

Who are the developers in FLOSS community-based projects? Why does that matter?

Paul A. David

*Oxford Internet Institute & Stanford University
and*

Joseph S. Shapiro

London School of Economics

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A surprising gap in the research literature...

- One major stream of popular interest and research attention has focused on the FLOSS development process observed in the larger, community-base projects...
 - these present intriguing questions and sources of data for software engineering specialists
 - and they have become emblematic paradigms of “commons-based peer production” (see, e.g. Benkler)
- It is well known (e.g., from studies of SourceForge) that there are many FLOSS developers working on very tiny projects.
- Most of what we know about the characteristics, motivations, and behaviors of FLOSS developers comes from web-surveys
- Major web-survey based studies describe the self-selecting members of the population at large, not the members of community-based projects.

Existing surveys of FLOSS developers date from 2001-04

Type	<i>Online survey, website posts, emailed lists</i>				<i>Emailed developers</i>			<i>Emailed developers from one project</i>	
Survey title	<i>TU Berlin</i>	<i>FLOSS-EU</i>	<i>FLOSS-US</i>	<i>FLOSS-ASIA</i>	<i>BCG</i>				
Reference if different from title	Robles et al. (WIDI 2001)	Ghosh et al. (2002)	David, Waterman, and Arora (2003)	Mitsubishi (2004)	Lakhani and Wolf (2005)	Hars and Ou (2002)	Haruvy, Wu, & Chakravarty (2003)	Lakhani and von Hippel (2002)	Hertel, Nieder, and Herrman (2003)
Data collection	June 2001 to Aug 2001	Feb 2002 to Apr 2002	Jan to June 2003	Dec 2003 - Jan 2004	Oct 2001, Apr 2002	-	-	Oct 99 to Feb 00	Feb-Apr 2000
Method	Online survey, website posts, emailed lists	Online survey, website posts, emailed lists	Online survey, website posts, emailed lists	Online survey, website posts, emailed lists	Emailed SourceForge contributors	Emailed developers	Emailed developers	Emailed developers	Linux mailing list announcements
Usable responses (rate)	5478	2784	1588	138	684 of 1994 (34%)	79 of 389 (20%)	160 of 2000 (8%)	336 of 1709 (19.6%)	141 (half developers)
Motivation questions	None	Reasons for joining FLOSS community; reasons for staying in FLOSS	Reason for developing FLOSS, reasons for specific project	Reason for developing FLOSS	Reasons for working on specific FLOSS project	Reasons for developing FLOSS	Reasons for developing FLOSS or working on specific project	None	Reasons for working in Linux community
Number of projects	-	-	-	-	287	41; 25% from Linux	More than 90	One: Apache	One: Linux kernel
Respondents per project	-	-	-	-	2.38	1.93	1.78	-	-

Why should we try to close this empirical gap?

The characteristics of participants in community-mode FLOSS development might differ from those who work on the mass of small projects...in regard to the nature of the resources that can be mobilized, and problems of managing those projects.

For example

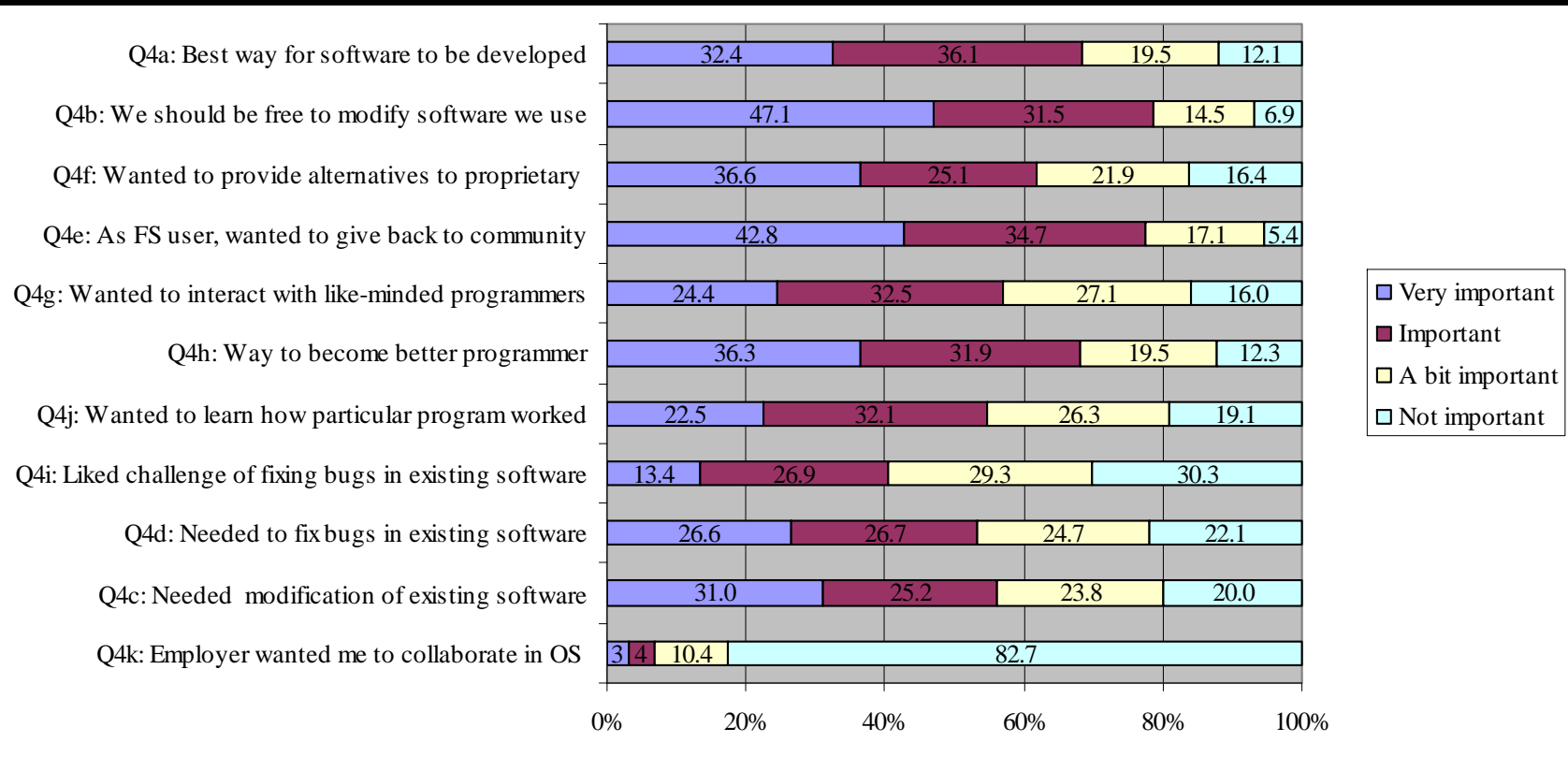
- age, experience and skill levels...affect quality of resource inputs
- occupational status, employment and family commitments may constrain available time to contribute
- motivation for contributing...may affect the roles they chose to take, and kinds of work they are disposed to undertake for the project
- reasons for attachment to a project may differentially affect permanence of attachment, and turn-over of project membership could affect both continuity of knowledge and expertise, and stability of community norms

