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Michael Fritsch
Sebastian v. Engelhardt

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Carl-Zeiss-Str. 3
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www.uni-jena.de

Max Planck Institute of Economics
Kahlaische Str. 10
D-07745 Jena
www.econ.mpg.de

Who Starts with Open Source? Institutional Choice of Start-Ups in the German ICT Sector*

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Abstract

We analyze the characteristics of new businesses in the German ICT industry, distinguishing them based on their choice between two IPR regimes: open source software (OSS) or closed source software (CSS). The share of new firms with an OSS-based business model has increased considerably over the last several years. OSS-based firms tend to be smaller (in terms of staff and capital) and experience less shortages of capital. Only older cohorts of OSS-intensive start-ups had more difficulty than their CSS counterparts in convincing potential financiers of their viability, indicating that OSS business models are now well established. We find no evidence that the lower entry barriers for OSS firms are particularly attractive to start-ups with low human capital endowment or to necessity-motivated entrepreneurs.

JEL classification: D02, L17, L26, L86

Keywords: New business formation, institutions, open source intellectual property rights, software industry

Address for correspondence:
Prof. Dr. Michael Fritsch
Sebastian von Engelhardt
Friedrich Schiller University Jena
School of Economics and Business Administration
Carl-Zeiss-Str. 3, D-07743 Jena, Germany

Phone: (03641) 943 – 220 (Fritsch), - 213 (von Engelhardt)

m.fritsch@uni-jena.de, sebastian.von.engelhardt@uni-jena.de

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1. Institutional choice and characteristics of ICT firms

Institutions can have many and various effects on start-up activity and entrepreneurship.[1] Since institutions typically differ among regions or countries, a great deal of the empirical research on the effects of institutions compares regions or countries (Amoros, 2009; Burke and Fraser, 2007; Hall and Sobel, 2008; Nyström, 2008), which can lead to severe problems of controlling for many types of country- or region-specific influences. However, comparative research within a country or region is possible only if there are different institutional (sub-)settings in a certain field. The information and communications technology (ICT) sector offers such an opportunity as here firms can choose between two different software-related IPR regimes: business models based on open source software (OSS) or those based on closed source software (CSS). In this case, firms not only act in the same country, region, and sector, but often directly compete in the same market. This paper analyzes the effects of OSS- versus CSS-based business models on the characteristics of new businesses in the ICT sector. Since the introduction of OSS has resulted in lower entry barriers and a reduction in the minimum efficient size for this type of business, our analysis also provides evidence concerning the effect of reduced entry barriers on the quality of start-ups set up under these conditions. Do the founders of OSS-based businesses comprise a higher share of necessity-motivated entrepreneurs? Do they have lower qualifications than founders of CSS-based firms?

The quality of many products is highly sensitive to the software the product contains. This is particularly true of the ICT sector where most goods and services are heavily based on software, which can be OSS or CSS, the latter also called “proprietary” software. CSS is based on the idea of exclusive intellectual property, protected by restrictive CSS licenses. Consequently, the user-customer receives CSS in the form of

[1] See Acs et al. (2008), Foss and Foss (2006), Henrekson and Sanandaji (2010), Henrekson (2007), and Bosma and Fritsch (2010) for an overview.

a binary code and has no access to the source code—the human-readable recipe of a software program.[2] OSS, to the contrary, is characterized by free access to the source code and is developed in a public, collaborative manner. The principle of openness is codified in the OSS license, which permits users to apply, change, and redistribute the software. This "new intellectual property paradigm" (Maurer and Scotchmer, 2006) implies different allocations of intellectual property rights (IPRs) and different modes of organization compared to CSS. High-quality OSS products, such as Linux, Apache, and the like, are developed by thousands of volunteers who often do not receive direct monetary reward. Moreover, an increasing number of profit-oriented firms, small and large, employ OSS-based business models and are active members of the OSS community. Since OSS is freely available and therefore cannot feasibly be sold, these business models are based on the idea of selling complementary products such as hardware (e.g., servers, cell phones), premium versions of the software, or different kinds of service, like maintenance.[3]

Neither CSS- nor OSS-based business models necessarily imply that the firm develops software on its own. For example, firms may use readymade software to control their hardware devices, provide service for third-party code, or host a website using web server software. Some firms may enhance the software codes, for example, by offering

[2] Software programs use a programming language that results in a human-readable source code. To run a software program on a computer, this code must be transformed into a machine-readable binary code. Since the transformation of a binary code into a programming language would require immense effort, transferring only the binary code maintains the source code as a virtual secret and also prohibits changes to the program because such changes require access to the source code itself.

[3] Prominent examples of hardware devices that use Linux as embedded software are Amazon's Kindle, Cisco's MDS and Nexus data switches, Linksys' WRT54G W-LAN router, numerous Motorola, Nokia, and Panasonic mobile phones, Philips' LPC3180 microcontroller, TomTom's GPS navigation systems, and various LCD and plasma televisions produced by LG Panasonic, Samsung, and Sony. Another recent example of embedded OSS is the software stack Android. Acer, Barnes and Noble, Dell, HTC Corporation/Google, Lenovo, LG, Motorola, Samsung, and Sony Ericsson all manufacture and sell mobile devices that come preinstalled with Android. Red Hat, Novell's SUSE, and other Linux distributors collect and optimize available OSS, bundle this with further CS (premium versions), and offer additional services, like support and maintenance.

customized versions, while others may develop entirely their own programs. We are interested in the whole set of such business models and focus on the differences between start-ups that use OSS and those that use CSS. Clearly, we need to control for the different kinds of business models because the business model also affects firm characteristics, for example, firms offering web service versus those selling hardware with installed software.

