keyword "open source";
– the software piracy rate, that is: the percentage of software installed in a country without a license.

We then fit a regression model to each of these two variables, with a selection (retaining only significant variables) from the following list as independent variables:

– population
– gross domestic product (GDP); GDP per capita

– net aid transfer (NAT); relative NAT as percentage of GDP; counted positive
  (negative) for doners (receivers, resp.)
– Human Development Index (hdi)
– transparency index (tri)
– Internet usage; relative Internet usage
– Internet hosts

The main purpose of the regression models in this context is to identify those
variables which have explanatory power on the two dependent variables, and
thus provide insight into which forces determine FOSS adoption and piracy.
This will give rise to the suggestion of policies concerning the software market.

2.2 FOSS Adoption and Piracy

How are FOSS adoption and piracy rates related across countries? Figure 1
shows a scatterplot of the doubly-logged Google count of the term "open source"
and piracy rates for 68 countries for which data were available. The correlation is
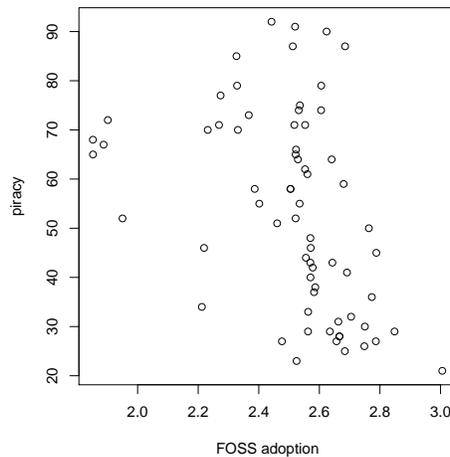-0.42. One possible explanation of the relatively high correlation is the presence

Fig. 1. FOSS adoption and piracy across countries

of common economic factors impacting FOSS prevalence as well as piracy. Our
next step is therefore a separate analysis of FOSS prevalence and piracy, which
will allow to investigate the role of economic and non-economic factors in more
detail.

2.3 FOSS Adoption: Its Determinants

Using stepwise procedures leads to the following model, fitted to 129 cases (the
numbers in parenthesis are the t values of the estimates):

$$\log(\log(\texttt{count.open.source})) = \underset{(-2.13)}{-1.546} + \underset{(3.27)}{0.8155} \times \log(\log(\texttt{population}))$$
$$+ \underset{(4.11)}{0.0485} \times \log(\texttt{internet.hosts})$$
$$+ \underset{(5.44)}{1.3070} \times \texttt{hdi}$$

This model has an R^2 of about 67%. It is not unexpected that population and the number of Internet hosts in a country contribute to explaining the number of occurrences of "open source" in a country-specific Google search. The Human Development Index (hdi) is a composite measure of life expectancy, education, and standard of living published by the United Nations Development Programme. In order to assess the contribution of non-economic factors in accounting for the variable `log(log(count.open.source))`, another regression model with (doubly logged) GDP per capita substituted for hdi was estimated. This model's R^2 is reduced to 61%. This is a clear indication of the importance of non-economic factors in explaining FOSS adoption.

2.4 Piracy: Its Determinants

Eliminating non-significant variables using a stepwise procedure leads to the model

$$\texttt{piracy} = \underset{(7.96)}{200.75} \quad \underset{(-4.28)}{-13.01} \times \log(\texttt{gdp.per.capita}) \quad \underset{(-4.39)}{-3.99} \times \texttt{tri}$$

This model has 63 degrees of freedom and an R^2 of about 80%. Economic factors are remarkably predominant in explaining piracy. Piracy and hdi are negatively correlated (-0.77), but substituting hdi for GDP per capita reduces R^2 to 60%, and simply adding hdi to the list of regressors leaves hdi insignificant. This underlines that the amount of piracy in a country is only indirectly related to education in that country.

3 Implementation of Policies in Public Agencies

Is there evidence that the server software variety (open source or proprietary) used by governmental bodies (central bank, bureau of statistics, finance regulator, foreign ministry, postal services) of countries depends on the characteristics of the respective country in terms of the variables listed above? We discussed this question in an earlier paper [4] by first clustering countries and then testing the null hypothesis that cluster membership and server software variety are independent. Independence was rejected only in the case of bureau of statistics; no clear pattern was found for the other public agencies. This suggests that governments, on a large scale, are not following a consistent policy in their selection of server software variety yet.

4 Suggestions Concerning Policies

It is generally accepted that innovation, both considering product- and processes innovation, stimulates economic growth. Many scholars from various disciplines have researched the foundations of innovation and policies concerning how to promote it [15, 16].

The question concerning the promotion of innovation is not easy to answer. Patterns of innovation embedded in organizational structures and actions are complex, but they can be analyzed by reduction to an individual level. The obvious fact about an innovation and the rule of thumb distinction between innovation and invention is that we can speak of innovation only if an invention is diffused to an institutional field.