A simple empirical strategy

- Start with a web-survey (*FLOSS-US*) that gathered demographic, occupational, skills, motivational, and effort supply data, *as well as project identifiers for 1588 respondents*
- Find the contemporaneous (2003) membership sizes of as many of the respondents as is possible (768 individuals), using project names and email addresses
- Establish relevant membership size boundaries for “large” (*community mode*) and “very small” (*independent mode*) FLOSS production
- Obtain “motivational profiles” by applying hierarchical cluster analysis to the “reasons for participating” responses from the entire survey dataset
- Statistically compare and contrast the distributions individuals belonging to the different motivational profiles, and having other continuous or categorical attributes, in the large, small and intermediate sized projects.

Survey motivation questions (1)

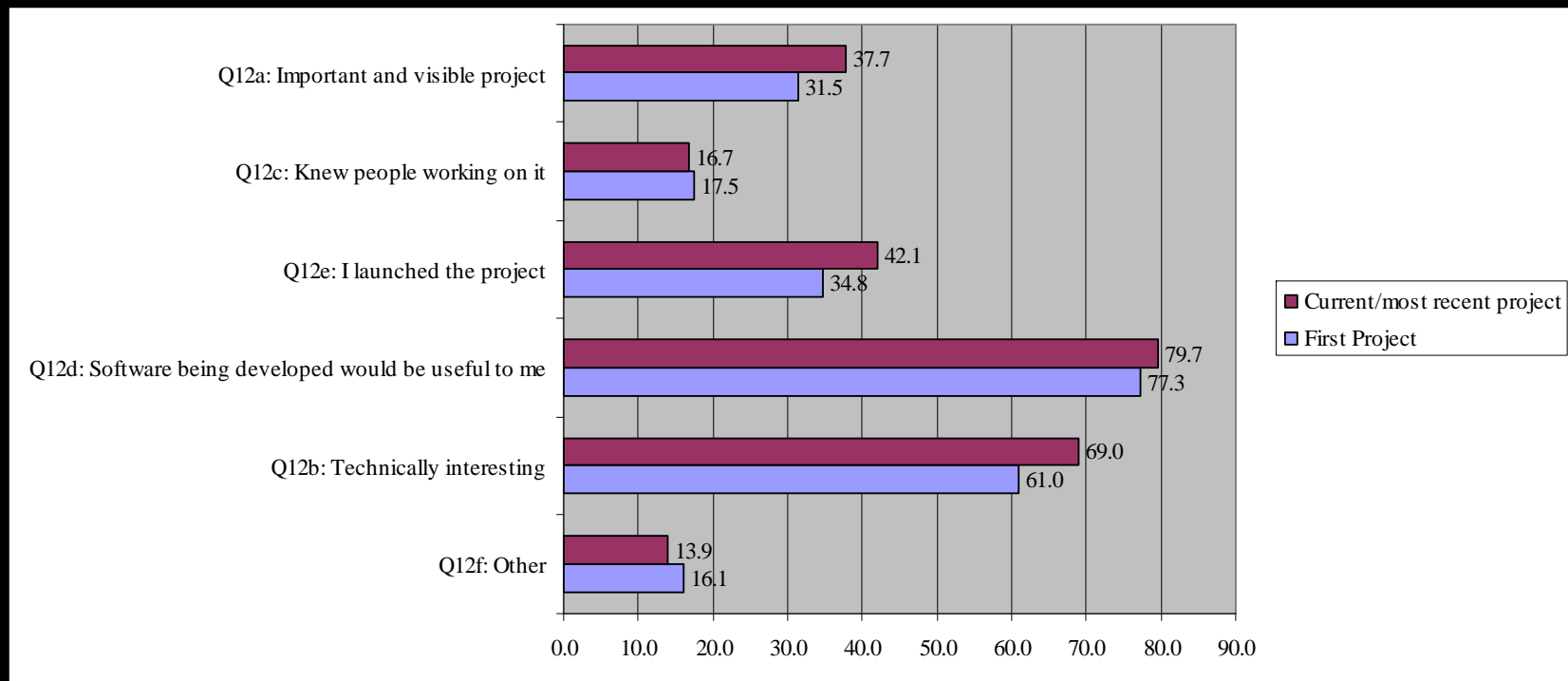
Motivation for first developing FLOSS (Q4)



Source: Analysis of FLOSS-US. Statistics include 1,459 respondents who answered every sub-part of Q4.

