

**SIXTH FRAMEWORK PROGRAMME
PRIORITY 2
INFORMATION SOCIETY TECHNOLOGIES**



FLOSSWORLD

**Free/Libre and Open Source Software: Worldwide
Impact Study**



D31: Track 1 International Report

Project Reference: 015722
Kind of Project: Specific Support Action
Start Date: May 2005
End Date: June 2007



Authors:

Paul David (OII)

Rishab A. Ghosh (MERIT)

Rüdiger Glott (MERIT)

Jesus Gonzales-Barahona

Federico Heinz (Fundacion Via Libre)

Joseph Shapiro (OII)

Table of Contents

1. Introduction.....	5
2. Design, Methodology and Background.....	5
2.1. Design and Methodology.....	5
2.2. Background: The FLOSS community as a learning environment	8
3. Homogeneity and Heterogeneity of FLOSS Communities in different countries.....	9
4. Human capacity building in the FLOSS community.....	12
5. Higher Education Institutions and the Global Role of FLOSS.....	20
5.1. Introduction.....	20
5.1.1. FLOSS in the HES: Some Motivating Issues.....	20
5.1.2 Organization of the Report and Overview.....	23
5. 2. Survey Populations and Respondents.....	25
5.2.1. Respondent Individuals.....	25
5.2.2 Respondent universities.....	26
5.3. Survey results.....	28
5.3.1 Work Responsibilities of the Respondents.....	28
5.3.2 Institutional Decision-making for Software and IT Expenditure Shares.....	28
5.3.3. IT Strategy, Use of floss, and Development of floss.....	30
5.3.4 Programming Courses offered.....	33
5.3.5 The Role of floss Experience in Hiring Employees.....	33
5.3.6 Software use.....	35
5.3.7. Concluding Observation on the Within-Institution Diversity of Practices	36
5.4. Correlates of the role of FLOSS in an institution.....	36
5.4.1. Discussion of constructed indices.....	37
5.4.2. Cross-country differences in FLOSS indices.....	38
5.4.3. Correlates of FLOSS Indices.....	39
5.5. Conclusion and Relevance for Policy.....	40
5.6. Tables and Figures for Section 5.....	42
6. Conclusions.....	72
Annex A.....	75
1: Questionnaire for Developer Survey.....	75
Annex A2: FLOSSWORLD Guidelines for the Developer Survey.....	93
Annex A3: Questionnaire for Employers.....	98
Annex A4: Guidelines for the localisation of the Employers Questionnaire.....	103
FLOSSWORLD Guidelines for the Employers Survey.....	103
Annex A5: Questionnaire for HEIs (Administrators).....	108
Annex A6: Questionnaire for HEIs (IT Managers).....	116
Annex A7: Guidelines for the Localisation of the HEIs Questionnaire.....	128
FLOSSWORLD Guidelines for the HEI Survey.....	128
Annex A 8: Statistical Appendix for the HEI Survey.....	133

List of tables (except for section 5)

Table 1: Design of Track 1.....	6
Table 2: FLOSSWORLD Developer Survey Sample by country.....	9
Table 3: Motivational clusters within the FLOSS communities of the FLOSSWORLD countries... 12	
Table 4: Top-3 skills that are considered to be better learnt in FLOSS than in a formal course.....	13

List of Figures (except for section 5)

Figure 1: Shares of FLOSS community members earning directly or indirectly money from FLOSS.....	11
Figure 2: Technical skills better learnt in FLOSS than in formal CS course – developers and employers compared.....	14
Figure 3: Managerial skills better learnt in FLOSS than in formal CS course – developers and employers compared.....	15
Figure 4: Role of FLOSS skills for professional career.....	16
Figure 5: Capacity of FLOSS to compensate for lack of formal degrees.....	17
Figure 6: Formal degrees and FLOSS experience compared - employers' view.....	17
Figure 7: FLOSS skills vs. proprietary software skills - developers' view.....	18
Figure 8: FLOSS skills vs. proprietary software skills - employers' view.....	19

1. Introduction

This deliverable presents and discusses findings from the Track 1 surveys, i.e.

- Survey of FLOSS developers
- Survey of employers (HR managers at businesses)
- Survey of universities and institutes of higher education (HEIs)

The purpose of Track 1 is to find out how FLOSS contributes to human capacity building and how these capacities are valued by FLOSS community members and by employers. In this context, the study of HEIs is intended to reveal the role of FLOSS for higher education and how FLOSS is employed and taught in HEIs.

It must be emphasised that FLOSSWorld was not designed in order to provide a statistically representative account of FLOSS-related human capacity building in the scrutinised regions, although in this report, based on the full sample of respondents, we strive to get as much insights in these issues as possible, in a methodologically sound way. FLOSSWORLD primarily aimed to strengthen Europe's leadership in international research in FLOSS and open standards, and to exploit research and policy complementarities to improve international cooperation, by building a global constituency of policymakers and researchers. FLOSSWorld thus contributes to enhancing Europe's leading role in research in the area of FLOSS and strongly embed Europe in a global network of researchers and policy makers, and the business, higher education and developer communities. Finally, another purpose of FLOSSWorld was to enhance the level of global awareness related to FLOSS development and industry, human capacity building, standards and interoperability and e-government issues in the geographical regions covered by the consortium. The project contributed significantly in establishing and /or supporting a stronger, sustainable research community in these regions. The requirements from the data quality regarding proper academic research were therefore of secondary importance. Testing if and under which conditions data can be gathered in these regions and how collaboration between European and local research partners in these regions can be organised was way more important than statistical representativeness. In order to measure the success of Track 1 the consortium defined following thresholds for data collection, regardless of whether or not the data that was collected was representative:

- Developer survey: 320 developers across 8 countries of respondents
- Employer survey: 400 employers across 8 countries of respondents
- HEI survey: 400 HEIs across 8 countries of respondents

All three surveys successfully reached these thresholds. It must be noticed, however, that the size of the country-specific samples varied a lot. These differences are described in detail in D45.

2. Design, Methodology and Background

2.1. Design and Methodology

The FLOSSWorld project has been designed with a clearly defined work structure in mind, with two chronological phases and three functional tracks. The two chronological phases of the workplan

are designed to reflect both the two structural phases of the thematic studies of Tracks 1 to 3, as well as the increasing levels of collaboration during the project lifetime.

Phase 1, “Design and implementation” focuses on the design and implementation of the studies, with workshops¹ bringing together researchers with representatives of business, education and policy communities. Phase 2, “Analysis and policy” focuses on the interpretation of survey results, further analysis and inputs to the policy development process. Workshops bring together researchers and policy makers, with strong representation from business as well as the education sector. Table 1 illustrates how Track 1 is structured along the two phases:

	Phase 1: Design, Implementation	Phase 2: Analysis, Policy
Track 1: study of human capacity building / skills development in FLOSS developer communities	<p>Plan analytical framework.</p> <p>Finalise design and methodology of survey and questionnaire (based on results of on-going FLOSSPOLs survey). Define representative sample for employer/business and university/HEI respondents. Identify sample for FLOSS developer survey (possibly with Track 2).</p> <p>Localise questionnaire. Conduct pre-testing of questionnaire.</p> <p>Conduct survey. (For developer survey, possibly conduct jointly with Track 2.)</p>	<p>Interpret survey results. Determine quantifiable skills development impact of FLOSS participation and value to employers.</p> <p>Compare by region and with Europe (relate to results from FLOSSPOLs, CALIBRE). Determine policy impact on use of FLOSS in the education sector.</p> <p>Determine impact of FLOSS-based skills development on employment generation and business success.</p>

Table 1: Design of Track 1

¹ The workshops held in the course of the FLOSSWORLD project are described in Deliverables D3, D4, and D33-D44.

The questionnaires for the empirical surveys were developed by the European partners (MERIT, URJC, and OII) while the local partners localised and adapted the surveys to the context of each target country – Argentina, Brazil, Bulgaria, China, Croatia, India, Malaysia and South Africa. Localisation involved three tasks:

1. translation of the questionnaire into local languages if and where appropriate (Bulgarian, Chinese, Spanish, Portuguese, etc...)
2. introduction of local terms to ensure international comparability – e.g. using local currencies in the questionnaire and localised scales when asking about income or expenditure levels
3. introduction of additional questions that are unique to each country's context (e.g. questions on the role of specific government organisations, businesses, HEIs or projects, which were carefully designed and positioned so that they did not reduce the international comparability of the rest of the questionnaire)

The surveys were conducted using a combination of web-based questionnaires, e-mail contacts and reminders, telephone and fax. The localised questionnaires were converted into an on-line form and hosted on a web server at UM.

The on-line questionnaires were accessible in two ways: *addressed access*, where unique web addresses were generated for each preselected respondent with identifying information pre-recorded; and *open access*, where respondents have been asked to provide contact information. Addressed access was used in particular when address lists for the respondents were available to the international partners, from which a sample could be drawn. Those respondents that were addressed personally were contacted by e-mail with a request to fill out the survey at the unique address created for them. This is the most reliable form of ensuring an authenticated representative sample of respondents. Open access was used when no respondents could be identified in advance or when the number of identifiable persons to survey was considered too low. For open access, the survey was publicised through mailing lists, online forums, or publicity to associations (of businesses, universities and governments, respectively).

Addressed access execution involved repeated reminders. These were mainly sent by email, but in some countries (Malaysia, Bulgaria) it turned out that phone calls to the addressed respondents were more efficient.

The questionnaire² for FLOSS developers asked, among other things, for detailed developer perceptions of skills learnt informally through FLOSS communities in comparison to a more formal setting (multi-disciplinary skills – understanding licensing issues, managing teams, writing modular software...). Developers were also asked to describe what activities (reading code, reading a book, participating in community discussion groups) lead to learning what skills. These questions aimed to determine what benefits for skills development are seen by participants. Finally, respondents were asked to quantify their skills in terms of increased employment possibilities and earning capacity.

The questionnaire for employers was directed at human resource managers at companies – not FLOSS or even software companies, simply employers of IT-skilled personnel. It complements the developer questionnaire to determine employers' perceptions of the type and level of skills learnt informally through participation in FLOSS communities, versus formally through, e.g., universities. Employers are also asked to quantify such skills in terms of hiring preferences and salary levels.

2 The questionnaires for the surveys and the guidelines for the local partners to execute the survey in their region are attached in Annex A. These documents are referred to in the proposal as Deliverable 6a (not to be released separately).

Universities and other Higher Education Institutes (HEIs) in target countries were surveyed to understand and utilize the information gathered by the survey of developers since for many target countries, the tertiary educational and training institutions are prime access points to the Internet for many young people, at high enough bandwidths to support interactive communication and initial involvement in experiential learning. These also are locales of personal contacts with more expert users and developers of FLOSS code, which may be important for effectiveness even in remote learning. (The FLOSS-US survey showed a clustering of Indian developers at one locale, an HEI in Bangalore.) Thus, the policies of HEIs, and the depth of their personnel's expertise are important factors conditioning the entry of new cohorts of developers, as indicated by the prominence of university and technical college students among respondents to FLOSS and FLOSS-US. The third Track 1 survey targeted at investigating HEIs usage and awareness of FLOSS in order to identify institutional obstacles and solutions to overcome them in the target countries, and further at identifying sources of institutionalized capability in regard to FLOSS use in instruction and research.

2.2. Background: The FLOSS community as a learning environment

FLOSS is not only a viable software development approach, but also a model for the creation of self-learning and self-organizing communities (Sowe, et al. 2006c). FLOSS is also a virtual learning context in which both professional software developers and novice users benefit by leveraging their knowledge and information access repertoire. Knowledge is mainly acquired in FLOSS through learning by doing. In recent times, FLOSS is making inroads not only in business and software industries but in colleges and universities as well. There is increased interest in the FLOSS learning environment (Sowe, et al., 2004; Bacon and Dillion, 2006) and in FLOSS projects as bazaars of learning (Sowe, et al., 2006). FLOSS is an alternative teaching methodology and an educational model at the same time (Faber 2002).

To a certain degree, the FLOSS community can be considered as a large community of practice (or as a reservoir of many such communities of practice), since membership in this community is not defined by official status but by participation, it develops informally around things that matter to people (in this case: software), and it produces a shared repertoire of communal resources (routines, sensibilities, artefacts, vocabulary, styles, etc.) (Wenger 2000; Ghosh et al. 2005a). virtual communities and communities of practice serve as important learning environments. Sowe et al. (2004, 2005) therefore concluded that FLOSS is also a model for the creation of self-learning and self-organizing communities. FLOSS communities can therefore be described as web-based learning communities (Sowe, et. al., 2004) in which individuals interact with collaborating peers to solve a particular problem and exchange ideas. Collaborative learning and the peer review process emphasize the importance of shared dialogue. In this regard, the principles and practices of learning in the FLOSS community appear helpful to master the challenges coming up with the growing demand for “lifelong learning” (OECD, 1977; Livingstone, 1999). These challenges consist mainly in the necessity of new leaning arrangements that are more informal, self-organized, and incidental (i.e. driven rather by situational personal interests and needs than by pre-defined curriculae of educational institutions or firms) (Keeton et al., 1976; Houle, 1976; Chickering, 1976; Coleman, 1976, 1995; Lave & Wenger, 1991; Watkins & Marsick, 1992; Cseh et al., 2000; Council of Europe, 2000; Dohmen, 2001; Overwien, 1999). David & Foray (2002) describe this change as an overall shift from “learning to do” to “learning to learn”. Given the potentials provided by the Internet, “communities of practice” (Brown & Duguid 1991), especially Internet communities are considered to be extremely successful in developing and deploying such new learning forms.

FLOSS communities often serve as prime examples when the capacities of such volatile network organizations are demonstrated (Faust & Holm, 2001; Demil & Lecocq, 2003; Hemetsberger. & Reinhardt, 2004; von Hippel, 2002; David & Foray, 2002; von Krogh et al., 2003). In fact, the FLOSS developer survey (Ghosh et al. 2002) has revealed that this community is mainly driven by its members' individual wish to learn about and share knowledge of the development of open source software, its philosophy, and the cooperation within the community (Ghosh et al., 2002; Ghosh et al., 2004).

The open source community thus provides a suitable object for research on the mechanisms and structures that characterise the new forms of learning. In the following we will examine what FLOSS community members in different developing countries and regions learn from their FLOSS engagement and whether or not these informally acquired capabilities provide an advantage on the labour markets in these regions. Special attention will thereby be given to aspects of homogeneity and heterogeneity of the different FLOSS communities and how these differences and similarities affect skills attainment and labour market opportunities.

3. Homogeneity and Heterogeneity of FLOSS Communities in different countries

Overall, 1029 FLOSS community members have participated in the FLOSSWORLD developer survey (see Table 3). The response from the countries covered by the consortium varied significantly, depending on the size of the country and its population as well as on the means the research consortium disposed of in order to contact community members in the 8 countries. For instance, the fact that Brazil provides more than half of all respondents is due to the fact that the Brazilian partner had lists with contact details of several thousand FLOSS developers. In the other countries FLOSS community members could usually not be approached directly, the survey was announced through mailing lists, forums, etc.

**FLOSSWORLD Developer Survey: Respondents
by country**

Country	Frequency	Percent
ARG	115	11,2
BGR	40	3,9
BRA	541	52,6
CHN	83	8,1
CRO	51	5,0
IND	71	6,9
MYS	77	7,5
ZAF	51	5,0
Total	1029	100,0

Table 2: FLOSSWORLD Developer Survey Sample by country

The demographic characteristics of the country-related sub-samples differ significantly only with regard to gender and the professional structure. The share of female respondents is rather small in

most countries, with 2% in Croatia and 4% to 6% in Argentina, Bulgaria, Brazil, India and South Africa. China however and especially Malaysia exceed the average share of female (6.6%) by far (China: 11%, Malaysia: 23%).

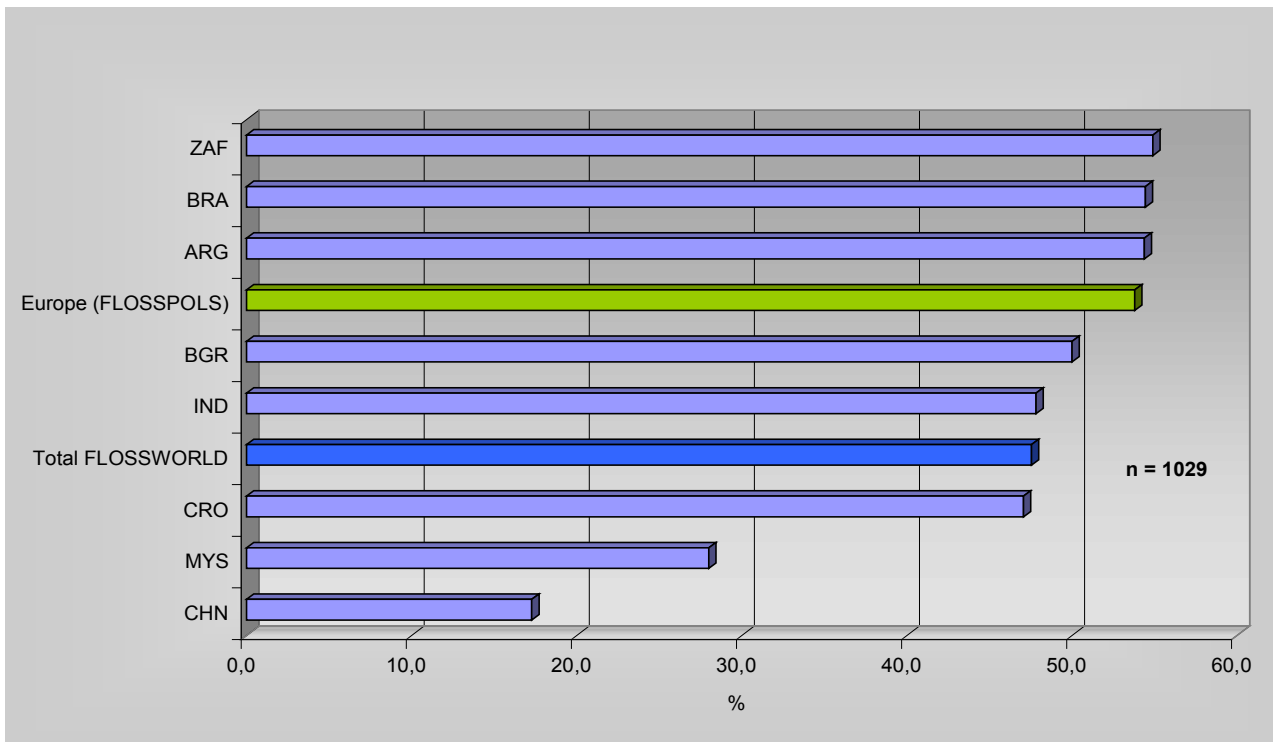
The share of students differs considerably between the countries: While their overall share within the sample is 16%, Bulgaria and Argentina show very small student shares (5% and 9%), whereas Croatia (24%) and especially China, where the vast majority of the community consists of students (61%) show above average shares of students. Similar differences can be observed with regard to the share of self-employed, which is considerably high in Argentina (44%, compared to an overall average of 22%) and very small in Croatia and Malaysia plus, of course, China, where self-employed make up only a share of 1%.

Homogeneity, by and large, can however be observed with regard to the age structure. Overall, the average age of the respondents is 29.2 years. The average age of the communities in the FLOSSWORLD countries is close to the overall average age, except for China. There, the FLOSS community is obviously built by very young members, as indicated by an average age of 25.5. South Africa provides the “oldest” community, with an average age of 31 years.

The educational structure of the respondents appears also quite homogeneous across the countries, which is explained by the fact that FLOSS obviously attracts a lot of its members from universities or from professions that require a university degree. Also – and closely related to the previous point –, the professions of the community members are very similar across all FLOSSWORLD countries, as usually software engineers, system administrators, and programmers provide the lion shares of the regional FLOSS communities.

Apart from these basic demographics, the economic structures in which FLOSS development is performed obviously do either not differ very much between the FLOSSWORLD countries and European FLOSS communities, at least as far as this can be illustrated by the community members' opportunities to earn money from their FLOSS engagement. As shown in Figure 1, except for China and Malaysia the shares of those who are able to earn direct or indirect monetary rewards from FLOSS are quite the same in all countries and regions. The lower shares of Chinese developers are due to the fact that this community consists mainly of students, the lower shares in Malaysia may be due to the relatively small share of self-employed, assuming that a higher share of self-employed leads to a higher degree of “commercial” projects within the community.

There are either no significant differences with regard to the ways in which community members gain their income from FLOSS. If they gain direct monetary rewards, this is usually rather paid for administrating or supporting FLOSS than for developing FLOSS; if they earn indirect monetary rewards this means usually that the respondent got his job because of his FLOSS experience. As we will see later, in both these FLOSS communities is the share of members that are still “seeking” their way and position, which might also hinder a broader “commercial” activity because this may require to commit oneself to clear tasks, time schedules, and maybe work that is not self-determined.



$P < .05$

Figure 1: Shares of FLOSS community members earning directly or indirectly money from FLOSS

Significant differences between the communities surveyed by FLOSSWORLD could also be observed with regard to the motivations of the FLOSS community members to join the FLOSS community. Though at first glance there is a strong agreement across all regional FLOSS communities that sharing knowledge and learning new skills, together with some ideological aspects (e.g. fighting the power of proprietary software (PROPS) companies), provide the main motivators for joining the community. A cluster analysis of following set of 13 motivators, of which the respondents were asked not to check more than four, revealed that there are five groups with distinct motivations within the overall sample.

Reasons to join the FLOSS community:

- to learn and develop new skills
- to share my knowledge and skills
- because I think that software should not be a proprietary product
- to solve a problem that could not be done by proprietary software
- to limit the power of large software companies
- to participate in new forms of cooperation
- to improve my job opportunities
- to participate in the OS/FS scene
- to improve OS/FS products of other developers
- to distribute not marketable software
- to get a reputation in the OS/FS developers' scene
- to get help in realizing a good idea for a software product
- to make money

The five motivational groups that could be identified are characterised as follows:

- Materialists – emphasise making money, improving job opportunities
- Philosophers – emphasise sharing knowledge, limit PROPS
- Helpseekers – emphasise software development, look for help in order to realise ideas
- Reputationseekers – emphasise getting a reputation in the FLOSS community
- Undecided – no clear motivational profile, obviously in a seeking phase within the community

Table 3 illustrates how these five groups are spread across the FLOSS communities in the surveyed regions.

Motivational clusters	ARG	BGR	BRA	CHN	CRO	IND	MYS	ZAF	Total
Materialists	18,4	10,0	18,2	11,0	9,8	12,9	17,1	19,6	16,6
Philosophers (share knowledge, fight PROPS)	17,5	22,5	21,3	5,5	27,5	17,1	7,9	17,6	18,6
Helpseekers	7,9	7,5	12,1	13,7	5,9	17,1	13,2	11,8	11,6
Reputationseekers	9,6	12,5	15,4	9,6	13,7	10,0	10,5	5,9	12,9
Undecided	46,5	47,5	33,0	60,3	43,1	42,9	51,3	45,1	40,2
Total	100	100	100	100	100	100	100	100	100

Table 3: Motivational clusters within the FLOSS communities of the FLOSSWORLD countries

The undecided provide the highest share in each FLOSS community, which is probably due to the high share of very young and / or new community members. The Argentinian community can be described as a community that is highly determined by these undecided; apart from that material orientations show also an above average share. The Bulgarian community appears to be mainly characterised by philosophers. Material orientations are not very strongly pronounced but mainly (if we neglect the residual category of the undecided). Brazil's FLOSS community shows a mixture of philosophers, materialists, and reputationseekers. China however, as well as Malaysia, must be classified as communities of the undecided. We assume that this feature contributes to the lower economic activity (in terms of earning money from FLOSS) in these two communities. The Croatian community shows a significant share of philosophers. The Indian community seems to be determined by software enthusiasts that use the community as a means to realise their ideas for software products or related services. The South African community shows the highest share of materialists, which might be explainable by the fact that this community shows the highest average age, so that the share of community members with professional and / or commercial interests is higher in this community than in the other ones.

4. Human capacity building in the FLOSS community

Although FLOSS is not just coding but offers its community members a wide variety of activities to perform and to learn (we have asked for more than 30 different activities in our survey), the community members in all communities showed such a homogeneous pattern that a meaningful distinction of typical activity groups was not possible. The homogeneity is explained by the fact that in all communities the members prefer to write code or to act politically but don't like to write

documentations or to localise texts or software.³ We therefore abstain from a detailed discussion of these activities.

More interesting than the question about general activity patterns is the question which skills improve most through participating in the FLOSS community. The degree of convergence between the 8 countries with regard to this question is impressive, as in almost all communities the same three skills are perceived as the most improving ones: to write code in a way that it can be re-used, to develop an awareness of legal issues, and to accept and respond to criticism from others (see Table 4, illustrating for each country the three skills that were evaluated most positively on a scale from 0 = “I learned nothing” to 4 = “I learned a lot”). Exceptions are only provided by the Chinese community, which members also learn a lot “to clearly define and achieve targets”, and the Indian and South-African community, which learns a lot “to coordinate your own work with the work of others”.

Overall, this observation leads to two fundamental findings with regard to the human capacity building in FLOSS: FLOSS provides not only technical skills but also social, technical and legal skills, and there is a common global understanding of what those skills are that improve most through FLOSS.

ARG	BGR	BRA	CHN	CRO
To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To write code in a way that it can be re-used	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To write code in a way that it can be re-used	To write code in a way that it can be re-used
To write code in a way that it can be re-used	To accept and to respond to criticism from others	To write code in a way that it can be re-used	To clearly define and achieve targets	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability
To accept and to respond to criticism from others	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To accept and to respond to criticism from others	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To accept and to respond to criticism from others

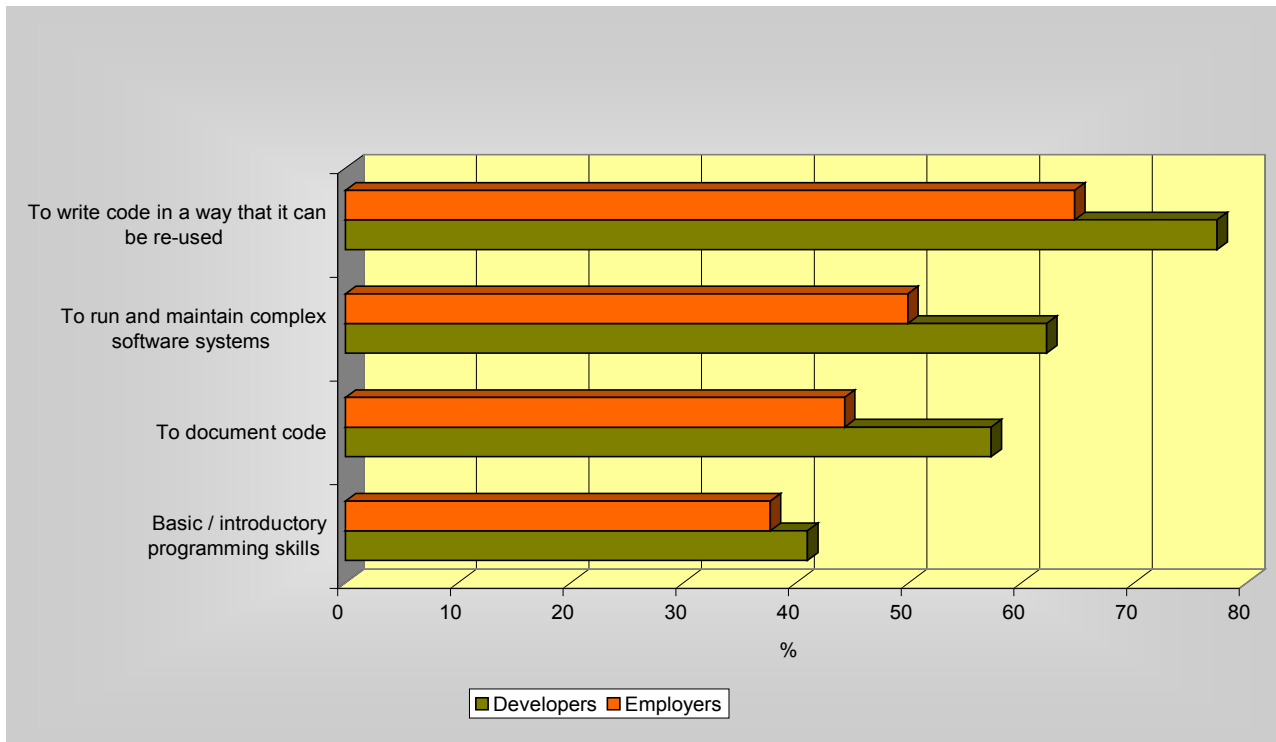
IND	MYS	ZAF	Total
To write code in a way that it can be re-used	To write code in a way that it can be re-used	To coordinate your own work with the work of others	To write code in a way that it can be re-used
To accept and to respond to criticism from others	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability	To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability
To coordinate your own work with the work of others	To accept and to respond to criticism from others	To accept and to respond to criticism from others	To accept and to respond to criticism from others

Table 4: Top-3 skills that are considered to be better learnt in FLOSS than in a formal course

Another important aspect of the capacities of the FLOSS community as a learning environment is whether or not it allows to learn some skills better than in an alternative environment, especially as compared to formal computer science courses. Interestingly, developers as well as employers report that there such “FLOSS-specific” skills, and the views of these two groups are quite congruent with

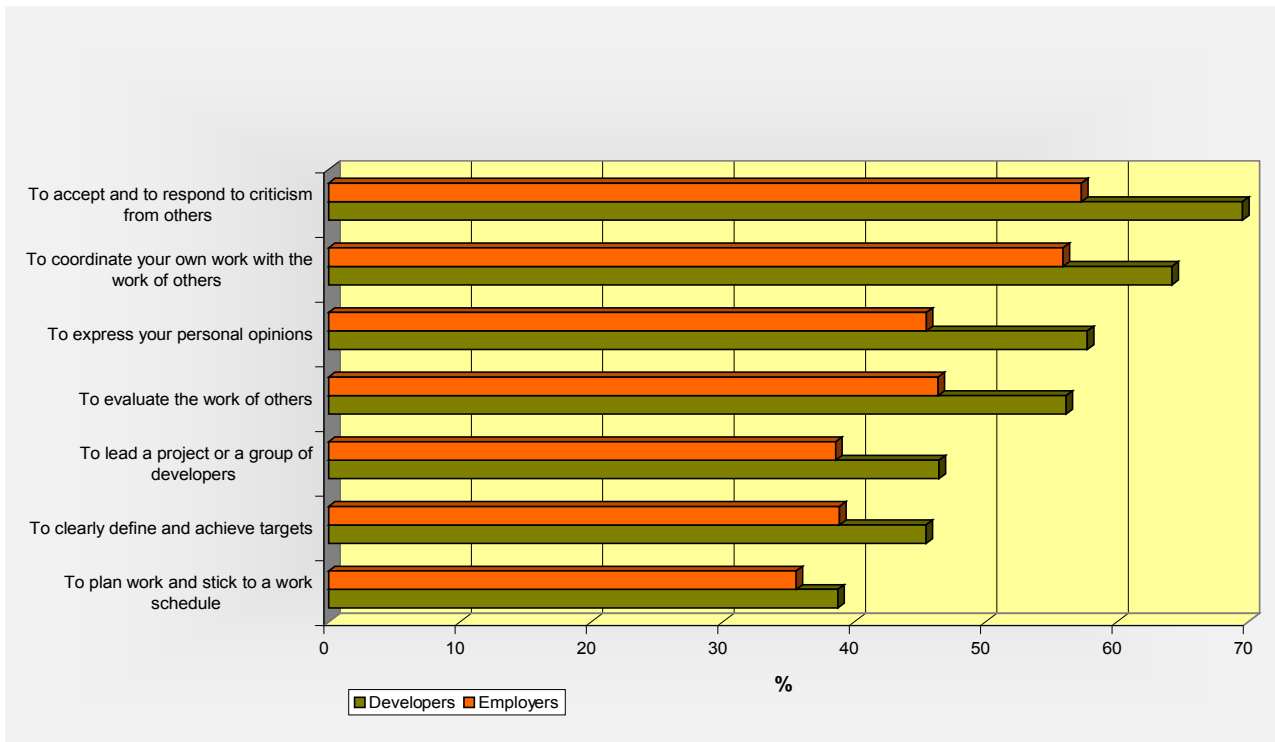
³ The same applies to ways of learning: Formal courses and workshops are refused while reading source code or books and participating in discussions is said to be a very useful way to learn.

regard to technical skills (Figure 2). The same holds true for managerial skills, as illustrated in Figure 3. Finally, 78% of the FLOSS community members say that legal skills related to software can better be learnt in FLOSS than in a formal CS course, which is also uttered by 63% of the employers



Share of respondents saying that these skills can better be learnt in FLOSS

Figure 2: Technical skills better learnt in FLOSS than in formal CS course – developers and employers compared



Shares of respondents answering these skills can better be learnt in FLOSS

Figure 3: Managerial skills better learnt in FLOSS than in formal CS course – developers and employers compared

Skills attainment in the FLOSS community is directly related to professional aspirations, as illustrated in Figure 4. In each country, the share of those FLOSS community members who say that they consider these skills as a core for their professional career is the biggest one, and only comparably few say that these skills are an end in itself and not related to their career. This is particularly true for Argentina, Bulgaria, India and South Africa.