On the one hand, our approach suggests a twofold body of policies in the software market:

1. supporting individual initiatives for inventions on an entrepreneurial level,
2. diffusion of innovations to an institutional field.

On the other hand, as described in previous sections, we face two different questions:

1. How can software piracy, being a universal problem of the proprietary software market, be reduced?
2. How can open source software, having a distinct mode of production in the software market, be promoted?

Given the two legs of discussion, we are lead to the interpretations given in the following paragraphs.

Reducing software piracy as a target for public policies. In our opinion, public policies should aim to increase social benefits and welfare and look after the individuals rather than corporations. Software piracy is not primarily a problem of individual initiatives, but rather of proprietary software companies. Our findings point to the fact of software piracy being economic, in other words, only economic incentives will be able to reduce it. Should such an achievement necessarily increase the social welfare? The answer is still on the fly. Or put that way, software piracy is a problem in itself, not for the software market. Thus, we conclude that *reducing software piracy itself* is not an adequate primary target for public policy makers. It is rather the *promotion of innovation and entrepreneurship in the software market* that will lead to a reduction in software piracy.

Promotion of Open source software as a target for public policies. Given the fact that innovation without an underlying individual initiative is hardly possible, we are lead to the conclusion that public policies should operate mainly on an individual level. This can be done by enriching the entrepreneurial characteristics of the software market initially by reducing the entry barriers. Technical details of open source software has a consequence of open source software being free of charge, that is using and developing software is effectively

much cheaper with an open source model. This circumstance fits also well into our suggestion that open source software should be promoted to equalize the power positions of small and large corporations. This is important because innovations do not necessarily come from large corporations.

We have thus come to the conclusion that reducing software piracy can be achieved only by means of promotions of innovation and entrepreneurship in the software market and this, in particular, can be achieved by promoting open source software. This, however, leaves the question how to design and run public policies.

Comino and Manenti [1] report that undertaking information campaigns is the most effective way of promoting open source software, compared to others like mandated adoption and subsidies. Their paper divides consumers of software into two groups: those who are aware of the existence of open source software and those who are not. They claim that there is a huge mass of uninformed consumers because of the little incentive of open source advocates to advertise. It is reported in their paper that information campaigns and mandated adoption can help the promotion of open source software, while subsidies always reduce it. This also explains why policies concerning direct economic aids would not be a good choice for reducing software piracy either. As noted by Joseph E. Stiglitz in his speech at the Third Steering Committee Meeting of the EURACE Project, public intervention in the real-estate sector in the US had significant adverse effects due to its purely financial nature which poorly accounted for behaviour of a large segment of consumers. Despite the lack of relevant research, software policies, especially in school education, also seem to suffer from adverse effects in the long term. Combined with the conclusions from Santarelli [16] that "general, adaptable skills are required to promote and facilitate innovation in a world with rapidly changing technology", this means in our context: Education in the IT area should not focus on how to operate specific, proprietary software packages, but rather emphasize the structure, methods, and philosophy on which software is built in general.

Another important issue about how to prepare a basis for robust, innovative technological environment is the enforcement of integration and interoperability of software products [14]. It is suggested that the software market introduces its own *de facto* standards, but they should be open. This can be done by emphasizing the importance of open standards which would decrease the market risk and promote innovation. Open source software is all about open standards, while proprietary software systematically denies room for interoperability by closing the source code, file formats and communication protocols. (This is somewhat mitigated in applications related to Internet or WWW, where open standards have to be followed.) However, recently, software companies such as Microsoft have started publishing standardized open file formats (OpenXML). Being the trend in this direction, governments should aim at interoperability and integration of a service-oriented infrastructure by adopting and promoting open standards.

5 Conclusions

Digital content, such as computer software, is easily copied. This creates obstacles as well as opportunities. In the case of open source software this capability is seen as a key facilitator for software development, whereas in the case of proprietary software (or other proprietary digital content for that matter) it is a threat to market appropriation. Both prevention of software piracy and subsidisation of research and development in the software market has been of interest to policy designers. The analysis in this study attempts to provide a better ground for policy thinking by bringing in the open source software to the picture, which, despite growing interest, was poorly accounted for in software policy discussions.

Our aproach attempts to account for relations between piracy, open source, and various indicators for a large set of countries. Despite the rudimentary nature of causal relations between economic indicators, piracy and open source adoption, we believe these relations are suggestive of the need for alternative thinking in policy design for the software market due to the nature of the products exchanged, and the highly interconnected nature of that market resting on availability of technical standards and information, more so than physical resources. Therefore we agree that claims for potential market failures due to a misfit between market appropriation and interoperability demands are well positioned.

Furthermore we claim that, based on observed outcomes of intervention attempts noted by other authors and our findings in this study, the development of public policies to prevent software market failures and promote mid-to-long term innovation should rest on stimulating quality labor and lowering entry barriers to the software market. Especially, but not exclusively, for developing countries with limited resources for subsidization, we suggest that promoting open source alternatives is a valuable resource for policy design.

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