To date, research into the effects an OSS-based business model has on the firm's properties and performance mainly focuses on OSS firms only and does not compare OSS firms with their CSS counterparts in order to identify the specific characteristics of OSS firms. The majority of literature describes various business models of OSS firms, why and how they are engaged in the OSS community, and whether such community participation has an impact on their economic success.[4] The relationship between OSS and entrepreneurship is analyzed by Gruber and Henkel (2006), who focus on new ventures that apply embedded Linux. Based on information from personal interviews, the authors conclude that market entry barriers for new ventures are less relevant for OSS-based firms. Since the sample does not contain CSS-based firms, this analysis does not allow a comparison between the two institutional settings. To the best of our knowledge, there are only two studies that directly compare OSS- and CSS-based firms. Investigating a sample of 134 software solutions developed by small and medium-sized Italian enterprises, Rossi Lamastra (2009) concludes that OSS solutions seem to be more innovative. Harison and Koski (2010) analyze how the characteristics of firms shape their OSS versus CSS decision for a sample of 170 Finish software companies. They distinguish between firms with no OSS (i.e., exclusively based on CSS) and firms with at least some use of OSS (either an OSS-CSS mix or exclusively OSS). Harison and Koski (2010) find that firms following an

[4] See, among others, Bonaccorsi et al. (2006), Dahlander and Magnusson (2006), Dahlander and Wallin (2006), Fosfuri et al. (2008), Harison and Cowan (2004), Rossi and Bonaccorsi (2006), Stam (2009), and West and Gallagher (2006).

OSS strategy are characterized by relatively well-qualified personnel as well as by a greater variety of services provided. According to their analysis, younger and smaller firms more often apply OSS strategies than do older ones. An analysis of the impact of the institutional choice between OSS and CSS on the decision to start a new business, however, has yet to be conducted.

This paper analyzes the characteristics of young OSS- and CSS-based ICT firms in Germany. Based on survey data, we investigate how the institutional choice between the two IPR regimes shapes the decision to set up a business. In the following, we first explain principal institutional differences between OSS and CSS (Section 2). Section 3 provides an overview of the relationship between institutions and entrepreneurship based on a conceptual model. We then derive hypotheses about the effect of OSS and CSS regulations on the decision to start a business and on the characteristics of the entries (Section 4). Section 5 introduces the data; Section 6 reports the results of the empirical analysis. Finally, we discuss our findings and suggest some avenues for further research (Section 7).

2. OSS versus CSS: A difference in institutions

Institutions such as legal rules generate incentive structures that shape human interaction. North (1994) distinguishes between formal institutions, such as rules, laws, constitutions, and the like, and informal institutions, such as common noncodified norms of behavior, conventions, self-imposed codes of conduct, and so forth. The key difference between OSS and CSS is that they are different kinds of “institutional arrangements” (Davis and North, 1971), distinguishable by their application of copyright law, which is codified in the software licenses. The different types of licenses define different IPRs and imply different governance structures regarding software development (for a more detailed exposition, see von Engelhardt, 2008).

CSS is based on exclusive ownership of the software and its source code. Aside from cases like contract programming, CSS users do not have the right to change or further develop the source code (abusus). CSS licenses only transfer the right to use the software as it is (usus and usus fructus). Consequently, the source code is “closed” as customers receive only the machine readable binary code. CSS users have to pay license fees for using the software, while the source code remains with the developing firm. Hence, the exclusively owned source code is an asset of the developing firm. In contrast, OSS is based on “inclusive” ownership: the OSS license transfers the whole set of rights to anybody who wants the software, including the right to change the code (abusus). Therefore, OSS is characterized by free access to the source code so as to enable users to change and further develop the code and thus firms cannot exclusively own OSS code. However, OSS is not software without any property rights or restrictions. Many forms of OSS licenses contain restrictions intended to ensure that OSS cannot be turned into CSS. For example, the most popular type of OSS license, the GNU General Public License (GPL), states that any further developed software as well as any derived code must also be licensed as a whole under the GPL.

Typically, OSS is not developed by a single person or firm but by a multitude of community members. Such community-based OSS projects are open and permeable but are certainly not unstructured. The projects are governed by a mixture of *formal* and *informal* institutions. This implies, for example, that firms with OSS-based business models must comply with the community rules; otherwise, they risk that the community will cease cooperating with them.

3. Institutions and entrepreneurship

The relationship between institutions and entrepreneurship can be explained with a simple conceptual model (Figure 1). The starting point of this conceptual model involves feasible entrepreneurial opportunities, that is, opportunities that are, in principle, open to anyone (for a more

detailed exposition, see Bosma and Fritsch, 2010). The available *entrepreneurial opportunities* are in many respects shaped by the governing formal and informal institutions.[5] Examples of how formal institutions shape entrepreneurial opportunities include legal requirements for starting a business or labor market regulations. Informal institutions, such as modes of conduct, routines, or a certain culture (Freytag and Thurik, 2010; Nguyen et al., 2009), also influence how entrepreneurial opportunities are perceived and acted upon. The differences between OSS and CSS with respect to formal (e.g., types of licenses) and informal (e.g., "hacker" ethics) institutions thus determine differences in the entrepreneurial opportunities of OSS- versus CSS-based business models. The licenses and the resulting IPR allocation determine the availability of the code and how this code can be used. For example, an OSS-based business model can be more flexible because the start-up firm has access to the source code and can thus change it (e.g., customize the software).[6] Furthermore, the informal institutions of the OSS community, for example, the culture of helping each other as well as the idea of "contributing back" (expected reciprocity), shape entrepreneurial opportunities.

Because the informal institutions—the unwritten rules—emerge through a network of interactions, these networks can be viewed as part of the informal institutions. The overlap between networks and informal

[5] There is a pronounced interdependence between the formal and informal institutions, chiefly because formal institutions often emerge from informal institutions. However, the governing formal institutions feed back into the informal institutions by providing the legal framework for interaction, which, in turn, may lead to the further development of formal rules. The emergence of OSS is a good example of such a development. OSS emerged from dissatisfaction with the closed source principle. Based on the informal institutions of hacker ethics and a culture of making software freely available, MIT scientist Richard Stallman designed and introduced the GNU General Public License (GPL), currently the most popular type of open source license. With the GPL, Stallman invented a new concept of copyright-based ownership (the so-called copyleft principle). It was an act of institutional entrepreneurship that changed the level of institutionalization by transferring some cultural norms—i.e., informal institutions—into a formal institution, the GPL.