Survey motivation questions (2)

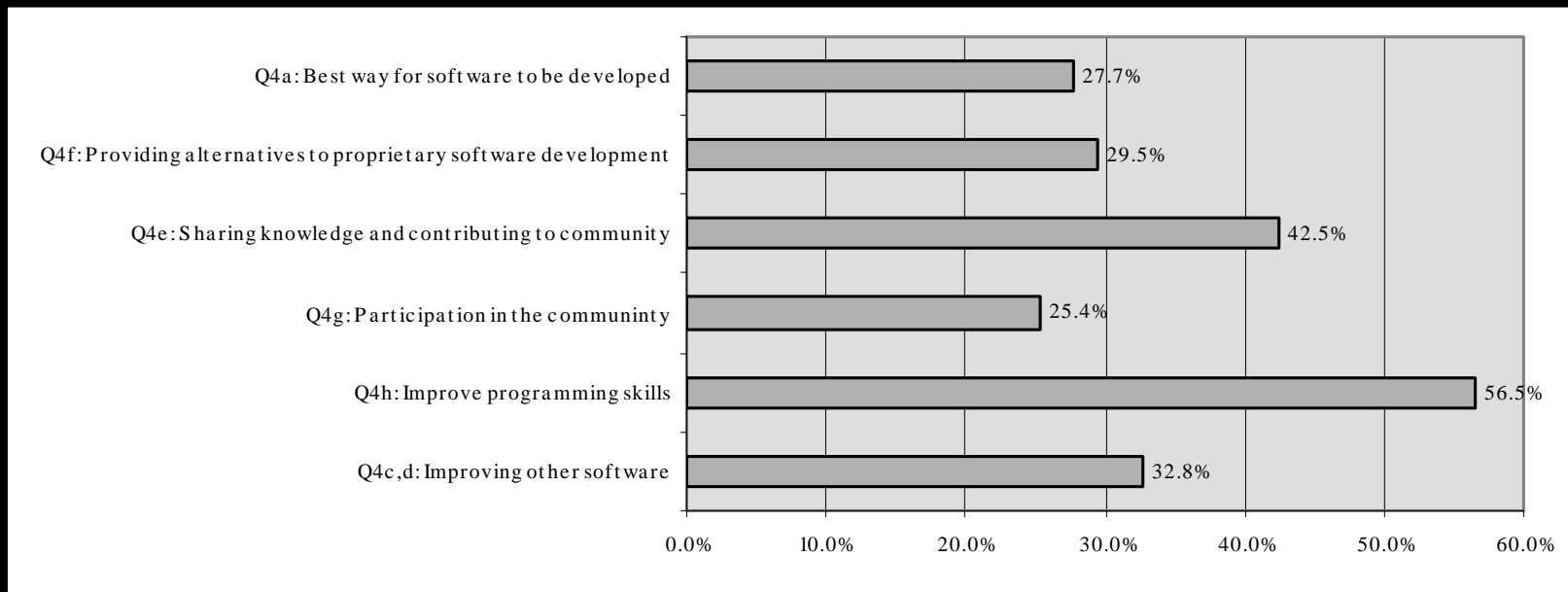
Motivation for choosing project



Source: Analysis of FLOSS-US. For current project, statistics include 1,394 respondents who listed some motivation for current project and answered every part of Q4. For first project, statistics include 1,232 respondents who listed some motivation for first project and who answered every part of Q4.

Checking the representativeness of the FLOSS-US responses to questions about “reasons for contributing”

Motivations for participating in FLOSS development, from the merged file of FLOSS-US (Q4) and FLOSS-EU survey response data



Source: Analysis of FLOSS-US and FLOSS-EU. Statistics include 4,402 respondents from FLOSS-US and FLOSS-EU combined. Data show portion responding “very important” for FLOSS-US or listing the motivation in FLOSS-EU. Analysis combines questions as follows: FLOSS-US Q4a combined with FLOSS-EU Q10; FLOSS-US Q4c and Q4d combined with FLOSS-EU Q6; FLOSS-US Q4e combined with FLOSS-EU Q3; FLOSS-US Q4f combined with FLOSS-EU Q12; FLOSS-US Q4g combined with FLOSS-EU Q4; FLOSS-US Q4h combined with FLOSS-EU Q2.

Characterizing the relative strengths of motivations for first developing FLOSS and choosing a specific project

Normalized intensity maps for the whole survey population

Normalized measure of intensity of importance assigned to the item		
Survey item		
<i>Panel A: Reason for first developing FLOSS (Q4)</i>		
Q4a: Best way for software to be developed	1.16	
Q4b: We should be free to modify software we use	2.33	
Q4f: Wanted to provide alternatives to proprietary	0.77	
Q4e: As free software developer, wanted to give back to community	2.93	
Q4g: Wanted to interact with like-minded programmers	0.73	
Q4h: Way to become better programmer	1.14	
Q4j: Wanted to learn how particular program worked	0.58	
Q4i: Liked challenge of fixing bugs in existing software	0.27	
Q4d: Needed to fix bugs in existing software	0.49	
Q4c: Needed modification of existing software	0.57	
Q4k: Employer wanted me to collaborate in OS	0.02	
Mean across Q4 sub-questions	1	
N	1,459	
<i>Panel B: Reason for choosing specific project (Q12)</i>		
	<i>Current/ most recent project</i>	<i>First project</i>
Q12a: Important and visible project	0.77	0.71
Q12c: Knew people working on it	0.34	0.39
Q12e: I launched the project	0.86	0.78
Q12d: Software being developed would be useful to me	1.62	1.74
Q12b: Technically interesting	1.41	1.37
Mean across Q12 sub-questions	1	1
N	1,459	1,459

Heterogeneity of individuals' motivations: empirics

Rather than thinking of the motivation of “the representative FLOSS developer”, think of individuals differing with respect to their motivational “orientations” or “profiles”.