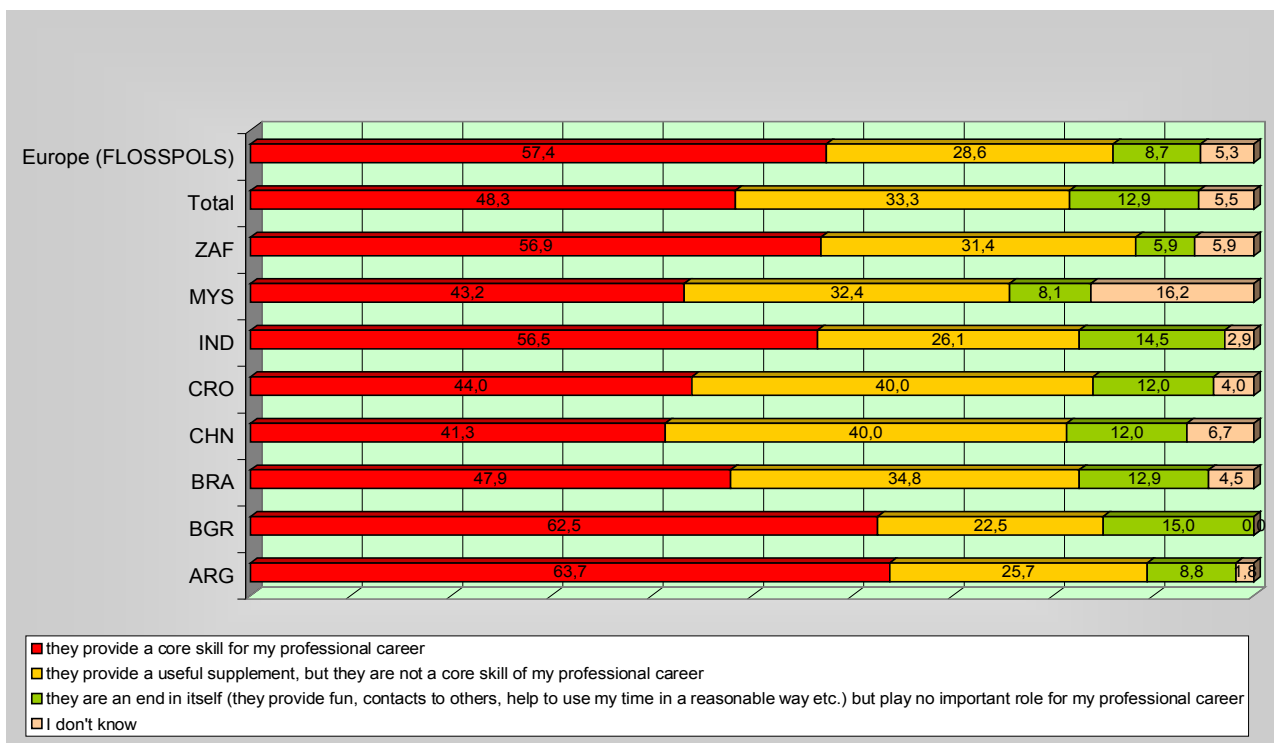
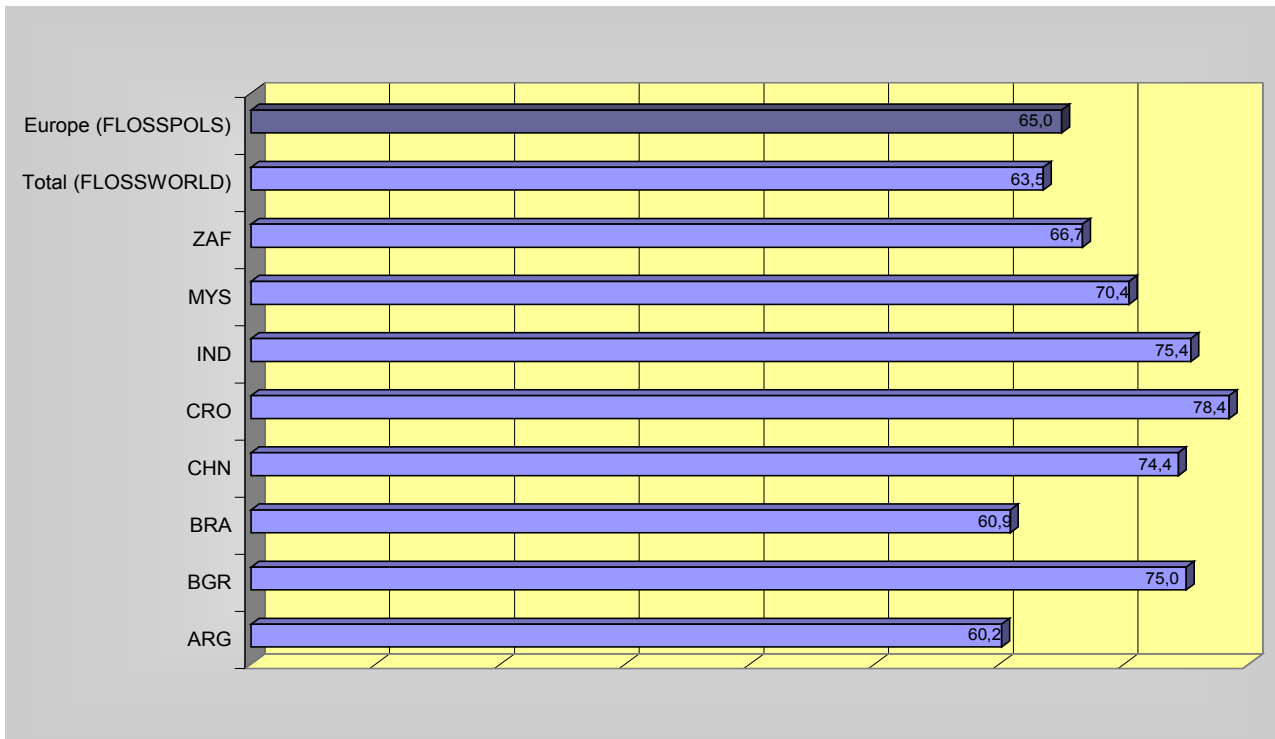


Figure 4: Role of FLOSS skills for professional career

Regarding the value of FLOSS skills as compared to formal degrees, overall 64% of the developers think that proven participation in the FLOSS community can compensate for the lack of formal degrees, like certificates or university degrees. As shown in Figure 5, the respective share is in Croatia, India, China and Bulgaria much larger.

The employers' opinion on this issue is unequivocal: Most of them see no difference between a formal degree and informal FLOSS experience; in China the employers even prefer informal experience over a formal degree (see Figure 6).



Shares of respondents who say that FLOSS can compensate for lack of formal degrees

Figure 5: Capacity of FLOSS to compensate for lack of formal degrees

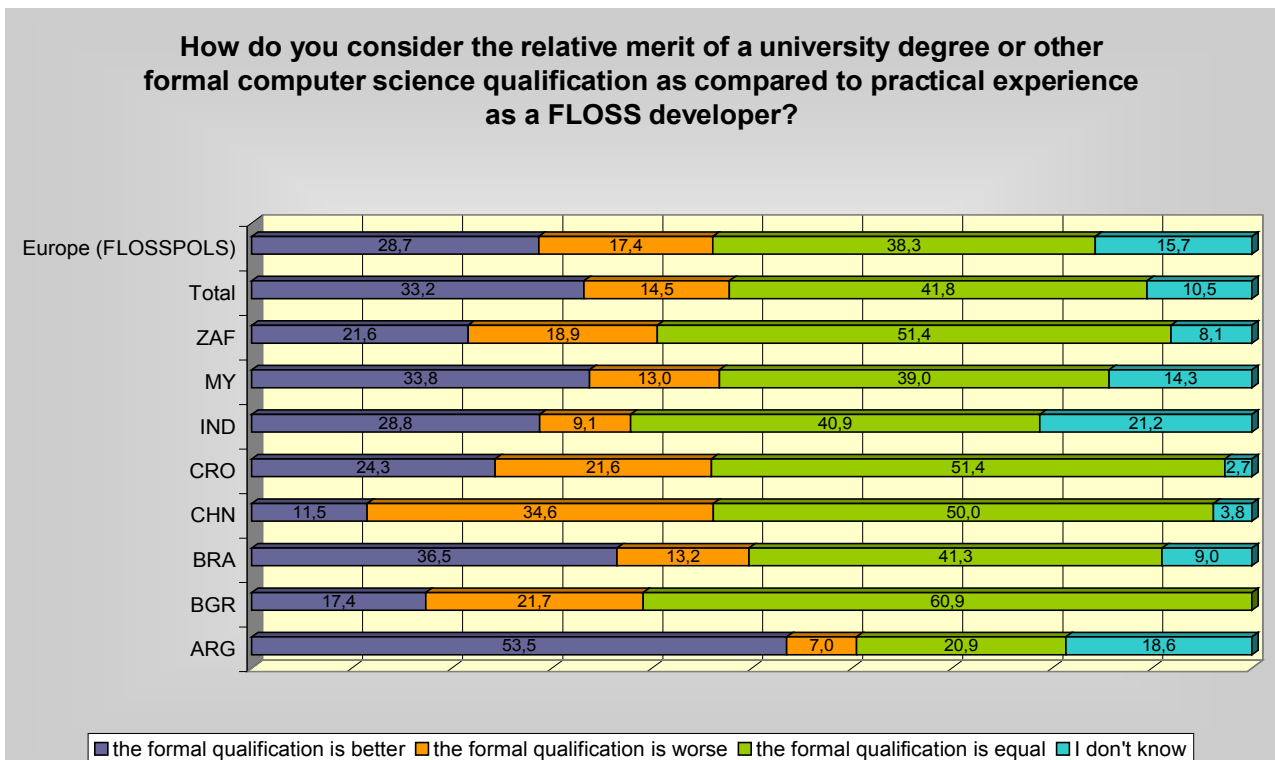


Figure 6: Formal degrees and FLOSS experience compared - employers' view

When two people with exactly the same level of formal qualifications but different experiences are imagined, Person A with proven experience developing an important component of a proprietary software product and Person B with proven experience developing an important component of a FLOSS software product of equivalent complexity, 37% of the FLOSS community members think that Person B would be in a better position to get a job⁴, 42% thinks that both are equal. Only 13% see Person A advantaged. 8% did not know how to decide on this question (see Figure 7).

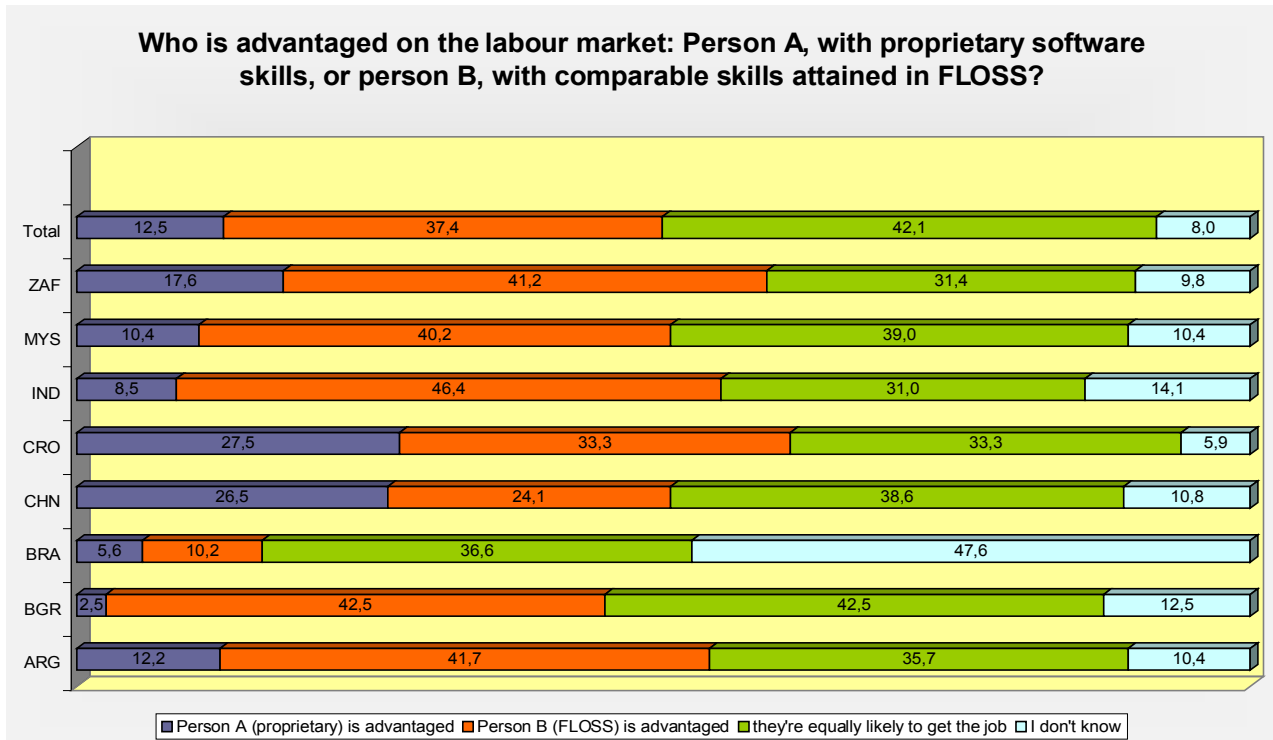


Figure 7: FLOSS skills vs. proprietary software skills - developers' view

The South African, Croatian and Malaysian community sees more often than the other communities people with proprietary software skills as advantaged. Indeed have our local partners in these countries confirmed that it is not easy for job applicants there to use FLOSS experience as a reference because many employers are not aware of FLOSS.

Employers tend to either say that the differences between Person A and Person B would not influence their preference (40% overall) or they would prefer Person B, with FLOSS skills (42%). This is probably due to the fact that the employer sample is biased towards companies for which FLOSS plays an important role. Only 13% would prefer Person A (4% do not know). Strongest support for FLOSS skills is expressed by South African and Chinese employers, while Croatian employers show comparably strong support for proprietary software skills (see Figure 8). The latter is in line with the perception of the Croatian developers. Overall, we can conclude for the “FLOSS-centred economy” - because most of the companies in our sample are FLOSS-centred – developers have by and large a realistic understanding of how employers value their FLOSS skills.

⁴ It was explained to the respondents that "job" refers not just to permanent employment, but also any other paid work including freelance or consultancy.

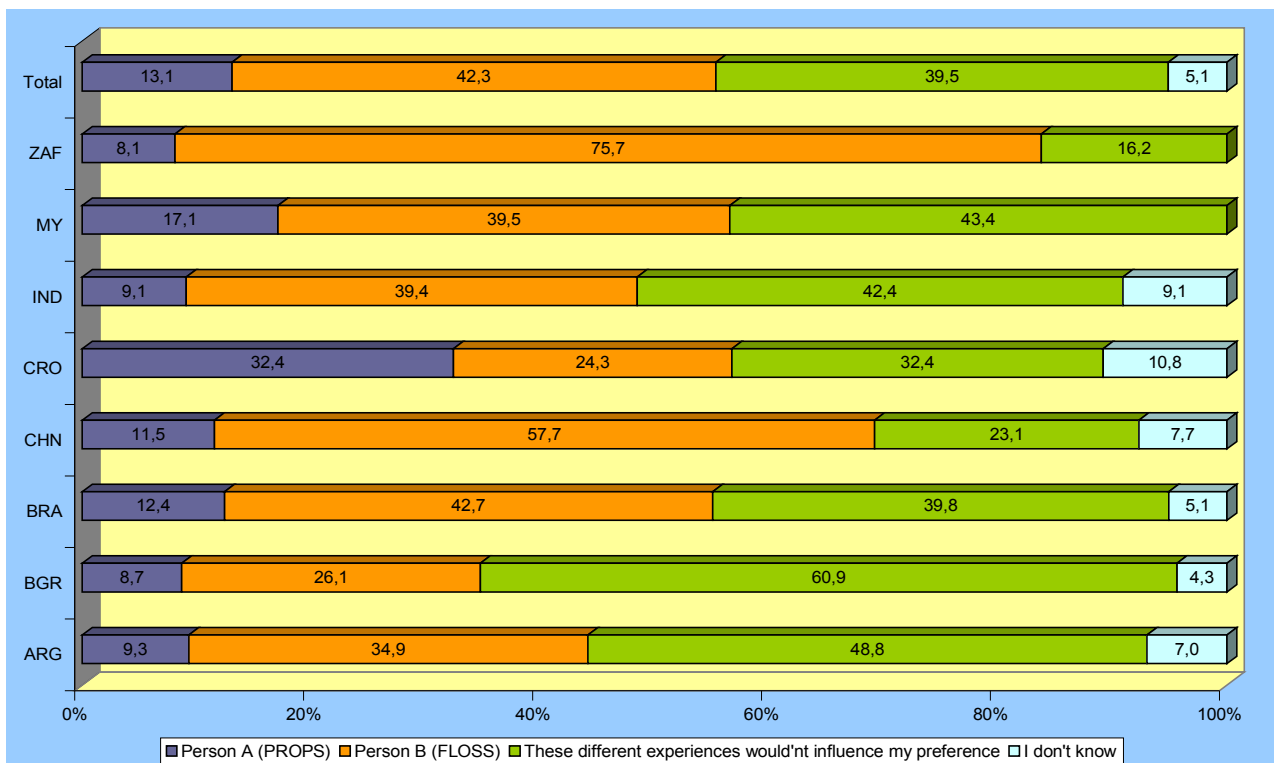


Figure 8: FLOSS skills vs. proprietary software skills - employers' view

The question whether the FLOSS community members think that people like person A, with proprietary development credentials, are paid the same by employers as people like person B, with FLOSS development credentials, was apparently hard to answer, as the shares of the “I don't know” responses ranges from 26% to 44%. 30% (but 45% in Croatia and 35% in South Africa) think that people with proprietary software credentials would get paid more. A better payment for a person with FLOSS credentials is assumed by only 14%, but by 24% in India and Malaysia, respectively. It should be noted in this context that overall only about one third to two fifths of the respondents could answer this question based on own experience in getting a job. Together with the high degree of uncertainty in the response to this question – which is also visible in the response of those who answered based on own labour market experience - we like to consider these findings as tentative.

45% of the employers replied that they pay persons with FLOSS experience the same as persons with a formal computer science qualification. 14% would pay more for a formal degree, and 19% would pay the FLOSS-skilled employee more. One fifth of the respondents did not know what to answer. Comparably strong support for formal degrees could be observed with Argentinian and Malaysian employers (more than 20% of them would pay an employee with formal degrees more), whereas strongest support for FLOSS is visible in Brazil, South Africa, and Argentina again.

5. Higher Education Institutions and the Global Role of FLOSS

5.1. Introduction

Policymakers in the private and public sectors, and researchers in the social sciences and software engineering, have sought to understand the dynamics and implications of the growth of Free/Libre/Open Source Software (FLOSS) by focusing primarily upon the motivations of the individuals that participate in its development and the conditions affecting the adoption of “open source” computer programs by business firms and government agencies.⁵ Comparatively little attention has been given to examining the extent to which FLOSS is being created, released and applied within the Higher Education Sector (HES). Moreover, virtually all the previous empirical research in that vein has been concentrated upon FLOSS development and diffusion in economically advanced regions of the world. This report seeks to help fill the resulting “double-gap” in knowledge regarding the global role of “open source” software, by presenting the findings of a recently completed survey of administrative staff members and information technology managers at “universities” in seven developing and “transition” economies.⁶

The present study represents one part of a broader enquiry supported by the EU 6th Framework Research Programme -- the *FLOSSWORLD* project, the aim of which is to increase knowledge about the global phenomenon of Free/Libre and Open Source Software (FLOSS) development and adoption, thereby contributing to informed public policy and effective collaboration between the EU and developing countries. As a Special Action Project, *FLOSSWORLD* seeks to advance Europe’s leadership in FLOSS development, to build a global constituency of policymakers and researchers, to enhance global awareness of FLOSS issues, and to strengthen the research communities in the participating regions. Toward those goals *FLOSSWORLD* has designed and carried out parallel surveys of government organizations, business firms, and individual developers, as well as universities in the selected group of countries: Argentina, Bulgaria, Brazil, China, Croatia, India, Malaysia, and South Africa. By highlighting the dynamics of open source software use in the universities of those countries, the present report facilitates comparisons of the role of FLOSS in a variety of organizations whose separate activities and interactions are of critical importance for the development of the capabilities of their respective societies and the well-being of their citizens. It examines inter-regional differences in the extent of the use of FLOSS in university teaching, research and administration, and the contributions of members of those institutions to open source software development. Its findings serve to highlight opportunities for improving the future role of FLOSS in the HES.

5.1.1. FLOSS in the HES: Some Motivating Issues

A growing body of research has pointed to the broader economic significance of the mode of production that has characterized the development of many of the most successful and extensively

5 Most of the systematic survey studies focus on the supply of open source software (FLOSS), inquiring into the characteristics, location and motives of the developers. Studies based upon extensive survey data include Robles et al. 2001; Ghosh et al. 2002; David, Waterman, and Arora 2003; Mitsubishi 2004. See David and Shapiro 2007 comparative details. The 2002 FLOSS Report by Ghosh et al., however, looked at business use and procurement policies as well. There are, in addition, numerous “case studies” of migration to FLOSS in business and non-profit organizations, although meta-analysis of their findings is generally difficult.

6 The survey focuses on the main categories of higher education institutions, which for convenience we refer to simply as “universities”. The latter term applies, therefore, to research universities, teaching colleges, research institutes, and other institutions that fall under the label of HEI -- with the caveat that some respondent institutions do not teach undergraduates, or do not conduct research, or in some other way do not fit the traditional conceptualization of a university. The higher education sector (HES) includes other tertiary educational organizations and programs that were not targeted by this survey, notably those specializing in continuing education and non-professionalized areas of vocational training.

adopted FLOSS programs (e.g., the GNU Linux, Apache, Mozilla and Firefox, MySQL, OpenOffice). These typically decentralized, self-governing, trans-national community-based, and heavily volunteer-dependent collaborations utilize “open” peer-based coordination, continuous workflow and early and frequent code release practices – all of which present marked divergences from the mode of production that had come to be established in the “closed”, proprietary sector of the global software industry. From the organizational standpoint, as well as from the uses to which these “open source” projects put the copyrights on the code contributed by developers, FLOSS as a system of allocating resources for production and distribution occupies a territory distinct from that governed by either the “visible hand” of hierarchical management or the “invisible hand” of the market. Its resemblance to prominent features of academic “open science” research collaborations has been remarked upon, but there are numerous respects in which FLOSS collaborations remain distinctive and far less institutionalized.⁷

Beyond its potentials as a paradigm for collaborative creation of a range of information products considerably broader than computer software, the FLOSS movement has come to be viewed as emblematic of a more general reorientation of the organization and conduct of many processes in the social and political sphere, one that may be particularly supportive of the production of public goods and participatory democracy (Benkler 2006). Rather strikingly, however, the roles that FLOSS may have in the sphere of Web-based skills acquisition, the support of conventional educational and training activities in computer programming and Web design, and the formation of human capital more generally, has not attracted equivalent attention.⁸ Public discussions of the relevance of “open source” programs for e-learning at the tertiary level (at least, those carried on in English language sources) have been largely preoccupied with questions of patent rights and licensing cost of “course management” and e-learning support software (particularly those arising from the “Blackboard Learning System” patents, and the possible threats to FLOSS alternatives such as “Moodle,” and MIT’s “Saki Project”).⁹

But, quite obviously, the potential contributions that the activities of FLOSS communities can make to university education and skill formation do not begin and end with the question of the costs to educational institutions of on-line course management software, and this is especially true when the situation of the developing and transition economies are considered. Universities (and educational institutions more generally) can be both significant contributors to, and beneficiaries from the development of FLOSS. The major educational and research missions of universities give them the potential to be powerful actors in this regard: they can prepare the users and developers of computer software to apply these tools as citizens, consumers, employees and entrepreneurs; they train researchers in scientific and technical fields that are becoming evermore reliant upon advanced digital information processing and retrieval technologies, and they are the institutional hosts for fundamental and applied research in the mathematical and computational sciences.

Furthermore, the policies of universities and the behaviors of their employees are of interest because the HES is a major employer and user of digital information and computer-mediated telecommunication resources, and the decisions made within these organizations about what hardware and software systems will be acquired and supported are shaped by incentives and constraints that are not identical to either those in government agencies or in private, profit-

7 For further discussion of the “open source” – “open science” relationship, see, e.g., Dalle, David, Ghosh and Steinmueller (2005); on open science institutions and norms among Internet-based research projects, see David, den Besten and Schroeder (2006).

8 It is striking that the discussion of “educational instruction” by Benkler (2006: pp. 315, 327) is brief, focused on the limited capacity of electronic communications to transform university level (or other) face-to-face instruction, and confined to the MIT Open Courseware Initiative and the potentialities of employing such public domain strategies to create open platforms on which textbook authors and instructors can collaborate. Benkler (op.cit., p. 326) cites the South African project (Free High School Texts) as the “the most successful commons-based textbook authoring project, which is also the most relevant from the perspective of development.”

9 See discussion and links at http://en.wikipedia.org/wiki/Blackboard_Inc.

oriented enterprises. Examining the use and development of FLOSS within HEI's, and the possible differences within the various functional divisions of the university (administration, teaching and research in the arts, and in the sciences) may be informative of more general questions about the ways in which different structures of organization and cognitive activity affect the balance of choice between proprietary software and FLOSS.

In addition, it must be recognized that HEI's are providers of high-speed internet connections with global sources of information that are likely to be far from ubiquitously available and therefore particularly important in many developing countries. Consequently, beyond questions concerning the extent to which universities and technical training institutes are offering instruction in the skills that would allow students and staff to modify and utilize open source computer code for their own uses, and to participate in collaborative projects on the Internet, one should consider how the policies of universities affect the access that students in developing regions can have to informal, experience-based learning interactions with global software development communities.¹⁰ Opportunities to observe, passively follow email forum discussions, and learn how to elicit and absorb technical help from more skilled programmers and sophisticated users of specialized software packages, can be especially important in settings where such expertise is not locally available. Although it is sometimes argued that the lack of expertise in computer programming in a region's workforce constitutes a powerful reason for relying exclusively on "closed", user-friendly software packages from proprietary vendors who can supply external support and help for unsophisticated users, as a developmental strategy this is very short-run in its priorities. It limits opportunities for skills development that can transform the region's resource endowment, and it ignores the potentialities for knowledge transfers from the existing international community of FLOSS developers and users to accelerate that learning process.

In developing regions of the world, where young people are unlikely to have their own personal computers and high bandwidth telecommunications connections, educational institutions can provide key portals for self-initiated skill formation through contact with distributed "communities of practice." To the extent to which universities encourage students and staff members to avail themselves of those "learning resources," international FLOSS development communities in turn may adopt norms and procedures that accommodate and facilitate informal processes of skill acquisition – rather than dealing with neophyte developers in ways that rebuff and discourage individuals for whom such contacts could constitute an important source of knowledge. Whether the foundations that support the activities of some of the larger FLOSS development communities would be willing and capable of taking such a pro-active role in contributing to the formation of human capital, and the enhancement of the software skill proficiency and versatility of scientific and technical workers in the materially less well endowed societies would become a quite relevant question if the higher education institutions were effective in facilitating the connections from their side.

The foregoing considerations provide ample motivation for enquiring into the policies and practices of universities (in the developed and the developing regions) regarding FLOSS. Considering this, it is really surprising that so little empirical research has been focused on the subject. Previous to the study reported here, the only systematic survey-based research addressing this range of topics (of which we are aware) is that carried out for UK universities and further education institutions by OSS Watch (2006).¹¹

10 John Seely Brown, in a lecture entitled "Relearning Learning: Applying the Long Tail to Learning" delivered at MIT (in April 2007) elaborated on the changing face of learning in terms that emphasize the educational potentials of the kinds of distributed interactions with communities of practice that are envisaged here: "We learn through our interactions with others and the world", and there's no more perfect medium for enabling this than an increasingly open and organized World Wide Web....In a digitally connected, rapidly evolving world, we must transcend the traditional Cartesian models of learning that prescribe 'pouring knowledge into somebody's head'." For a summary and links to the lecture, see: <http://www.checkpoint-elearning.com/article/3822.html>.

11 OSS Watch is the Advisory Service on free and open source software established by the Joint Information Services

The data used in this paper have been extracted from the survey responses of two groups of university employees – administrative staff members and IT managers – totaling 446 individuals who reported on the conditions at 310 distinct HEIs. The first group, administrative respondents, includes Deans of Research, Vice-Provosts of the university, or other individuals in high administrative positions who must oversee operations of the university as an organization. The members of the group that we have labeled “IT managers” are occupants of a more varied assortment of university posts, including a Provost of Information Services, Vice-Provost of Information Technology, and other individuals (including those with teaching roles) who are responsible for managing the informational technology infrastructure of their institution. Universities are complex and highly variegated organizations, despite their outward similarities of purpose; they have correspondingly differentiated and complicated personnel structures whose members this survey did not explicitly seek to contact: a typical university employee works in a department or research institute that operates within a school, and is located on a specific academic university campus or in an urban facility. Moreover, schools and even entire university campuses may be only one local affiliate of a national university containing several such units. Adoption of FLOSS may differ within and between each of these organizational levels. In one university where individuals from several departments responded, we are able compare IT adoption policies and demonstrate the heterogeneity of FLOSS policies even within a single university. Although statistical averages and modal values are convenient in summarizing the data, considerable caution should be employed in reaching for generalization about the way that FLOSS figures in work of the “typical” university community of any one of the countries in this survey, let alone in activities of the typical university student or academic workgroup in developing regions. Conducting a study of open source software adoption by universities in economically less advanced regions, nevertheless, may yield further potentially useful insights regarding the important aspects of the development and growth process in a global context. One broad concern of economic growth policy is the formation of “absorptive capacity” in developing countries that will enable their producers to continue to identify, locate and successfully utilize scientific knowledge and technological information originating elsewhere, and particularly in societies where the scientific and engineering resource endowment is greater and average technical skill levels in the working population are higher. FLOSS itself is a technological artifact that is readily (and almost costlessly) transported, but whether it is “transferred” -- in the sense of being effectively absorbed into use – is a more complex matter. Studying the extent and pattern of adoption of FLOSS in developing and transition countries may therefore provide comparative measures of “absorptive capacity”, as well as insights into possible mechanisms and institutional policies affecting the formation of capabilities for successful technology transfer in other areas.¹²

5.1.2 Organization of the Report and Overview

The presentation of our findings is organized as follows. Section two outlines the survey methodology and response rates. It emphasizes that the data represent a selected sample from predominantly technical universities in each of the seven countries. Within universities, the individuals who respond may be more interested in FLOSS than are the individuals who do not

Committee (JISC) of the Research Councils in the UK, which is based in the Oxford University Computer Service. The OSS Watch 2006 survey is available at: <http://www.oss-watch.ac.uk/studies/survey2006/survey2006report.xml>. Also available are the findings of an informal survey (conducted by Barry Cornelius in April 2005) of Linux on desktop computers at Oxford University, and a May 2006 update presenting similar fragmentary data on FLOSS software use gathered from several other UK universities [<http://www.oss-watch.ac.uk/studies/linuxdesktopsurvey.xml>]. The OSS Watch 2006 survey employed an online questionnaire that extended a design piloted by a much smaller 2003 survey (also available on the OSS Watch website), and made use of many portions of the instrument developed for the FLOSSWorld HEI survey. Future research will therefore exploit the “developed country bench-mark” that this affords, offering direct comparisons with the responses reported here – subject, of course, to the variants in the wording of questions introduced by translation from the basic English version.

12 As the average university employee is likely to have a better educational preparation and higher skill levels than the average member of the work force, the implicit measures of absorptive capacity yielded by looking at FLOSS adoption and use in HEI’s relate to a “best practice” rather an “average practice” concept of technology transfer.

respond. So it would not be unreasonable to surmise that the picture created by our study describes the state of affairs among technology savvy individuals at the “leading edge” of universities’ involvements with FLOSS, rather than the situation that is more typical in the HES as a whole. Section three summarizes responses to most of the questionnaire items, and highlights the following five principle sets of descriptive findings:

- **First, reported average rates of FLOSS use and FLOSS development at universities vary substantially across countries, but FLOSS use lies in the range above 60 percent whereas FLOSS development typically lies in the range below 60 percent.** As might be expected, the reported use of FLOSS in these institutions is far more prevalent than development activity: whereas the national average proportions of universities that use FLOSS in some form fall in the range between 0.63 and 1.00, the corresponding range for the mean proportion that are reported to develop FLOSS lie in the range from 0.27 to 0.61 (save for handful of responding universities in Bulgaria, where reported rate averaged 0.93). Universities in Argentina and Brazil use FLOSS more extensively than do their counterpart institutions in other countries, especially those in China, among which the adoption of FLOSS is less common than the rest of the sample. Despite the prominence of the Indian Institute of Technology and the increasing role that information technology plays in India’s economy, FLOSS does not have a comparatively prominent role in the countries universities of India. Overall differences between countries explain only 14 percent of variation in FLOSS use, so an institution’s country says only about one-sixth as much about the institution’s use of FLOSS as do the institution’s other characteristics.
- **Second, views among administrators and IT managers are not closely aligned regarding the appropriateness of the share that their institutions’ IT budgets devote to software purchase and licensing fees, although there is a clear preponderance of opinion that budget shares in the range 0.20-0.40 “seem reasonable”.** A clear majority among the administrators are comfortable with software budget shares in the range up to .50; those that think otherwise appear to agree, on balance, that the shares in that range are too low rather than too high; whereas at each point in the budget range above .30 a clear majority of IT managers view their institutions’ share as reasonable. Expectations that there will be a need to reduce expenditures on software are rather more closely aligned between administrators and IT managers at each level of the actual institutional budget range, but, perhaps not surprisingly, the consensus on the need for cuts that emerges among respondents whose institutional software expenditure shares are in the 0.30-0.60 range is considerably more pronounced in the case of the administrators.
- **Third, a substantial portion of universities ask technical job applicants about their FLOSS experiences** and give positive weight to such experience in making hiring decisions. This finding is consistent with, but by no means proves, the contention that an important motivation for developers to volunteer contributions to FLOSS projects is their expectation that such participation will improve their employment prospects in the software industry or professional careers by signaling their technical abilities and achievements.
- **Fourth, a majority of the survey respondents report that courses are offered at these institutions that would provide students with basic and advanced programming skills,** and courses in web management and advanced html appear to be no less frequently available. While this is important in initiating development of the abilities of graduating cadres entering employment to use and modify open source code, and permitting them to interact with and participate in the code development activities of international FLOSS projects, comparable skills development support generally is not afforded to university staff. Nor are these software skills course offerings equally extensive across the countries: whereas as average of 3 or more courses per institution is the country norm, with Bulgarian and Indian universities averaging more than 4 such offerings apiece, the average barely exceeds 2 courses per institution in Croatia.
- **Fifth, having a departmental policy for purchasing computer software which is**

clear or which supports FLOSS adoption is neither necessary nor sufficient for a university to attain high levels of prevalence in the adoption of FLOSS. Many universities that extensively use FLOSS lack clear software policies, and many universities with IT “neutral” policies regarding procurement do not use FLOSS. **Such policies, however, when not anti-thetical to releasing FLOSS appear to be strongly associated with the reported presence of open source software development activity within the institution.**

Section 4 analyzes the correlates of reported FLOSS use, software adoption policy, open source software development activity, and IT personal hiring preferences, with the aid of two statistical methods – principal component analysis and multivariate regression. These techniques are explained briefly in the methodological appendix. It is found that cross-country differences explain only 15 percent of variation in the reported prevalence of FLOSS use. Knowledge of a university’s country, in other words, says less about the university’s use of FLOSS than does knowledge of other characteristics of the university. Survey data are relatively uninformative about FLOSS use, however, as data from the present survey explain only 20 percent of variation in FLOSS use across respondents.

Section 5 summarizes the report’s findings with a view to their possible bearing on higher education and science policies aimed at human capital formation involving IT skills and the absorption of technologies embedded in software. A statistical Appendix presents auxiliary tables, methods for statistical tests and regression analysis, and further discussion of possible selection bias in the survey.

5. 2. Survey Populations and Respondents

5.2.1. Respondent Individuals

Local survey affiliates in each of eight countries identified potential universities as targets for direct email requests to cooperate by responding to the survey. In most cases the university administrators and information technology (IT) personnel were contacted by direct email and informed of the online (Web) location of the questionnaire(s).

The survey responses thereby obtained includes the answers supplied by a total of 446 individuals, just over half of whom are IT managers. National sample sizes vary: China, the country with the world’s largest population, has only 54 respondents, while Malaysia has 128. Bulgaria and South Africa have small samples of 7 and 12 respondents, respectively, while Argentina, Croatia, and India have intermediate sample sizes. The samples from Brazil, Croatia, and India substantially over-represent IT staff, while the sample from Argentina most under-represents IT staff. These differences in proportion across countries have robust statistical significance, but they could indicate different true ratios of IT to administrative staff in these countries, or they could reflect varying response probabilities across individuals and countries.

Respondents had mean age of 39.5, with the average South African aged 47 and the average Bulgarian aged only 35. Large web-based surveys of FLOSS developers place their mean ages in the range between 27 to 29 (David and Shapiro 2007), so the HEI survey represents an older population, reflecting the likely situation of university administrators and IT staff members, compared with considerably younger typical entrants to labor markets and the students who have been found to represent sizable proportions among the population of FLOSS developers at large. The mean ages of the HEI survey respondents for the eight countries show variations, as has been indicated, and the same thing may be said in regard to their composition by gender, which ranges widely: females were entirely absent among the respondents from South Africa, but represented more and two-fifths of the (comparably small) number of Bulgarian respondents. The mean of the

female proportions in the whole sample (0.183) approximates the average that is found among the other, more substantial national samples, but even for that part of the data set the country-to-country differences are considerable – ranging from 0.11 to twice that proportion.¹³ Whereas the respondents’ mean age varies significantly across countries, in the case of their gender compositions we are able only marginally to statistically reject the hypothesis that in each country the proportion of females among responding university officers is the same.¹⁴

On average the survey required 20.7 minutes to complete, or just over one minute per question. A few respondents took much longer (Figure 1). National language imperfectly predicts time required for completing the survey, as the average South African respondent spent 21 minutes,¹⁵ but the average Bulgarian and Chinese respondents spent only 11 and 14 minutes completing the survey, respectively. Connection speed, time required to think of an answer to a question, and other factors likely played roles in determining the time required for the survey. Survey duration was right-skewed, with a few respondents taking nearly an hour.