[6] It is, of course, also possible to customize a CSS code, but this requires a special license agreement with the original CSS developer and, probably, payment of license fees. In the case of OSS, the code can be further developed without such a special agreement.

institutions is particularly due to the fact that certain rules or a certain "culture" may be specific to a certain network and inapplicable to other networks, as illustrated by the example of OSS hacker ethics.

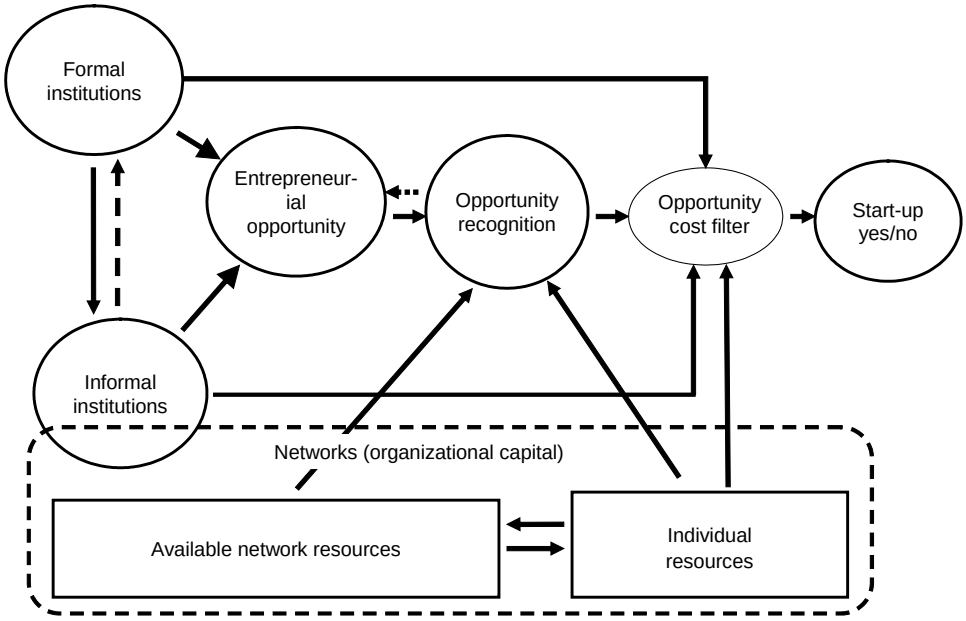

Figure 1: Institutions and entrepreneurship: A conceptual model

Taking advantage of an *entrepreneurial opportunity* depends, first, on the opportunity being recognized as such, as well as on the costs and benefits of starting a business compared to alternatives such as dependent employment, living on unemployment benefits, or obtaining an education, all of which can act to "filter" out the realization of some business opportunities. According to the model of occupational choice (Knight, 1921; Lucas, 1978; Kihlstrom and Laffont, 1979; Holmes and Schmitz, 1990), potential entrepreneurs compare the (pecuniary and nonpecuniary) benefits they anticipate receiving from employment with those they expect to accrue from starting a business. The *opportunity costs* of entrepreneurship are affected by:

(a) formal institutions, such as unemployment benefits or the tax system, as well as informal institutions, such as the social prestige of self-employment or family history; and

(b) individual resources as well as by resources available in the network.

Individual resources comprise all those input factors needed to start a business, including labor, human capital, financial capital, organizational capital, social capital, physical capital, knowledge, and technology. Individual resources also encompass personal characteristics that are at least partially innate, such as education, risk attitudes, motivations, and preferences.

A person's *network* of relationships—his or her ego network—represents the person's organizational capital, that is, the ability to mobilize the resources of others in one's own venture. Note that there is an important difference between the *overall network* and an actor's individual *ego network*. *Overall* networks enable actors to connect their individual resources with the resources of others, thereby aggregating and transforming these resources into an aggregate resource stock available to all members of the network. This aggregate stock of resources influences how an individual member of the network will see and possibly pursue an entrepreneurial opportunity. The OSS "community" is a good example of this type of network as belonging to it reduces the amount of individual resources needed to start an own businesses in this sector.

4. CSS- versus OSS-based start-ups: Hypotheses

ICT firms can choose between OSS- and CSS-based business models. However, since each type of business model does not exclude the other, that is, both can be used at the same time, in many cases the choice is really a question of the degree to which OSS and CSS are used by ICT start-ups.

The decision to adopt an OSS- or a CSS-based business model has implications for the individual resources needed to start up. CSS-based start-ups either have to pay license fees or develop their own software; OSS-based start-ups can use the code provided by the community and

moreover obtain support from the community in further development of the software code. This sort of support is mainly accessed by two channels: collaborative development of the software code and/or assistance via discussion forums. Freely available source code as well as OSS community support can considerably reduce the amount of resources, particularly as to personnel, needed to start a firm. Thus, in following an OSS-based strategy, a founder may be able to substitute network resources for individual resources, meaning that setting up an OSS-intensive start-up should require less personal resources than starting a new business based on CSS. Hence, we assume that:

H I: OSS-based new businesses are smaller at inception than CSS-based start-ups.

This expected statistical relationship between OSS business models and start-up size raises the question of causality: Do founders choose OSS-based business concepts of necessity because they do not have sufficient resources to set up a CSS-based firm, or is the choice of an OSS-based concept primarily motivated by other reasons that are independent of resource requirements? With regard to capital, we can control for this issue to some degree based on information about whether a lack of capital was one of the main problems when starting the business. If we find that OSS founders do, indeed, experience more difficulty in obtaining capital than do the founders of CSS-based firms, it could be an indication that the lower capital requirements of an OSS-based concept may have been a reason to favor this type of business model. If capital bottlenecks play no special role for OSS founders, however, then the smallness of OSS start-ups may be viewed as more of a result of, than a reason for, choosing OSS. Nevertheless, the insignificance of capital bottlenecks for OSS founders does not necessarily mean that such shortages are unimportant, since it could be that founders of OSS-based firms that report no such bottlenecks would have experienced them if they had chosen a CSS-based concept. We expect that:

H II: OSS-intensive start-ups face capital bottlenecks to a lesser degree than CSS-based new businesses.