Some evidence of heterogeneity:

(1) factor analysis of reasons for beginning FLOSS (Q4):

- shows a wide (non-normal) distribution, rather than zero variance;
- high factor loadings associated with assigning great importance to becoming a better programmer, interacting with like-minded programmers, wanting to have the freedom

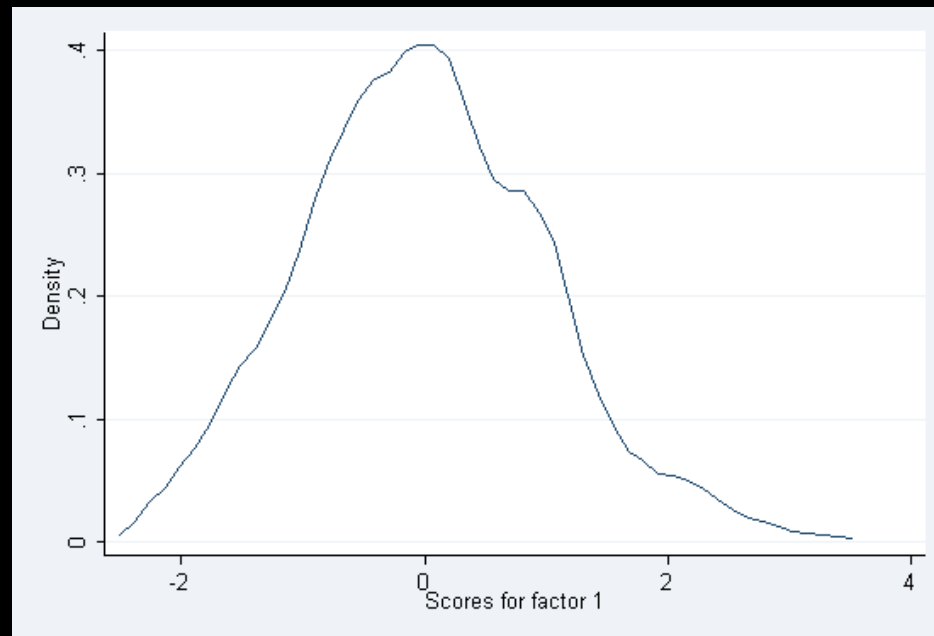
(2) boot-strap estimates show wide variances in the proportions of (randomly drawn) first-time joiners of a 30 member project that would name *some* reasons as very important: e.g., the 95% confidence interval is

- .25 to .61 for “desire to give back to the community
- .16 to .48 for saying “FLOSS is the best way to develop software” ;

But only 0 to .09 would cite their employer’s instruction as being a very important an employer wanting them to do it.

Factor analysis of ‘beginning’ motivations (1)

Density of motivation factor scores



Source: Analysis of FLOSS-US. Uses 1,459 observations. Density depicted using Epanechnikov kernel with half-width of 0.15 evaluated using 50 points.

Factor analysis of ‘beginning’ motivations (2)

Factor analysis of individual motivation responses to Q4

<i>Variable</i>	<i>Factor loadings</i>
Q4h (Way to become better programmer): very important	0.49
Q4h: important	-0.05
Q4h: a bit important	-0.21
Q4h: not important	-0.4
Q4g (Wanted to interact with like-minded programmers): very important	0.44
Q4g: important	0.11
Q4g: a bit important	-0.2
Q4g: not important	-0.42
Q4b (We should be free to modify software we use): very important	0.41
Q4b: important	-0.11
Q4b: a bit important	-0.2
Q4b: not important	-0.33
Q4f (Wanted to provide alternatives to proprietary): very important	0.41
Q4f: important	-0.01
Q4f: a bit important	-0.1
Q4f: not important	-0.4
Q4e (As FS software, wanted to give back to community): very important	0.37
Q4e: important	-0.07
Q4e: a bit important	-0.22
Q4e: not important	-0.29
Q4a (Best way for software to be developed): very important	0.36
Q4a: important	0.1
Q4a: a bit important	-0.2
Q4a: not important	-0.42
Q4j (Wanted to learn how particular program worked): very important	0.36
Q4j: important	0.15
Q4j: a bit important	-0.06
Q4j: not important	-0.5

Table continued:

Q4i (Liked challenge of fixing bugs in existing software): very important	0.28
Q4i: important	0.31
Q4i: a bit important	0.09
Q4i: not important	-0.59
Q4d (Needed to fix bugs in existing software): very important	0.1
Q4d: important	0.22
Q4d: a bit important	0.08
Q4d: not important	-0.42
Q4c (Needed modification of existing software): very important	0.05
Q4c: important	0.13
Q4c: a bit important	0.15
Q4c: not important	-0.35
Q4k (Employer wanted me to collaborate in OS): very important	0.05
Q4k: important	0.1
Q4k: a bit important	0.31
Q4k: not important	-0.33
Factor scores: median	0.02
Factor scores: standard deviation	1
Shapiro-Wilk W test for normality: Prob > z	0
N	1,459
Source: Analysis of FLOSS-US.	