5.2.2 Respondent universities

To give a clearer picture of the institutions represented in these data, Table 2 provides descriptive statistics indicating the size and scope of the respondent universities’ educational activities the several countries. For several reasons, calculating response rates for this survey is not trivial. Surveyors contacted one or more people at each university, and sometimes in different departments or campuses of one national university. Sometimes the person who responded from a university differed from the person who was contacted in that university. Further, surveyors and respondents refer to one university in many ways – via acronym, nickname, departmental name only, department and faculty, or any combination of the preceding options in English and/or local languages. Table 2 presents an “institutional response rate”: the numerator is the number of distinct universities which had at least one person answer the survey, and the denominator is this number of distinct respondent universities added to the number of distinct universities which were contacted but did not respond. The response rate statistics are reported therefore approximate the portions of the contacted universities that had at least one person fill out the survey.

Overall, forty-eight percent of the universities invited to participate actually submitted a response, but the response rate varied from a high of 77 percent in Malaysia to a low of 24 percent in India. Since the survey offers nearly no data on the non-respondent individuals or institutions, the data allow no testing whether respondent institutions differ in observable ways from non-respondent institutions.

This response rate led 310 distinct universities to respond, implying that the survey contains just below 1.5 mean respondents per university.¹⁶ Malaysia had the largest sample of individuals, but Croatia has the greatest number of universities, with 71 different institutions responding. Bulgaria

13 It is interesting to note that the mean proportion of females among these respondents closely approximates the (20 percent) share of females among the employess of proprietary software firms surveyed by the FLOSSPolS Project (2006): the latter far exceeds the share of females among FLOSS developers that respond to web-surveys, which is in the neighborhood of 3 percent. In the case of the FLOSS-US survey, only 1.6 percent of the approximately 1500 respondents to that survey question identified themselves as female (see David, Waterman and Arora (2003).

14 The Appendix Section A2 explains the Pearson χ^2 and ANOVA F statistics reported in some tables.

15 In this instance, as elsewhere, we report sample statistics calculated after discarding outlier observations that are obviously erroneous: one of the South African respondents appeared to have taken more than 20 hours to complete the survey, most probably because they had interrupted their work but remained connected to the server, which eventually recorded their log-out time.

16 When a national university has campuses in several cities, Table 2 identifies these campuses as distinct institutions. The existence of measurement errors in the size data is suggested by Figure 2, where “age heaping” is clearly present in the size distribution of the responses to questions about the numbers of undergraduate and graduate students enrolled: note the local peaks on 10, 20, and 30 thousand undergraduates; there are indications of heaping at 5, 7,5(?), 10 thousand graduate students.

had only five institutions respond, and South Africa had only 9.

A surprisingly high portion of universities only sent responses from IT staff. The survey requested responses from administrative personnel, and also requested administrative respondents to designate an IT manager who could either supplement or replace the administrative response. Given this survey design, one would expect a majority universities to have an administrative respondent, and some to also have IT managers as respondents in those instances where the administrator was unable to supply answers to technical questions; in a minority of cases, one would expect only responses from an IT respondent. The data, however, contain more responses from IT personnel than one might expect: 46 percent of universities have IT managers only, 35 percent have admin respondents only, and 19 percent have both types of respondents. The breakdown of respondent type varies across country: Brazil, China, and Croatia have relatively more IT managers, while Argentina has a disproportionate number of administrator-respondents.¹⁷ One-fourth of the responding universities represent technical institutions, as one might expect given the survey's announced focus on IT software. Technical institutions are identified from university names—institutions like “Binary” or “Multimedia” university are identified as technical, while others are not. University naming may reflect demand for different types of education in different countries, and it is striking to note that over 60 percent of respondent universities in Argentina and India are technical, while no more than a third of any other country's sample is technical.

Respondents to this survey also represent large universities, with mean enrollment of 13,500 students, about three-fourths of whom are undergraduates (Table 2). This reflects the presence of a long right-hand tail in the size distributions of the respondents' undergraduate and graduate enrollments. University size correlates somewhat with country size, as China has the largest universities (22,300 undergraduates and 31,000 graduates) and Croatia has the smallest (1,100 undergraduates and only 770 graduates).¹⁸ Indeed, of the 14 institutions in this survey with the largest student enrollment, 7 are Chinese. Administrative and academic staff sizes are somewhat correlated with student size—Brazilian and Chinese universities have the largest staff sizes, and those in Croatia have the smallest. For each of these enrollment and staffing variables, data show statistically significant differences across countries. Given the sample of 310 distinct universities, Table 2 implies that in total this survey represents universities teaching about 4.2 million students ($=310 \times 13,410$).

Since Malaysia has the largest sample of 128 individual respondents, we disaggregate the responses for the 48 universities on which they reported, in order to obtain a quantitative indication of the degree of within-country heterogeneity (Table 3). Although most institutions are represented by one or two respondents, quite a few of these universities have many more than that. From University Putra Malaysia there were 18 respondents, constituting 14 percent of the Malaysian sample. Multimedia University provided the second-largest sample, with 8 respondents. By any measure, university size has little relation to sample size, perhaps due to varying response rates but possibly may be caused by reporting error in university size measures.¹⁹ As one may see from Table 3, the variations in institution size as indicated by the structure of student enrollments, faculty and administrative personnel are generally consistent, but positions in the rank-order by size shows no systematic association with the institutions' place in the ranking by number of individual respondents.

17 These results may say more about the assignment of job-titles than about the comparative technical expertise of respondents designated as administrative and IT managers, respectively. In presenting survey results, however, we consider the possibility that on average there may be differences between the typical occupants of those positions, and so separate the responses from the two groups for statistical analysis.

18 Nearly all enrollment levels reported in the survey are rounded to the nearest hundred or thousand, and administrative and IT staff may not know their institutions' exact enrollment, so these statistics probably include more measurement error than other statistics do.

19 A least squares regression of the number of survey respondents from a university on variables for that university's enrollment and staff size reveals no association larger than 0.0001, with no statistical significance for any parameter estimate. The existence of measurement errors in the size data is suggested by Figure 2, in which the presence of “age-heaping” in the size distribution of reported enrollment numbers already has been noticed.

5.3. Survey results

5.3.1 Work Responsibilities of the Respondents

The responsibilities of these respondents defy simple characterization. Half of IT managers hold an executive position as a manager or department head, while only a third of IT staff conduct research as a part of their work (Figure 3). Administrators juggle even more tasks, with over half doing some kind of teaching and nearly three-fourths holding an executive position. Although Figure 3 suggests that IT staff face varying levels of responsibility, a rather more comprehensive picture is presented of the technical skill/experience levels of IT managers, based on their responses to a subsequent set of survey questions concerning 7 specific technical capabilities and managerial capacities required by their positions (Figure 4).²⁰ Between half and two-thirds of IT managers reported that they have skills in the listed areas or have responsibilities in these areas as part of their work: 52 percent reported skill in database administration, 65 percent reported skill in administration, and intermediate proportions reported skill in software development, programming, internet/web design, ICT/software teaching, and network administration.

Most respondents – administrative and IT – have a variety of responsibilities for IT practices, making them potentially good sources of information for understanding FLOSS use in universities (Figure 4). Although nearly two-thirds of respondents purchase software, only 42 percent administer information and communication technology (ICT) budgets, and only a third design or approve software licensing agreements. Over half develop and/or implement institutional ICT policies. These tasks require expertise in several subjects – technical expertise for identifying and implementing required ICT systems, legal expertise for designing or approving software agreements, and fiscal expertise in designing budgets – so it is unsurprising that respondents fill some but not all of these tasks. From Figure 5 it is seen that the pattern in the proportions of the various skills and responsibilities are quite similar for the subsets of university administrators and IT managers.

5.3.2 Institutional Decision-making for Software and IT Expenditure Shares

Advocates of FLOSS and advocates of proprietary software each argue that the respective merits of their products will cause some classes of users, if not all users, to adopt them in preference to the alternative. In many universities, as is the case in many business organizations, a centralized procurement process determines the software that manages systems and appears on individual users' computers. Indeed, 69.3 percent of respondents to the HEI survey agreed that decisions regarding software purchases for their institution are “made on an institution wide basis.” Regardless of the substantive attributes FLOSS or proprietary software products in particular contexts of application, it seems likely that the process by which universities choose software will influence the software they ultimately install. For instance, one might suppose that IT managers, if they had the decision to make, would select different software from that which would be chosen by financial or other managers in the ranks of university administration. Understanding the locus of departmental decisions about procurement of software, then, may help understand why some departments and, indeed, some universities do or do not adopt FLOSS.

IT managers clearly play the most important role in choosing software—nearly half of respondents identified their institution's IT manager as most important in this decision, and another fourth of respondents said that the individuals holding that position was second-most in importance (Figure 6). Users play an important role in 40 percent of institutions, whereas financial and other managers play less important roles, and external consultants have effectively no role to speak of. Panels A and B of Figure 6 show that there is a generally close agreement of views

20 The item asks whether IT staff have “personal technical skills and/or responsibilities in your employment position,” so responses may include all staff that have technical skills in an area, regardless of whether the respondent's employment requires use of the skill.

between members of the general university administration and IT managers concerning the locus of influence in decision-making on these matters; the proportion among IT managers that rate their role as dominant is only slightly bigger than the proportion among administrators who accord them top importance.²¹

Only half of respondents offered answers to questions on the composition of IT budgets, which could reflect lack of knowledge on these budgets, unwillingness to divulge this information, or other reasons. Respondents who estimated the composition of IT budgets indicated that a fourth of expenditure goes to software and license fees while a tenth goes to IT personnel (Table 4). Malaysia and India dedicated the greatest portions of their IT budgets to software and license fees, while Bulgaria and Croatia recorded the lowest proportional expenditure on software and license fees. Statistics on budget expenditure for software explicitly excluded expenditure on IT personnel, though the survey did not specify whether these data included contracted-in personnel, such as database consultants from external firms.

Opinions about the “reasonability” of the current levels of expenditures on software purchases and license fees also vary widely among institutions and countries. In India, 71 percent of respondents felt that expenditure on these items was reasonable, while among Croatian respondents only a third took that view, and nearly 60 percent of Croatians stated that expenditure on these items was too high. Views about the reasonability of software and license fees did not strongly correlate with opinions about the need to change expenditure on these items in the near future. In Malaysia, for example, only 24 percent of respondents felt that expenditure on these items was “too high,” while 69 percent identified a need to reduce expenditure on them in the next two years. In Croatia, by contrast, 59 percent of respondents thought that expenditure on these items was too high, but only 7 percent saw a need to reduce expenditure on them in the near future (Table 4).

By combining observations on the actual IT budget structure with those on the respondents’ opinions about the appropriateness of the fraction of their institutional or department IT budget that was devoted to software purchasing and license fees, it is possible to form a view of whether or not there exists a clear consensus on this question, and whether in the absence of funding shocks such a consensus is essentially stable or would generate pressures for substantial reallocations of IT budgets. Figure 7 (Panels A and C) presents these results: there is a clear preponderance of opinion that budget shares in the range 0.20-0.30 “seem reasonable”, but the views among administrators and IT managers on the appropriateness of the share of their institutions’ IT budgets that is devoted to are not perfectly aligned.²² A substantial majority of the administrators (c. 60 percent) are comfortable with software budget shares in the range up to 0.45-.50; those that think otherwise are on balance of the view that shares in that range are too low rather than too high. By contrast, as actual software expenditure shares rise from 0.10 to 0.30 an emerging majority among IT managers view the software share of their IT budget shares as being “reasonable”; this reaches the 60 percent level when the software budget share is 0.40, and

21 There is only one notable point of disagreement in the assessments reported in Panels A and B of Figure 6. 29 percent of the IT managers say that financial administrators have either a top or second-tier importance in software purchasing, and 23 percent of them attribute that influence to “other management”; by contrast, 36 percent of administrators give “other management” personnel primarily or secondary influence, and only 18 percent of them say that financial managers are at the top or second position in these decisions. IT managers appear to have a less nuanced perception than do the administrators of exactly who it is – if not they – that have sway in software purchasing decisions. This is perhaps also reflected by the relatively larger frequency (17 vs 10 percent among administrators) with which top influence is attributed to “others” by the IT managers.

22 The survey questions for Administrators (Q.10) and Managers (Q.17) asked explicitly for their views regarding “the share of software purchases and license fees in the total IT budget,” rather than about absolute levels of expenditures on those items. This had the advantage of “normalizing” the responses for each institution and avoiding a need to convert different currencies in order to aggregate across countries, especially as exchange rates may well not reflect purchasing power relatives in software and IT equipment. The drawback, of course, is that the question did not elicit information regarding whether or not the level of the funding for software is regarded to be adequate.

thereafter it continues to drift slightly higher throughout the range of ever-larger software shares. The appetite for more software appears not to be easily sated among IT managers. Indeed, among those not content with their actual budget shares, the preponderant opinion favoring higher relative expenditures for software remains positive throughout the entire range from 0.30 to 0.80.

Perceived needs to reduce expenditures on software in the course of the coming years are more closely aligned between the two groups (Figure 7, Panels B and D). A clear majority of opinion supporting that forecast emerges among both the administrators and the IT managers whose budget shares are in the range from 0.30 to 0.60. But the strength of that majority is more pronounced among members of the administration, where more than 60 percent always see a coming need to reduce outlays for software and 75% express that opinion by the time one reaches software budget shares of 0.60. The conjunction of the two sets of views suggests that if it is not possible to meet currently desired rates of software acquisition with lowered expenditures vis-à-vis the overall IT budgets in these institutions, there will be very substantial discontent – especially in the ranks of IT managers.

5.3.3. IT Strategy, Use of FLOSS, and Development of FLOSS

One motivation for undertaking this survey was to understand how and why the use of FLOSS varies across countries. Table 5 describes one potentially important element of software adoption: formal departmental IT policies or strategies. Fifty-eight percent of respondents indicated that their department had a formalized policy: Malaysians were most likely to have such a policy (92 percent prevalence), while Brazilians were least likely to have one (29 percent). Three-fourths of stated policies mentioned FLOSS as an option for procurement, giving a good basis for FLOSS use. About 90 percent of institutional IT policies in Argentina and 95 percent in Brazil, mention FLOSS.²³ Even more surprisingly, over a third of IT policies require procurement of FLOSS software if it is available.²⁴ These requirements are most common in Brazil, India, and Argentina, but relatively rare in China and Croatia and completely absent in South Africa. In those policies that did not mention FLOSS, a large portion (67%) either did not discuss software or did not specify any type of software. A small portion (15%) focus on proprietary software, and only 2 institutions – one in Croatia, and one in Malaysia – had policies that explicitly excluded FLOSS.

In short, the institutions in this survey are only moderately likely to have a formal IT policy, but most formal policies mention FLOSS – nearly all formal policies in Latin America do – and over a third of these policies require acquisition of FLOSS software if such acquisition is possible.

Although not all institutions have IT policies that mention FLOSS, many institutions and administrators use FLOSS. Nearly 90 percent of respondents indicated that their institutions use FLOSS, but use of FLOSS differs across groups within an institution (Figure 8). In only 9 percent of institutions do administrators use FLOSS “a great deal,” and in half of respondent institutions, administrators use FLOSS only “a little.” Teaching staff and non-science students are even less likely to use FLOSS, while 6 percent of teaching staff and 17 percent of computer science students use FLOSS “a great deal.” Among all these groups, computer science students show the greatest use of FLOSS. (The Lickert scales used for responding to these questions do not allow simple comparison across countries, but in Section 4 we develop a scalar index summarizing use of FLOSS in institutions and compare this index across countries.)

To simplify presentation, we only disaggregate FLOSS use by country for the “whole institution” sub-question, and not for the sub-questions focusing on specific academic groups, but we report the responses from administrators and IT managers separately (Figure 9). Again, Latin America has the greatest prevalence of institutional FLOSS use, with 98 and 97 percent of institutions

23 Only 4 Bulgarians responded to the question in column (3) of Table 4, and no Bulgarians answered the questions in columns (4) to (7).

24 Note that column (3) of Table 4 only includes respondents who answered “yes” to the question in column (2), so $0.49 * 0.74 = 0.36$.

in Argentina and Brazil, respectively, using FLOSS. FLOSS use is least common in China, with only 73 percent of Chinese respondents using FLOSS. A statistical test rejects the hypothesis that FLOSS use is equal across countries.

The aforementioned statistics do not measure the intensity of FLOSS use within an institution, but among respondents there is general agreement that of the extent of FLOSS use should be increased for all academic groups (Figure 10). Overall, 95 percent of respondents believe that FLOSS use needs to increase in their particular institution, and the proportion within each of the countries does not vary notably from that high level (Figure 11): a statistical test fails to reject the hypothesis that the proportion holding that opinion uniform across all the countries.

Although Figure 8 showed that computer science students are more likely than other academic groups to use FLOSS survey, from Figure 10 it is seen that there was strong consensus among both Administrative respondents and IT managers that greater use of FLOSS was most relevant for computer science students: 88 percent of the former and 85 percent of the latter respondents thought that FLOSS use should be increased “much” or “a great deal” among computer science students. Strikingly, 87 and 83 percent of these respondents, respectively gave the same answers to the question in the case of the teaching staff. The proportion of IT managers that called for FLOSS use to increase “a great deal” or “much” among Administrative staff was somewhat higher (77 percent) than the proportion holding those views (69 percent) among the Administrative respondents themselves. There was close agreement in the strength of the two groups’ consensus on the desirability of increasing the use of FLOSS among science students other than computer scientists, but Administrators were less inclined than IT managers to take the same position in regard to students outside the sciences.

The preceding questions have concerned respondents’ reports on FLOSS use in their respective institutions. Since it is unlikely that they have precise knowledge of the prevalence of FLOSS use among particular groups (for example, non-science students), the foregoing data regarding their opinions is potentially subject to substantial divergences from the actual situation on which the respondents were commenting. Figure 15 offers a means of assessing the correspondence between opinion and reality in this matter: it shows the country-level prevalence of experience with FLOSS use among the survey respondents (administrators and IT managers combined). At an overall level, comparison with the data from Figure 8 suggests a reassuring level of consistency. According to Figure 15 the global proportion of respondent’s reporting that they personally used FLOSS at work is 31 percent, whereas from Figure 8 it will be seen that administrators reported that 33 percent of the teaching staff and same percentage of their own colleagues were using FLOSS “a great deal” or “much, whereas IT managers gave 24 and 33 percent for the corresponding percentages.

There is, in addition, a reassuring degree of agreement in the two sets of observations if one uses them to rank-order the countries according to the degree of institutional use of FLOSS. For this purpose we can use the proportion reporting any level of FLOSS at work (from the compliment of the percentage reporting “None” in Figure 15), and the mean of the national proportions given by the administrators’ and IT managers’ who reported on institutional use of FLOSS (in Figure 9). The ordering of 4 highest countries on the latter measure ranking of countries is Bulgaria (100%), Croatia 89%), Brazil (76%), Malaysia (67%), and these 4 are also in the 5 top-ranked group on the measure constructed from Figure 9, which includes Argentina (99%) as well. Aside from the anomaly of Argentina’s position, which is at the very bottom rank according to Figure 15’s measure of any own use (31%). This gross agreement is only mildly reassuring, however, as even after omitting Argentina the rank correlation within the group formed by the top 4 is not perfect; and the same must be said in regard to the rank correlation between the bottom 4 (with Argentina again excluded) according to Figure 15, and the estimates from Figure 9: China comes lowest (at 69%) according to Figure 9, but on the basis of the estimates from Figure 15 it follows Malaysia and outranks India (53%) and South Africa (50%). Of course, it is quite possible that there are marked variations among these countries in the relationship between the extent of institutional use and the prevalence of FLOSS use among institutional employees who responded to the survey. The importance of student use, given variations in the relative importance of high- and low-use students in the sciences, could account for the looseness of the cross-country rank associations that

have been examined.

The data based on “own use” also paint a picture of considerable inter-country variations in the circumstances of FLOSS use among personnel employed at HEIs. In Brazil, 76 percent of respondents use FLOSS at work, and about half of these respondents had used FLOSS outside work as well. In Croatia, 89 percent of respondents use FLOSS in some capacity, and 76 percent used it both privately and at work.²⁵ Two-thirds of Malaysian respondents had some personal experience with FLOSS, half of Indian respondents did, but among Argentinean institutions’ respondents that proportion was only a one-third. A statistical test confirms that respondents in different countries have significantly different experiences in both the extent and circumstance of their use of FLOSS .

As important as these academic institutions’ use of FLOSS may be in terms of its effects upon skill formation among their students, or in releasing IT budgets for other purposes, it is also relevant to consider the extent to which university-based developers in these regions are active as contributors to FLOSS production. After all, the prevalence of participation in the development of open source software among students is itself an indicator the degree to which expertise has been acquired in programming skills and understanding of software systems; and in the case of faculty it should be informative about the capabilities of the instruction that the institution is able to provide for those seeking to develop those skills. FLOSS development work can take many forms in the university setting : faculty and students might develop programs for their own use but then post these programs at an online code repository; students, staff or faculty, might contribute to one or another of the large FLOSS projects, such as Gnome and KDE which garner the most media attention, or they may collaborate to form small, team-based FLOSS development projects relating to their training, or create such software in the course of their individual research work, or participate in extensive multi-institutional scientific collaboration that develop highly specific FLOSS program to support their activities. This survey does not distinguish among these various forms of FLOSS development. Nor does it report code levels of software development activity such as numbers of “commits”, lines of code contributed, average hours spent, average proportions of institutional personnel involved, nor any other measures of the intensity of participation in FLOSS production. Nonetheless, the survey provides a “first look” at the proportion of universities and of specific academic groups within these responding HEI’s that engage in such activities.

Overall, approximately half of the institutions represented in the responses were contributing to FLOSS development (Figure 12). This statistic may reflect an average over time; it may reflect an average over individuals, or it may reflect a subjective judgment about the level of FLOSS participation necessary for a person to respond that the entire institution develops FLOSS.

Computer science students have the greatest involvement among all the academic groups listed in Figure 12, with one in ten institutions having computer science students that contribute “a great deal,” and four in eight institutions having such students contribute “much” or more intensely to FLOSS. Half of institutions report that students in other sciences have little or no involvement in FLOSS, and three-fourths of institutions report that non-science students have little or no involvement in FLOSS. The extent of participation among administrative staff members falls somewhere between that of the computer science students and the other science students at these institutions. Teaching staff are nearly as likely as computer science students to contribute to FLOSS.

The finding that computer science students as a group contribute somewhat more frequently to FLOSS development than faculty members should not be particularly surprising. Firstly, since most computer science students develop software as part of coursework, computer science students face a low cost of putting homework-based FLOSS software online. Teaching staff, by contrast, may face greater obligations to develop teaching material and research papers, which may require substantial time investment to convert into FLOSS programs. Secondly, the responses regarding faculty do not relate specifically to members of science and engineering departments (except in those instances where the institution itself is small and quite specialized in those fields). Thirdly, the collaborative atmosphere of study in some universities could encourage students to work together with distant peers by developing FLOSS. Lastly, FLOSS developers emphasize the important roles of FLOSS in building programming skills and signaling ability to potential employers

25 Only 3 Bulgarians responded to this survey item.

(see David and Shapiro 2007), and these human capital formation and competence signally motivations may have greater relevance for students, who may have yet to enter the labor market, than those already holding jobs on the teaching staff.

What may be rather more surprising, however, is that the prevalence of FLOSS development activity does not vary across countries in a way that is associated with the varying prevalence of FLOSS usage at these HEI's, at least not at the aggregate levels reflected in cross-country comparisons. Figure 8b showed that institutions in Latin America were most likely to use FLOSS, whereas institutions in China were least likely to do so. Figure 13 shows that the prevalence of FLOSS development in the two major countries in Latin America exceed the 0.50 mark, and exceeds the survey-wide average (0.47) level, but South Africa and Bulgaria also report very high rates of FLOSS development even though these two countries also have the smallest samples (6 and 12 responses to the relevant survey items, respectively). FLOSS development is least prevalent in Croatia's respondent universities, yet FLOSS use there was very widely reported by IT managers, and only somewhat less so by upper-level members of the administration.

5.3.4 PROGRAMMING COURSES OFFERED

The level of FLOSS use in an institution may depend on the level of programming skills in that institution, and the presence of courses which teach programming skills may explain some of the variation in FLOSS prevalence across institutions and countries. Most institutions surveyed offer standard courses to students: introductory programming, advanced programming, and simple and advanced html. These high percentages partly reflect the fact that many respondents represent technical institutions and often computer science and engineering departments within technical institutions. Surveys of humanities faculty or liberal arts institutions would probably find far lower prevalence. The high prevalence of html courses may reflect market demand for programmers to develop sophisticated web pages, but only a third of respondent's institutions offer a shell scripting course. In general, these courses are more widely made available for students than for university staff (Figure 16), and this holds *a fortiori* for the more advanced software course offerings. For example, the average ratio of staff-to-student course in basic html is 0.63, but the ratio is 0.47 for courses in advanced html, and 0.50 for those in shell scripting.

To simplify comparison of these data across countries, we calculate the within-country mean of the total number of these courses that each institution offers. A statistical test confirms that total course offerings differ significantly across countries. The first bar of Figure 17, for example, shows that surveyed institutions in Argentina on average offer four of the seven options that are listed. Average course offers are most ample at the Indian institutions represented in this survey, where the average HEI offers nearly 5 of the 7 listed options: whereas in Croatia, by contrast, the average institution barely offers two of the courses mentioned. From Figure 17 China is seen to come next lowest to the bottom rank in the average number of course offerings per institution, and it was third from the bottom rank in the prevalence of university-based contributions to FLOSS production (Figure 13). In these two cases, a thin range of course offerings in programming, software and web skills, appears to go together with limited FLOSS development activity within the universities.

5.3.5 THE ROLE OF FLOSS EXPERIENCE IN HIRING EMPLOYEES

Economic research on FLOSS development has debated the extent to which the interest in signaling skills or experience to future employers motivates developers to contribute to FLOSS programs (see Lerner and Tirole 2002, Ghosh et al. 20005, David and Shapiro 2007 and sources reviewed therein). Unlike surveys of FLOSS developers, the HEI survey is in part a survey of employers, since Universities hire some computer scientists and software developers as faculty and/or staff members. This provides an unusual opportunity to examine if non-business

employers actually take FLOSS experience into account (whether positively or negatively) in their hiring decisions. Employer consideration of the FLOSS experience of job applicants as a positive qualification is a necessary but not sufficient condition to justify the view that developers voluntarily contribute to FLOSS development because they hope to thereby signal their software skills and related capabilities to prospective employers. Of course, to establish that signaling plays a role in developers' motives cannot in itself reveal the extent to which other motivating factors -- such as ideological commitment to "sharing", or intrinsic satisfactions and the desire to improve skills -- also influence the behavior of contributing FLOSS developers.²⁶

Given these *caveats* about the interpretative conclusions to be placed on the data, the survey results confirm that university employers do give positive weight to the FLOSS experiences of job applicants. Overall, 54 percent of respondents report having asked job applicants about FLOSS experience during interviews (Figure 18). The questionnaire does not clarify whether all of the respondent's interviews have involved such questions, or whether the issue arose at only one interview. Only a fifth of these positions, however, involved leadership roles.²⁷

At a minimum, then, one can say that the data militate against the view that university employers regard FLOSS experience as irrelevant in filling some faculty and staff positions. From Figure 19 it will be seen that 57 percent of respondents state that some positions in their institution require FLOSS experience, with FLOSS experience being most valued in Brazil and least valued in South Africa. There is in this regard as elsewhere a strong institutional emphasis on FLOSS in Brazil, asking job applicants about FLOSS experience is reported less frequently there than in Malaysia's HEIs (Figure 11c). At the opposite end of the spectrum, the practice of asking such questions about job candidates' experience with FLOSS is least prevalent in Bulgaria, Croatia, and South Africa, and a statistical test confirms that the cross-national differences in this regard are statistically significant.

The responses to a hypothetical job interview situation from administrators and IT managers further confirms the salience accorded to FLOSS experience in hiring decisions at these HEIs. The survey posed the following question to all the responding individuals:

Suppose you were to face a choice between two prospective employees (person A and person B) with exactly the same level of formal qualifications but different experiences: Person A has proven experience developing an important component of a proprietary software product, as an employee of a proprietary software company. Person B has proven experience developing an important component of a free software / open source software product of equivalent complexity, as an independent participant of the developer community. Would you be more likely to hire person A or person B? *Please select one answer only.*

As Figure 21 indicates, the respondents overwhelmingly expressed a preference for the hypothetical FLOSS-experienced candidate to an alternative who had had experience with proprietary software development instead. Indeed, fewer than one in ten respondents said that they would give the job to the otherwise equally qualified candidate who had experience in a proprietary company. The variations in the reported country proportions on this question around the overall proportion of 57 percent favoring candidates with FLOSS experience are not inconsistent with other indicators of pro-FLOSS sympathies: Brazil consistently displays the greatest support for FLOSS, with two-thirds

26 The FLOSSWorld survey of developers explores these motivations, and focuses in considerable detail on developers goals and expectations with regard to the acquisition and improvement of both software programming and a variety of skills and experience that may be acquired by participating in FLOSS development projects. Attitudes and practices of business employers in regard to their hiring criteria, which may be compared with those of the non-business (HEI) organization discussed here, were surveyed more-or-less at the same time in the same countries as part of the FLOSSWorld project. Comparison of the two perspectives, and the expectations of employment seeking developers in each country is a topic left for future research.

27 Surprisingly, 18 percent of respondents state that they do not ask job candidates about FLOSS experience but that some positions in their institution require FLOSS experience. This statistic may arise because few positions require FLOSS experience and hence most interviews do not focus on FLOSS experience; because Universities learn about FLOSS experience from a candidate's resume rather than asking a candidate directly about FLOSS experience; or simply due to misreporting on one of the involved survey items.

of Brazilian respondents reporting that they would prefer the candidate with FLOSS experience. Argentina's respondents declare somewhat less preference for job applicants with FLOSS experience, although the low, 40 percent among them that declared a preference for FLOSS-experienced candidates (over one that only had worked for a proprietary software firm) did represent 0.8 of those respondents that expressed any clear hiring preferences at all. A statistical test cannot, however, reject the hypothesis that the portion of respondents who prefer the FLOSS-experienced job-candidates is the same across all these countries.

This majority preference for FLOSS experienced job-applicants may reflect a variety of factors. First, if respondents themselves contribute to FLOSS projects, they may share broad ideological sympathies with other FLOSS developers, and hence expect that a FLOSS developer would have a style of work or personality more similar to their own and would "fit in" with their colleagues and co-workers. Second, respondents may judge that even if two job applicants had worked satisfactorily on projects of equivalent technical complexity, the candidate with FLOSS experience would have received more criticism from peers and learned more about various aspects of the software development process than a person who had been employed as a programmer in a proprietary software company. Third, given that 57 percent of respondents state that some jobs in their institutions require FLOSS work (Figure 20), it is not surprising that 54 percent of respondents would display a preference for job candidates who have some FLOSS experience. A statistical test does not reject the hypothesis that the portion of respondents who prefer the FLOSS candidate is equal across countries. But the variations in the reported country proportions on this question are not inconsistent with other indicators of pro-FLOSS sympathies: Brazil consistently displays the greatest support for FLOSS, with two-thirds of Brazilian respondents reporting that they would prefer the candidate with FLOSS experience. Argentina's respondents declare somewhat less preference for job applicants with FLOSS experience, but, the low, 40 percent of them said they would give preference to a FLOSS-experienced candidate (over one that only had worked for a proprietary software firm) nonetheless represented 0.8 of those respondents that expressed any clear hiring preferences whatsoever.

In appraising the implications of these findings one should bear in mind the heavy representation of technical institutes in this sample of HEI's; also, the individuals to whom the survey was addressed were (in the case of those with IT management responsibilities) most likely to be hiring for positions in which software skills and experience of some sort would be an essential qualification. Nevertheless, it may be relevant to note that individuals who have experience as contributors in large FLOSS projects are likely to possess not only coding skills and familiarity with software tools, but a capacity to quickly grasp the organizational structure of large and complex community processes, and to interact productively with others in situations that allow individuals considerable autonomy while providing them with scant explicit management direction. That bundle of attributes is likely to be perceived by job interviewers to be particularly useful qualities for faculty and non-faculty employees in an academic institution.

5.3.6 SOFTWARE USE

A final set of questions, directed only to IT staff, asked respondents to list the software programs that the institution used on central server computers and on Desktop PCs. Windows remains dominant: 94 percent of respondents said that desktop PCs use Windows XP, and 67 percent of respondents indicated that central servers use Windows Server 2003. GNU/Linux has about equal popularity, with about 84 percent coverage of central servers and 55 percent coverage of desktop PCs. Sun's Solaris operating system is also popular for central servers. Presumably these universities have different servers running different operating platforms, explaining the high coverage statistics for Windows, GNU/Linux, and Solaris.

Some prominent FLOSS programs, such as FreeBSD and OpenBSD, were rarely used, with less than one in seven respondents using these on a central server or on a PC. In short, widespread support for and development of FLOSS programs at these institutions has not led these institutions to

abandon use of Windows, or to pursue widespread adoption of many FLOSS programs besides GNU/Linux for PCs and central servers besides (Figure 22).

Responses to a subsequent question on whether a software program is used at all in an institution, however, reveal much more widespread use of FLOSS programs. Five in six respondents said their institution used Apache—a high rate of prevalence. Other major FLOSS programs also had achieved extensive penetration of the HEI market—83 percent of responding universities used GNU/Linux; 41 percent reported using GNOME; 48 percent used KDE; and other smaller programs had equally high prevalence (Figure 23). The difference between Figures 14 and 15 may arise because program use is highly varied within institutions, so although most FLOSS programs appear on at least one computer in each institution—giving the high rates of prevalence for Figure 23—few FLOSS programs run on most PCs or servers in each institution, yielding the lower rates of prevalence seen in Figure 22.

The survey questionnaire's design allows for a simple examination of the extent to which survey respondents are aware whether or not the programs their institutions are using are FLOSS. An earlier survey question asked respondents to indicate whether their university used FLOSS, and the preceding questions ask IT managers whether their university uses specific FLOSS programs. Comparing these two responses provides an indication of the extent to which IT managers recognize either that some or none of the programs they use are FLOSS. Table 6 suggests that over 90 percent of IT managers correctly realize that at least some programs running on their computers are FLOSS. Only 8 percent of IT managers—20 individuals—indicated that their university did not use FLOSS, but subsequently listed specific FLOSS programs running on their university's systems. Awareness of whether specific programs are proprietary or FLOSS, at least, is high.

5.3.7. CONCLUDING OBSERVATION ON THE WITHIN-INSTITUTION DIVERSITY OF PRACTICES

The foregoing review of findings on the various aspects of university policies and practices affecting the extent of use of FLOSS, the provision of instruction in skills pertinent to creating software, staff technical capabilities and the hiring preferences that affect the availability personnel familiar with open source computer programs and the methods of creating them, should not be allowed to promote the impression that there is substantial homogeneity of practices in all these respects through the universities from which the survey data have been drawn. Table 7 therefore should serve as a caution against slipping casually into thinking in those terms. Using the information supplied by multiple respondents who reported on the state of affairs as viewed from distinct departmental vantage points within a single institution, it reveals the existence of inter-departmental diversity of practice in every one of the dimensions itemized, save the first, which shows a reassuring consistency of reporting on the existence of an institution-wide IT policy. When considering the statistics formed by aggregating one or two observations from a number of separate institutions in a given country, it is therefore appropriate to bear in mind the likelihood that the variation that one finds within such a sample is just as likely, if not more likely to arise from the diversity of the places within those institutions from which the respondents have been drawn, as from inter-institutional differences. Or to put the point another way, differences in the relative representation within distinct HEI's of the various types of departments that appear in Table 7 are a likely source of observed inter-institutional variations in practices.

5.4. Correlates of the role of FLOSS in an institution

Some of the discussion to this point has ventured speculations about the possible interrelationships among the responses to different topics covered by the survey questionnaire. To explore the data in a statistically rigorous and more systematic fashion, we may first apply principal component analysis to a selection of an array of survey item responses, in order to construct five indices that

capture the various main roles of FLOSS within higher education institutions. We can then compare the indices across the eight countries, and use regression analysis to measure the strength and statistical significance of association of these FLOSS indices with observable individual- and university-specific characteristics. We present and discuss these exploratory results as an essentially descriptive exercise, rather than a test of specific behavioral hypotheses or an effort to estimate underlying structural relationships.