OSS-based ICT start-ups may have more difficulty convincing potential financiers of their future viability, for two reasons. First, since OSS-business models are relatively novel, they may be viewed with more skepticism by potential investors than would more conventional CSS-based concepts. In particular, potential financiers might expect that customers will only rarely accept (and thus purchase) OSS-based solutions. Second, financiers might assess OSS start-ups as more risky because the business model is not, or is very rarely, based on selling the software. Thus, the economic success of OSS start-ups relies to a much higher degree on complementary products and services than is the case for CSS start-ups. Moreover, OSS-based firms may be regarded as more risky because their success partly depends on future developments in the appropriate software community. A certain project may be split up (forking) or even die off due to a lack of further voluntary contributions. In other words: the differences between the formal and informal institutions of OSS versus CSS determine differences in entrepreneurial opportunities and result in higher risk for OSS-based business models. Potential financiers may thus be more hesitant to invest in OSS business models than in CSS-based ones. For these reasons, we expect that:

H III: OSS-based start-ups have more difficulty convincing potential financiers of their future viability than do CSS-based new businesses.

As discussed above, starting an OSS-based business may require fewer individual resources than setting up a business based on CSS. Hence, the relatively low entry barriers for OSS-based businesses may attract founders with qualifications and experience of a quality that would be insufficient to set up a CSS-based firm (Fritsch and Schroeter, 2009; Parker, 2009). If this is true, the lower entry barriers to starting an OSS-based business would lead to an increase in the number of ICT entries, but these additional entries would have a relatively low quality.

This in no way implies that all OSS-start-ups are of low quality, only that low-quality start-ups are more likely to be OSS-based than based on CSS. It therefore may be expected that start-ups with less experienced founders and less educated staff have a higher level of OSS usage.[7]

H IV: Founders and personnel of OSS-based start-ups have lower levels of qualification and experience than do those of CSS-based new businesses.

Due to the lower entry barriers for OSS-based firms, we anticipate that:

H V: Founders of OSS firms are more likely to be necessity motivated than founders of CSS-based firms.

OSS-based businesses have lowers barriers to entry, which makes it relatively easy to realize a business idea (take advantage of an opportunity) as well as to establish a firm out of necessity. The reason for expecting a greater number of necessity-motivated founders among the OSS firms is that necessity entrepreneurs tend to be relatively short of own resources and thus unable to start a venture in a field with relatively high entry barriers, such as CSS. In other words, opportunity entrepreneurs should be less deterred by high entry barriers than necessity-motivated founders. The results will provide evidence as to the degree to which lower entry barriers are conducive to an increase in the number of primarily necessity motivated start-ups.

5. Data

Our data are based on a survey of founders of German ICT firms conducted in the autumn of 2009. In a first step, we sent an invitation by

[7] Hypothesis IV does not necessarily contradict Harison and Koski (2010), who found that established software firms with OSS-based business models have higher levels of human capital in terms of education. First, Harison and Koski (2010) focus on software firms, whereas we analyze firms in all parts of the ICT sector. Second, and more important, Harison and Koski (2010) study established firms, while we focus on start-ups. If, for example, start-ups with a low level of qualification exit the market rather quickly, meaning that those OSS firms that survive have relatively well-qualified personnel, there is not contradiction between our hypothesis and the results of Harison and Koski (2010).

post to about 6,000 firms[8] asking them to participate in an online inquiry and containing an individual access key. We specifically required that the questions be answered by the founder or a member of the founding team. After about two weeks, we sent a reminder. As a result, more than 700 founders of ICT firms filled out our online survey completely. As some of those firms did not sufficiently match the focus of our research, we ended up with a data set of usable answers from 680 founders, a response rate of more than 11 percent.

The survey requested information about the firm in 2009 as well as at the time of its start-up. The questions about OSS versus CSS focused particularly on the business models applied and were intended to discover the degree to which OSS is a part of the end product sold to customers. We explicitly excluded aspects covering the use of freely available software such as OpenOffice for business correspondence and the like. The firm founders were asked to select from a list up to three business fields in which the firm was active when founded (see Table A1 in the Appendix). For each of these business fields, we then asked for usage of OSS[9] at the time of start-up. Furthermore, we asked for the year of start-up, the number of employees at start-up, and important problems faced when setting up the firm. Table A1 in the Appendix provides definitions of the variables from the survey that we use in this analysis.

[8] The addresses of the ICT firms were selected from the *heise IT-Markt*, which is an online catalogue for German ICT firms run by the *heise* publishing company. Among other products, *heise* publishes the periodical *c't*, a highly reputated IT journal, as well as the German version of MIT's *Technology Review*. The homepage of *heise* is a well-known web address for ICT issues, and with its *heise news ticker* the company runs one of the most successful (German) ICT news portals. The *heise IT-Markt* offers German ICT firms the opportunity to include their profile, i.e., their name, address, product portfolio, etc., in a freely available Internet database. Potential customers can search for ICT firms in this database using different search parameters (region, products, etc.). Starting at the end of March 2009, we collected names and postal addresses of firms operating in the industry subcategories of interest for of this study. After cleaning the data of duplicates and misleading entries, we ended up with addresses for 15,300 firms. From this database, we drew a random sample of 6,000 firms.