Stability of motivations for project choices

Distributions of five listed reasons								
	<i>Response for first project</i>							
	Q12a	Q12c	Q12e	Q12d	Q12b	ANOVA	P value	N
<i>Response for current project</i>								
Q12a: Important and visible project	0.39	0.18	0.3	0.68	0.58	8.62	0	426
Q12c: Knew people working on it	0.4	0.3	0.26	0.66	0.6	5.65	0	191
Q12e: I launched the project	0.25	0.14	0.38	0.65	0.5	9.09	0	481
Q12d: Software would be useful	0.27	0.17	0.28	0.73	0.54	6.1	0	909
Q12b: Technically interesting	0.29	0.17	0.28	0.7	0.59	5.52	0	783
Pearson chi-square (df=16)	14.4							
Prob > chi-square	0.57							

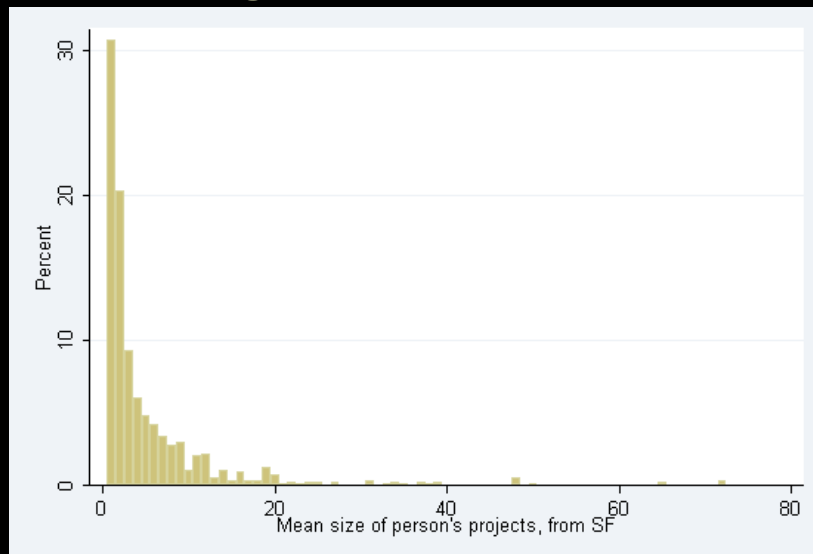
Notes: Analysis using FLOSS-US. In Panel A, each row shows distribution of responses for current project across responses for first project. An observation in the table may appear in multiple cells.

χ^2 tests the independence of rows and columns on the basis of a 1,459 observation dataset with the same cell frequencies appearing in the table, but with each observation appearing in only one cell. Diagonal entries (indicating same response for first as for current project) appear in bold.

All entries exclude observations with same first and current projects.

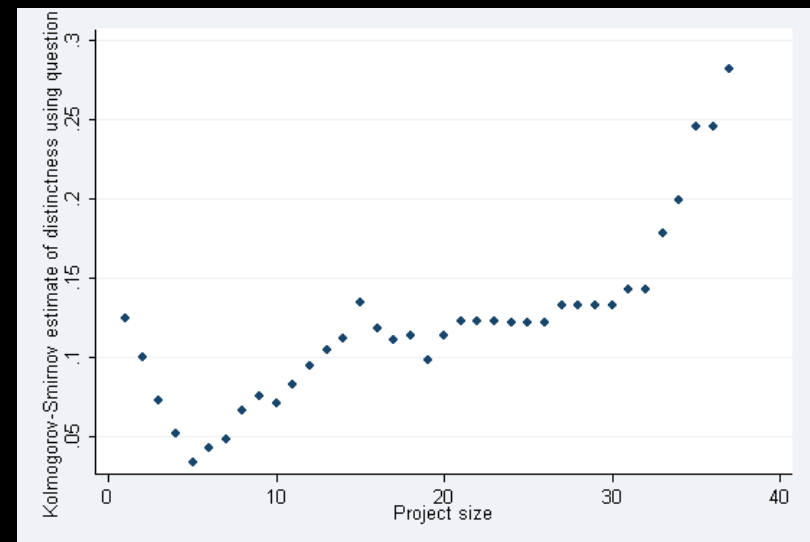
Finding respondent project sizes, and determining size class limits for projects

Histogram of project sizes found in SourceForge.Net



Source: Analysis of FLOSS-US and search of SourceForge.Net (SF). Histogram bins have width one. If only one of a developer's projects has known size, this figure plots the developer according to that size. If both a developer's current and first projects have known size, this figure plots the developer according to the mean of the two projects' sizes, rounded to the nearest integer. Obviously large projects (linux kernel, apache, etc.) not included.

Distinctness of projects (by sizes) estimated from binary partitions based on the derived "motivation factor" scores of individuals.



Source: Analysis of FLOSS-US

Developer transitions across project size-class boundaries

ranges			
	<i>First project</i>		
<i>Current project</i>	<i>Small</i>	<i>Medium</i>	<i>Large</i>
Panel A: All developers			
Small	111	42	32
Medium	30	80	22
Large	13	7	47
Pearson chi-squared(4)	140.58		
Prob > chi-squared	0		
Panel B: Developers for whom first and current/most recent project differ			
Small	51	42	32
Medium	30	29	22
Large	13	7	18
Pearson $\chi^2(4)$	7.96		
Prob > χ^2	0.09		
Panel C: Developers with > 1 year exp			
Small	24	5	1
Medium	6	15	2
Large	0	1	2
Pearson $\chi^2(4)$	29.21		
Prob > χ^2	0		

	<i>First project</i>		
<i>Current project</i>	<i>Small</i>	<i>Medium</i>	<i>Large</i>
Panel D: All developers with 1-2			
Small	19	10	3
Medium	8	17	0
Large	0	2	6
Pearson $\chi^2(4)$	36.89		
Prob > χ^2	0		
Panel E: All developers with 2-5 y			
Small	28	16	6
Medium	5	26	5
Large	4	1	12
Pearson $\chi^2(4)$	46.86		
Prob > χ^2	0		

Source: Analysis of FLOSS-US. Includes only developers for whom both first and current/recent project are known as small, medium, or large.