5.4.1. Discussion of constructed indices

We construct the first index, which reflects the extent to which institutions use FLOSS, using six survey items (Appendix Table A1). Missing observations have been recoded for this purpose to have value zero, and we include indicators for non-response to reflect the recoding.²⁸ This first index increases as an institution's use of FLOSS increases. The index is based on one survey item, which asks whether the institution overall uses FLOSS, and five items which have Lickert scales for responses indicating the extent to which particular groups use FLOSS. For each of these last items, the response "not at all" has a negative scoring coefficient and most (though not all) of the "a little," "much," and "a great deal" responses have positive coefficients. Although these coefficients do not always increase in size as reported extent of use of FLOSS increases, the general pattern shows that increases in this index reflect increased use of FLOSS.

The second index reflects the extent to which institutions *develop* FLOSS (Appendix Table A2). The variable with the largest scoring coefficient is a binary indicator for whether any group in the institution develops FLOSS. The subsequent four items again question the extent to which particular groups in the university develop FLOSS. None have negative coefficients, but generally the smaller coefficients appear on the response, "Not at all," and the larger coefficients appear on the response, "A great deal."

The third index reflects the extent to which an institution's *software procurement policy strategy supports* or coheres with use of FLOSS. The three dominant contributors to the index are binary questions for whether the institution has a stated IT policy or strategy; whether the stated policy or strategy includes FLOSS as a procurement option; and whether the policy requires FLOSS. Again, more positive values of the index reflect more favorable policies towards FLOSS.

The fourth index measures the extent to which the institution has a *clear licensing policy for releasing software*. The largest coefficient appears on the first variable, which measures whether the institution has any policy developed by students or staff. The subsequent three questions have Lickert scales reflecting the extent to which the institution releases software under commercial licenses, FLOSS licenses, or for free. These coefficients do not display a clear pattern, so we interpret this index as reflecting the clarity of a license policy rather than the coherence of policy with a particular type of license.

The final index reflects the extent to which a respondent's institution *favours FLOSS experience in hiring* job candidates. Its four constituent questions – whether the institution asks job applicants about FLOSS experience; whether the institution has positions requiring FLOSS experience; whether such positions usually involve leadership; and whether, given a choice between candidates with proprietary and FLOSS experience, the institution prefers the FLOSS candidate – all have large positive coefficients.

28 Krueger and Zhu (2004) explain the rationale for this method in one context. The approach somewhat resembles that of the statistical mean-shift outlier model. We judge the use of indicators for non-response to be less subjective than imputation, and the potential bias of using indicators to be less severe than that of dropping all observations which fail to answer any relevant survey items.

5.4.2. Cross-country differences in FLOSS indices

We first consider the extent to which these factors correlate with each other—that is, the extent to which use, development, policy, and other FLOSS -related characteristics vary in different directions even within the same institution. Table 8, a matrix of pairwise correlations between these indices, shows that all but one of the pairwise correlations is positive, and half of them are statistically significant, implying that there is a notable amount of positive correlation across institutional characteristics related to FLOSS. But no correlation coefficient exceeds 0.39, and the mean pairwise correlation is 0.16, showing that these indices are not homogenous within institutions. The extent to which FLOSS is being developed in a HEI is the best single predictor of whether or not that institution has a clear policy for software licensing, whether the institution’s policy supports FLOSS use, and whether FLOSS is considered in hiring job applicants. One realistic possibility is that administrators and academic staff who develop FLOSS become more supportive of using FLOSS on the institution’s computers, hiring job candidates with FLOSS experience, and using permissive licenses to release software developed in-house. But another possibility consistent with Table 8 is that these different dimensions of institutional policy are not casually interrelated, but have a common latent cause: influential individuals in the institution may, due to their education, personality, or other reasons, be predisposed to develop FLOSS, prefer using FLOSS and hiring FLOSS-experienced job applicants, and it is their prior orientation that reflects itself in the policies of their institution. While it is not possible here to identify which of those possibilities underlies the pattern in the responses, one should note that the strongest correlation in Table 8 appears between having a clear licensing policy and the prevalence of FLOSS development. Whatever was the direction of the causal process that gave rise to this association in particular instances, it seems reasonable to suppose that in the sample as a whole both paths of influence had been present: university authorities who became aware that FLOSS development was being undertaken in their institution would be inclined to set a policy about licensing, and the announcement of a clear policy permitting free and open source licensing of software developed with university resources would be likely to encourage the development of FLOSS by faculty, staff and students.

The indices for FLOSS use, development, and policy framework have statistically significant differences across countries, though the indices for type of software release and the role of FLOSS in hiring differ only marginally in that respect (Table 9). Consistent with the results noted in earlier sections of the report, Table 9 shows that Brazilian institutions are most likely to use FLOSS. HEI’s in Bulgaria and Argentina also are likely to use FLOSS, whereas in Malaysia and South Africa that is somewhat less likely, and universities in China, Croatia and India – in that order – are still less likely to be found using FLOSS. Although the units of the within-country means of these indices do not have a clear interpretation, the large and somewhat surprising gap between India and other countries may reflect substantial differences in FLOSS use. Differences across countries explain 14 percent of the variation in FLOSS use, so while cross-country differences are important, within-country differences explain the great majority (86 percent) of the variation. To put that another way, if one wished to anticipate the extent of a randomly chosen institution’s use of FLOSS, knowing the institution’s national location would be only about one-sixth as informative as knowing the institution’s other characteristics.

A somewhat similar pattern appears for the index reflecting development of FLOSS: universities in South Africa, Bulgaria, and Brazil are most likely to be developing FLOSS, those in Argentina, India, and Malaysia are somewhat less likely to do so, and HEIs in China and Croatia are far less likely to be sites of FLOSS development activity. Given the correlation coefficient of 0.20 between the indices for FLOSS use and development (Table 8), the similarity of country rankings based on these measures is unsurprising.

We observe different cross-country patterns, however, in the measures of FLOSS-friendly IT procurement policy, type of software release, and the role of FLOSS in hiring. Malaysia and South Africa have the IT policies most conducive to FLOSS use, while Brazil, Croatia, and India have the least favorable policies. It is notable that Brazilian institutions have such high rates of using and developing FLOSS, despite the relative absence of policies supporting FLOSS use. Bulgaria and Malaysia have the clearest policies for releasing software, though the somewhat small Bulgarian

sample gives little basis for inference, and we cannot reject the hypothesis that the clarity of licensing policy is equal in all countries. Brazilian institutions again put the greatest emphasis on FLOSS experience in hiring potential employees, while Argentine and South African institutions on average put the least emphasis on FLOSS experience when hiring potential employees.

Further enquiry into both the differences reported between use and development and the latter's association with clear university policy statements are in order before venturing anything resembling policy recommendations, if only because it is conceivable that in some part of these observations are artifacts of the survey instrument itself. University administrators – whose responses contribute to these averages – may have a view that is systematically different from that of IT managers as to what is entailed by “university development of software.” When asked whether FLOSS is being “developed anywhere in your university” the administrative response may be colored by the idea of code development being undertaken as a condition of employment, or a formal requirement for students in some programs, and then being released under *corporate* copyright – whether of the conventional or the open source kind. IT managers, on the other hand, may be more likely to have in view the activities of students and faculty writing open source code as part of instructional course requirements or for their own research use, and not bothering to formally release it. The more formalized and clearly stated is university policy on such matters, the more likely it might be for administrators to recognize and acknowledge the existence of development activity within their institution. Lack that, however, administrators may systematically under-represent the extent of actual open source development that members of the university community are undertaking. Therefore, before making too much of either the statistical differences in between the prevalence of use of FLOSS and that of its development at these universities, or the association between the presence of explicit IT policies and the frequency of reports of university development work, some closer attention should be given to these issues of perception and interpretation on the part of the respondents. Nevertheless, some simple checks to see whether comparisons of the administrative and IT manager responses lend support to the form of bias suggested above do not find administrative personnel understating systematically reporting lower rates of FLOSS development than the IT manager counterparts.

5.4.3. Correlates of FLOSS Indices

To combine some findings of the preceding pages, we estimate regressions which measure the association of each FLOSS index with a respondent's sex, age, and identity as IT staff or administrator; with a university's reported enrollment and staff size, with the other indices; and with country indicators (Table 10). One can interpret the coefficients in these regressions as the association of a given explanatory variable with a constructed FLOSS index, controlling for other explanatory variables listed in the regression. For a few reasons, these regressions do not measure causal effects, but rather they provide a more careful way of measuring association than the correlations of Tables 8 and 9 have done.²⁹ Some of the regressions in Table 10 include university fixed effects (see Appendix Section 2 for details). Since the data include several respondents from most universities, these fixed effects regressions effectively control for all characteristics like location, management quality, and others which do not vary within a university.³⁰ Including university fixed effects to some extent reduced the bias due to omitted variables (including “unobservables”), and hence yields estimates of the coefficients that are likely to be closer to true

29 Two realities temper causal inference from these regressions. First, numerous unobservable individual-, university-, and country-specific characteristics in each regression may correlate with both the FLOSS indices and other explanatory variables, thereby biasing results. Second, it is likely that the explanatory variables cause some change in the response variable, as the regression suggests, but also that the response variable causes change in the explanatory variables. Such simultaneity is difficult to address, and forces interpretation of regressions as association rather than causation.

30 Since reports of undergraduate enrollment, graduate enrollment, and staff size vary between respondents from a single university, for present purposes these variables do vary within a university.

values than are the least squares estimates. Unfortunately, including an indicator for each university both prevents inclusion of country indicators in regressions and substantially decreases precision by eliminating degrees of freedom. Given the relative merits of each type of estimator, both are presented in Table 10.

We find some association between the characteristics of the individual respondents and the role of FLOSS in the respondent's institution. Controlling for other variables, females are slightly less likely to report frequent use and development of FLOSS in their universities, though the association is not statistically significant. A similar role appears for IT managers, among whom the probability of reporting that their university uses or develops FLOSS is slightly lower probability than it is among administrative respondents, but here too the difference is statistically insignificant. Older respondents are less likely to report that their universities develop FLOSS, but more likely to say that their institution has a clear software licensing policy – which emphasizes that relationships which hold in the international and intra-national cross-section comparisons among institutions do not necessarily manifest themselves at the micro-level of individual respondents. The least squares and fixed effects estimates provide relatively similar sized coefficients on the age variable, though the fixed effects estimates have little precision, suggesting that the effect is not due to older people happening to work in universities which avoid development of FLOSS. Since contribution to FLOSS programs is widely found to be most common among young people (David and Shapiro 2007), these results hardly can be a surprise. For the same reason, the respondent's age itself, has no association with the likelihood of FLOSS being used in their teaching institution.

Some university characteristics, however, do exhibit a statistically significant association with FLOSS use. Undergraduate enrollment has no large association with the role of FLOSS in a university, while universities with more graduate students or teaching staff are slightly more likely to develop FLOSS or to have supportive IT policies for using FLOSS. The FLOSS indices included as explanatory variables reaffirm the findings of Table 8, though in Table 10 the magnitudes of the associations are generally smaller since Table 10 controls for other university and individual characteristics while Table 5 does not. Table 10 also reaffirms some of the same cross-country associations that appear in Table 9, but these regressions explain only 6 to 29 percent of variation in FLOSS use and licensing across universities. Clearly this picture, while informative remains incomplete as many other factors influence FLOSS use, adoption, and license policy.

5.5. Conclusion and Relevance for Policy

Free/Libre/Open Source Software (floss) attracts interest from many researchers and policymakers because they seek both to explain the features of its unusual mechanism of production and to examine the potential insights of floss for other individual and collective activities. Understanding how and why universities use and develop floss is particularly important because universities prepare software developers for beginning work, train researchers in technical fields, provide high-speed internet connections for people in developing countries, and support much groundbreaking research in the mathematical and computational sciences. Furthermore, university employees may face different incentives than government and private sector employees do. Understanding how universities use and develop floss may help understand the role that floss plays in other institutions, and the policies that could affect floss use in any institution.

This report, using a new survey of university staff members in developing countries, reaches a variety of conclusions which have some relevance for higher education and scientific policy in both Europe and developing countries. A simple but startling statistic is that although almost all universities use floss, only half actually develop floss. The peer nature of floss production implies that floss may provide free technical training, signaling value for obtaining employment, and flexibility to tailor software products from Europe and the U.S. to local languages and circumstances. Students and staff at many of the universities which do not develop floss might investigate reasons for the absence of floss development and mechanisms to address it. The data

show strong association between having a clear policy for licensing out software developed in-house and the participation of students and staff members in floss development activities. This relation seems sensible, since students and staff may be more likely to develop floss programs if they know that their university will support release of these programs under a specific license scheme. Perhaps universities without a clear policy on licensing tacitly are supporting the use of Creative Commons or other similar licenses for outgrowths of research, but do not explicitly say so. Formalizing and publicizing such a policy could encourage increased development of floss programs by students and staff, but the existence of a causal connection here remains to be established.

Several of the survey questions yielded responses that indicated a substantial consensus among administrators and IT managers that the proportions of departmental or university IT budgets allocated for software were reasonable when they remained in the range from 0.20 to 0.45, although opinions on this issue were by no means perfectly aligned between the two groups of respondents. The national average of HEI IT budget shares devoted to software lie in the 0.20-0.35 range (Bulgaria being distinctly on the low side at 0.125), so there is reason to think that there would be quite general discomfort with a serious effort to cut expenditures on software purchase and license fees, which a majority of the respondents – and especially those among the administrations – believe will be necessary in the near future. Differences among instructional and research programs from department to department, and among research groups within departments call for higher or higher or lower spending in this IT category and it is important that universities not adopt a one-size-fits all approach to setting budget norms, or imposing funding reductions. Nonetheless, encouragement of a systematic examination throughout these institutions of the potentials of migration to floss to decrease expenditures on software and license fees could produce useful results in many departments.

The data also show that many universities ask technical job applicants about their floss experiences and consider these experiences when hiring new technical staff. This finding supports the idea that one motivation for developer contributions to floss is the goal of signaling ability to future employers. Using other survey data from employers, it would be useful to investigate support for this claim in other industries. If employers indeed consider floss experience in hiring technical staff, it might imply an important role for floss experience as part of a technical university education—universities, for example, could encourage students as an individual project or thesis to develop a module for a floss project.

Finally, it has been found that many universities and departments in China, Croatia, and elsewhere do not offer standard programming courses that are potentially important for developers to learn skills necessary for making technical contributions to floss programs. In part this finding may reflect a lack of awareness on the part of survey respondents from engineering schools or other non-computer-science departments of course offerings that do exist. But it may also reflect an opportunity for accreditation systems to include in their assessment criteria the question of whether a university's computer science programs adequately prepare students for technical work at the level that would be required to fully participate in floss programs.

5.6. Tables and Figures for Section 5

Table 1. Characteristics of respondents

Country	Sample size			Female (%)	Age (mean)	Wrote in name (%)
	Number of respondent individuals	IT (% of total)	Admin (% of total)			
Argentina	43	27.91	72.09	9.30	43.19 (10.01)	55.81
Bulgaria	7	42.86	57.14	42.86	35.43 (9.52)	85.71
Brazil	72	69.44	30.56	17.65	42.67 (9.06)	38.89
China	54	48.15	51.85	22.22	36.67 (9.75)	0.00
Croatia	83	68.67	31.33	11.11	38.03 (10.38)	100.00
India	47	72.34	27.66	23.40	40.17 (9.59)	44.68
Malaysia	128	42.97	57.03	23.02	37.91 (8.68)	0.00
South Africa	12	58.33	41.67	0.00	46.58 (8.63)	83.33
Total	446	54.71	45.29	18.26	39.52 (9.70)	38.57
N				438	431	446.00
Pearson $\chi^2(7)$		39.72		13.93		269.33
χ^2 p-value		0.00		0.05		0.00
F stat					4.67	
p-value					0.00	

Notes: see Appendix section 2 for explanation of χ^2 statistic and F statistics. Means are across individual respondents rather than across universities.

Table 2. Characteristics of respondent universities

	Institutional response rate	Number of distinct universities	IT respondent only (% of universities)	Admin respondent only (% of universities)	IT and admin respondent(s) (% of universities)	Technical university (% of universities)	Undergraduate enrollment	Graduate enrollment
Argentina	0.64	36	0.25	0.67	0.08	0.61	12,379 (22,703)	4,758 (9,947)
Bulgaria	0.42	5	0.40	0.40	0.20	0.20	4,415 (1,674)	875 (177)
Brazil	0.31	57	0.63	0.26	0.11	0.04	11,248 (8,721)	2,086 (2,559)
China	NA	50	0.96	0.04	0.00	NA	22,348 (17,034)	31,037 (58,699)
Croatia	0.74	71	0.65	0.23	0.13	0.21	1,052 (1,381)	770 (1,107)
India	0.24	34	0.62	0.26	0.12	0.65	3,424 (10,291)	1,431 (2,714)
Malaysia	0.77	48	0.10	0.25	0.65	0.33	5,939	1,551

South Africa	0.60	9	0.33	0.33	0.33	0.11	(6,554)	(2,632)
							14,607	3,251
Total	0.48	310	0.46	0.35	0.19	0.26	(10,210)	(3,086)
							9,308	4,102
N						446	301	252
Pearson $\chi^2(7)$						95.54		
χ^2 p-value						0.00		
F-stat			12.40	8.36	24.14		12.18	7.60
p-value			0.00	0.00	0.00		0.00	0.00

Notes: standard deviations appear in parentheses. Total is mean across universities rather than across countries. N presents number of respondents to Institutional response rate is total number of universities which had at least one person respond, divided by total number of institutions contacted. Response rate is due to various spellings, abbreviations, and informal names for Universities. The response rate is not calculated for the Chinese survey due to limited characters in the respondent and nonrespondent lists. Similarly, Chinese universities in administrative and IT surveys are not matched due to limited characters.

Table 3. Sample sizes from Malaysian institutions

<i>Institution</i>	<i>Sample size</i>	<i>Undergrad enrollment</i>	<i>Graduate enrollment</i>	<i>Teaching & research staff</i>	<i>Administrative & support staff</i>
Binary University College	2	2,258	236	46	28
Curtin University	2	-	-	-	-
Help University College	2	-	-	-	-
Institute of Advanced Technology	1	-	65	-	51
International Islamic University Malaysia, Gombak	4	1,078	40	89	40
International Islamic University Malaysia, Kuala Lumpur	3	4,306	1,697	1,702	1,679
International Islamic University Malaysia, Selangor	2	1,100	125	90	30
International University College of Technology Twintech	1	400	-	30	3
Kolej University Islam Malaysia	2	2,500	-	131	10
Kolej University Kejuruteraan & Teknologi Malaysia	1	800	15	-	13
Kolej University Kejuruteraan Utara Malaysia	3	1,520	12	111	14
Kolej University Sains des Teknologi Malaysia	2	1,790	1,859	109	24
Kolej University Teknikal Kebangsaan Malaysia	2	4,776	302	475	-
Kolej University Teknologi Antarabangsa Twintech	1	400	-	30	3
Kolej University Tun Hussein Onn	5	2,700	20	127	49
Malaysia University of Science and Technology	2	-	-	23	23
Multimedia University	8	13,496	1,051	512	354
Open University	1	-	-	-	-
Polytechnic Sultan Hj Ahmad Shah	2	6,392	-	341	99
Polytechnic Sultan Salahuddin Abdul Aziz Shah	1	5,901	-	394	87
Polytechnic Ungku Omar	6	3,400	0	537	145
Sultan Zainal Abidin Islamic College	1	4,500	-	400	-
Swinburne University of Technology, Sarawak	2	850	208	74	59
University College Antarabagsa Sedaya	1	4,839	18	200	100
University College Sedaya International	1	4,839	18	200	100
University Kebangsaan Malaysia	4	18,686	7,315	-	-
University Kuala Lumpur, Bangi	2	-	1,300	170	60
University Kuala Lumpur, Gombak	2	1,500	1,500	150	50
University Kuala Lumpur, Kulim	3	713	0	57	41
University Malaya, Kuala Lumpur	3	-	-	-	-
University Malaya, Petaling Jaya	2	22,989	10,263	1,588	3,120
University Malaysia Sabah	2	1,234	60	90	50
University Malaysia Sarawak, Kota Samarahan	1	5,000	5,200	500	500
University Malaysia Sarawak, Kuching	1	-	-	-	-
University Malaysia Sarawak, Sarawak	2	2,840	110	360	360

University Pendidikan Sultan Idris	3	13,797	707	-	-
University Putra Malaysia	18	1,060	950	459	454
University Sains Malaysia, Georgetown	2	850	250	35	13
University Sains Malaysia, Minden	5	7,639	5,060	12	84
University Sains Malaysia, Penang	4	12,650	3,825	1,845	15
University Sains Malaysia, Pulau Pinang	2	760	224	32	49
University Technology Malaysia, Johor	2	4,000	500	2,000	1,000
University Technology Malaysia, Selangor	1	-	-	14,000	12,000
University Technology Malaysia, Shah Alam	3	11,250	2,750	1,146	520
University Technology Petronas	3	5,200	667	300	227
University Tun Abdul Razak	1	10,000	1,000	222	238
University Tunku Abdul Rahman	2	14,000	93	586	386
University Utara Malaysia	2	18,500	4,000	1,250	1,100
Total	128	6,634	1,664	632	502

Table 4. Mean expenditure on IT, software purchases, license fees, and personnel

	<i>University software budget (Mean in PPP US\$)</i>	<i>Software budget per student (Mean in PPP US\$)</i>	<i>Software purchases & license fees (as % of IT budget)</i>	<i>Personnel cost (as % of IT budget)</i>	<i>Software purchases as share of budget is: too high</i>	<i>Software purchases as share of budget is: too low</i>
Argentina	1,018,272 (1,248,041)	111.66 (189.96)	23.71 (29.40)	20.20 (27.57)	0.15 (.36)	0.00 (.00)
Bulgaria	291,667 (125,012)	62.45 (6.90)	12.50 (4.33)	0.00 (.00)	0.38 (.48)	0.00 (.00)
Brazil	1,183,209 (1,485,861)	95.44 (90.34)	20.92 (17.62)	10.44 (20.43)	0.12 (.32)	0.00 (.00)
China	1,679,379 (1,791,246)	70.80 (87.63)	26.23 (28.80)	3.63 (11.48)	0.06 (.23)	0.00 (.00)
Croatia	58,771 (68,439)	49.79 (62.92)	16.88 (25.18)	3.92 (11.29)	0.60 (.49)	0.00 (.00)
India	856,771 (992,069)	424.78 (409.44)	31.18 (23.46)	14.22 (28.67)	0.11 (.32)	0.00 (.00)
Malaysia	1,591,794 (1,801,621)	311.99 (477.09)	33.24 (20.60)	10.26 (15.32)	0.28 (.45)	0.00 (.00)
South Africa	2,273,148 (1,850,340)	149.76 (65.85)	33.73 (13.95)	15.25 (20.71)	0.25 (.43)	0.00 (.00)
Total	1,124,106 (1,527,296)	167.86 (293.40)	24.99 (23.99)	9.21 (19.55)	0.25 (.43)	0.00 (.00)
N	182	114	199	214	340	340
F-stat	3.63	2.89	1.93	2.43	8.07	2.43
p-value	0.02	0.01	0.07	0.02	0.00	0.00

Notes: For first four columns, table entries are mean across universities within equal countries. standard deviations appear in parentheses. For last two columns, table entries are the percentage of respondents to each question. For continuous variables, F-stat is ANOVA-based test of null hypothesis that the variable is the same across all countries. For binary variables, F-stat is Rao and Scott's (1984) implementation of a Pearson χ^2 test, which is necessary since the number of universities varies across countries. See statistical appendix for details. Mean year 2004 PPP exchange rate (most recent available) drawn from World Bank (2005). Each student includes graduate and undergraduates combined.

Table 5. Presence of IT strategy, mention of FLOSS

	<i>If yes in (1),</i>	<i>If yes in (2),</i>	<i>If no in (2), why not?</i>
--	-----------------------	-----------------------	-------------------------------

	<i>Institution has stated IT policy or strategy?</i> (1)	<i>policy mentions FLOSS as option?</i> (2)	<i>policy requires FLOSS if available?</i> (3)	<i>Doesn't mention software</i> (4)	<i>Doesn't specify type of software</i> (5)	<i>Focuses on proprietary software</i> (6)	<i>Explicitly excludes FLOSS as an option</i> (7)
<i>Panel A: Admin respondents</i>							
Argentina	0.70	0.86	0.68	0.00	1.00	0.00	0.00
Bulgaria	0.50	1.00	0.00	n.a.	n.a.	n.a.	n.a.
Brazil	0.26	1.00	0.64	n.a.	n.a.	n.a.	n.a.
China	0.42	0.88	0.14	1.00	0.00	0.00	0.00
Croatia	0.35	0.85	0.20	n.a.	n.a.	n.a.	n.a.
India	0.45	0.75	0.33	0.00	1.00	0.00	0.00
Malaysia	0.91	0.62	0.43	0.30	0.39	0.03	0.08
South Africa	1.00	0.75	0.00	0.00	0.00	1.00	0.00
Total	0.60	0.76	0.42	0.27	0.45	0.08	0.06
N	168.00	101.00	69.00	22.00	22.00	22.00	22.00
F stat: countries have same mean	6.20	1.12	1.64	1.10	1.44	3.71	0.11
p-value	0.00	0.35	0.13	0.36	0.23	0.01	0.98
N	168	101	69	22	22	22	22
<i>Panel B: IT managers</i>							
Argentina	0.46	1.00	0.27	n.a.	n.a.	n.a.	n.a.
Bulgaria	1.00	1.00	1.00	n.a.	n.a.	n.a.	n.a.
Brazil	0.32	0.92	0.68	0.00	0.00	0.00	0.00
China	0.81	0.57	0.50	0.24	0.38	0.38	0.00
Croatia	0.41	0.77	0.31	0.20	0.40	0.20	0.20
India	0.30	0.83	0.78	n.a.	n.a.	n.a.	n.a.
Malaysia	0.91	0.49	0.39	0.11	0.54	0.11	0.00
South Africa	0.83	0.60	0.00	0.00	0.50	0.50	0.00
Total	0.52	0.70	0.45	0.14	0.46	0.21	0.04
N	222.00	109.00	73.00	30.00	30.00	30.00	30.00
F stat: countries have same mean	6.59	1.94	1.53	0.29	0.35	0.77	1.07
p-value	0.00	0.06	0.15	0.88	0.84	0.54	0.37
F stat: same IT-admin mean	2.26	0.84	0.38	1.53	0.05	3.30	0.03
p-value	0.13	0.36	0.54	0.22	0.83	0.08	0.87

Notes: Table entries are portion of respondents from each country that answered "yes" to the indicated question. N presents number of respondents from to each question. For binary variables, F-stat is Rao and Scott's (1984) implementation of a Pearson c2 test, which is necessary since the number of respondents varies by university. n.a. denotes no responses from a particular country to a particular question

Table 6. Believed and actual use of FLOSS

		<i>Report use of a specific FLOSS program</i>	
		<i>No</i>	<i>Yes</i>
<i>State that institution uses FLOSS</i>	<i>No</i>	0.01	0.01
	<i>Yes</i>	0.09	0.89
N		238	
F stat		10.17	
p-value		0.00	

Notes: Table entries are relative cell frequencies. Includes only IT managers, since admin survey did not include a question on whether desktop computers or servers use particular FLOSS programs. Figures are averages across universities. Columns are based on answers to questions 23-4, wherein IT managers list programs used on PCs, servers, and elsewhere in the university. Rows are based on answer to question 15, wherein respondents indicate whether the university uses any FLOSS programs.

Table 6b. Comparing reported FLOSS use between IT and Admin respondents

	<i>Admin</i>	<i>IT</i>	<i>Admin</i>	<i>IT</i>
	Response: not at all		Response: a great deal	
Administrators	20%	12%	5%	12%
Teachers	3%	10%	4%	8%
CS students	3%	5%	10%	23%
Other science students	18%	13%	12%	6%
Non-science students	36%	33%	4%	3%

Notes: Compare to Figures 8b and 8c

Table 7. FLOSS dynamics within a university

<i>Department or institute within the university</i>	<i>Life science institute</i>	<i>Social science institute</i>	<i>Engineering department</i>	<i>Different engineering department</i>	<i>Life sciences department</i>	<i>Graduate studies office</i>	<i>Life science institute</i>
Institution has stated IT policy or strategy	1	1	1	1	1	1	1
Stated policy or strategy lists OS as procurement option	0	1	0	0	1	1	n.a.
Use OS in your institution	0	1	1	1	1	0	0
Develop OS in your institution	0	0	1	1	0	0.5	n.a.
Staff/students have developed a licensing policy	n.a.	n.a.	0	1	n.a.	1	n.a.
Use FLOSS on servers or desktops	1	n.a.	n.a.	n.a.	1	1	0
Positions in university require OS experience	1	n.a.	n.a.	n.a.	1	1	0
Are these usually leadership positions	1	n.a.	n.a.	n.a.	1	1	n.a.
Choice of hiring candidate: prefer proprietary	1	n.a.	n.a.	n.a.	0	0	0
Choice of hiring candidate: prefer FLOSS	0	n.a.	n.a.	n.a.	0	1	0
Choice of hiring candidate: wouldn't matter	0	n.a.	n.a.	n.a.	1	0	1
N	1	1	1	1	1	2	1

Note: n.a. indicates that no individual answered the indicated question. All responses are from a single university. Table entries are portion of individual department (column) who answered "yes" to the question (row).

Table 8. Correlations of FLOSS indices

	<i>Use FLOSS S (1)</i>		<i>Develop FLOSS (2)</i>		<i>FLOSS-friendly IT policy (3)</i>		<i>Value FLOSS in hiring (5)</i>
Use FLOSS	1.00						
Develop FLOSS	0.23	***	1.00				
FLOSS-friendly IT policy	0.08	*	0.15	***	1.00		
Value FLOSS in hiring	-0.12	*	0.31	***	-0.13	**	1.00

Notes: standard deviations appear in parentheses. *** represents statistical significance at 99% level. Each university has equal weight in calculations.

Table 9. Differences in FLOSS indices across countries

	<i>Index: use FLOSS (1)</i>	<i>Index: develop FLOSS (2)</i>	<i>Index: FLOSS- friendly IT policy (3)</i>	<i>Index: Value FLOSS in hiring (5)</i>
Argentina	0.61	0.28	0.62	0.02
Bulgaria	0.73	1.44	-0.10	2.24
Brazil	0.89	0.65	-0.33	-0.57
China	-0.71	-0.57	-0.19	-0.02
Croatia	-0.58	-0.71	-0.31	0.07
India	-0.84	-0.16	-0.57	0.31
Malaysia	0.48	0.38	0.80	0.28
South				
Africa	0.50	1.22	0.96	0.25
N	446	446	446	244
ANOVA F	11.23	5.61	4.38	2.18
Prob > F	0.00	0.00	0.00	0.04
R ²	0.15	0.08	0.07	0.06

Notes: standard deviations appear in parentheses. N presents number of respondents categorized on each index. Each index has mean zero across all observations.

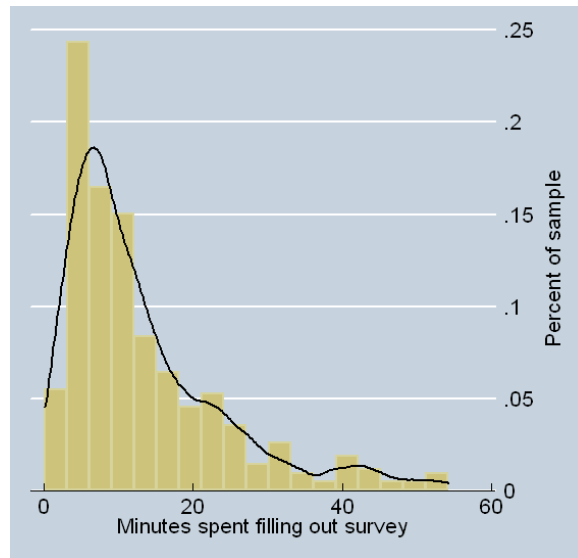
Table 10. Correlates of FLOSS indices, least squares estimates

<i>Dependent variable</i>	<i>Use FLOSS</i>		<i>Develop FLOSS</i>		<i>FLOSS-friendly IT policy</i>		<i>Value FLOSS in hiring</i>	
	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>	<i>(6)</i>	<i>(9)</i>	<i>(10)</i>
IT respondent	-0.171	-0.013	0.026	0.09	0.117	-0.175	-	-
	[0.169]	[0.312]	[0.217]	[0.457]	[0.214]	[0.418]	-	-
Female	-0.377	0.054	-0.267	-0.716	-0.494	-0.432	0.205	-0.286
	[0.219]*	[0.560]	[0.256]	[0.748]	[0.260]*	[0.656]	[0.299]	[1.207]
Age	-0.018	0	-0.021	-0.007	-0.016	-0.026	0.025	-0.056
	[0.009]**	[0.023]	[0.012]*	[0.030]	[0.011]	[0.027]	[0.014]*	[0.088]
Undergraduate enrollment	0	0	0	0	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]**	[0.000]	[0.000]	[0.000]
Graduate enrollment	0	0	0	0	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Teaching & research staff	0	0	0	0	0	0	0	0
	[0.000]*	[0.000]	[0.000]*	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Index: FLOSS use			0.156	0.094	-0.033	-0.016	-0.04	-0.083
			[0.068]**	[0.259]	[0.077]	[0.198]	[0.062]	[0.377]
Index: FLOSS development	0.099	0.042			0.085	0.164	-0.191	-0.103
	[0.042]**	[0.116]			[0.055]	[0.128]	[0.053]***	[0.280]
Index: FLOSS-friendly IT policy	-0.021	-0.009	0.088	0.195			-0.082	-0.088
	[0.051]	[0.105]	[0.056]	[0.152]			[0.052]	[0.295]
Country: Argentina	0.003		-0.163		-0.245		-0.217	
	[0.252]		[0.431]		[0.407]		[0.603]	
Country: Bulgaria	0.13		1.186		-0.875		2.288	

	[0.335]		[0.560]**		[0.845]		[0.931]**	
Country: Brazil	0.292		0.113		-1.207		-0.955	
	[0.241]		[0.414]		[0.343]***		[0.447]**	
Country: China	-1.219		-0.882		-1.039		-0.435	
	[0.280]***		[0.382]**		[0.374]***		[0.528]	
Country: Croatia	-0.772		-0.721		-1.009		-0.52	
	[0.278]***		[0.350]**		[0.319]***		[0.474]	
Country: India	-1.204		-0.138		-1.236		-0.369	
	[0.389]***		[0.430]		[0.384]***		[0.532]	
(Reference Country: Malaysia)								
Country: South Africa	-0.131		0.84		-0.098		-0.182	
	[0.341]		[0.662]		[0.500]		[0.640]	
Constant	1.293	0.304	0.898	0.278	1.368	1.466	-0.545	2.257
	[0.380]***	[0.994]	[0.558]	[1.227]	[0.492]***	[1.115]	[0.726]	[3.301]
University fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
N(observations)	426	426	426	426	426	426	236	236
N(universities)	300	300	300	300	300	300	236	236
R ²	0.2	0.07	0.16	0.09	0.11	0.07	0.18	0.14

Notes: parentheses contain heteroskedastic-robust standard deviations clustered about 281 universities for estimates without fixed effects. Parentheses for fixed effects estimates contain heteroskedastic-robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%

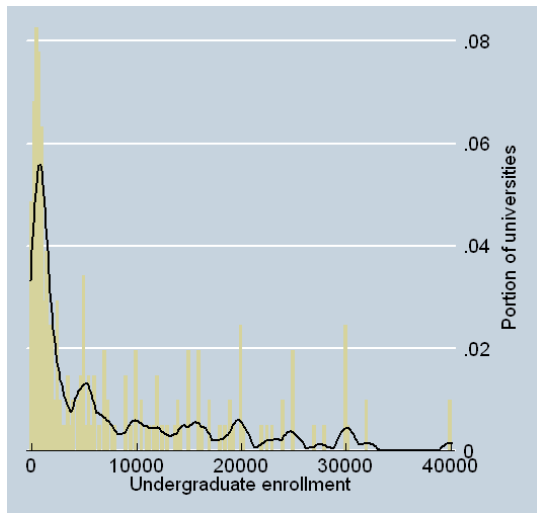
Figure 1. Time spent on survey



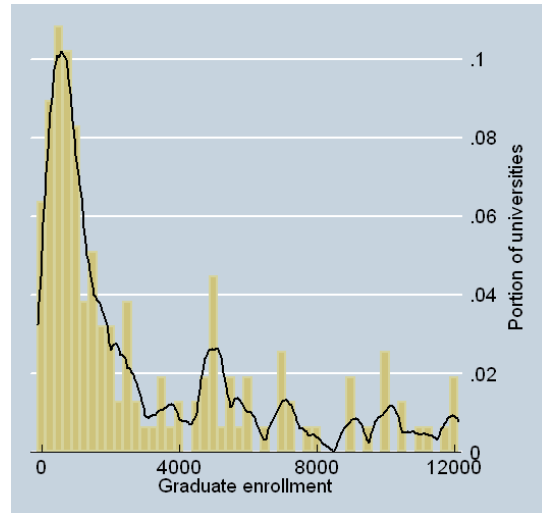
Notes: Line represents density estimated using Epanechnikov kernel evaluated at 300 points with bandwidth of 3. Time spent on survey has mean=20.68, median=10.60, and standard deviation=37.95. Bin width is 3. Graph shows averages across individuals.