[9] Regarding OSS, we asked whether the software used in the respective business field at time of founding was OSS. Possible answers were "yes, exclusively," "mainly,"

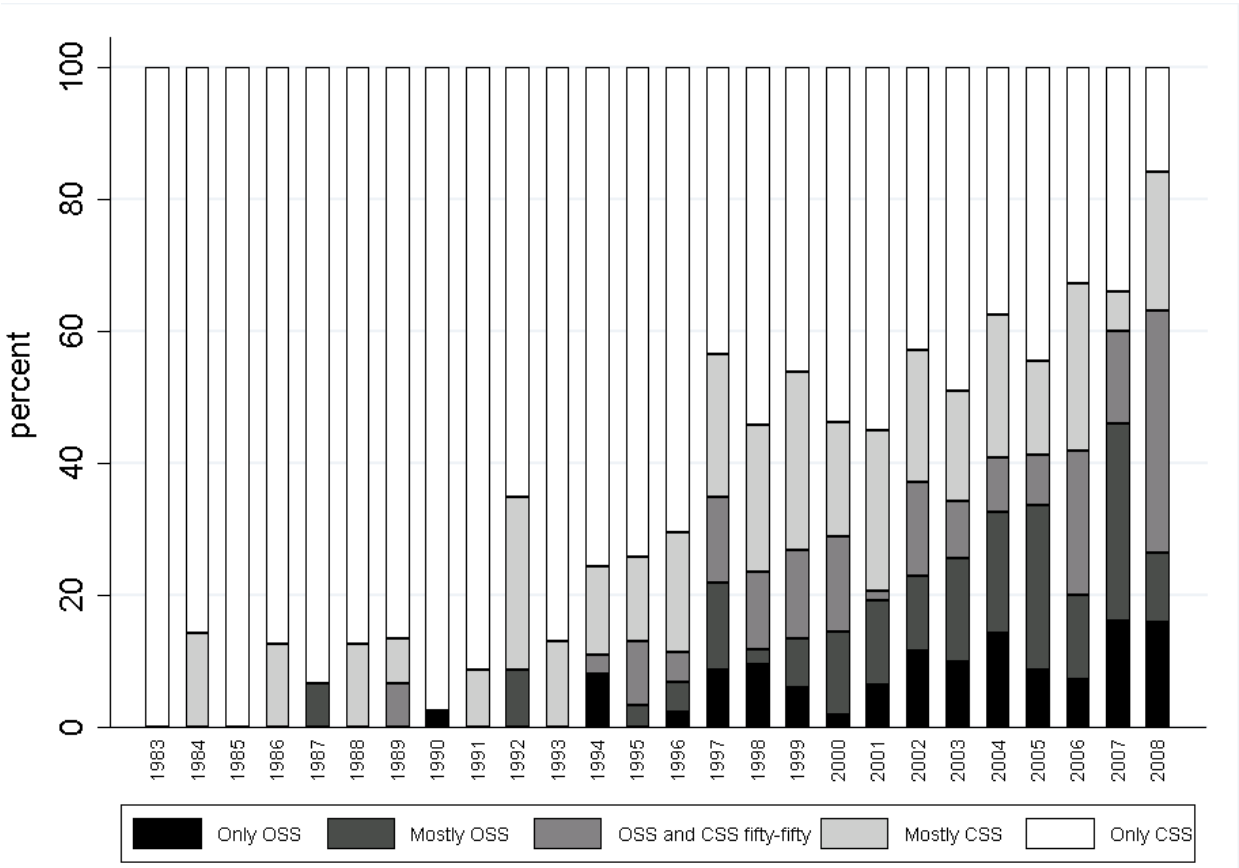

Figure 2: Institutional change as institutional choice: OSS and CSS use in German ICT start-ups, 1983–2008

Since the emergence of OSS in 1984,[10] the number of firms engaged in the OSS business has increased steadily. The resultant institutional change in the ICT sector is reflected in our survey data. In the period 1984–2008, the share of start-ups based entirely on CSS decreased considerably (Figure 2). Since the late 1980s, there is a rising share of start-ups for whom at least 50 percent of their business is based on OSS. That the share of start-ups completely based on OSS never exceeds 16 percent indicates that the vast majority of new firms favor a strategy that is a mixture of OSS and CSS. Thus, coexisting within the

"about 50%," "a small extent," "no (nearly) never," and "I do not want to answer this question."

[10] The year 1984 can be regarded as the initial year for what we now call "open source software" since software development of the General Public License (GNU) project began in January 1984.

market are mainly OSS-based firms, mainly CSS-based firms, and firms that combine a use of both OSS and CSS. The share of start-ups with hybrid strategies (i.e., business models based on a mix of OSS and CSS) increased over the years, reaching a maximum of 68.42 percent in 2008.

Since all our information on start-ups comes from firms that were in business at the time of the survey, there is undoubtedly some survivor bias to the data, that is, start-ups that exited the market previous to our survey are not included. Examining the number of firms ordered by their reported year of founding illustrates this bias. Starting with 1984, the number of firms tends to increase, reaching its peak in 2004. Comparing these numbers with general data about newly founded ICT businesses from the start-up panels of the Centre for European Economic Research (ZEW Mannheim)[11] shows that for earlier years the trend in our data (number of start-ups) does not match the development of ICT foundings reported in the ZEW data. This discrepancy is clearly due to the fact that our data include survivors only. In addition, our data show a drop in the number of start-ups between 2007 and 2008, which does not reflect the general trend of the ZEW data. This suggests an underrepresentation of 2008 start-ups in our sample, which can be explained by a time lag for being included in the *heise* database, the source of addresses for our survey.