Non-motivational Characteristics of FLOSS developers, by project size (1)				
Project size	Small	Large	Diff	Source
Age	27.6 (7.5)	30.3 (7.8)	**	Q1
Experience	4.4 (3.4)	6.4 (4.7)	**	Q1
Separated, divorced, or unmarried	0.75	0.71		Q40
Children under age 6	0.13	0.11		Q39
Worked on >5 projects	0.22	0.40	**	Q9
Current and first projects overlap	0.57	0.65		Q11
Duration of first & current project overlap (mths)	31.04	48.43	**	Q11
Duration of current project: 0-1 years	0.45	0.34	*	Q11
Duration of current project: 1-5 years	0.49	0.49		Q11
Duration of current project: >5 years	0.06	0.18	**	Q11
Mean hrs/wk, current project	10.93 (12.0)	11.00 (11.8)		Q13
Max hrs/day, current project	10.8 (5.5)	11.7 (6.2)		Q14
Days of working at maximum intensity	12.7 (44.8)	8.2 (15.9)		Q15
Hours spent during most intense period	145.8 (537.7)	105.3 (249.6)		Q14,15
Total projects: one	0.11	0.09		Q9
Total projects: multiple, current=first	0.74	0.70		Q9
Total projects: multiple, current & first differ	0.13	0.16		Q9

Non-motivational characteristics of FLOSS developers, by project size (2)				
Project size	Small	Large	Diff	Source
Current project: role 1	0.30	0.20	**	Q16
Current project: role 2	0.27	0.21		Q16
Current project: role 3	0.32	0.38		Q16
Current project: role 4	0.20	0.14		Q16
Current project: role 5	0.27	0.35		Q16
Current project: role 6	0.14	0.18		Q16
When work on FLOSS: before work	0.14	0.25	**	Q37
When work on FLOSS: after work	0.72	0.77		Q37
When work on FLOSS: at work, during work hours	0.33	0.48	**	Q37
When work on FLOSS: on weekends	0.74	0.73		Q37
When work on FLOSS: at work, off work hours	0.19	0.34	**	Q37
When work on FLOSS: unemployed, so anytime	0.18	0.13		Q37
N	422	176		

Project roles defined as follows:

- 1=coding and project maintenance and algorithm design;
- 2=coding and algorithm design and user interface;
- 3=debugging and testing and feedback;
- 4=project maintenance and communication and algorithm design;
- 5=coding but not project maintenance and not algorithm design;
- 6=documentation and public relations and communication.

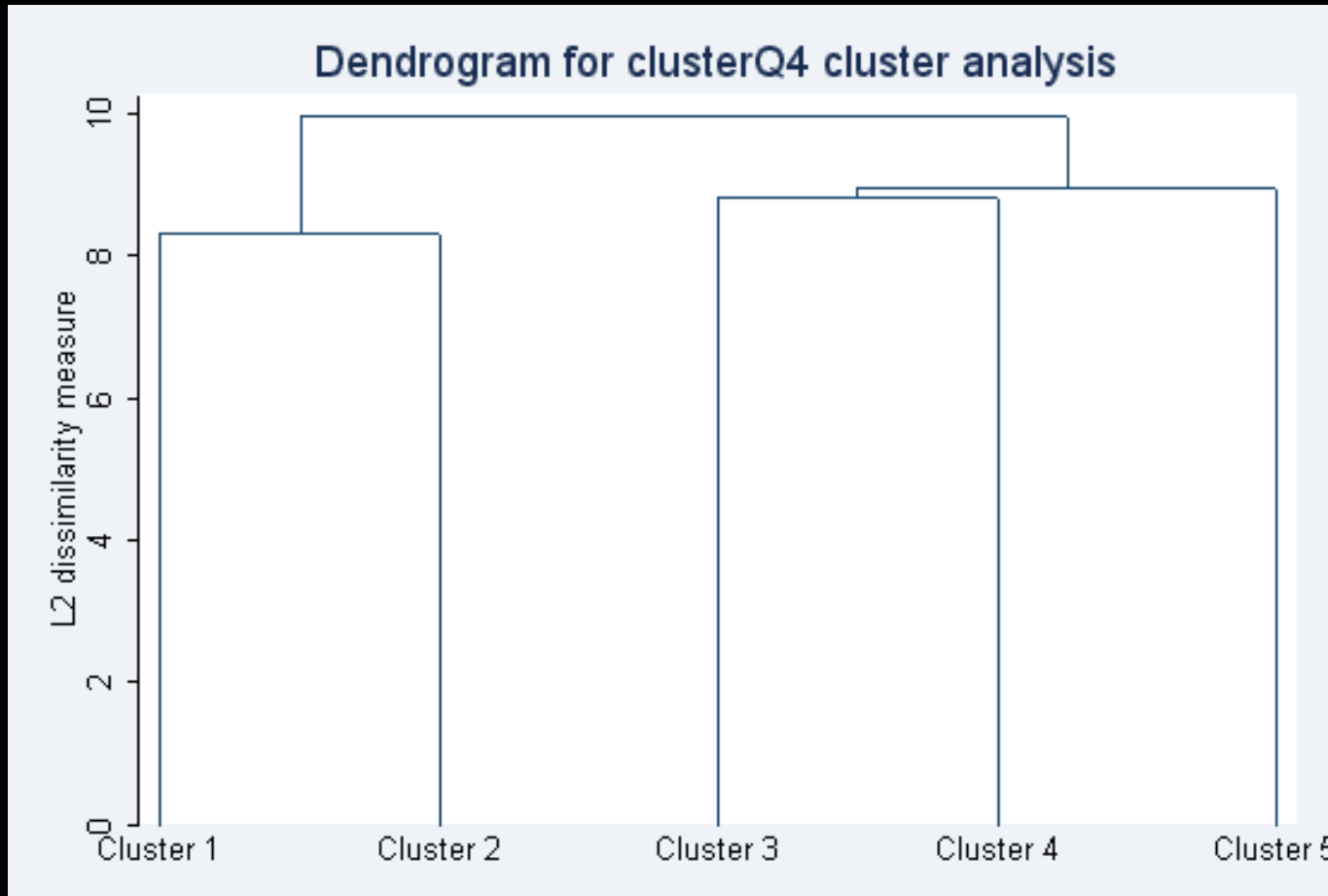
Motivational intensity differences of populations developing large (≥ 30 person) vs small (<2 person) FLOSS projects