Figure 2. University enrollment

Panel A: Undergraduate student enrollment



Panel B: Graduate student enrollment

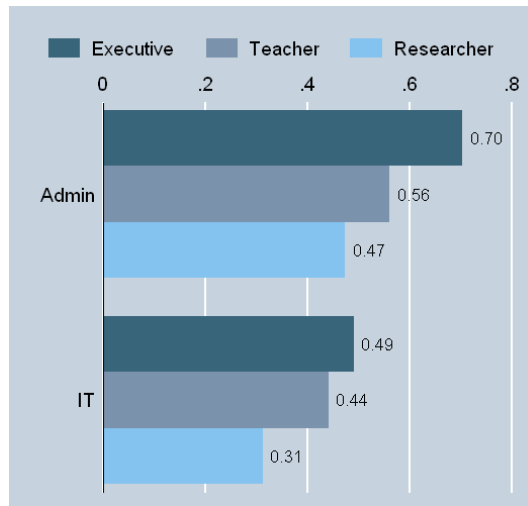


Note: lines represent density, estimated using Epanechnikov kernel evaluated at 300 points with bandwidth of 3.

Panel A: histogram has bin size of 250. Graph excludes the five universities which have reported undergraduate enrollment of over 40,000 students. Graph shows averages across universities. Undergraduate enrollment defined as maximum undergraduate enrollment reported among any respondent from a university.

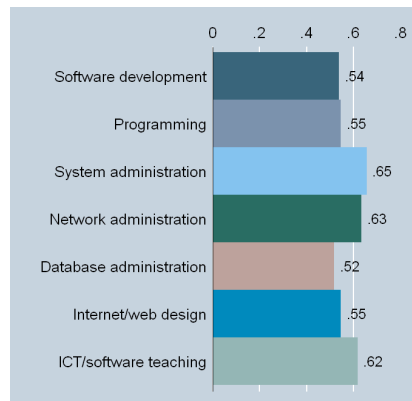
Panel B: histogram has bin size of 250. Graph excludes the four universities with reported graduate enrollment of over 12,000 students. Graph shows averages across universities. Graduate enrollment defined as maximum graduate enrollment reported among any respondent from a university.

Figure 3. Respondent responsibilities



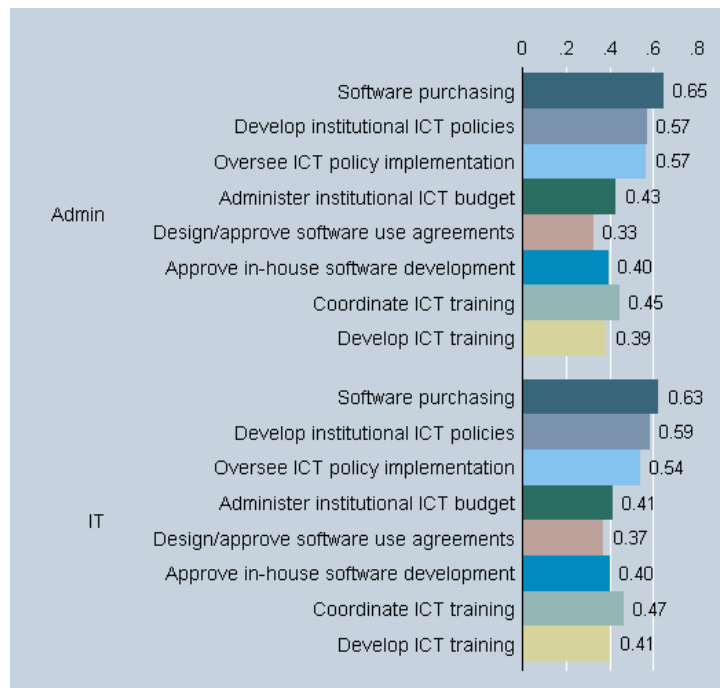
Notes: admin responses based on 196 individuals. IT responses based on 240 individuals. Graphs show averages across individuals. For the three responsibilities, respectively, a fixed effects regression comparing administrative and IT managers from within the same university shows that administrative respondents are 18.3 percentage points more likely to have executive responsibilities (p-value = 0.09), 10.6 percentage points more likely to have teaching responsibilities (p-value = 0.31), and 25.6 percentage points more likely to have researching responsibilities (p-value = 0.01). The statistical appendix explains the details of these estimates.

Figure 4. IT respondent technical skills or responsibilities.



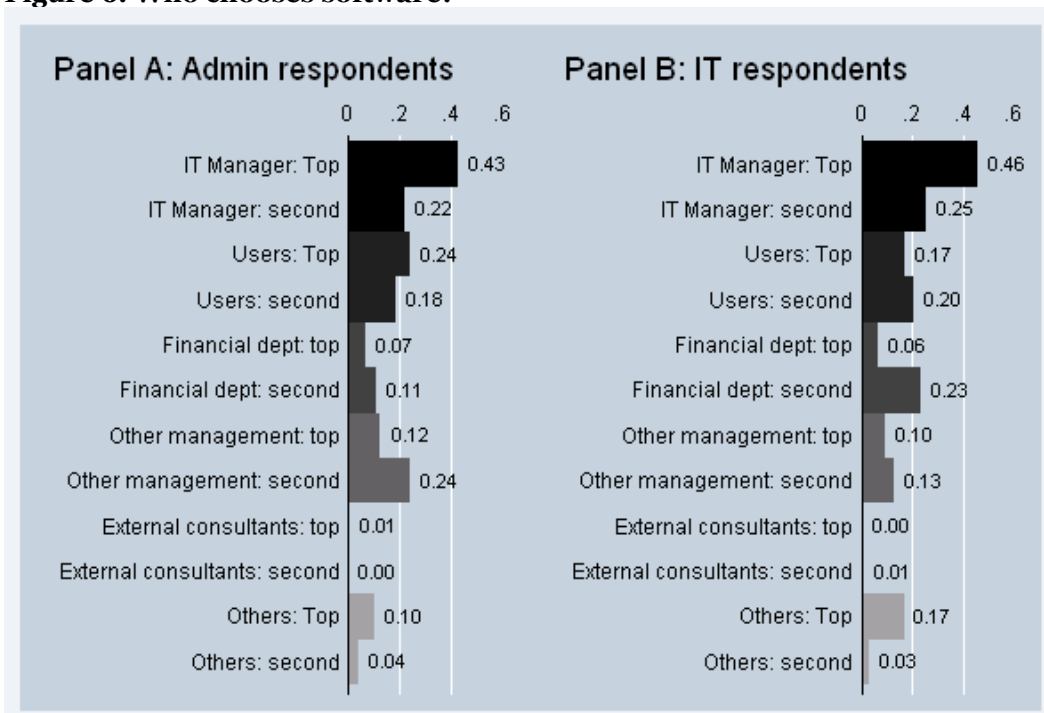
Notes: data based on 240 respondents. Graph shows averages across individuals. Only IT managers answered this survey item.

Figure 5. Respondent Administrative Responsibilities



Note: Admin statistics based on 202 responses. IT statistics based on 244 responses. Data show averages across individuals. For each of the eight responsibilities listed, at any level of statistical significance above 90%, a fixed effects regression fails to reject the null hypothesis that admin and IT managers from the same university have the same responsibilities. The statistical appendix explains the details of this estimate.

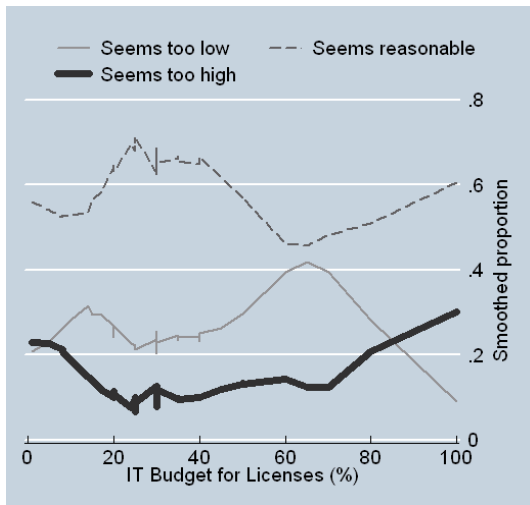
Figure 6. Who chooses software?



Notes: Panel A based on 173 observations; Panel B based on 218 observations. Graph shows averages across universities. For each item, a fixed effects regression fails to reject the null hypothesis that administrative and IT managers from within a university give the same responses. The statistical appendix explains the details of this estimate.

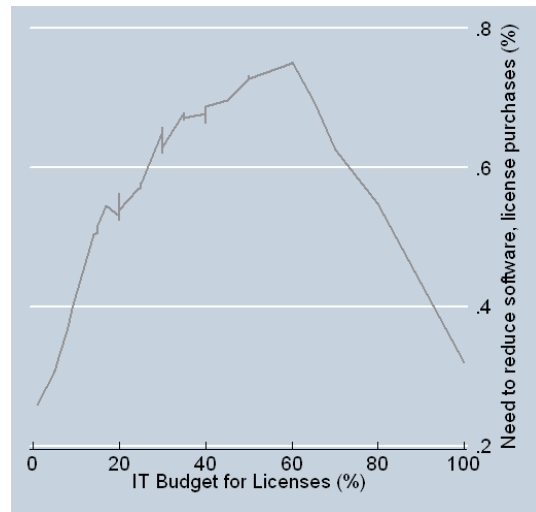
Figure 7. Perceived reasonability of budget.

Panel A. Admin respondents: Reasonability of expenditure on software & license fees



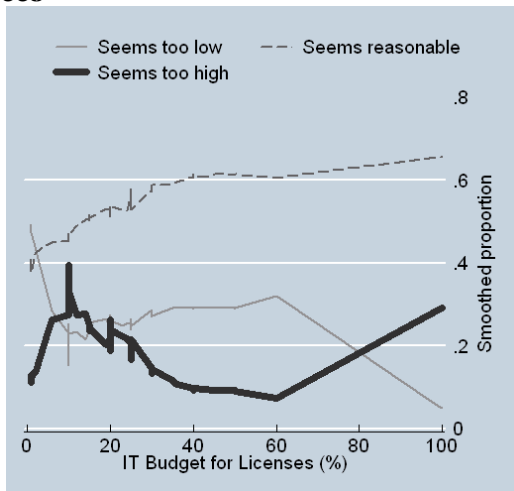
Based on 86 observations.

Panel B. Admin respondents: Need to reduce spending on software & license fees.



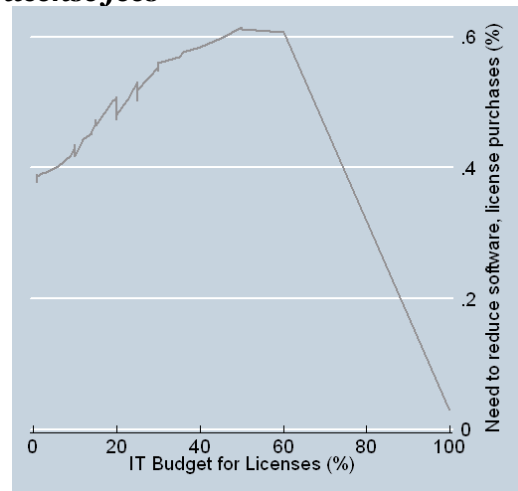
Based on 85 observations.

Panel C. IT managers : Reasonability of expenditure on software & license fees



Based on 102 observations.

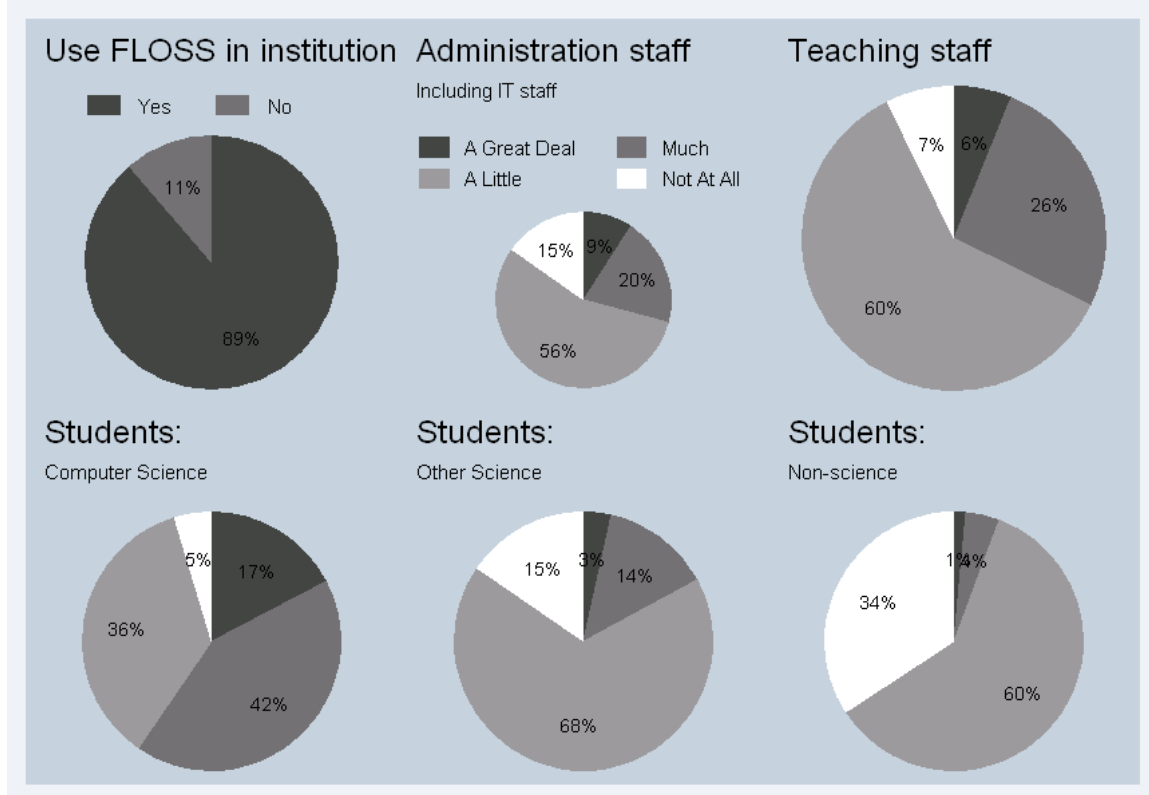
Panel D. Admin respondents: Need to reduce spending on software & license fees



Based on 102 observations.

Note: graphs show averages across individuals. Lines represent density function for each sub-population, estimated using Epanechnikov kernel evaluated at 300 points.

Figure 8. FLOSS use among administrators, teachers, and students
Panel A. All individuals



Panel B. Admin respondents

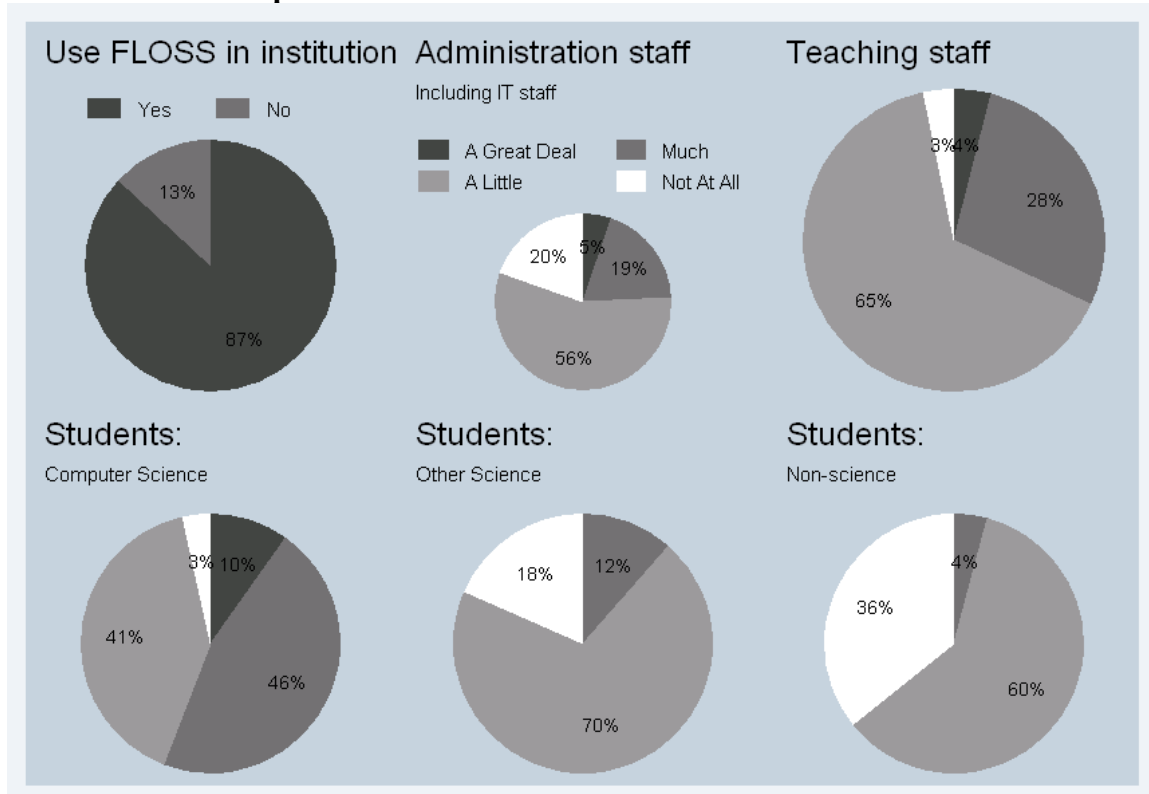


Figure 8, continued: Panel C. IT managers

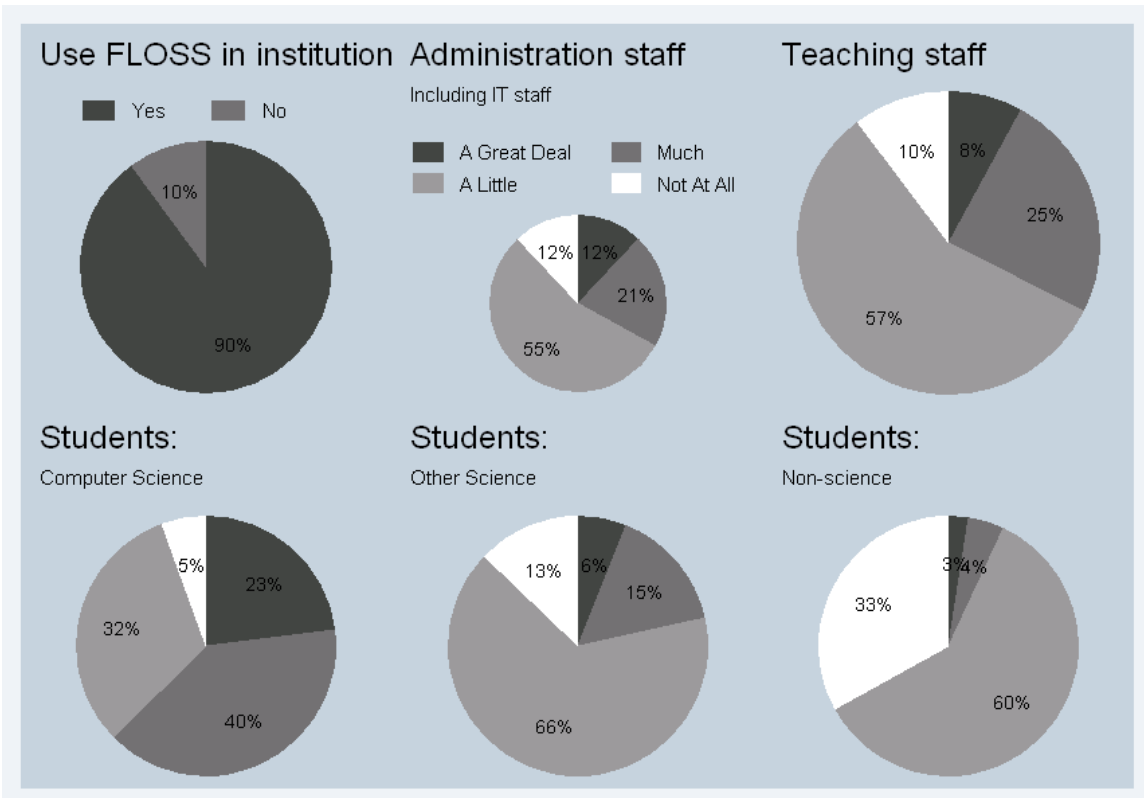
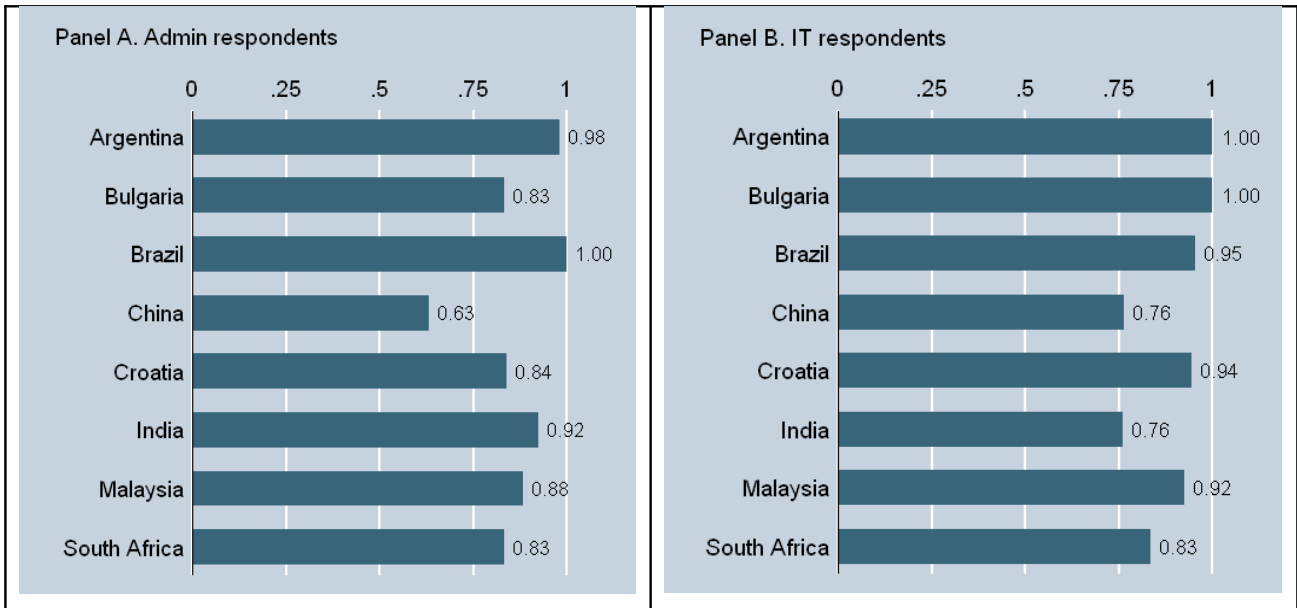


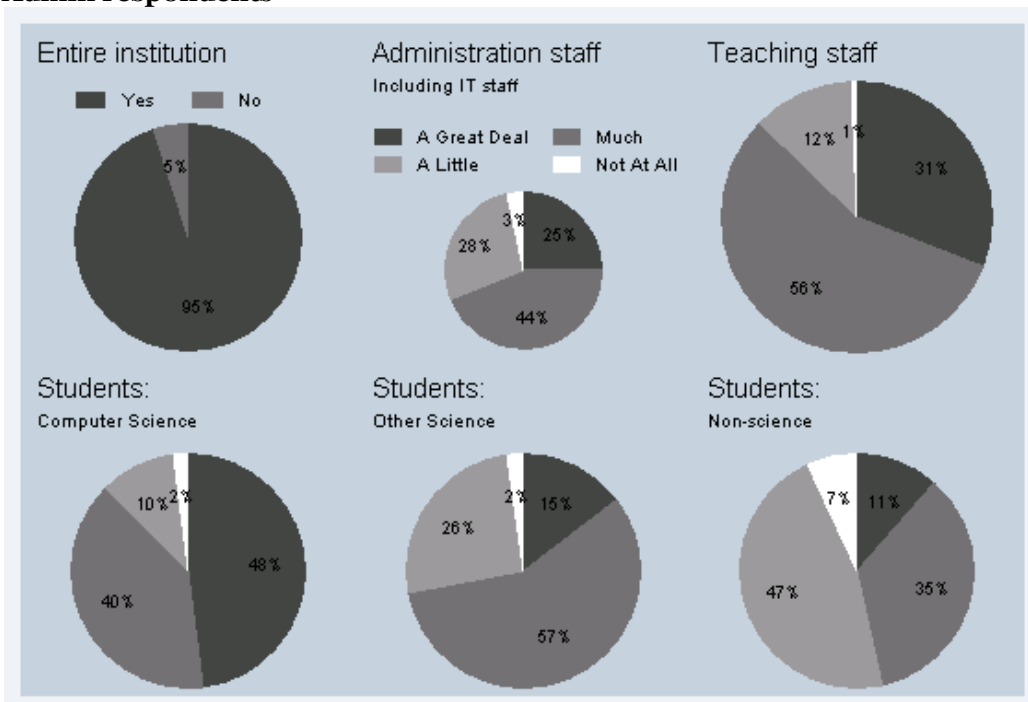
Figure 9. Institutional FLOSS use, by country



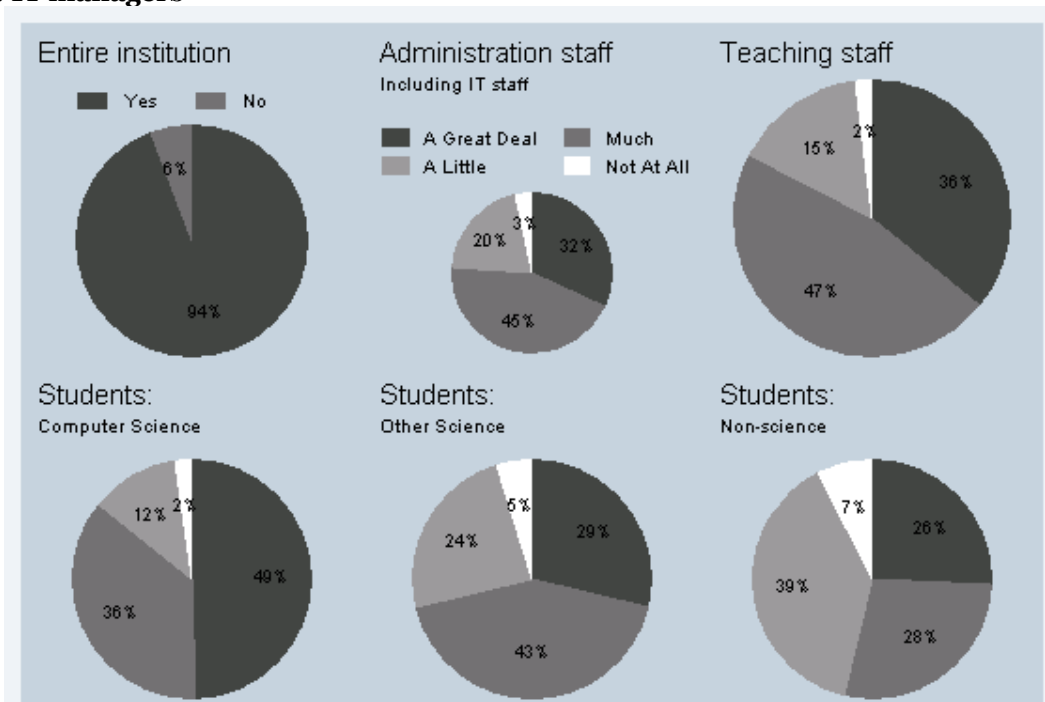
Panel A: 183 observations. Panel B: 238 observations. These graphs show averages across universities. A Rao-Scott F test rejects the hypothesis that admin and IT managers have the same distribution across countries with p-value=0.00. The statistical appendix explains the details of this test.

Figure 10. Extent to which FLOSS use should increase among administrators, teachers, and students.

Panel A: Admin respondents

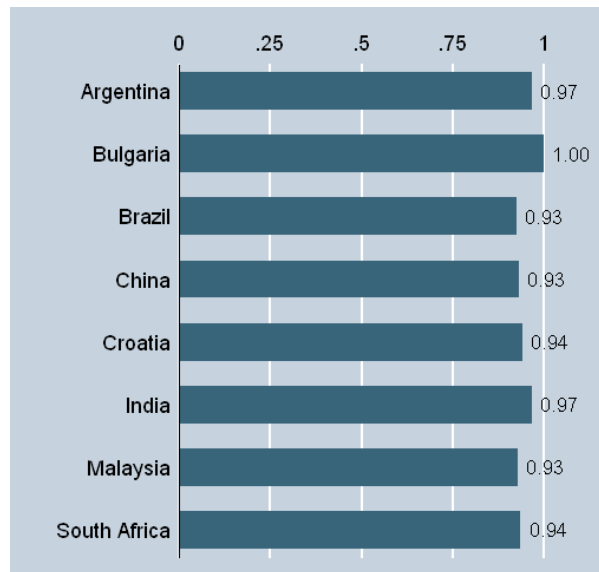


Panel B: IT managers



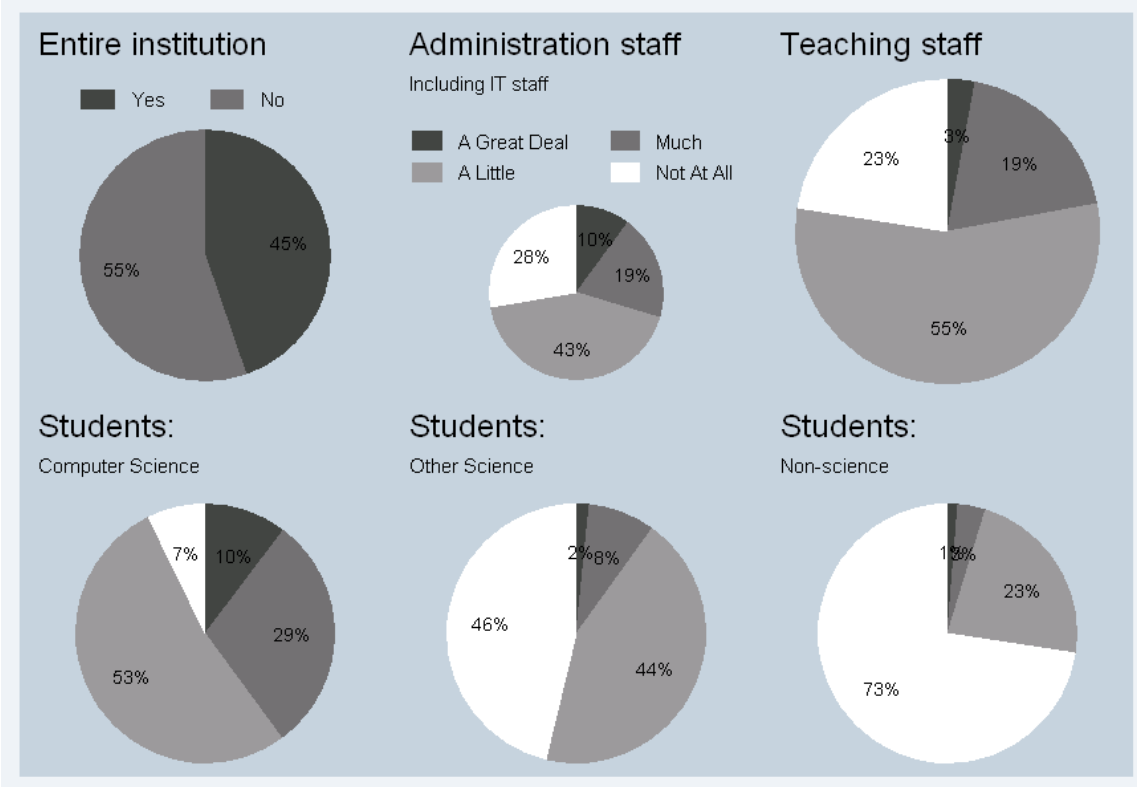
Panel A based on 165 individuals and Panel B based on 225 individuals, though not all individuals answer all sub-questions. Graphs show averages across individuals. Fixed effects regressions for each survey item fail to reject the null hypothesis that admin and IT managers from a university have the same response. The statistical appendix explains the details of these estimates.

Figure 11. Need for FLOSS use to increase in entire institution



Notes: Based on 390 observations. Mean=0.94. Graph shows mean across universities. A Rao-Scott F test fails to reject the null hypothesis that responses are the same in every country (p-value=0.97). The statistical appendix explains the details of this test.