6. Who chooses OSS for start up?

Our goal is to explain the intensity of OSS use in various fields of business by looking at the individual characteristics of the start-up firms. As the dependent variable is of an ordinal character—ranging from always OSS (4) to never OSS (0) (see Table A1)—we applied ordered logit analysis (for details, see Greene, 2008). To avoid survivor bias, we estimate the models for the relatively recent cohorts of 2005 to 2008,

[11] We are indebted to the Centre of European Economic Research (ZEW Mannheim) for providing these data.

but also for 2003 to 2006.[12] Since our sample of start-ups in 2008 may be biased due to relatively incomplete coverage of that specific vintage, we also ran all models for the 2005–2007 period. Descriptive statistics and correlations between variables are shown in Tables A2 and A3 in the Appendix. Testing for the parallel regression (proportional odds) assumption, we perform a Brant test for each of our models. Furthermore, we include two control dummies for the broad business fields of "further development of software" and "new media and Internet." The first dummy assumes a value of 1 if the founder reported that own software developments were part of the product sold.[13] The second dummy has the value 1 if "web hosting," "web design and web service," or "services of new media agencies and related" was a business field at time of start up.[14]

The results for the more recent cohorts (2005–2008), which should not be affected by a strong survivor bias, clearly indicate that OSS-based start-ups tend to be smaller in terms of personnel and in terms of capital invested (Table 1), confirming Hypothesis I. We also find that OSS start-ups are less constrained by the availability of capital than are CSS start-ups. Because of the considerable correlation between the "lack of capital" and the "convince financiers" variables, the model is also run without one of these variables (Models (2) and (3)) but the results remained largely unchanged. Due to some correlation between "education" and "experience," Model (4) is run without the "education" variable, while in Model (5) the "experience" variable is omitted. We find that OSS start-ups are not characterized by a less well-qualified initial personnel than are CSS start-ups. On the contrary, there is indication that the initial personnel for OSS start-ups are significantly more highly

[12] The two periods overlap by one year so as to have a sufficient number of observations.

[13] This means that either "selling own hardware with own developments of software," "selling third-party hardware with own developments of software," or "selling own developments of software" were chosen as a business field in the survey.

[14] We also ran all models with the complete set of detailed business field dummies (see Table A1 in the Appendix) and found very similar results. For these models, however, the Brant test could not be computed.

Table 1: Characteristics of software start-ups (2005 to 2008) according to use of OSS in their business model (ordered logit analysis)

Dependent Variable: OSS					
	(1)	(2)	(3)	(4)	(5)
Size (staff)	-0.398**	-0.340*	-0.402**	-0.333*	-0.396**
	(0.028)	(0.070)	(0.027)	(0.065)	(0.032)
Size (capital)	-0.406***	-0.401***	-0.407***	-0.392***	-0.386***
	(0.000)	(0.002)	(0.000)	(0.001)	(0.001)
Lack of capital	-0.874**		-0.905**	-0.870**	-0.909**
	(0.041)		(0.019)	(0.039)	(0.039)
Convince financiers	-0.0947	-0.570		0.00481	-0.287
	(0.861)	(0.284)		(0.993)	(0.605)
Education	0.568	0.574	0.559		0.617*
	(0.117)	(0.121)	(0.122)		(0.091)
Experience	0.854	0.911	0.878	0.918*	
	(0.128)	(0.120)	(0.111)	(0.088)	
Necessity motivation	-0.379	-0.352	-0.370	-0.286	-0.425
	(0.333)	(0.364)	(0.340)	(0.444)	(0.282)
Age of firm	0.0859	0.0836	0.0850	0.0702	0.0799
	(0.585)	(0.610)	(0.591)	(0.651)	(0.616)
New media & Internet	2.413***	2.349***	2.419***	2.411***	2.284***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Further development of software	1.500**	1.517**	1.489**	1.463***	1.497**
	(0.011)	(0.024)	(0.011)	(0.010)	(0.014)
cut1					
Constant	0.0923	0.475	0.110	-0.00585	-0.740
	(0.927)	(0.639)	(0.911)	(0.995)	(0.383)
cut2					
Constant	1.195	1.552	1.211	1.089	0.342
	(0.235)	(0.124)	(0.222)	(0.269)	(0.685)
cut3					
Constant	2.075**	2.407**	2.092**	1.960*	1.208
	(0.046)	(0.020)	(0.042)	(0.051)	(0.166)
cut4					
Constant	3.626***	3.905***	3.644***	3.484***	2.746***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.004)
Number of observations	135	135	135	135	135
Pseudo R^2	0.169	0.157	0.169	0.163	0.163
df_m	10	9	9	9	9
probchi2	5.71e-09	8.16e-10	1.99e-09	4.05e-09	2.08e-09

qualified than the CSS personnel, particularly in the analyses of the 2005–2007 (Table A4) and 2003–2006 cohorts (Table A5). Model (4) indicates that OSS founders are also more likely to have had some experience in the software sector before start up. There is no statistically significant evidence that OSS start-ups are more necessity motivated than are new CSS-based firms.

The highly significant coefficient for the business field dummy "new media and Internet" indicates that start-ups in this area have a strong propensity to use OSS, which is plausible since the output of some of the most successful OSS projects, such as the Lamp stack software for running web servers, is widely used in the Internet economy.[15] Regressions not including the start-ups of the "new media and Internet" group led to very similar results compared to regressions that did include these start-ups.[16]

Excluding firms started in 2008 because they may represent a biased selection of all start-ups that year reveals results very similar to those found for the new businesses of the 2005–2008 period (Table A4 in the Appendix), one main difference being that now education level has a positive impact on OSS intensity. Running the models for the older start-up cohorts of 2003–2006 largely confirms the results, with, in this case, one difference being that the impact of the staff variable is no longer statistically significant and there is an age effect instead. Obviously, the surviving OSS-based start-ups of this period did not begin with significantly fewer personnel than their OSS counterparts, but they were

[15] Most web servers are driven by an OSS "Lamp Stack" software suite that includes a Linux operating system, Apache web server, MySQL database, and PHP/Perl/Python programming languages. Development is supported by corporations such as Novell, IBM, Oracle, and Borland, who then bundle Lamp with their proprietary hardware and software. Small web developers also use Lamp in their businesses and contribute-code to the project.

[16] We also checked for a "hardware effect" in the sense that firms that sell hardware have a significantly different attitude toward OSS than do software firms. Hence, we excluded the new media and Internet start-ups and ran the models with a hardware/software dummy as the business field variable. This variable was never statistically significant and the results for the other variables remained largely unchanged. Also, running the regressions for software start-ups only did not lead to any significant change in the results.

significantly smaller in terms of capital requirements. It is remarkable that the older OSS-based start-ups report that convincing investors of their viability was a problem. This may be a reflection of the skepticism with which OSS-based start-ups were viewed at that time, particularly if one keeps in mind that our data are affected by a survivor bias so that our sample contains only those businesses proven to be viable for a number of years.