Normalized motivations for developing FLOSS, by Project Size				
<i>Survey item</i>				
<i>Panel A: Reason for first developing FLOSS (Q4)</i>				
	<i>Size</i>	<i>Small</i>	<i>Medium</i>	<i>Large</i>
Q4a: Best way for software to be developed		1.31	0.99	0.55
Q4b: We should be free to modify software we use		0.96	1.2	0.76
Q4f: Wanted to provide alternatives to proprietary		1.07	1.03	0.71
Q4e: As free software developer, wanted to give back to community		1.01	0.83	1.2
Q4g: Wanted to interact with like-minded programmers		1.07	1.02	0.74
Q4h: Way to become better programmer		1.11	1.01	0.7
Q4j: Wanted to learn how particular program worked		0.84	0.92	1.61
Q4i: Liked challenge of fixing bugs in existing software		0.88	1.03	1.14
Q4d: Needed to fix bugs in existing software		0.77	1.09	1.57
Q4c: Needed modification of existing software		0.78	1.37	1.03
Q4k: Employer wanted me to collaborate in OS		1.21	0.5	0.98
Mean across Q4 sub-questions		1	1	1
<i>Panel B: Reason for choosing current project (Q12)</i>				
	<i>Size</i>	<i>Small</i>	<i>Medium</i>	<i>Large</i>
Q12a: Important and visible project		0.92	0.89	1.24
Q12c: Knew people working on it		0.8	1.09	1.25
Q12e: I launched the project		1.49	0.86	0.37
Q12d: Software being developed would be useful to me		0.91	0.99	1.16
Q12b: Technically interesting		0.88	1.17	0.98
Mean across Q12 sub-questions		1	1	1
N		422	245	180

Notes: Analysis using FLOSS-US. Higher values represent greater importance assigned to question. With each column of each panel, shading represents relative importance: most important items have darkest shade while least important items have no shading. Panel A shades 3 most important items, while Panel B shades 2 most important items. See text for formulae.

Hierarchical cluster analysis yields “motivational profiles” for developers, based on reasons for beginning FLOSS

Dendrogram of five clusters constructed from Q4 only



Source: Analysis of FLOSS-US.

Interpreting and characterizing the motivational profiles

Motivations for first developing FLOSS, by Q4 cluster					
<i>Survey item</i>	C1	C2	C3	C4	C5
<i>Panel A: reason for first developing FLOSS (Q4)</i>					
Q4a: Best way for software to be developed	0.06	0.05	1.48	1.12	1.09
Q4b: We should be free to modify software we use	0.19	0.05	0.95	1.91	2.22
Q4f: Wanted to provide alternatives to proprietary	0.06	0.04	1.02	0.54	1.44
Q4e: As FS software, wanted to give back to community	0.42	0.09	0.44	0.88	3
Q4g: Wanted to interact with like-minded programmers	0.1	0.29	0.83	0.17	1.13
Q4h: Way to become better programmer	0.54	1.08	2.86	0.12	0.76
Q4j: Wanted to learn how particular program worked	0.13	2.51	1.54	0.24	0.36
Q4i: Liked challenge of fixing bugs in existing software	0.16	1.97	0.77	0.24	0.2
Q4d: Needed to fix bugs in existing software	1.29	3.44	0.37	3.86	0.14
Q4c: Needed modification of existing software	1.02	1.5	0.45	9.43	0.06
Q4k: Employer wanted me to collaborate in OS	7.03	0	0.29	0.93	0.61
Mean across Q4 sub-questions	1	1	1	1.77	1
N	59	145	696	234	325
<i>Panel B: Reason for choosing current/most recent project (Q12)</i>					
Q12a: Important and visible project	0.93	0.99	1.1	0.84	0.82
Q12c: Knew people working on it	0.75	1.02	1.04	1.01	0.82
Q12e: I launched the project	1.45	0.52	0.88	0.9	1.56
Q12d: Software being developed would be useful to me	0.87	1.35	0.92	1.59	0.75
Q12b: Technically interesting	1	1.11	1.06	0.67	1.05
Mean across Q12 sub-questions	1	1	1	1	1
N	59	145	696	234	325

Notes: Analysis using FLOSS-US. Panels A-B present twice-normalized scores for five clusters generated by hierarchical complete linkage cluster analysis with responses to Q4. Higher scores represent greater importance assigned to question.