Figure 12. Extent to which administrators, teachers, and students develop FLOSS
Panel A. All individuals



Panel B. Admin respondents

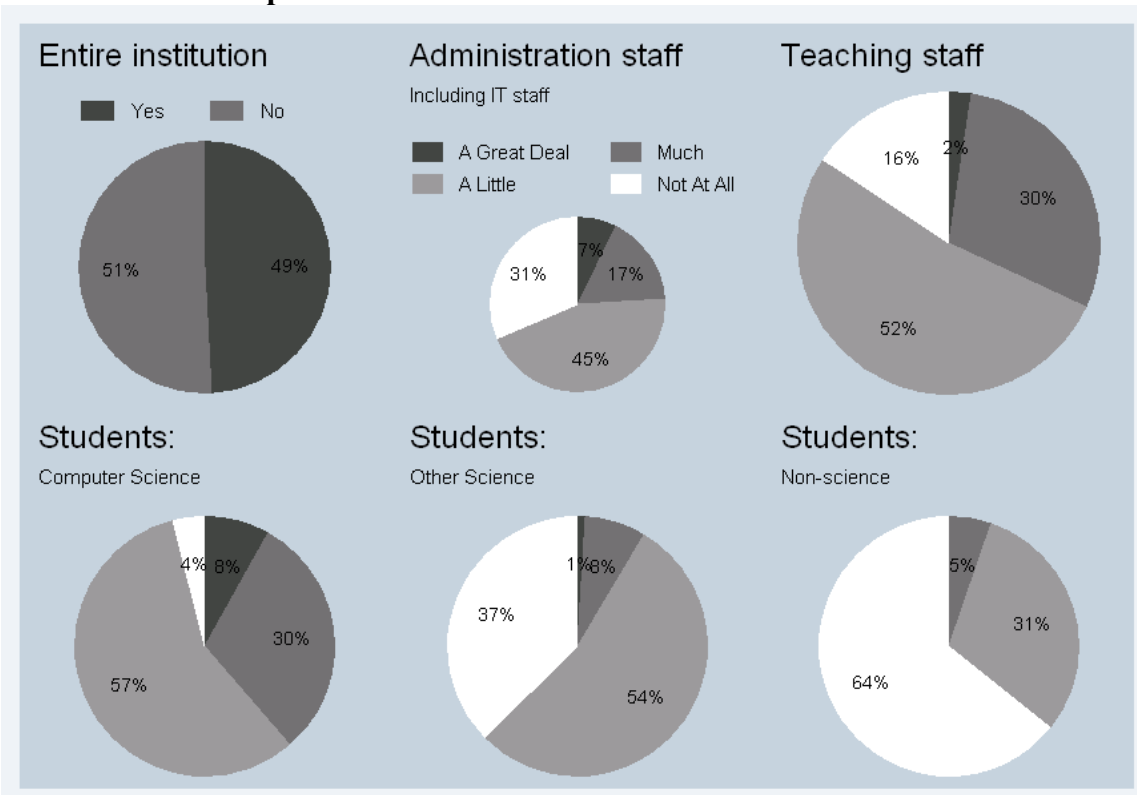
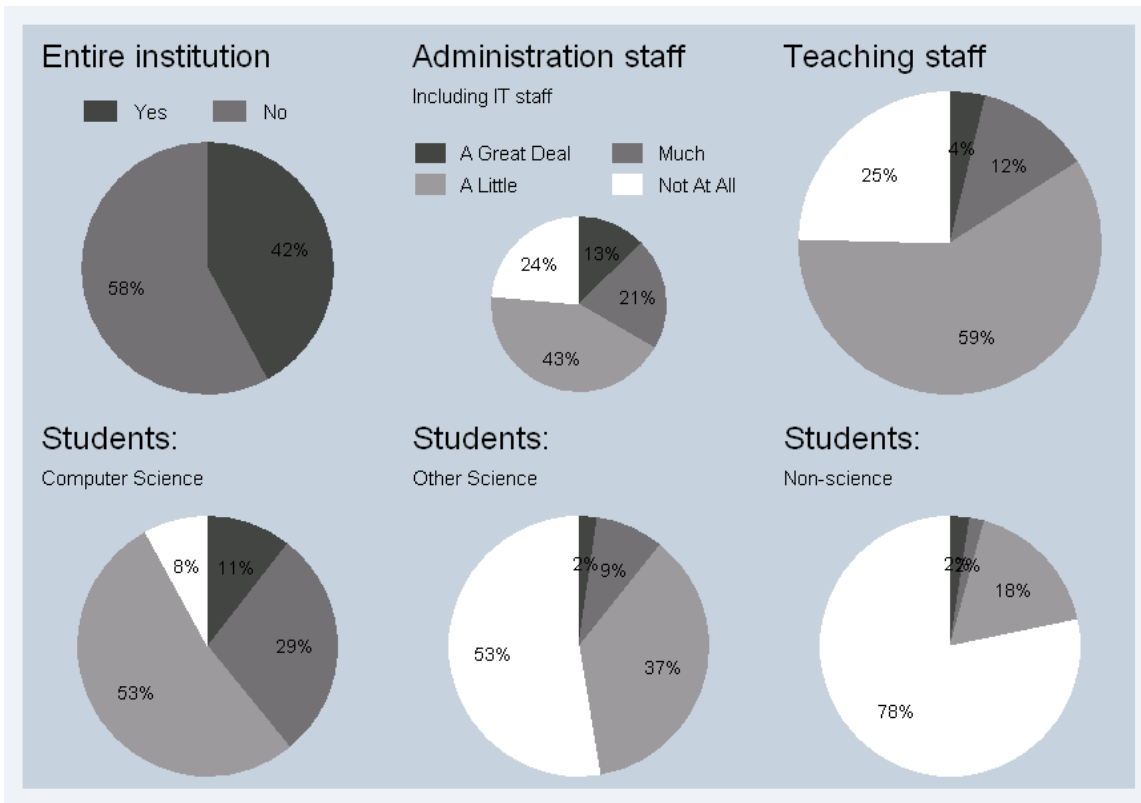
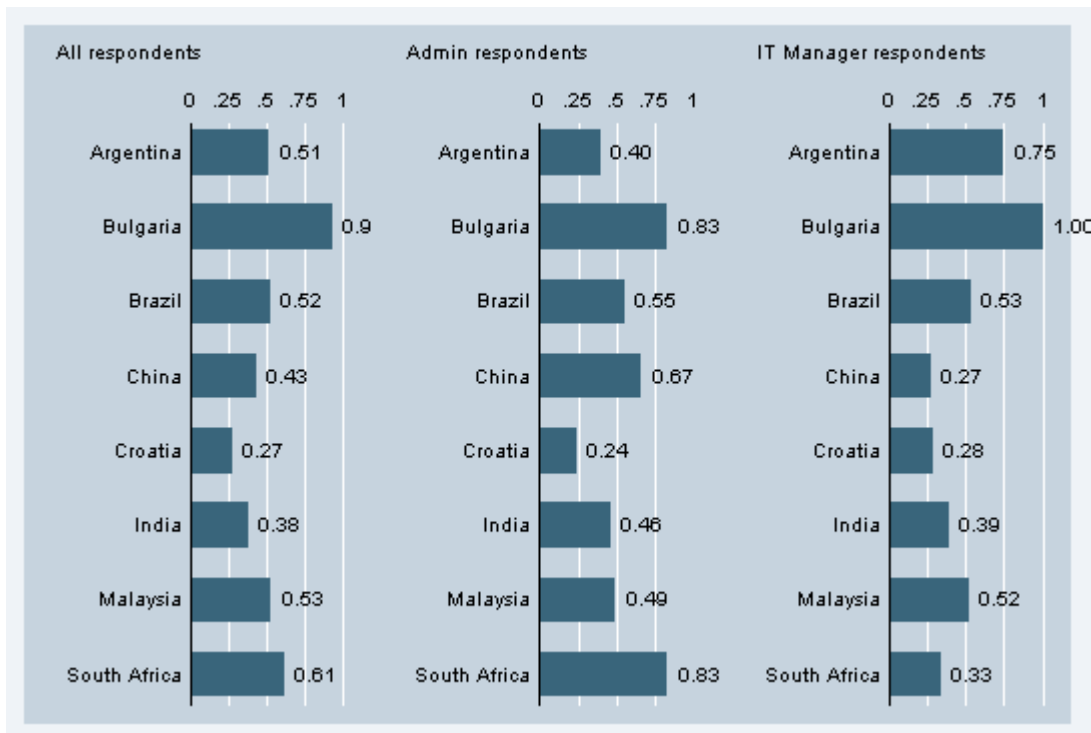


Figure 12, continued: Panel C. IT Managers



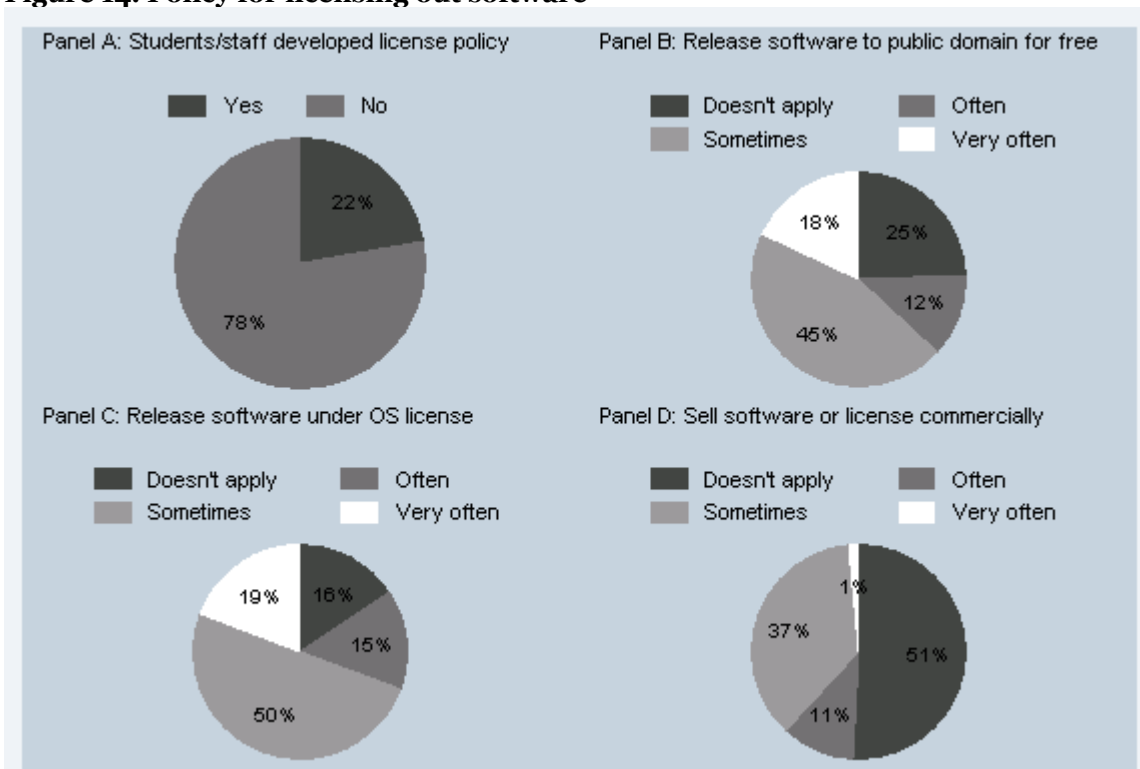
Graphs based on 403 responses, though some individuals do not answer all sub-parts of the question. Graphs show mean across universities.

Figure 13. Do you develop FLOSS anywhere in your institution?



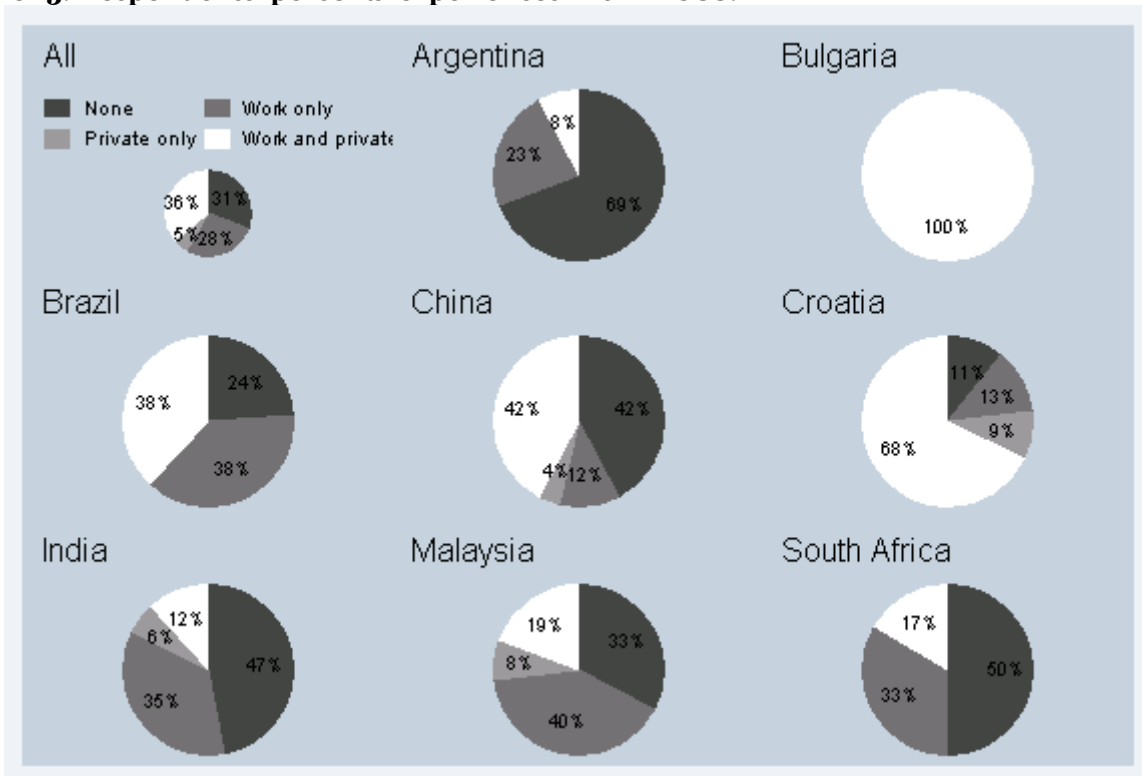
Based on 403 observations. Mean=0.45. Graph shows mean across universities. A Rao-Scott F test rejects the null hypothesis that responses are the same across countries (p-value=0.00). The statistical appendix explains the details of this test.

Figure 14. Policy for licensing out software



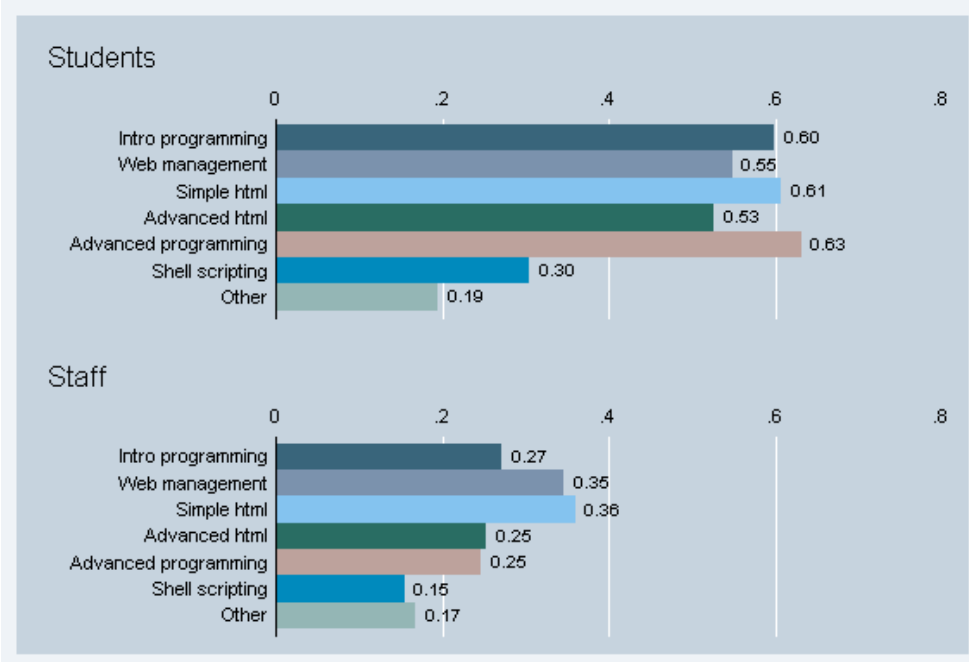
Panel A based on 446 observations; Panels B and C based on 32 observations (including only those who answer “yes” in Panel A); Panel D based on 30 observations.

Figure 15. Respondents' personal experiences with FLOSS.



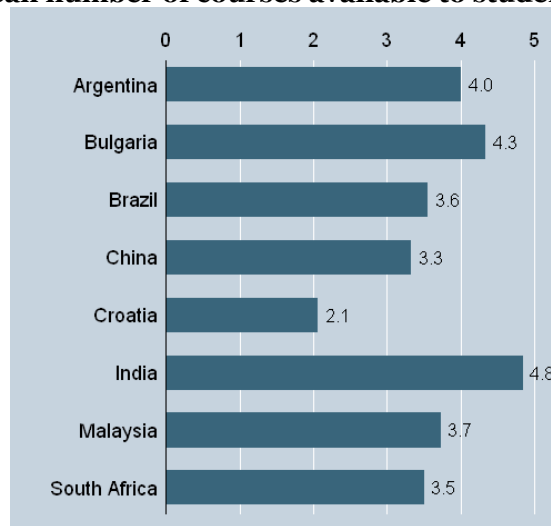
Graphs based on 240 observations. (This question appeared in the IT survey only.) Graphs show mean across individuals. A Rao-Scott F test rejects the null hypothesis that responses are the same across countries with p-value below 0.000. The statistical appendix explains the details of this test.

Figure 16. Availability of computer programming courses to students and staff at institution



Based on 228 observations. Graphs show mean across universities. Questions appeared in IT survey only.

Figure 17. Mean number of courses available to students, by country

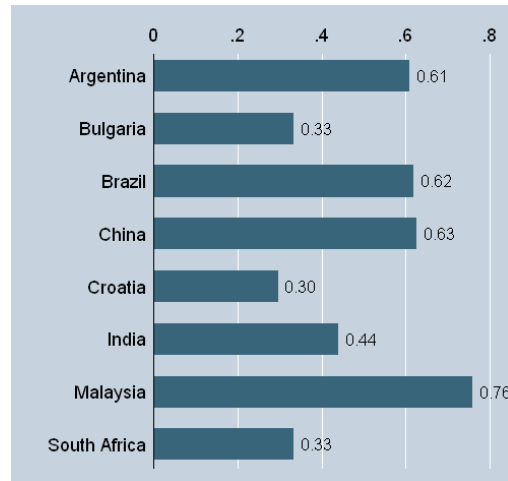


Based on 227 observations. Graphs represent means across universities. Each bar represents the total number of student courses listed in Figure 16 that a respondent institution offers. A Rao-Scott F test rejects the null hypothesis that responses are the same in each country (p-value=0.00). The statistical appendix explains the details of

this

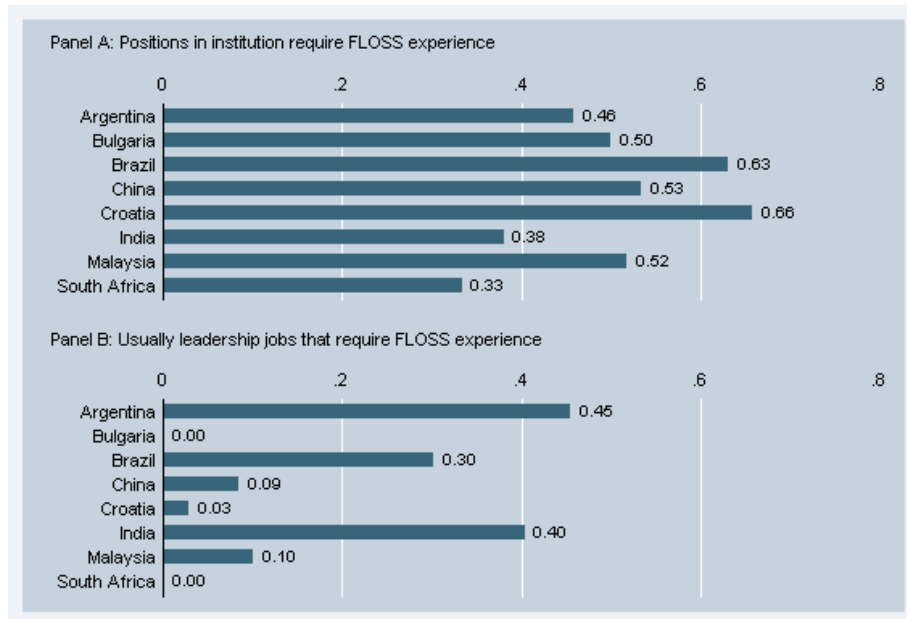
test.

Figure 18 Do you ask job applicants about their FLOSS experience?



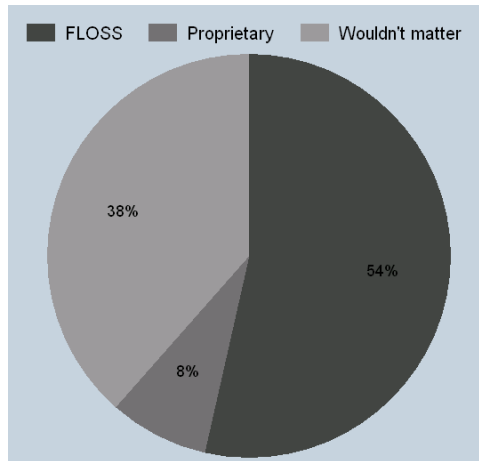
Based on 227 observations. Mean=0.52. Graph shows means across universities. A Rao-Scott F test rejects the hypothesis that responses are the same in each country (p-value = 0.00). The statistical appendix explains the details of this test.

Figure 19 FLOSS jobs in institution



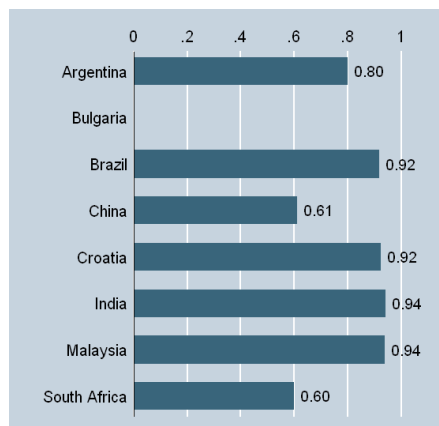
Panel A based on 240 observations. A Rao-Scott F test fails to reject the null hypothesis that response are the same in each country (p-value=0.27). Mean across universities is 0.56. Panel B based on 136 observations and includes only individuals who responded “yes” to the question underpinning first graph. A Rao-Scott rejects the null hypothesis that responses are the same in each country (p-value=0.01). Mean across universities is 0.17. The statistical appendix explains the details of this test.

Figure 20. What type of experience do you prefer in hiring staff?



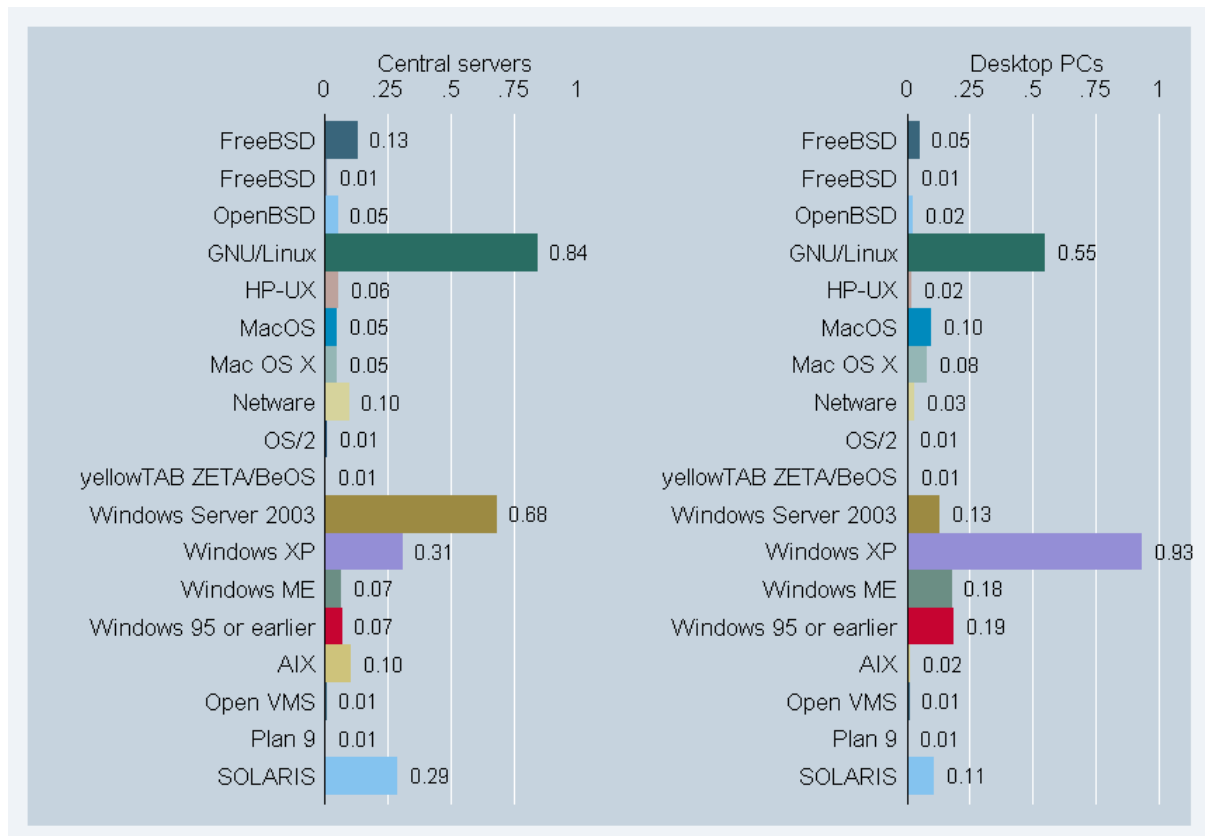
See main text for explanation of exact source question. Based on 226 observations. Graph shows mean across individuals. Question only included in IT survey.

Figure 21. Preference for FLOSS candidate, by country.



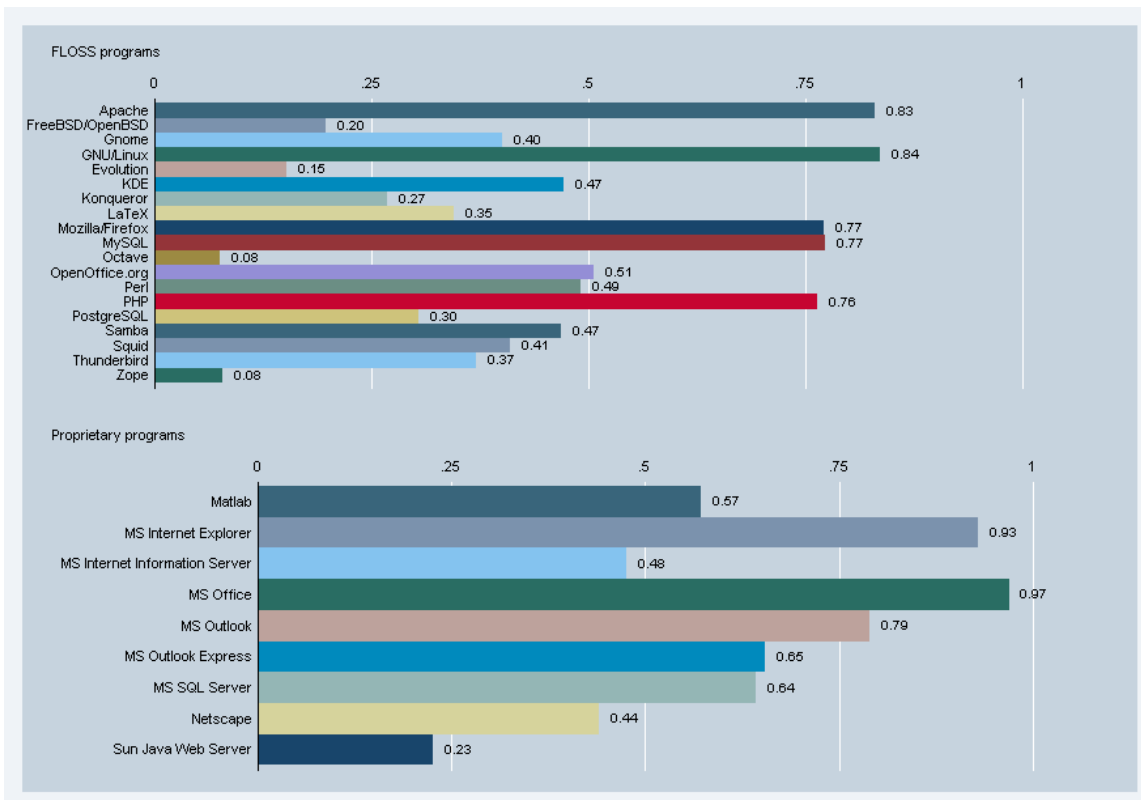
See main text for explanation of exact source question. Based on 226 observations. Graph shows mean within country, a cross individuals. A Pearson χ^2 test fails to reject the null hypothesis that responses are the same in every country (p-value=0.20). Graph includes only respondents who expressed a preference for the FLOSS or proprietary candidate. The statistical appendix explains the details of this test.

Figure 22. Basis of IT system for central servers and desktop PCs.



Based on 236 observations (Central servers); 240 observations (Desktop PCs). Graphs show mean across universities.

Figure 23. Software systems used in institution



Based on 238 observations (first 19 programs) and 244 observations (remaining 9 programs). Graph shows mean across universities.

6. Conclusions

FLOSSWORLD has proven that a successful collaboration between European and non-European research partners is possible and reveals valuable results. Four main findings – apart from the ones that derived from the HEI survey and that are discussed in the section above – of the FLOSSWORLD Track 1 on human capacity building must be emphasised:

1. Despite all national and cultural specifics appears the FLOSS community more homogeneous than the research team has assumed when the research project was started.
2. FLOSS is evidently a very powerful learning environment not only in Europe and North America but also in developing countries.
3. Participating in FLOSS has a positive impact on job opportunities, regardless of where in the world people decide to join the FLOSS community
4. Employers recognise already the value of informally acquired skills in the FLOSS community

Ad 1: The degree of homogeneity not only regarding demographic aspects of FLOSS but also regarding aspects of “living FLOSS”, such as motivations to join the community, activities, preferences regarding learning methods and contents indicates that there is hardly any significant difference between developed and developing countries as it is known from the “normal” economy. The FLOSS community, probably due to its effective communication means, has succeeded in establishing common standards and values that go far beyond the technological dimension and core of this community.

Ad 2: The fact that people say worldwide that they joined the FLOSS community because they want to learn and share their knowledge implies that - besides software - “learning” is the second important asset around which the community (re-)creates itself and develops its enduring dynamics. The study has revealed that FLOSS participation results in skills improvements not only in the field of software technology but also in managerial, legal, and social skills.

Ad 3: Though FLOSS community members might not think about their career when they join this community they recognise very soon that the things they learn within the community are something that many employers demand. Community members have thereby a very realistic understanding of what their skills are worth. Thus, despite the high degree of uncertainty that we found when we asked the community members for relative payments for FLOSS-skills and proprietary software skills it must be assumed that the knowledge transfer within the FLOSS community also enables its members to assess realistically their labour market opportunities.

Ad 4: The employer survey showed a significant bias towards companies for which FLOSS plays an important or even very important role. Therefore we can at this moment draw conclusions only for the part of the global software economy that is centred around or at least deals to some degree with FLOSS. However, given the highly pervasive character of many FLOSS products it is to assume that this part of the economy will reach a point when proprietary software economy and FLOSS economy become congruent. At this point, those companies that have already experience with tapping the potentials of the FLOSS community as a pool of skilled experts and a relatively costless learning environment might have advantages over other companies.

Bibliography

Benkler, Y. 2006. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven: Yale University Press.

Boston Consulting Group (BCG). 2003. *Boston Consulting Group/OSDN Hacker Survey*. Boston: Boston Consulting Group.

Dalle, J-M, and PA David. 2003. "The Allocation of Software Development Resources in 'Open Source' Production mode." SIEPR Discussion Paper 02-27.

Dalle, J-M, PA David, RA Ghosh and W E Steinmueller. 2005. "Advancing economic research on the free and open source software mode of production," in *How Open Will the Future Be? Social and Cultural Scenarios based on Open Standards and Open-Source Software*, eds. M. Wynants and J. Cornelis, Brussels: VUB Press, 2005. [Preprint available at: <http://siepr.stanford.edu/papers/pdf/04-03.html>.]

David, PA, M den Besten and R Schroeder, "How 'Open' is e-Science?," in *Proceedings of the IEEE 2nd International Conference on eScience and Grid Computing*, Amsterdam, 4- 6th December 2006. (Oxford Internet Institute OeSS Project Working Paper, 10 July 2006, [available at: <http://www.oii.ox.ac.uk/microsites/oess/papers.cfm>]).

David, PA, and F Rullani. 2006. "Open source software development dynamics: project joining and new project generation on SourceForge." (October) SIEPR Discussion Paper, Stanford University, Sant'Anna Institute of Advanced Studies.

David, PA, and JS Shapiro. 2007. "Are 'open source' software developers at-large really representative of the participants community-based FLOSS projects?" Working Paper, OII Oxford and LSE (April).

David, PA, A Waterman, and S Arora. 2003. *FLOSS-US: The Free/Libre/Open Source Software Survey for 2003*. (September) SIEPR-Stanford Economics of Open Source Software Project [available at: <http://www.stanford.edu/group/floss-us/report/FLOSS-US-Report.pdf>].

Ghosh, RA, R Glott, B Krieger, and G Robles. 2002. "Free/Libre and Open Source Software: Survey and Study." International Institute for Infonomics, University of Maastricht, The Netherlands. Available at <http://www.infonomics.nl/FLOSS/report/>

Ghosh, RA, R Glott, B Krieger, and G Robles. 2005. "Free software developers: who, how, and why." In Soete, L, and B ter Weel. Eds., *The Economics of the Digital Society*. Edward Elgar.

Hars, A, and S Ou. 2002. "Working for free? Motivations for participating in Open-Source projects." *International Journal of Electric Commerce* 6: 25-39.

Hemetsberger, A and Reinhardt, A.H.C.R. (2006a). "Learning and Knowledge-building in Open-source Communities - A Social-experiential Approach."

Hemetsberger, A. and Reinhardt, C., 2004. Sharing and creating knowledge in open-source communities: the case of KDE. Fifth European Conference on organizational knowledge, learning and capabilities. Innsbruck, Austria.

Hemetsberger, A., 2006. Understanding Consumers' Collective Action On The Internet: A Conceptualization And Empirical Investigation Of The Free- And Open-Source Movement. Available from <http://hemetsberger.cc/publications/pdf/habilitation.pdf>

Hertel, G, S Nieder, and S Herrmann. 2003. "Motivation of Software Developers in Open-Source Projects: An Internet-based Survey of Contributors to the Linux Kernel." *Research Policy* 32: 1159-1177.

Krueger, A.B., and P. Zhu. 2004. "Another look at the New York City School Voucher Experiment." *American Behavioral Scientist* 47: 658-698.

Lerner, J, and J Tirole. 2001. "The Open Source Movement: Key Research Questions." *European Economic Review* 45(4): 819-826.

Lerner, J. and J. Tirole, 2002. "Some Simple Economics of Open Source," *Journal of Industrial Economics*, 50(2), 2002: pp. 197-234.

Lerner, J., and J. Tirole. 2005. "The Economics of Technology Sharing: Open Source and Beyond." *The Journal of Economic Perspectives* 19: 9-120.

Maurer, S.P., and S. Scotchmer. 2006. "Open Source Software: the New Intellectual Property

Paradigm." NBER Working Paper 12148.

Michlmayr, M., 2004. Managing Volunteer Activity in Free Software Projects, Proceedings of the 2004 USENIX Annual Technical Conference, Freenix Track. pp.93-102.

Overwien, B., 1999. Informelles Lernen: eine Herausforderung an die internationale Bildungsforschung. In P. Dehnbostel, W. Markert and H. Novak, eds., Workshop Erfahrungslernen in der beruflichen Bildung – Beiträge zu einem kontroversen Konzept. Neusäss. pp.295-314.

Sowe, S.K., 2007b. An empirical study of knowledge sharing in free and open source software projects, Ph.D. Department of Informatics, Aristotle University, Thessaloniki, Greece.

Sowe, S.K., Karoulis, A. and Stamelos I., 2005. A constructivist view of knowledge management in open source virtual communities, In D.A. Figueiredo and A. Paula, eds., Managing Learning in Virtual Settings: The Role of Context, Idea Group, Inc, pp:290-308.

von Krogh, G. et al., 2003. Community, Joining, And Specialization In Open Source Software Innovation: A Case Study, Research Policy, (32), pp.1217-1241.

Voß, G, and Pongratz, H., 1998. Der Arbeitskraftunternehmer. Eine neue Grundform der Ware Arbeitskraft? Kölner Zeitschrift für Soziologie und Sozialpsychologie, 50 (3), pp.131-158.

Watkins, K.E. and Marsick, V.J., 1992. Towards a theory of informal and incidental learning in organisations. International Journal of Lifelong Education, 11 (4), pp.287-300.

Wenger, E., 2000. Communities of Practice and Social Learning Systems.

Wenger, E.C., 1998. Communities of Practice: Learning, Meaning, and Identity. Cambridge: Cambridge University Press.

Wenger, E.C., 2000. Communities of Practice and Social Learning Systems. Organization, 7 (2), pp.225-246.

Mitsubishi Research Institute. 2004. "Free/Libre/Open Source Software Asian Developers Online Survey (FLOSS-ASIA)." Working Paper, Tokyo, Japan.

Open Source Software Advisory Service (OSS Watch). 2006. "OSS Watch Survey 2006: Report."

Rao, JNK, and AJ Scott. 1984. "On Chi-squared Tests for Multiway Contingency Tables with Proportions Estimated From Survey Data." *Annals of Statistics* 12: 46-60.

World Bank. 2006. *World Development Indicators*. Washington, DC. The World Bank.