In all start-up cohorts—except the two most recent (2005–2008 and 2005–2007)—we find that the control variable for the age of a firm is significantly related to the use of OSS at the time of start up. This means that older firms show a lower probability of having been an OSS-based start-up than more recently founded businesses. There are two possible interpretations of this finding. First, as shown in Figure 2, OSS was less common in earlier periods, only becoming more popular in recent years. Second, if it is the case that OSS start-ups suffer a higher chance of failure than CSS start-ups, this statistical relationship may be a result of a survivor bias in the data.

We conclude that the results of our analyses support Hypothesis I, which states that smaller start-ups—in terms of staff and capital—are more likely to be OSS intensive than are larger ones. Supporting Hypothesis II, we find that OSS-intensive start-ups report a lesser degree of capital shortage, which may be seen as an indication that the main reason for choosing an OSS-based business model is not that the firms cannot afford CSS. In short, generally, OSS is not a strategy of the weak, but an efficient way of realizing an entrepreneurial opportunity. A statistically significant relationship between problems of convincing potential financiers and OSS intensity (Hypothesis III) is found only for the 2003–2006 cohorts, suggesting that the problems of convincing financiers were due to a relative unfamiliarity with and thus non-acceptance of this fairly new type of business model during those years. When our indicators for experience and education are statistically significant, they have a positive sign, meaning that Hypothesis IV,

stating that founders of OSS firms have lower levels of education and experience, is rejected. According to our data, OSS instead seems to attract relatively highly qualified entrepreneurs. We find no indication in our data that OSS is particularly attractive to necessity-based start-ups; thus, Hypothesis V is rejected.

7. Summary and outlook

We find evidence that OSS-based business models enable firms to be smaller in terms of staff and capital so that they tend to experience capital shortages to a lesser degree than new businesses based on CSS. The disadvantage of finding it difficult to convince financiers to invest in the firm is found only for older cohorts and does not appear to apply to more recently founded firms. The rising share of OSS-intensive start-ups over time indicates that this business concept is attractive to entrepreneurs, and not necessarily, or even, to just those of low qualifications or who are starting a firm out of necessity. Indeed, we find some evidence that founders of OSS-based businesses have a relatively high level of both experience and education. Taken together, our results suggest that the lower entry barriers for OSS-based business as compared to CSS appear to have led to an increase of this type of business in the ICT sector, resulting in intensified competition.

Our results show a clear, but complex, effect of institutions—here, the IPR regime—on the characteristics of market entry. At least in the case of OSS start-ups we cannot find evidence that the lower hurdles for market entry have led to more necessity-motivated entrepreneurship and/or lower average quality of start-ups in terms of qualification and experience. According to our results, the new IPR regime has opened up new opportunities for entrepreneurship that are mainly seized by well-qualified founders, many of whom engage in a mixed strategy of using both OSS *and* CSS. It is no doubt true that lower entry barriers have allowed a number of low-quality and necessity-motivated firms into the market, but, on average, OSS start-ups do not encompass more necessity-motivated firms than do CSS

start-ups and their founders tend to be better qualified than those who start CSS-based firms.

Future work should analyze the effects of institutional innovation in greater detail. An interesting avenue to explore would be how these two business models (OSS and CSS) evolve over time. Do firms that start with a high share of OSS switch to more CSS over time? Do mainly CSS-based firms tend to increase their share of OSS as they become more established in the market? What makes these types of business models successful? Another intriguing issue is the effect OSS-based business has on the innovative performance of markets. Is the high degree of labor division in OSS development and the openness of the OSS community conducive to innovation? If yes, what kind of innovation—incremental, radical, or both? Or, more generally, if the OSS regime makes the ICT sector more entrepreneurial, how does this affect the market? The ICT sector, with its two coexisting IPR regimes, provides a good opportunity for a better understanding generally of the relationships between institutions, entrepreneurship, and markets.

References

Acs, Zoltan, Sameeksha Desai, and Jolanda Hessels (2008): Entrepreneurship, economic development and institutions. *Small Business Economics*, 31, 219–234.

Amorós, José Ernesto (2009): Entrepreneurship and quality of institutions. UNU-WIDER Research Papers 2009/07, World Institute for Development Economic Research (UNU-WIDER), Helsinki.

Bonaccorsi, Andrea, Silvia Giannangeli and Cristina Rossi (2006): Entry strategies under competing standards: Hybrid business models in the open source software industry. *Management Science*, 52, 1085–1098.

Bosma, Niels, and Michael Fritsch (2010): Institutions, capital and individual entrepreneurship recognition: An evolutionary conceptual model. Friedrich Schiller University Jena and Utrecht University (mimeo).

Burke, Andrew, and Stuart Fraser (2007): The impact of intellectual property rights on self-employed entrepreneurship: An international analysis. Cranfield Management Research Paper Series 10/07, Cranfield University School of Management.

Dahlander, Linus, and Mats G. Magnusson (2006): Business models and community relationships of open source software firms. In Jürgen Bitzer and Philipp J. Schröder (eds.), *The Economics of Open Source Software Development*, Amsterdam: Elsevier, 111–130.

Dahlander, Linus, and Martin W. Wallin (2006): A man on the inside: Unlocking communities as complementary assets. *Research Policy*, 35, 1243–1259.

Davis, Lance, and Douglass C. North (1971): *Institutional Change and American Economic Growth*, Cambridge University Press, Cambridge.

Engelhardt, Sebastian von (2008): Intellectual property rights and ex-post transaction costs: The case of open and closed source software. Jena Economic Research Papers # 047-2008, Friedrich-Schiller-University and Max Planck Institute of Economics Jena.

Fosfuri, Andrea, Marco S. Giarratana, and Alessandra Luzzi (2008): The penguin has entered the building: The commercialization of open source software products. *Organization Science*, 19, 292–305.