Interpreting and *caricaturing* the motivation-based clusters

Salient characteristics of the motivational profiles

<i>Cluster</i>	<i>Profile label</i>	<i>Key characteristics</i>
1	<i>Professionals</i>	Non-ideological, expert, self-employed or company-sponsored to collaborate on FLOSS projects
2	<i>Aspiring hackers</i>	No need to modify existing code but like fixing bugs and learning new programs
3	<i>Social learners</i>	Become better programmers, learn how programs work, work with like-minded, "give back to community," support FLOSS ideology
4	<i>Social hackers</i>	Experienced hackers, needed to modify existing code and fix bugs, use the code
5	<i>User-innovators</i>	Modifying existing software isn't so important, learning & interacting with like-minded others is unimportant; wanted to "give back to community," and launched own project.

Demographic and occupational characteristics of clusters

	C1	C2	C3	C4	C5	ANOVA F- stat	ANOVA P- value
Derived motivation factor	0.7	0.544	-0.55	-0.93	-1.02	286.23	0
	<i>-0.53</i>	<i>-0.82</i>	<i>-0.67</i>	<i>-0.73</i>	<i>-1.17</i>		
Age	30	28.8	28.5	30.7	28.5	3.86	0
	-7.8	-7.2	-8	-8.5	-8		
Years experience in FLOSS	5.6	6.4	5.1	5.4	4.1	8.6	0
	-3.9	-4.9	-4.2	-4.7	-3.3		
Began developing FLOSS in year 2000 or later	0.29	0.3	0.42	0.38	0.51	6.41	0
Began developing FLOSS before the year 2000	0.68	0.66	0.54	0.58	0.46	5.56	0
Highest formal education: high school	0.2	0.14	0.22	0.12	0.23	4.42	0
Highest formal education: undergraduate	0.42	0.39	0.38	0.36	0.37	0.26	0.91
Highest formal education: graduate	0.35	0.42	0.34	0.46	0.35	3.11	0.01
Highest formal education: professional	0.04	0.05	0.06	0.07	0.05	0.36	0.84
Female	0	0	0.02	0.03	0.01	1.29	0.27
No children	0.69	0.84	0.77	0.76	0.81	2.07	0.08
Children under age six	0.14	0.09	0.12	0.12	0.11	0.44	0.78
Children over age six	0.12	0.04	0.09	0.14	0.07	3.22	0.01
Unmarried, without partner	0.42	0.38	0.42	0.34	0.36	1.34	0.25
Unmarried, not living with partner	0.16	0.16	0.13	0.1	0.18	1.43	0.22
Unmarried, living with partner	0.16	0.15	0.19	0.2	0.16	0.53	0.71
Married, not living with spouse	0	0	0.01	0.01	0	0.56	0.69
Married, living with spouse	0.26	0.3	0.24	0.32	0.29	1.19	0.31
Separated/divorced	0	0	0.01	0.03	0.02	1.08	0.37
Student	0.19	0.27	0.3	0.24	0.32	1.79	0.13
Employee	0.56	0.59	0.49	0.55	0.5	1.66	0.16
Self-employed	0.19	0.13	0.16	0.18	0.15	0.7	0.59
Not employed	0.07	0.01	0.04	0.02	0.04	1.95	0.1
Expected future FLOSS role: consultant	0.46	0.59	0.54	0.56	0.5	1.45	0.22
Expected future FLOSS role: employee	0.47	0.57	0.56	0.61	0.62	1.74	0.14
Expected future FLOSS role: owner/offer/director	0.53	0.43	0.53	0.57	0.48	2.43	0.05
N	59	145	696	234	325		

Notes: Analysis using FLOSS-US. ANOVA tests the null hypothesis that all clusters have same mean value. Orange indicates significance at error levels $\geq .05$. Standard deviations for continuous variables appear in *italics* below mean values. Each cell presents mean for all individuals answering the relevant survey item, and non-response causes some cells to represent less than the total number of observations in the relevant cluster.

Motivational cluster assignments among the project size groups

Project size and cluster assignment			
	<i>Known size</i>		
Cluster	<i>Small (1-2)</i>	<i>Large (>29)</i>	<i>Total</i>
1 (Professionals)	5.20%	5.60%	5.30%
2 (Aspiring hackers)	7.60%	16.70%	10.30%
3 (Social learners)	49.10%	45.00%	47.80%
4 (Social hackers)	14.00%	12.80%	13.60%
5 ("User-innovators")	24.20%	20.00%	22.90%
Total	100.00%	100.00%	100.00%
N	422	180	602
Pearson $\chi^2(4)$	11.66	weak dependence of size and	
Prob > χ^2	0.02	cluster assignments	
χ^2 goodness-of-fit(4)	21.63	distribution of developers	
Prob > χ^2	0	by clusters differs by size	

Summary of empirical findings

Developers contributing to large FLOSS projects differ significantly and small projects have important differences in the following dimensions:

- the “mix” of their motivational “orientations”
- the relative intensity of importance assigned to the more “technical” reasons for contributing to FLOSS, and selecting specific projects
- their demographic and educational characteristics
- durations of project participation (not discussed here)
- project roles (not discussed here)
- whether they are directly paid for FLOSS work

Some implications of the empirical findings

- Okay, we found that developers contributing to large FLOSS projects do differ significantly from those in small projects.

So what? How could more precise knowledge about their characteristics and motivations of the developers contribute to our research on the community-based software production mode?