Annex A

1: Questionnaire for Developer Survey

organisation :
name :
position :
email :
country :

1 / 53. What is your gender?

man

woman

2 / 53. How old are you?

3 / 53. What is your nationality?

4 / 53. In which country do you live?

5 / 53. When did you join the FLOSS community?

6 / 53. What is the highest level of education you have completed?

:

:

- :
-
-

- :
-
-
-

Other:

Please specify

7 / 53. From which age onwards did you use a computer?

years old

8 / 53. At what age did you have your first computer of your own?

years old

I do not own a computer

9 / 53. What is your current employment status?

- I do not work at present because I am unemployed
 - I do not work at present because I am a stay-home spouse
 - I do not work at present because I am student
 - I am employed
 - I am self-employed / free lancer / contractor
 - I am retired
-

9a / 53. If you are employed or self-employed, what is your profession?

- Software engineer
- Programmer
- System Administrator
- Network Administrator

- Database Administrator
- Internet / Web designer
- Designer/Illustrator/Graphic Artist
- Researcher
- Consultant
- Executive (Manager, Department Heads)
- University staff

Other profession ? Please specify:

10 / 53. Approximately, what is your monthly gross income (i.e. total income per month, including benefits, before taxes)? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

--	--

11 / 53. Do you earn money from FLOSS, either directly or indirectly? Please check every item that applies to you.

- No, I don't get any monetary remuneration for my FLOSS activities
 - Yes, I am paid directly for developing FLOSS
 - Yes, I am paid directly for supporting FLOSS
 - Yes, I am paid directly for administrating FLOSS
 - Yes, I am paid directly for other FLOSS activities
 - Yes, I am paid indirectly, - I got my job because of my FLOSS experience
 - Yes, I am paid indirectly, - I develop FLOSS at work although my job description does not include FLOSS development (i.e. my employer does not know that I develop FLOSS)
 - Yes, I am paid indirectly, - I also develop FLOSS at work (my employer knows that I develop FLOSS at work)
-

Part 2: Your role in the FLOSS community

12 / 53. Remembering the time you joined the Free/Libre and Open Source Software community, what was the reason for this? (Maximal four answers)

- to participate in new forms of cooperation
- to learn and develop new skills
- to share my knowledge and skills
- to participate in the OS/FS scene
- to improve my job opportunities
- to improve OS/FS products of other developers
- to get a reputation in the OS/FS developers' scene
- to distribute not marketable software
- to get help in realizing a good idea for a software product
- to solve a problem that could not be done by proprietary software
- to limit the power of large software companies
- because I think that software should not be a proprietary product
- to make money
- I do not know

13 / 53. How would you characterise your participation in the Free / Libre / Open Source Software (FLOSS) community? Please indicate for each item to which degree it applies to you. Please indicate also how the importance of these activities has changed for you since you joined the FLOSS community. Leave out the activities you have never performed!

activity	scale	changing importance
I observe what the others do, but do not actively participate	<input type="text"/>	<input type="text"/>
I participate in discussions	<input type="text"/>	<input type="text"/>
I read questions & answers in forums	<input type="text"/>	<input type="text"/>
I answer questions in forums	<input type="text"/>	<input type="text"/>
I provide documents to help people with their FLOSS problems (e.g. tutorials, HOWTOs)	<input type="text"/>	<input type="text"/>
I read bug-reports / release reports	<input type="text"/>	<input type="text"/>
I test software	<input type="text"/>	<input type="text"/>
I write code / fix bugs / provide patches	<input type="text"/>	<input type="text"/>
I provide ideas for new features for a software project	<input type="text"/>	<input type="text"/>

I package software	<input type="checkbox"/>	<input type="checkbox"/>
I translate software or documentation (internationalisation / localisation)	<input type="checkbox"/>	<input type="checkbox"/>
I translate texts about the idea / philosophy of FLOSS	<input type="checkbox"/>	<input type="checkbox"/>
I provide graphics, sounds, or other creative elements for a project or Website	<input type="checkbox"/>	<input type="checkbox"/>
I document software	<input type="checkbox"/>	<input type="checkbox"/>
I have a coordinating function for a project (development)	<input type="checkbox"/>	<input type="checkbox"/>
I help organising workshops, congresses, and other meetings	<input type="checkbox"/>	<input type="checkbox"/>
I participate in technical workshops, congresses, and other meetings	<input type="checkbox"/>	<input type="checkbox"/>
I participate in political activities (e.g. against software patents)	<input type="checkbox"/>	<input type="checkbox"/>
I try to raise public awareness for FLOSS	<input type="checkbox"/>	<input type="checkbox"/>
I try to convince people to migrate towards FLOSS	<input type="checkbox"/>	<input type="checkbox"/>
I administer websites for FLOSS activities	<input type="checkbox"/>	<input type="checkbox"/>
I moderate mailing lists for FLOSS activities	<input type="checkbox"/>	<input type="checkbox"/>
Other, please specify	<input type="text"/>	

13a / 53 Are you a member of local / national FLOSS groups (e.g. LUGs, voluntary associations, etc.)

yes

No

if yes, please list the groups:

14 / 53. What licences do you use for the FLOSS software you write? Please answer separately for situations in which you can choose the license yourself and situations in which you have to use a license that is prescribed by the project you contribute to.

a) When I choose the licence myself, I choose:	
strong reciprocal / copyleft licences: LGPL, GPL, etc	<input type="text"/>
weak copyleft licences: CDDL, Mozilla license	<input type="text"/>
permissive ("BSD"-like) licenses: BSD, MIT, Apache, Perl Artistic, Zope etc.	<input type="text"/>
b) When I contribute to projects which have chosen a licence, :those licences are:	
strong reciprocal / copyleft licences: LGPL, GPL, etc	<input type="text"/>
weak copyleft licences: CDDL, Mozilla license	<input type="text"/>
permissive ("BSD"-like) licenses: BSD, MIT, Apache, Perl Artistic, Zope etc.	<input type="text"/>

15 / 53. What are the roles of an open source/free software license? Check all that apply.

- To prevent others from appropriating the software we've created
- To allow us to create OS/FS without scaring commercial firms from using it
- To force credit to be given to programmers' work
- To promote the launching of other OS/FS programs
- To protect the freedom that software users should have

Part 3: Learning in the FLOSS community

16 / 53. Which of the following skills improved through your participation in the FLOSS community? Please indicate for each item whether you learned nothing, little, some, more or a

lot. If you don't know how to answer an item or if you have no opinion on it, tick "not applicable".

Technical skills:	
Basic / introductory programming skills	<input type="checkbox"/>
To write code in a way that it can be re-used	<input type="checkbox"/>
To re-use code written by others	<input type="checkbox"/>
To document code	<input type="checkbox"/>
To create new algorithms	<input type="checkbox"/>
To become familiar with different programming languages	<input type="checkbox"/>
To design modular code	<input type="checkbox"/>
To run and maintain software systems	<input type="checkbox"/>
To look for bugs	<input type="checkbox"/>
To fix bugs	<input type="checkbox"/>
Managerial and teamwork skills:	
To clearly define and achieve targets	<input type="checkbox"/>
To plan work and stick to a work schedule	<input type="checkbox"/>
To evaluate the work of others	<input type="checkbox"/>
To coordinate your own work with the work of others	<input type="checkbox"/>
To lead a project or a group of people	<input type="checkbox"/>
To express your personal opinions	<input type="checkbox"/>
To clearly articulate an argument	<input type="checkbox"/>
To accept and to respond to criticism from others	<input type="checkbox"/>
To settle conflicts within a group	<input type="checkbox"/>
To motivate people	<input type="checkbox"/>
To keep a community going	<input type="checkbox"/>
Legal skills:	
To understand copyright law issues	<input type="checkbox"/>

To understand patent law issues	
To understand licences	
To understand the differences between copyrights, patents, and licences	
To improve your understanding of liability issues	
General skills:	
To better understand English, especially technical discussion	
To interact with other people	
To understand and work with people from different cultures	
General awareness of ongoing developments:	
To get an overview of developments in software technology	
To get an overview of the skills you need in the software professions	

17 / 53. In your opinion, which of the following skills can be better learnt within the FLOSS community as compared to a formal computer science course, e.g. at university or at a firm?

Technical skills

- To write code in a way that it can be re-used
- To document code
- To run and maintain complex software systems
- Basic / introductory programming skills

Managerial and teamwork skills

- To clearly define and achieve targets
- To plan work and stick to a work schedule
- To evaluate the work of others
- To coordinate your own work with the work of others
- To lead a project or a group of developers
- To express your personal opinions
- To accept and to respond to criticism from others

Legal skills

- To develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability

18 / 53. How useful do you personally consider the following activities as ways of learning the technical skills referred to in the previous questions? If you don't know or don't want to answer, leave it blank

Learning by participating in training courses	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Participate in workshops or congresses	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Participate in the discussions within the FLOSS community	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Reading bug reports	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Fix bugs	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Reading source code of programs and patches	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Checking programs	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this

Guidance from mentors	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Reading other developers' feedback to my patches / bug-reports/bug-fixes	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Reading books or articles on programming	<input type="radio"/> not at all useful <input type="radio"/> slightly useful <input type="radio"/> useful <input type="radio"/> very useful <input type="radio"/> I have never done this
Other self-study, - please specify: <div style="border: 1px solid black; height: 150px; width: 100%; margin-top: 10px;"></div>	

19 / 53. What do you think about the skills you develop in the FLOSS community? (Note: in the items below, ?professional career? refers to your existing career or the professional career you plan to have.)

- they provide a core skill for my professional career
- they provide a useful supplement, but they are not a core skill of my professional career
- they are an end in itself (they provide fun, contacts to others, help to use my time in a reasonable way etc.) but play no important role for my professional career
- I don't know

20 / 53. How much did you already know about FLOSS before you joined the FLOSS community?

Technical aspects of FLOSS (programming languages, projects, products)	<input type="radio"/> nothing <input type="radio"/> a little <input type="radio"/> quite a lot <input type="radio"/> really a lot
How work and cooperation in FLOSS is organised	<input type="radio"/> nothing <input type="radio"/> a little <input type="radio"/> quite a lot <input type="radio"/> really a lot
The philosophy of free software or open source software	<input type="radio"/> nothing <input type="radio"/> a little <input type="radio"/> quite a lot <input type="radio"/> really a lot
The difference between FLOSS licences and proprietary licences	<input type="radio"/> nothing <input type="radio"/> a little <input type="radio"/> quite a lot <input type="radio"/> really a lot

21 / 53. In the last week: How many hours did you spend on experimenting with coding programs, reading books, articles, documentation, mailing lists, and other activities that you think develop your skills in relation to FLOSS? If you are a freelancer on FLOSS, please separate if possible the time you spent on FLOSS-related activity privately (e.g. at home) and the time you spent on FLOSS-related activity in your professional environment (e.g. at work).

privately: hours

professionally: hours

22 / 53. Do you think that proven participation in the FLOSS community can compensate for the lack of formal degrees, like certificates or university degrees?

- yes
 no

23 / 53. Imagine two people with exactly the same level of formal qualifications but different experiences: Person A has proven experience developing an important component of a proprietary software product. Person B has proven experience developing an important component of an FLOSS software product of equivalent complexity. Who do you think is in a better position to get a job? Note: "job" refers not just to permanent employment, but also any other paid work including freelance or consultancy.

- Person A, with proprietary development credentials, is advantaged
 Person B, with FLOSS development credentials, is advantaged

- They are equally likely to get a job
 - I don't know
-

24 / 53. Do you think that people like person A, with proprietary development credentials, are paid the same by employers as people like person B, with FLOSS development credentials?

- Yes
 - No, Person A (proprietary) gets paid more
 - No, Person B (FLOSS developer) gets paid more
 - I don't know
-

24a / 53. If your answer is 'NO': What do you think the salary difference per month is? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

--	--

25 / 53. Did you respond to the previous question based on your own experience in getting a job?

- Yes
 - No
-

Part 4: Contributing to FLOSS projects

26 / 53. In the last week: How many hours did you spend on contributing to FLOSS projects, in any way - including coding, writing a translation, documentation, FLOSS-related website, FLOSS-related email, or any other FLOSS-related activity that you perform of which you make the results available to others?

--

27 / 53. What is the name of the FLOSS project you contributed the most in the past month

--

What is the URL of this project?

--

28 / 53. How much time did you spend in a typical week contributing to this project?

hours

29 / 53. Why did you join this project?

<input type="checkbox"/>	Because I got somehow involved, after being a user of this project
<input type="checkbox"/>	Because I had a friend who was a developer of the project
<input type="checkbox"/>	Because I chose it as the most appropriate for my skills
<input type="checkbox"/>	Because I chose it as the most appropriate for my interests
<input type="checkbox"/>	Because I was hired to work in it
<input type="checkbox"/>	Because I worked in similar projects / a similar project before
<input type="checkbox"/>	Because I wanted to learn something new (I never worked in similar projects before)

30 / 53. In how many FLOSS projects are you actively involved at present?

31 / 53. Approximately, in how many FLOSS projects did you participate since you joined the community?

32 / 53. Approximately, how many FLOSS projects did you lead since you joined the community?

33 / 53. Approximately, with how many Free / Libre / Open Source Software participants do you have regular contact on an individual basis (e.g. by email or telephone)? Note: "Free / Libre / Open Source Software participant" means every person who is somehow actively involved in the community.

34 / 53. Do you work more with the local community in the country you live in or do you work more with international developers

More with the local community in my country

- More with international developers
 - I don't know
-

35 / 53. FOR EMPLOYED AND SELF-EMPLOYED (INCL. FREELANCERS AND CONTRACTORS) ONLY: Do you work on Free / Libre and Open Source projects more within the firm ore with independent developers?

- More within the firm
 - More with independent developers
 - I don't know
-

36 / 53. Do you usually choose projects and tasks yourself or are you usually delegated to projects and tasks?

- I choose them myself
 - I am delegated
 - I don't know
-

Part 5: Women in the Free/Libre/Open Source Software Community

37 / 53. Do you normally use an online identity that indicates whether you are male or female?

- Yes
 - No
-

38 / 53. Among people with whom you collaborate and interact regularly and which you know well in the FLOSS community, how many women and how many men are there (including yourself)?

- men (number)
 - women (number)
 - People whose gender I do not know (number)
-

39 / 53. In your opinion, for whom is it easier to receive acknowledgement for work in the FLOSS community - men or women?

- Men
 - Women
 - Nobody cares whether you are a man or a woman
 - I do not know
-

40 / 53. Regarding the FLOSS community as a whole, do you think that it would be better if

there were more female participants?

- Yes
 - No
 - I do not know
-

41 / 53. Would you personally enjoy it if you could collaborate with more women in your FLOSS activities?

- Yes
 - No
 - I do not know
-

42 / 53. What do you think the differences in the FLOSS community between men and women are

Women are not as interested in technology as men	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Women ask more questions than men	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Women are more interested in the documentation (writing guidelines, helps, user guides) than men	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Men spend more time on research (about coding details, bugs, code improvements) than women	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Men work on their own, women prefer to work in teams	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know

Women work more effectively than men	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
In online contexts women often get more attention as a women rather than a FLOSS participant	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
In offline contexts women often get more attention as a women rather than a FLOSS participant	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Women have less time than men to participate in FLOSS	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Women and men contribute differently to the FLOSS community	<input type="radio"/> very true <input type="radio"/> mainly true <input type="radio"/> mainly false <input type="radio"/> completely false <input type="radio"/> I do not know
Other differences - please specify	

43 / 53. Regarding the FLOSS community as a whole, have you ever observed or experienced discriminatory behaviour against women?

- Yes, I have observed discriminatory behaviour
- Yes, I have experienced discriminatory behaviour
- no

44 / 53. Regarding your collaboration with others during your FLOSS activities, have you

ever observed or experienced discriminatory behaviour against women?

- Yes, I have observed discriminatory behaviour
 - Yes, I have experienced discriminatory behaviour
 - no
-

45 / 53. Due to your household work: Do you have problems at home to dedicate time to your open source / free software activities?

- never
 - rarely
 - sometimes
 - often
 - very often
 - I do not know
-

46 / 53. Approximately, how many hours of spare time do you have per week?

47 / 53. How much of this spare time do you spend in front of a computer - in hours per week?

number of spare time hours spent on the Internet

number of spare time hours spent for FLOSS activities (coding, organising meetings, etc.)

number of spare time hours spent for other computing activities (gaming, writing personal emails, etc.)

48 / 53. Did it happen that other FLOSS community members asked you to meet for social events outside the FLOSS community?

- Yes, quite often
 - Yes, but not very often
 - Never
-

49 / 53. Have you ever been asked for a date by a FLOSS participant?

- Yes, quite often
- Yes, seldom
- Never

49a / 53. Would you be interested in getting to know FLOSS participants for activities unrelated to the FLOSS community?

- Yes
 - No
 - I don't know
-

Part 6: Contact

50 / 53. What is your SF / BerliOS / Savannah username?

<input type="text"/>	SF username
<input type="text"/>	BerliOS username
<input type="text"/>	Savannah username

51 / 53. Would you allow us to contact you in case we have further questions?

- yes
 - no
-

52 / 53. Do you want to receive notification of the survey results by e-mail?

- yes
 - no
-
-

53 / 53. If you answered "Yes" to question 51 or 52, please could you provide us with your email address?

Annex A2: FLOSSWORLD Guidelines for the Developer Survey

The following guideline provides a stepwise instruction for the preparation and execution of the developer survey. It refers to the analytical framework paper and to the revised version of the respective global questionnaire.

1. **Check the revised global questionnaire** carefully with regard to understandability of the wording, order of the questions, and completeness of aspects that are surveyed again. Inform MERIT and URJC about changes you want to make and errors.
2. **Localise the questionnaire.** As described in the analytical framework paper, localisation means to translate the complete questionnaire into your language, to introduce local terms to ensure international comparability (e.g. using local currencies in the questionnaire and localised scales when asking about income or expenditure levels, but do also localise the FLOSS terminology that we use (e.g. FLOSS, F/OSS, Libre Software, Free Software, Open Source Software, or any other term that you think would be best to use in the region you survey) and the educational degrees and professions) and to add questions that are unique to each country's context. **At the end of this text a separate short list is provided for the questionnaire of the question numbers and points that MUST be localised by ALL FLOSSWORLD PARTNERS.**
3. **Prepare the circulation of the questionnaire** (start in parallel to localisation): Figure out how you want the questionnaire to be circulated. For FLOSS community participants we expect to use only the online version. Therefore you must as soon as possible identify which organisations (developer forums, user groups, mailing lists, etc.) you want to use in order to distribute the questionnaire. Get in touch with them, explain the purpose of the survey, and find out whether they are willing to distribute the questionnaire. Make a list of all these organisations with contact details (i.e. name of contact person, email address, and any other information that is relevant for contacting this person). If you find out that a different way of circulating the questionnaire (i.e. by letter or fax or face to face during user group meetings or conferences) would be better, you have to collect contact information (telephone or fax numbers or locations / dates for possible face to face interactions) of the persons you want to survey (not only of persons / organisations you want to distribute the questionnaire). These personalised address lists must be sent to MERIT, too. *Note: The advantage of an online version is that it can be distributed within your*

local FLOSS community independently from you – once we have posted it to the multipliers you specified, it will be further distributed within the community in a self-organised way. If you rely on other channels for distributing the questionnaire you will have to organise the distribution of the questionnaire yourself.

4. **Create different versions of an introductory email or letter/fax** in order to announce the survey and explain its purpose to the multipliers or persons that are intended to distribute the questionnaire or to be surveyed. This will be done by MERIT and coordinated with you. *You will have to localise the introductory letter and send it back to MERIT.*
5. **Send the localised questionnaire to MERIT.** The localised questionnaires will be converted into on-line form and hosted on a web server at UM (in cases where connectivity is an issue, questionnaires can be hosted on local web servers arranged by the international partners). The on-line questionnaires will be accessible in two ways: addressed access, where unique web addresses will be generated for each pre-selected respondent with identifying information pre-recorded; and open access, where respondents may be asked to provide contact information. *The developer survey is intended to use open access, but that's no must and depends on your and your respondents' preferences³¹ - for instance, if you compile lists of user group or developer group members, these people could receive the online questionnaire individually through addressed access, while others receive the open access version.* If you want to use letters or faxes, MERIT will create a database that you can access online and in which you can fill in the responses you get.
6. **Pre-test preparation and execution:** Select a limited number of developers (usually, 5-10 respondents suffice for this purpose), for instance members of a specific user group, and let them fill in the questionnaire. If possible, you should try to talk to a couple of the pre-test respondents directly about the questionnaire, this provides you with much deeper insights in how the questionnaire works and how the targeted group of respondents might react than indirect communication. For the pre-test we will need some additional questions on the items listed below. These questions must also be sent to MERIT in order to include them in the pre-test version of the questionnaire. Answers to the pretest must be treated as normal responses and therefore be submitted to MERIT, if appropriate they will get integrated in the final survey dataset. Extra items the respondents should comment on in the pre-test are:

³¹ See the analytical framework.

- understandability of the questions,
- questions that appear difficult or impossible to answer,
- questions they did not want to answer,
- questions (or terms) they find unclear or annoying,
- the time they needed to complete the questionnaire (in an online version we can monitor this ourselves) and whether or not they find it too time-consuming (ask for the concrete question at which they got the feeling the questionnaire is too long),
- their general impression of the survey and the questionnaire
- further comments

7. **Analysis of the pre-test:** Particular attention will be given to any local differences in understanding or answering the localised versions of the questionnaire.

8. **Revision of the questionnaire** (if necessary), including localisation of the new elements and revision of the online version.

9. **Distribution of the final version of the questionnaire together with the introductory letter** to either the multipliers (the Internet forums, user groups, mailing lists etc.) or to the persons in the address lists that have been collected during step 3. This will be done by MERIT. Depending on which way of distributing the questionnaire you chose the questionnaire will either be sent by email to multipliers, providing open access to the online questionnaire for the respondents, or to the persons that you have specified in personalised address lists, providing addressed access to the online questionnaire (a combination of both is also possible). In case of addressed access, MERIT will attribute each personal record with a personal password that will be used in the introductory email to allow respondents to access their personal version of the online questionnaire (i.e. nobody else will be able to see what they reply). If you prefer to distribute the questionnaire by fax or by letter these paper versions must be distributed by you and the completed questionnaires must be returned to you, too. In case of letter questionnaires we recommend strongly to use pre-paid response envelopes with your address, as this eases the respondents to reply and raises the response rate.

10. **Data collection:**

- For online survey with open access to the online questionnaire: Respondents will fill out the questionnaires directly on the website, the responses will automatically be transferred

into a password-protected database that can be accessed by you online.

- For online survey with addressed access to the online questionnaire: Respondents will access the online questionnaire and authenticate by entering their personal password, then they will complete the questionnaire. The responses will automatically be transferred into a password-protected database that can be accessed by you online.
- For letter or fax survey: The respondents will send you back the completed questionnaires. You will have to access the password-protected database that is provided online by MERIT and to enter the responses manually in this database.
- For face to face interviews / meetings: Either use a computer to have the interviewee fill out the questionnaire online, or fill out a paper version of the questionnaire which you will then provide in electronic form to MERIT as with the letter survey described above.

11.Shortlist of question numbers and points in the questionnaire that must be localised by all local partners:

- FLOSS terminology (i.e. FLOSS, F/OSS, Open Source Software, etc.)
- Question 6: educational degrees
- Question 9a: professions
- Question 10: currency
- Question 22a: currency
- Question 25: name of main FLOSS project
- Question 32: if you think that language barriers are important we might have to include an extra question on this here
- Question 38: If you know or have hints that there are a lot of women in in the FLOSS community of your country we have to change or drop this question.

- Question 39: If you know or have hints that there are a lot of women in in the FLOSS community of your country we have to change or drop this question.
- Question 41: Maybe nothing for the questionnaire itself but something we should keep in mind while interpreting the results: There may be regional differences in what is perceived as discriminatory behaviour.
- Question 42: Maybe nothing for the questionnaire itself but something we should keep in mind while interpreting the results: There may be regional differences in what is perceived as discriminatory behaviour.

Question 43: The hypothesis behind this question is (as you probably assumed already) that women are burdened more with household and family than men and therefore behave different in the community. If for your country the division of household and family work in the family deviates from the classical "Western-European" way (i.e. women do the lion share of this work) you should let us know.

Annex A3: Questionnaire for Employers

How many people (including yourself) work in your company?

1-5

6-10

11-30

31-50

51-100

101-250

501-1000

more than 1000

By and large: Do you know free software / open source software and its differences compared to proprietary software? (Note: We do not mean expert knowledge here, but basic knowledge on open source software and its main differences compared to proprietary software).

yes

no

1 / 10. Do you use or develop free software / open source software in your company?

no

yes

I'm not sure

I don't know

2 / 10. Do you know whether there are employees in your company who have experience in the field of free software / open source software?

yes

no

2a / 10. What is the share of those with free software / open source software experience in your company?

1-10%

11-20%

21-30%

31-40%

41-50%

51-60%

61-70%

71-80%

81-90%

91-100%

I don't know

3 / 10. Do you ask job applicants about their experience in the field of free software / open source software?

yes

no

4 / 10. Do you ask directly about experience in the field of free software / open source software in job advertisements?

yes

no

5 / 10. Are there positions in your company that require experience in free software / open source software?

yes

no

5a / 10. Are these positions usually leadership positions?

yes

no

6 / 10. For a prospective or current employee: How do you consider the relative merit of a university degree or other formal computer science qualification as compared to practical experience as a developer in the free software / open source software community?

the formal qualification is better

the formal qualification is worse

the formal qualification is equal

I don't know

7 / 10. In your opinion, which of the following skills can be better learnt within the free

software / open source software community as compared to a formal computer science course, e. g. at university or at firm?

Technical skills

Technical skills better learnt in FLOSS: to write code in a way that it can be re-used

Technical skills better learnt in FLOSS: to document code

Technical skills better learnt in FLOSS: to run and maintain complex software systems

Technical skills better learnt in FLOSS: basic / introductory programming skills

Managerial and teamwork skills

Managerial skills better learnt in FLOSS: to clearly define and achieve targets

Managerial skills better learnt in FLOSS: to plan work and stick to a work schedule

Managerial skills better learnt in FLOSS: to evaluate the work of others

Managerial skills better learnt in FLOSS: to coordinate your own work with the work of others

Managerial skills better learnt in FLOSS: to lead a project or a group of developers

Managerial skills better learnt in FLOSS: to express personal opinions

Managerial skills better learnt in FLOSS: to accept and to respond to criticism from others

Legal skills

Legal skills better learnt in FLOSS: to develop an awareness of legal issues relating to software, such as copyright, patents, licensing, liability

8 / 10. If a prospective employee has a formal computer science qualification, do you think that experience in the free software / open source software community (i.e. experience in developing, supporting, or using Open Source / Free Software) adds value?

- yes
- no
- I don't know

8a / 10. Do you offer prospective employees with free software / open source software development experience but no formal degree different pay than those with formal qualifications such as a university computer sciences degree but no practical experience?

- No, they earn the same
- Yes, those with formal degrees but no practical experience get paid more
- Yes, employees with free software / open source software experience but no formal degree get paid more
- I don't know

9 / 10. Suppose you were to face a choice between two prospective employees (person A and person B) with exactly the same level of formal qualifications but different experiences: Person A has proven experience developing an important component of a proprietary software product, as an employee of a proprietary software company. Person B has proven experience developing an important component of a free software / open source software product of equivalent complexity, as an independent participant of the developer community. Would you be more likely to hire person A or person B?

- Person A (with proprietary software experience)
 - Person B (with free software / open source software experience)
 - These different experiences would not influence my preference
 - I don't know
-

10 / 10. How do you assess the role of free software / open source software within your organisation (in any form - as a software user, developer, or vendor)?

- very important
 - important
 - hardly important
 - not important at all
-

1 / 3. Do you know whether there are employees in your company who have experiences in the field of free software / open source software?

- yes
 - no
-

1a / 3. What is the share of those with free software / open source software experiences in your company?

- 1-10%
 - 11-20%
 - 21-30%
 - 31-40%
 - 41-50%
 - 51-60%
 - 61-70%
 - 71-80%
 - 81-90%
 - 91-100%
 - I don't know
-

2 / 3. Do you ask job applicants about their experiences in the field of free software / open source software

- yes
 - no
-

2a / 3. Do you usually employ developers with experiences in the field of free software / open source software on leadership positions?

- yes
 - no
-

2b / 3. Do you think that it will become useful for your company in future to ask job applicants for experiences in the field of free software / open source software?

- yes
 - no
 - I don't know
-

3 / 3. Would you offer prospective employees with free software / open source software development experience but no formal degree different pay than those with formal qualifications such as a university computer sciences degree but no practical experience?

- No, they earn the same
 - Yes, those with formal degrees but no practical experience get paid more
 - Yes, employees with free software / open source software experience but no formal degree get paid more
 - I don't know
-

3a / 3. How much (EURO or other currency per month) would you pay more? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

--	--

Annex A4: Guidelines for the localisation of the Employers Questionnaire

FLOSSWORLD Guidelines for the Employers Survey

The following guideline provides a stepwise instruction for the preparation and execution of the employers survey. It refers to the analytical framework paper and to the revised version of the respective global questionnaire.

1. **Check the revised global questionnaire** carefully with regard to understandability of the wording, order of the questions, and completeness of aspects that are surveyed again. Inform MERIT about changes you want to make and errors.
2. **Localise the questionnaire.** As described in the analytical framework paper, localisation means to translate the complete questionnaire into your language, to introduce local terms to ensure international comparability (e.g. using local currencies in the questionnaire and localised scales when asking about income or expenditure levels, but do also localise the FLOSS terminology that we use (e.g. FLOSS, F/OSS, Libre Software, Free Software, Open Source Software, or any other term that you think would be best to use in the region you survey) and the educational degrees and professions) and to add questions that are unique to each country's context. **At the end of this text a separate short list is provided for the questionnaire of the question numbers and points that MUST be localised by ALL FLOSSWORLD PARTNERS.**
3. **Prepare the circulation of the questionnaire** (start in parallel to localisation): Figure out how you want the questionnaire to be circulated, this may be dependent on the availability of contact information for companies in your country. You can either use databases that contain such information, search the Internet, contact industry or employer associations, use address books, yellow pages, etc. At any rate it would be good if you have a name of a person in the companies you want to survey who is able to answer our questions (anyone who is responsible for hiring people for IT functions, i.e. usually HR or IT managers, in small companies maybe the CEO) and to whom we can send the questionnaire. Our experience in Europe is that eliciting such information through phone calls is an extremely hard and time-consuming business. Nevertheless, having a personal contact usually helps considerably to raise the response rate, and you can explain the purpose of the survey and ask for the preferences of the respondents regarding the kind of questionnaire (online, letter, fax). Make as soon as possible a list of all the

organisations you want to contact, together with contact information (name of the company, name of the contact person, email address(es), and any other information that is relevant for contacting this organisation) and information about their level (local-regional-central, association of government organisations, etc. - whatever you find useful) and the way how they should be contacted (email, letter, fax, phone, maybe even face to face). Send all these information to MERIT. If you find out that circulating the questionnaire by letter or fax or face to face would be better, you have to collect contact information (telephone or fax numbers or locations / dates for possible face to face interactions) of the persons you want to survey. These lists must be sent to MERIT, too. *Note: The advantage of an online version is that it can be very easily distributed and responded. If you rely on other channels for distributing the questionnaire (i.e. telephone, fax, face to face) you will have to organise the distribution of the questionnaire yourself.*

4. **Create different versions of an introductory email or letter/fax** in order to announce the survey and explain its purpose to the companies or, if applicable, contact persons in the companies. This will be done by MERIT and coordinated with you. *You will have to localise the introductory letter and send it back to MERIT.*
5. **Send the localised questionnaire to MERIT.** The localised questionnaires will be converted into on-line form and hosted on a web server at UM (in cases where connectivity is an issue, questionnaires can be hosted on local web servers arranged by the international partners). The on-line questionnaires will be accessible in two ways: addressed access, where unique web addresses will be generated for each pre-selected respondent with identifying information pre-recorded; and open access, where respondents may be asked to provide contact information. *The developer survey is intended to combine addressed and open access, because you might see a possibility to get the questionnaire and the introductory letter circulated in a self-organised way within industry or employers associations in your country.* If you want to use letters or faxes, MERIT will create a database that you can access online and in which you can fill in the responses you get.
6. **Pre-test preparation and execution:** Select a limited number of companies (usually, 5 respondents suffice for this purpose), for instance Hr or IT managers of companies of different size in the area where you live, and let them fill in the questionnaire. If possible, you should try to talk to a couple of the pre-test respondents directly about the questionnaire, this provides you with much deeper insights in how the questionnaire works and how the targeted group of

respondents might react than indirect communication. For the pre-test we will need some additional questions on the items listed below. These questions must also be sent to MERIT in order to include them in the pre-test version of the questionnaire. Answers to the pretest must be treated as normal responses and therefore be submitted to MERIT, if appropriate they will get integrated in the final survey dataset. Extra items the respondents should comment on in the pre-test are:

- understandability of the questions,
- questions that appear difficult or impossible to answer,
- questions they did not want to answer,
- questions (or terms) they find unclear or annoying,
- the time they needed to complete the questionnaire (in an online version we can monitor this ourselves) and whether or not they find it too time-consuming (ask for the concrete question at which they got the feeling the questionnaire is too long),
- their general impression of the survey and the questionnaire
- further comments

7. **Analysis of the pre-test:** Particular attention will be given to any local differences in understanding or answering the localised versions of the questionnaire.
8. **Revision of the questionnaire** (if necessary), including localisation of the new elements and revision of the online version.
9. **Distribution of the final version of the questionnaire together with the introductory letter** to the persons in the address lists that have been collected during step 3. This will be done by MERIT. Depending on which way of distributing the questionnaire you chose the questionnaire will either be sent by email to the persons that you have specified in personalised address lists, providing addressed access to the online questionnaire. If you found a way to distribute the questionnaire in a self-controlled way within industry or employers, open access to the questionnaire will also be provided. In this case the respondents will have to specify the name of their company and some other relevant information (such as their function) that otherwise would have been collected in step 3. (Note: A combination of addressed and open access to the questionnaire is generally possible). In case of addressed access, MERIT will attribute each personal record with a personal password that will be used in the introductory email to allow respondents to access their personal version of the online questionnaire (i.e. nobody else will be

able to see what they reply). If you prefer to distribute the questionnaire by fax or by letter these paper versions must be distributed by you and the completed questionnaires must be returned to you, too. In case of letter questionnaires we recommend strongly to use pre-paid response envelopes with your address, as this eases the respondents to reply and raises the response rate.

10.Data collection:

- For online survey with addressed access to the online questionnaire: Respondents will access the online questionnaire and authenticate by entering their personal password, then they will complete the questionnaire. The responses will automatically be transferred into a password-protected database that can be accessed by you online. After a specified period of time (i.e. one week after distributing the questionnaire), those who did not reply will get a reminder by email. We usually send 3-4 email reminders and then make a final reminder phone call before we close the survey.
- For online survey with open access to the online questionnaire: Respondents will fill out the questionnaires directly on the website and have to specify some extra personal information (name of company, industry, etc.), the responses will automatically be transferred into a password-protected database that can be accessed by you online. Reminders cannot be used because we have no contact information.
- For letter or fax survey: The respondents will send you back the completed questionnaires. You will have to access the password-protected database that is provided online by MERIT and to enter the responses manually in this database. You will also be responsible for sending reminder letters and faxes. At any rate, you should calculate a longer survey period for letter and fax surveys than for the online survey (at least double the time).
- For face to face interviews / meetings: Either use a computer to have the interviewee fill out the questionnaire online, or fill out a paper version of the questionnaire which you will then provide in electronic form to MERIT as with the letter survey described above. Since you meet the respondent personally there's no need for reminders.

11.Non-response analysis: Not all of the contacts you have collected for the lists will reply. The crucial question for the validity of our results is whether our respondents differ significantly

from the non-respondents in one or more respects. If this is the case our sample would be biased towards this or these characteristics, for instance towards FLOSS users. In order to estimate whether such (a) bias(es) exist(s) we have to conduct a non-response analysis. This means that we have to contact the non-respondents (or a sub-sample of them) again after the survey is closed and to ask them a couple (2-4) of relevant questions that allow comparing the non-respondents and the respondents with regard to characteristics that are important for the survey. For instance, FLOSS usage, size of the organisation, and level of the organisation could be such important criteria. The small questionnaire for the non-response analysis will be created in collaboration of all consortium partners, the execution of the non-response survey will fall into the responsibility of the local partners. The results of the non-response survey must be sent to MERIT and will be analysed and compared there.

12.Shortlist of question numbers and points in the questionnaire that must be localised by all local partners:

- FLOSS terminology (i.e. FLOSS, F/OSS, Open Source Software, etc.), see for instance first filter question
- Question 4: the usefulness of this question depends on whether or not recruiting by job advertisements is the dominating way of hiring people

Annex A5: Questionnaire for HEIs (Administrators)

What is your gender?

female

male

I don't want to answer this question

Which year were you born?

1 / 18. What is the total number of students that your institution currently enrolls? If you don't know an answer, leave it blank. Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of undergraduate students

number of graduate and postgraduate students

2 / 18. What is the total number of teaching and research personnel that your institution currently employs? If you don't know the answer, leave it blank. Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of teaching and research personnel

3 / 18. What is the approximate total number of central and departmental administrative personnel and support staff (e.g. research assistance, administrative assistants, ICT staff etc.) currently working at your institution? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of administrative and support personnel

4 / 18. Does your job involve following positions? Please select all that apply.

an executive position (e.g. manager, department head)

a position as lecturer / teacher

a position as researcher

other

5 / 18. Do you have any of the following administrative responsibilities? Please select all that apply.

Software procurement/purchasing
Developing institutional ICT policies
Overseeing implementation of ICT policies
Developing/administrating institutional ICT budgets
Designing/approving software licensing agreements
Approving software development in-house
Managing/coordinating ICT training
Developing ICT training
None of these

6 / 18. Are decisions on software purchases in your institution made on an institution wide basis?

yes

no

I don't know

6a / 18. Who is (are) most important for decisions on software purchases in your organisation? Please choose not more than two answers and rank them by a '1' for most important and a '2' for second most important.

IT Manager / Head of IT department

users

financial department

other management (possibly including yourself)

external consultants

others

Please specify

I don't know

7 / 18. Roughly speaking, how large was the IT budget of your institution in 2005? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

I don't know

8 / 18. Roughly speaking, what is the percentage of the share of software purchases and license fees in your organisation's IT budget in 2005?

I don't know

9 / 18. Roughly speaking, what is the percentage of the share of personnel cost in your organisation's IT budget in 2005? In case the IT budget does not include personnel cost please fill in 0.

I don't know

10 / 18. What do you think: Is the share of software purchases and license fees in the total IT budget of your institution too high, too low, or reasonable?

too low

reasonable

too high

I don't know

11 / 18. Do you see a need for reducing the expenditure for software purchases and license fees in your institutions within the next two years?

yes

no

I don't know

12 / 18. Does your institution have a stated IT policy or strategy?

yes

no

I don't know

13 / 18. Does this IT policy or strategy include Open Source Software (OSS) as an option when procuring software?

yes

no

I don't know

13a / 18. Does this policy require that you choose the Open Source Software (OSS) application, if one exists, instead of a proprietary software alternative?

yes

no

I don't know

13b / 18. Why does the IT policy or strategy not include Open Source Software (OSS) as an option when procuring software?

the policy does not explicitly or implicitly mention software

the IT policy mentions software, but does not specify the type of software

the IT policy focuses only on proprietary software

the policy explicitly excludes OSS as an option

other reason

I don't know

14 / 18. Do you use open source software in your institution?

yes

no

I don't know

14a / 18. To which extent do the following groups in your institution use open source software?

Administration staff (including IT staff)	not at all a little much a great deal I don't know
Teaching staff	not at all a little much a great deal I don't know
Students in computer science	not at all a little much a great deal I don't know
Students in other science	not at all a little much a great deal I don't know

Students in non-science	not at all a little much a great deal I don't know
--------------------------------	---

15 / 18. Would you find it useful to increase the share of open source software in your institution?

yes

no

I don't know

15a / 18. To which extent should the use of open source software in your institution increase for the following groups?

Administration staff (including IT staff)	not at all a little much a great deal I don't know
Teaching staff	not at all a little much a great deal I don't know
Students in computer science	not at all a little much a great deal I don't know
Students in other science	not at all a little much a great deal I don't know
Students in non-science	not at all a little much a great deal I don't know

16 / 18. Do you develop open source software anywhere in your institution?

yes

no

I don't know

16a / 18. To which extent do the following groups in your institution develop open source software?

Administration staff (including IT staff)	not at all a little much a great deal I don't know
Teaching staff	not at all a little much a great deal I don't know
Students in computer science	not at all a little much a great deal I don't know
Students in other science	not at all a little much a great deal I don't know
Students in non-science	not at all a little much a great deal I don't know

16b / 18. Do you have a policy on licensing the use of software that has been developed by staff or students in your institution?

yes

no

I don't know

16c / 18. What best describes your institution's licensing policy?

We release our software into the public domain for free	does not apply at all sometimes often very often I don't know
We release our software under an open source software license	does not apply at all sometimes often very often I don't know
We sell our software or license it commercially	does not apply at all sometimes often very often I don't know

17 / 18. Do you have personal experience in working with OSS?

yes

no

17a / 18. What kind of experience do you have?

work-related experience

private experience

18 / 18. Is there anything you would like to add to the information that you gave in this survey that you have not been able to express?

Annex A6: Questionnaire for HEIs (IT Managers)

What is your gender?

female

male

I don't want to answer this question

Which year were you born?

drop-down

1 / 25. What is the total number of students that your institution currently enrolls? If you don't know an answer, leave it blank. Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of undergraduate students

number of graduate and postgraduate students

2 / 25. What is the total number of teaching and research personnel that your institution currently employs? If you don't know the answer, leave it blank. Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of teaching and research personnel

3 / 25. What is the approximate total number of central and departmental administrative personnel and support staff (e.g. research assistance, administrative assistants, ICT staff etc.) currently working at your institution? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

number of administrative and support personnel

4 / 25. Does your job involve following positions? Please select all that apply.

an executive position (e.g. manager, department head)

a position as lecturer / teacher

a position as researcher

other

5 / 25. Do you have any of the following personal technical skills and/or responsibilities in your employment position? Please check all that apply.

Software development (e.g. producing code, producing packages etc.)

Programming

System administration

Network administration

Database administration
Internet / Web design
ICT / Software training or teaching
None of these

6 / 25. Do you have any of the following administrative responsibilities? Please select all that apply.

Software procurement/purchasing
Developing institutional ICT policies
Overseeing implementation of ICT policies
Developing/administrating institutional ICT budgets
Designing/approving software licensing agreements
Approving software development in-house
Managing/coordinating ICT training
Developing ICT training
None of these

7 / 25. Are decisions on software purchases in your institution made on an institution wide basis?

- yes
 no
 I don't know
-

7a / 25. Who is (are) most important for decisions on software purchases in your organisation? Please choose not more than two answers and rank them by a '1' for most important and a '2' for second most important.

IT Manager / Head of IT department (possibly yourself)

users

financial department

other management

external consultants

others

Please specify

I don't know

8 / 25. Roughly speaking, how large was the IT budget of your institution in 2005? Please, use ONLY numbers with no other characters (e.g. 10000 for ten thousand).

I don't know

9 / 25. Roughly speaking, what is the percentage of the share of software purchases and license fees in your organisation's IT budget in 2005?

 %

I don't know

10 / 25. Roughly speaking, what is the percentage of the share of personnel cost in your organisation's IT budget in 2005? In case the IT budget does not include personnel cost please fill in 0.

 %

I don't know

11 / 25. What do you think: Is the share of software purchases and license fees in the total IT budget of your institution too high, too low, or reasonable?

- too low
 reasonable
 too high
 I don't know
-

12 / 25. Do you see a need for reducing the expenditure for software purchases and license fees in your institutions within the next two years?

- yes
 no
 I don't know
-

13 / 25. Does your institution have a stated IT policy or strategy?

- yes
 no
 I don't know
-

14 / 25. Does this IT policy or strategy include Open Source Software (OSS) as an option when procuring software?

- yes

- no
 - I don't know
-

14a / 25. Does this policy require that you choose the Open Source Software (OSS) application, if one exists, instead of a proprietary software alternative?

- yes
 - no
 - I don't know
-

14b / 25. Why does the IT policy or strategy not include Open Source Software (OSS) as an option when procuring software?

- the policy does not explicitly or implicitly mention software
 - the IT policy mentions software, but does not specify the type of software
 - the IT policy focuses only on proprietary software
 - the policy explicitly excludes OSS as an option
 - other reason
 - I don't know
-

15 / 25. Do you use open source software in your institution?

- yes
 - no
 - I don't know
-

15a / 25. To which extent do the following groups in your institution use open source software?

Administration staff (including IT staff)	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Teaching staff	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know

Students in computer science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in other science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in non-science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know

16 / 25. Would you find it useful to increase the share of open source software in your institution?

- yes
 no
 I don't know

16a / 25. To which extent should the use of open source software in your institution increase for the following groups?

Administration staff (including IT staff)	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Teaching staff	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in computer science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know

Students in other science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in non-science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know

17 / 25. Do you develop open source software anywhere in your institution?

- yes
 no
 I don't know

17a / 25. To which extent do the following groups in your institution develop open source software?

Administration staff (including IT staff)	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Teaching staff	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in computer science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
Students in other science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know

Students in non-science	<input type="radio"/> not at all <input type="radio"/> a little <input type="radio"/> much <input type="radio"/> a great deal <input type="radio"/> I don't know
-------------------------	--

17b / 25. Do you have a policy on licensing the use of software that has been developed by staff or students in your institution?

- yes
- no
- I don't know

17c / 25. What best describes your institution's licensing policy?

We release our software into the public domain for free	<input type="radio"/> does not apply at all <input type="radio"/> sometimes <input type="radio"/> often <input type="radio"/> very often <input type="radio"/> I don't know
We release our software under an open source software license	<input type="radio"/> does not apply at all <input type="radio"/> sometimes <input type="radio"/> often <input type="radio"/> very often <input type="radio"/> I don't know
We sell our software or license it commercially	<input type="radio"/> does not apply at all <input type="radio"/> sometimes <input type="radio"/> often <input type="radio"/> very often <input type="radio"/> I don't know

18 / 25. Do you have personal experience in working with OSS?

- yes
- no

18a / 25. What kind of experience do you have?

- work-related experience
- private experience

19 / 25. Which of the following types of computer programming courses are available at your institution to students or staff?

for students

- Introductory programming course (e.g. Visual Basic, Python, Deplhi, etc.)
- Web management tools course (e.g. Frontpage, Dreamweaver, etc)
- Simple HTML course
- Advanced HTML course (e.g. CSS, javascript, etc)
- Intermediate, advanced programming (e.g. C/C++, Java, C#, Pascal/Delphi, etc.)
- Shell scripting course (e.g. Perl, Bash, etc.)
- Other course

Please describe:

- I don't know

for staff

- Introductory programming course (e.g. Visual Basic, Python, Deplhi, etc.)
- Web management tools course (e.g. Frontpage, Dreamweaver, etc)
- Simple HTML course
- Advanced HTML course (e.g. CSS, javascript, etc)
- Intermediate, advanced programming (e.g. C/C++, Java, C#, Pascal/Delphi, etc.)
- Shell scripting course (e.g. Perl, Bash, etc.)
- Other course

Please describe:

I don't know

20 / 25. Do you ask job applicants about their experiences in the field of free software / open source software?

- yes
 - no
-

21 / 25. Are there positions in your company that require experiences in free software / open source software?

- yes
 - no
-

21a / 25. Are these positions usually leadership positions?

- yes
 - no
-

22 / 25. Suppose you were to face a choice between two prospective employees (person A and person B) with exactly the same level of formal qualifications but different experiences: Person A has proven experience developing an important component of a proprietary software product, as an employee of a proprietary software company. Person B has proven experience developing an important component of a free software / open source software product of equivalent complexity, as an independent participant of the developer community. Would you be more likely to hire person A or person B?

- Person A (with proprietary software experience)
 - Person B (with free software / open source software experience)
 - These different experiences would not influence my preference
 - I don't know
-

23 / 25. Which of the following operating systems are the basis of the IT system of your institution? Answer this question for servers and desktop PCs separately.

on central servers

- Windows Server 2003
- Windows XP
- Windows ME
- Windows 95 or earlier
- AIX
- Free BSD
- NetBSD
- OpenBSD
- GNU/Linux
- HP-UX
- MacOS
- Mac OS X
- Netware
- Open VMS
- OS/2
- Plan 9
- SOLARIS
- yellowTAB ZETA/BeOS
- I don't know

on desktop PCs

- Windows Server 2003
- Windows XP
- Windows ME
- Windows 95 or earlier
- AIX
- Free BSD
- NetBSD
- OpenBSD
- GNU/Linux

- HP-UX
 - MacOS
 - Mac OS X
 - Netware
 - Open VMS
 - OS/2
 - Plan 9
 - SOLARIS
 - yellowTAB ZETA/BeOS
 - I don't know
-

24 / 25. Which of the following software systems are used in your institution?

- Apache
- FreeBSD/OpenBSD
- Gnome
- GNU/Linux
- Evolution
- KDE
- Konqueror
- LaTeX
- Matlab
- Microsoft Internet Explorer
- Microsoft Internet Information Server
- Microsoft Office
- Microsoft Outlook
- Microsoft Outlook express
- Microsoft SQL Server
- Mozilla/Firefox
- MySQL
- Netscape
- Octave
- OpenOffice.org
- Perl

- PHP
 - PostgreSQL
 - Samba
 - Squid
 - Sun Java Web Server
 - Thunderbird
 - Zope
-

25 / 25. Is there anything you would like to add to the information that you gave in this survey that you have not been able to express?

Annex A7: Guidelines for the Localisation of the HEIs Questionnaire

FLOSSWORLD Guidelines for the HEI Survey

The following guideline provides a stepwise instruction for the preparation and execution of the higher educational institutions (HEI) survey. **PLEASE NOTE: the HEI questionnaires are not final by now, as the revised versions that have been distributed in December do not fully address the comments from UWC and CSIR. We plan to cut several questions in each of the two HEI questionnaires. Therefore we need your comments and your decisions on which questions in the two questionnaires are most important to you before January 15!**

1. **Check the revised global questionnaires** carefully with regard to understandability of the wording, order of the questions, and completeness of aspects that are surveyed again. Inform OII about changes you want to make and errors.
2. **Localise the questionnaire.** As described in the analytical framework paper, localisation means to translate the complete questionnaire into your language, to introduce local terms to ensure international comparability (e.g. using local currencies in the questionnaire and localised scales when asking about income or expenditure levels, but do also localise the FLOSS terminology that we use (e.g. FLOSS, F/OSS, Libre Software, Free Software, Open Source Software, or any other term that you think would be best to use in the region you survey) and the educational degrees and professions) and to add questions that are unique to each country's context. **At the end of this text a separate short list is provided for the questionnaire of the question numbers and points that MUST be localised by ALL FLOSSWORLD PARTNERS.**
3. **Prepare the circulation of the questionnaire** (start in parallel to localisation): Figure out how you want the questionnaire to be circulated, this may be dependent on the availability of contact information for government organisations in your country. You can either use databases that contain such information, search the Internet for such organisations and associations of such organisations, use address books, yellow pages, etc. At any rate it would be good if you know the name of a person in the organisations you want to survey who is able to answer our questions and to whom we can send the questionnaire. Our experience in Europe is that eliciting such information through phone calls is an extremely hard and time-consuming business. Nevertheless, having a personal contact usually helps considerably to raise the response rate, and

you can explain the purpose of the survey and ask for the preferences of the respondents regarding the kind of questionnaire (online, letter, fax). Make as soon as possible a list of all the organisations you want to contact, together with contact information (name of the organisation, name of the contact person, email address(es), and any other information that is relevant for contacting this organisation) and the way how they should be contacted (email, letter, fax, phone, maybe even face to face). Send all these information to OII/MERIT. **Be aware that the survey addresses two separate groups of questions that can be answered by two separate groups of people – IT managers and administrators! You will possibly have to build two separate contacts lists.** If you find out that circulating the questionnaire by letter or fax or face to face would be better, you have to collect contact information (telephone or fax numbers or locations / dates for possible face to face interactions) of the persons you want to survey. These lists must be sent to OII/MERIT, too. *Note: The advantage of an online version is that it can be very easily distributed and responded. If you rely on other channels for distributing the questionnaire (i.e. telephone, fax, face to face) you will have to organise the distribution of the questionnaire yourself.*

4. **Create different versions of an introductory email or letter/fax** in order to announce the survey and explain its purpose to the government organisations or, if applicable, contact persons in these organisations. This will be done by OII/MERIT and coordinated with you. *You will have to localise the introductory letter and send it back to OII/MERIT.*
5. **Send the localised questionnaire to OII/MERIT.** The localised questionnaires will be converted into on-line form and hosted on a web server **at UM** (in cases where connectivity is an issue, questionnaires can be hosted on local web servers arranged by the international partners). The on-line questionnaires will be accessible in two ways: addressed access, where unique web addresses will be generated for each pre-selected respondent with identifying information pre-recorded; and open access, where respondents may be asked to provide contact information. If you want to use letters or faxes, OII/MERIT will create a database that you can access online and in which you can fill in the responses you get.
6. **Pre-test preparation and execution:** Select a limited number of HEIs (usually, 5 HEIs suffice for this purpose) and let them fill in the questionnaire. If possible, you should try to talk to a couple of the pre-test respondents directly about the questionnaire, this provides you with much deeper insights in how the questionnaire works and how the targeted group of respondents might

react than indirect communication. For the pre-test we will need some additional questions on the items listed below. These questions must also be sent to OII/MERIT in order to include them in the pre-test version of the questionnaire. Answers to the pretest must be treated as normal responses and therefore be submitted to OII/MERIT, if appropriate they will get integrated in the final survey dataset. Extra items the respondents should comment on in the pre-test are:

- understandability of the questions,
- questions that appear difficult or impossible to answer,
- questions they did not want to answer,
- questions (or terms) they find unclear or annoying,
- the time they needed to complete the questionnaire (in an online version we can monitor this ourselves) and whether or not they find it too time-consuming (ask for the concrete question at which they got the feeling the questionnaire is too long),
- their general impression of the survey and the questionnaire
- further comments

7. **Analysis of the pre-test:** Particular attention will be given to any local differences in understanding or answering the localised versions of the questionnaire.
8. **Revision of the questionnaire** (if necessary), including localisation of the new elements and revision of the online version.
9. **Distribution of the final version of the questionnaire together with the introductory letter** to the persons in the address lists that have been collected during step 3. This will be done by OII/MERIT. Depending on which way of distributing the questionnaire you chose the questionnaire will either be sent by email to the persons that you have specified in personalised address lists, providing addressed access to the online questionnaire. (Note: A combination of addressed and open access to the questionnaire is generally possible). In case of addressed access, OII/MERIT will attribute each personal record with a personal password that will be used in the introductory email to allow respondents to access their personal version of the online questionnaire (i.e. nobody else will be able to see what they reply). If you prefer to distribute the questionnaire by fax or by letter these paper versions must be distributed by you and the completed questionnaires must be returned to you, too. In case of letter questionnaires we recommend strongly to use pre-paid response envelopes with your address, as this eases the respondents to reply and raises the response rate.

10. Data collection:

- For online survey with addressed access to the online questionnaire: Respondents will access the online questionnaire and authenticate by entering their personal password, then they will complete the questionnaire. The responses will automatically be transferred into a password-protected database that can be accessed by you online. After a specified period of time (i.e. one week after distributing the questionnaire), those who did not reply will get a reminder by email. We usually send 3-4 email reminders and then make a final reminder phone call before we close the survey.
- For online survey with open access to the online questionnaire: Respondents will fill out the questionnaires directly on the website, the responses will automatically be transferred into a password-protected database that can be accessed by you online. Reminders cannot be used because we have no contact information.
- For letter or fax survey: The respondents will send you back the completed questionnaires. You will have to access the password-protected database that is provided online by OII/MERIT and to enter the responses manually in this database. You will also be responsible for sending reminder letters and faxes. At any rate, you should calculate a longer survey period for letter and fax surveys than for the online survey (at least double the time).
- For face to face interviews / meetings: Either use a computer to have the interviewee fill out the questionnaire online, or fill out a paper version of the questionnaire which you will then provide in electronic form to OII/MERIT as with the letter survey described above. Since you meet the respondent personally there's no need for reminders.

11. **Non-response analysis:** Not all of the contacts you have collected for the lists will reply. The crucial question for the validity of our results is whether our respondents differ significantly from our respondents in one or more respects. If this is the case our sample would be biased towards this or these characteristics, for instance towards FLOSS users. In order to estimate whether such (a) bias(es) exist(s) we have to conduct a non-response analysis. This means that we have to contact the non-respondents (or a sub-sample of them) again after the survey is closed and to ask them a couple (2-4) of relevant questions that allow comparing the non-respondents and the respondents with regard to characteristics that are important for the survey.

For instance, FLOSS usage, size of the organisation, and level of the organisation could be such important criteria. The small questionnaire for the non-response analysis will be created in collaboration of all consortium partners, the execution of the non-response survey will fall into the responsibility of the local partners. The results of the non-response survey must be sent to MERIT and will be analysed and compared there.

12.Shortlist of question numbers and points in the questionnaire that must be localised by all local partners:

- **both questionnaires**
 - IT-terminology, educational degrees and professions, FLOSS terminology (i.e. FLOSS, F/OSS, Open Source Software, etc.)
 - Terminology for "institution" and / or "organisation"

- **questionnaire for administrators**
 - Question 14: currency
 - Question 15: currency
 - Question 17: currency

- **questionnaire for IT managers**
 - Question 12: list of operating systems
 - Question 13: list of software systems
 - Question 30: list of courses

Annex A 8: Statistical Appendix for the HEI Survey

Section A1. Scoring coefficients from principal component analysis.

Table A1. Scoring coefficients from principal component analysis for FLOSS use

<i>Variable</i>	<i>Scoring coefficient</i>
Use open source in institution	0.32
Use open source in institution (no response)	-0.24
Administration staff use OS: not at all	-0.21
Administration staff use OS: a little	0.26
Administration staff use OS: much	0.08
Administration staff use OS: a great deal	0.08
Teaching staff use OS: not at all	-0.30
Teaching staff use OS: a little	0.36
Teaching staff use OS: much	0.02
Teaching staff use OS: a great deal	0.02
Computer science students staff use OS: not at all	-0.20
Computer science students use OS: a little	0.21
Computer science students use OS: much	0.19
Computer science students use OS: a great deal	0.05
Other science students use OS: not at all	-0.29
Other science students use OS: a little	0.35
Other science students use OS: much	-0.07
Other science students use OS: a great deal	0.05
Non-science students use OS: not at all	-0.27
Non-science students use OS: a little	0.27
Non-science students use OS: much	-0.08
Non-science students use OS: a great deal	0.09
N	446

Table A2. Scoring coefficients from principal component analysis for FLOSS development

<i>Variable</i>	<i>Scoring coefficient</i>
Develop FLOSS anywhere in institution	0.45
Develop FLOSS anywhere in institution (no response)	-0.15
Administration staff (including IT staff) develop FLOSS: not at all	0.14
Administration staff (including IT staff) develop FLOSS: a little	0.24
Administration staff (including IT staff) develop FLOSS: much	0.14
Administration staff (including IT staff) develop FLOSS: a great deal	0.22
Teaching staff develop FLOSS: not at all	0.06
Teaching staff develop FLOSS: a little	0.28
Teaching staff develop FLOSS: much	0.15
Teaching staff develop FLOSS: a great deal	0.22
Students in computer science develop FLOSS: not at all	0.11
Students in computer science develop FLOSS: a little	0.28
Students in computer science develop FLOSS: much	0.20
Students in computer science develop FLOSS: a great deal	0.13
Students in other science develop FLOSS: not at all	0.04
Students in other science develop FLOSS: a little	0.25
Students in other science develop FLOSS: much	0.06
Students in other science develop FLOSS: a great deal	0.30
Students in non-science subjects develop FLOSS: not at all	0.04
Students in non-science subjects develop FLOSS: a little	0.15
Students in non-science subjects develop FLOSS: much	0.05
Students in non-science subjects develop FLOSS: a great deal	0.37
N	446

Table A3. Scoring coefficients from principal component analysis for institutional IT policy framework

<i>Variable</i>	<i>Scoring coefficient</i>
Institution has stated IT policy or strategy	0.46
Stated IT policy or strategy includes FLOSS as procurement option	0.46
Policy requires FLOSS rather than proprietary alternative	0.33
Strategy does not include FLOSS because: doesn't mention software	0.02
Strategy does not include FLOSS because: doesn't specify software type	0.03
Strategy does not include FLOSS because: focuses only on proprietary	0.01
Strategy does not include FLOSS because: explicitly excludes FLOSS	0.03
Strategy does not include FLOSS because: other	0.04
Institution has stated IT policy or strategy (no response)	-0.20
Stated IT policy or strategy includes FLOSS as procurement option (no response)	-0.47
Policy requires FLOSS rather than proprietary alternative (no response)	-0.45
Strategy does not include FLOSS because: (no response)	-0.06
N	446

Table A4. Scoring coefficients from principal component analysis for role of FLOSS in hiring

<i>Variable</i>	<i>Scoring coefficient</i>
Ask job applicants about FLOSS experience?	-0.32
Positions in company require FLOSS experience?	-0.49
Do these positions usually involve leadership?	-0.22
Hiring choice: prefer FLOSS experience?	-0.31
Ask job applicants about FLOSS experience (no response)	0.30
Positions in company require FLOSS experience (no response)	0.32
Do these positions usually involve leadership (no response)	0.49
Hiring choice: prefer FLOSS experience (no response)	0.28
N	245

Section A2. Averages across universities or individuals

For many survey items, the question of interest requires comparing across universities rather than across individual respondents. But the number of respondents per university varies depending on idiosyncratic factors. Averaging across individuals would give excess weight to universities where several individuals happened to respond. Averaging across individuals within a university, then averaging across universities, would discard the additional information that the data contain about universities where several individuals have responded. (Put another way, in a university where ten individuals respond, the data contain more information about the within-university mean than the data do in a university where only one individual responds, and inference should reflect the additional information.) As a further complication, in some questions we compare only IT managers across universities, in other questions we compare only administrative respondents across universities, and in others we compare all respondents across universities.

To properly make these comparisons, we construct and use weights as follows. For survey items which require comparison across individual respondents (for example, Table 1 or Figure 1), we use no weights and state in the table or figure notes that in the data each person receives equal weight. For survey items which require comparison across universities, we weight each observation by the inverse of the number of respondents from the observation's university. For example, if X_i is an indicator for whether person i 's university has a software acquisition policy, due to errors or other reasons, X_i may vary within universities. Then an estimator of the portion of *universities* which have a software acquisition policy is

$$(1) \quad \frac{1}{N} \sum_{i=1}^N X_i w_i$$

where N is the total number of persons who responded to the survey item and w_i is the person-specific weight, i.e., the inverse of the number of respondents from person i 's university. In some estimates we further cluster standard errors within universities to reflect the fact that observations from the same university are not independently distributed.

To estimate a mean across universities for IT managers only, we estimate equation (1) but define N as the total number of IT persons who responded to the survey item, and define w_i as the inverse of the total number of IT managers from person i 's university.

Section A3. Statistical tests and regressions

We use three tests to investigate whether the distributions of responses to a given question item differ across countries, and whether they differ between administrative and IT managers. For continuous variables, we report the F-statistic from analysis of variance (ANOVA). This is numerically equivalent to estimating a regression while including an indicator for each country, then calculating from the regression the F-test that the countries all have coefficients of zero. The null hypothesis of the F-test is that a variable of interest has equal values across all countries. Rejection of this hypothesis (generally, p-value < 0.05 or < 0.10) implies that the variable of interest has statistically significant differences across countries. The ANOVA test statistic is easily adapted to the use of weights.

The ANOVA F-test assumes that the involved variable is normally distributed. For unweighted estimates (i.e., across individuals rather than across universities) and discrete variables, we report a Pearson χ^2 test of independence across rows and columns. Let i index the I different rows, j index the J different columns, and n_{ij} represent a cell count. Define row and column sums as follows:

$$n_{.i} = \sum_{j=1}^J n_{ij}$$

$$n_{.j} = \sum_{i=1}^I n_{ij}$$

Further define $m_{ij} = \frac{n_{.i} n_{.j}}{n}$, where $n = \sum_i \sum_j n_{ij}$. Then the Pearson test statistic is as follows:

$$T = \sum_i \sum_j \frac{(n_{ij} - m_{ij})^2}{m_{ij}}$$

Under the null hypothesis that the rows and columns are independent, $T \sim \chi^2_{(I-1)(J-1)}$. Rejection of this hypothesis (generally, p-value < 0.05) implies that the variable of interest has statistically significant differences across countries.

Pearson's test cannot be directly estimated when each observation has a weight, as occurs in estimates across universities rather than across individuals. But Rao and Scott (1984) generalize the Pearson test to allow weights. The test statistic resulting from their generalization has an F distribution under the null hypothesis of independence, and we report this F statistic in tables which require a test of independence (typically, whether a binary outcome has the same proportion in different countries) but which also require weights.

Section 4 uses least squares and fixed effects regressions to measure the association of several variables with FLOSS use, development, and three other FLOSS-relevant indices. We derive estimating equations as follows. For each person p in institution i , we observe the outcome Y_{ph} , a vector of individual-specific explanatory variables Z_{ph} , and a vector of explanatory variables X_h which is specific to a higher education institution. We first estimate the following equation using least squares:

$$(A1) \quad Y_{ph} = \gamma_1 X_h + \gamma_2 Z_{ph} + \varepsilon_{ph}$$

The least squares estimates assume that the errors ε_{ph} are independently and identically distributed, with $\varepsilon_{ph} \sim N(0, \sigma^2)$.

In reality, however, the errors are not independent, since respondents from the same university will have above-average similarity. Clustering standard errors about universities would resolve this issue of inference.

But a second problem of consistency remains: the explanatory variables may correlate with university-specific unobserved variables. To see why, write the composite error term as the sum of two errors—a university-specific error, and an idiosyncratic error which varies across universities and individuals:

$$\varepsilon_{ph} = \mu_h + \eta_{ph}$$

If $cov(\mu_h, X_h) \neq 0$ or if $cov(\mu_h, Z_{ph}) \neq 0$, which is likely if any unobserved university-specific factors correlate with the explanatory variables in the regressions, then equation (A1) will not provide consistent estimators of the parameter vectors γ_1 and γ_2 . Fixed effects estimates include a dummy variable for each university μ_h .³² Since these indicators capture any university-specific effects, the fixed effects equations cannot include the covariates X_h , which in our data means that the fixed effects estimates do not include country indicators. Since this loss is potentially traded off against potentially decreased bias, we present both least squares and fixed effects estimates.

Some estimates test whether an administrative and IT respondent from the same university will have different responses to a survey item. This test differs from ANOVA, or the Pearson tests because it eliminates any features common to universities, and retains only administrative-IT differences that persist within universities. To estimate this test, for each outcome, we estimate the following equation using least squares:

$$Y_{iu} = \theta_0 + \theta_1 adm_{iu} + \sum_{u=1}^U \phi_u + \varepsilon_{iu}$$

For each individual i in university u , we regress the outcome Y on a constant, an indicator adm which takes the value one if the observation is an administrative respondent and zero otherwise, and on set of indicators ϕ_u , one for each university. Reported standard errors and p-values are robust to heteroskedasticity. In tables and figures we report a t-test of the null hypothesis $H_0: \theta_1 = 0$. Failure to reject this hypothesis implies that within a university, the responses of admin and IT individuals are statistically indistinguishable.

Although some regressions have binary outcomes, we use the linear probability model rather than a probit or logit, for simplicity of estimation while including fixed effects. Similarly, since the likelihood function for an ordered probit is difficult to maximize while including fixed effects for over 300 universities, when the outcome is a Lickert scale or another ordered outcome, for this comparison of admin and IT managers we redefine the outcome to have value one for the most positive responses and value one for the most negative responses. In these situations each table explains the constructed definition of the response

32 For simplicity, in estimation, the within-university mean of equation (A1) is subtracted from (A1), and the resulting equation estimated by least squares. This estimator is numerically equivalent to including an indicator for each university then estimating the equation by least squares.

variable.

Section A4. Selection Bias.

Findings from this survey are subject to the standard caveats of possible selection bias. The survey obtained an average response rate of 50 percent, and lack of data on nonrespondent universities makes it difficult to know whether the data over-sample those individuals and universities with particularly strong positive or negative feelings about FLOSS. The universities in these data collectively teach about 3.7 million students, so the data certainly represent a large population of universities, though perhaps not a national population for any particular country. Nonetheless, one should note that characteristics common to the universities in this survey may not be common to all universities.

Probabilistic surveys or surveys with substantial nonresponse often estimate a weight for each respondent, where the weight represents the number of respondents in the true overall population that the particular respondent represents. Although the number of respondents per university varies, and although half of the universities contacted for the survey did not respond, we do not construct survey weights for the data for a few reasons. First, the sample is not stratified, clustered, or probabilistic, so the survey design does not necessitate use of weights. Second, the original list of universities to survey was not based on a university census, so weights would only seek to ensure that statistics in this report represented the population of contacted universities, and not the population of all universities. Third, variation in the number of individuals who respond from each university is due to different universities having different staff sizes, different individual nonresponse, and a different number of individuals invited to participate in the survey. The absence of good data on these factors implies that statistics obtained using constructed sample weights might have more bias relative to true population values than the statistics presented in this report (which do not use weights) have. Fourth, since the data offer nearly no information on nonrespondent universities, we would have little basis for constructing sample weights which reflect a university's probability of responding to the survey. The preceding points suggest that estimating survey weights and using them to calculate statistics in this report might give more or less accurate results than the results obtained without such survey weights. Given that use of survey weights somewhat complicates explanations of results, and that FLOSSworld targets policymakers, academics, the business community, and the FLOSS community, we judge that the report better serves its purposes without constructing and using survey weights.

Section A5. Principal component analysis

We use principal component analysis to construct four indices which measure broad characteristics of universities with regard to FLOSS. No single survey item fully captures a university's tendency to use FLOSS, develop FLOSS, maintain a FLOSS-friendly IT policy, or consider FLOSS in hiring, so we combine information from several survey items to derive indices measuring these underlying latent characteristics. Factor analysis methods can generally seek to reduce several variables in a dataset to one index. Principal component analysis – only one type of factor analysis – obtains factor scores which maximize the variability of the constructed factor. All factors are constructed to have mean zero and standard deviation one. The scoring coefficients report in Appendix section A1 represent the linear coefficients of each variable in creating the constructed factor. For example, a scoring coefficient of 0.2 on a particular covariate would indicate that this covariate increases the constructed factor by 0.2 standard deviations.

Section A6. Survey design

Countries used varying methodologies to identify and survey universities. A partial list of survey design follows.

Bulgaria: the total number of universities in Bulgaria is 45. The universities which have some reputation and are the preferred choice for study are not more than 12-15, and 15 universities were contacted by email and phone.

Croatia: Local affiliates in CARNet (Croatian Academic and Research Network) have two contacts

with each member institution: a system engineer (technical) and a CARNet coordinator (administrative). Since Croatia has relatively few universities, and since departments within universities have financial independence for most purposes, including IT investments, affiliates contacted a variety of departments and not merely universities. The System engineer who is a CARNet technical contact was chosen as a “technical” respondent, while a vice dean for finance, investment, or business or strategic projects was chosen as an “administrative” respondent.

Malaysia: MIMOS collaborated with the Ministry of Higher Education (MOHE) for the survey. MOHE sent a circular / directive directly to all the Vice Chancellors from a selected university list via fax and email attaching both hard and soft copies of the survey forms. The directive requested the VCs to redirect the circular to all the Branch Campuses and relevant Faculties / Schools (e.g. Engineering, Computer Science, Admin, Library, Management etc). All the responses were directed back to MIMOS and were keyed in directly into the FLOSSWorld online template.