Foss, Kirsten, and Nicolai Foss (2006): Entrepreneurship, transaction costs, and resource attributes. *International Journal of Strategic Change Management*, 1, 53–60.

Freytag, Andreas, and Roy Thurik (2010): Introducing entrepreneurship and culture, in Freytag, Andreas, and Roy Thurik (eds.) *Entrepreneurship and Culture*. Berlin: Springer.

Fritsch, Michael, and Alexandra Schroeter (2009): Are more start-ups really better? Quantity and quality of new businesses and their effect on regional development. Jena Economic Research Papers # 070 – 2009, Friedrich Schiller University and Max Planck Institute of Economics Jena.

Greene, William H. (2008): *Econometric Analysis*, 6th edition. Upper Saddle River: Pearson, Prentice Hall.

Gruber, Marc, and Joachim Henkel (2006): New ventures based on open innovation—An empirical analysis of start-up firms in embedded Linux. *International Journal of Technology Management*, 33, 356–372.

Hall, Joshua C., and Russell S. Sobel (2008): Institutions, entrepreneurship, and regional differences in economic growth. *Southern Journal of Entrepreneurship*, 1, 69–96.

Harison, Elad, and Robin Cowan (2004): On substitution of intellectual property and free disclosure: An analysis of R & D strategies in software technologies. *Economics of Innovation and New Technology*, 13, 477–487.

Harison, Elad, and Heli Koski (2010): Applying open innovation in business strategies: Evidence from Finnish software firms. *Research Policy*, 39, 351–359.

Henrekson, Magnus (2007): Entrepreneurship and institutions. *Comparative Labor Law and Policy Journal*, 28, 717–742.

Henrekson, Magnus, and Tino Sanandaji (2010): The interaction of entrepreneurship and institutions. Working Paper Series 830, Research Institute of Industrial Economics, Stockholm.

Holmes, Thomas J., and James A. Schmitz (1990): A theory of entrepreneurship and its application to the study of business transfers. *Journal of Political Economy*, 98, 265–294.

Kihlstrom, Richard E., and Jean-Jacques Laffont (1979): A general equilibrium entrepreneurial theory of firm formation based on risk aversion. *Journal of Political Economy*, 87, 719–748.

Knight, Frank H. (1921): *Risk, Uncertainty and Profit*. New York: Houghton Mifflin.

Lucas, Robert E. Jr. (1978): On the size distribution of business firms. *Bell Journal of Economics*, 9, 508–523.

Nguyen, Thang V., Scott E. Bryant, Jerman Rose, Chiung-Hui Tseng, Supara Kapasuwan (2009): Cultural values, market institutions, and entrepreneurship potential: A comparative study of the United States, Taiwan, and Vietnam. *Journal of Developmental Entrepreneurship*, 14, 21–37.

North, Douglas C. (1994): Economic performance through time. *American Economic Review*, 84, 359–368.

Nyström, Kristina (2008): The institutions of economic freedom and entrepreneurship: Evidence from panel data. *Public Choice*, 136, 269–282.

Parker, Simon (2009): *The Economics of Entrepreneurship*. Cambridge: Cambridge University Press.

Rossi, Christina, and Andrea Bonaccorsi (2006): Intrinsic motivations and profit-oriented firms in open source software: Do firms practise what they preach? In Bitzer, J. and Schröder, P. J. H. (eds), *The Economics of Open Source Software Development*. Elsevier, 84–109.

Rossi Lamastra, Cristina (2009): Software innovativeness. A comparison between proprietary and free/open source solutions offered by Italian SMEs. *R & D Management*, 39, 153–169.

Stam, Wouter (2009): When does community participation enhance the performance of open source software companies? *Research Policy*, 38, 1288–1299.

West, Joel, and Scott Gallagher (2006): Challenges of open innovation: The paradox of firm investment in open-source software. *R & D Management*, 36, 319–331.

Appendix

Table A1: Definition of variables

Variable	*Coding*	*Definition*
OSS	ordinal	The dependent variable. Intensity of OSS usage in the respective business field, at time of start up. The answering categories and the corresponding values are: 4 = “Yes, exclusively”; 3 = “Mainly”; 2 = “About 50%”; 1 = “To a small extent”; 0 = “No (nearly) never.”
Size (staff)	cardinal	Number of full positions—including the founders. We asked participants to convert number of employed people in full positions (e.g., one founder and a secretary with a 50% position makes 1.5 positions).
Size (capital)	cardinal	Sum of real capital and financial capital.
Lack of capital	binary	1 if founders marked “Lack of own capital” as one of the start-up problems they faced (permitted to mark more than one).
Convince financiers	binary	1 if founders marked “Difficulties in convincing potential financiers regarding the business concept” as one of the start-up problems they faced (permitted to mark more than one).
Education	binary	1 if there was at least one person in the firm with a university diploma or other corresponding level of education (at time of start up).
Experience	binary	1 if at least one of the founders had experience in the sector.
Necessity motivation	binary	1 if start-up was necessity based. Q: “Did you found the firm in order to realize a business idea or because there was no better alternative to generate income?” Answer categories are “To realize business idea”; “There was no alternative way to generate income” (=necessity); “Because of both reasons”; “Other reasons, namely ….”
Controls		
Age of firm	cardinal	2010 minus the year of start-up. Question: “When did you start your business (year of first turnover)?”
New media and Internet	binary	1 if “web hosting” or “web design/service” or “new media agency” is 1 (see list below).
Further development of software	binary	1 if “selfHW_furthSW” or “extHW_furthSW” or “furthSW” is 1 (see list below).
List of disaggregated controls for business fields:		
Web hosting	binary	1 if “web hosting” is a start-up business field.
Web design/service	binary	1 if “web design and web service” is a start-up business field.
New media agency	binary	1 if “services of (new media) agencies and related” is a start-up business field.
selfHW_extSW	binary	1 if “selling own hardware with third-party software” is a start-up business field.
selfHW_furthSW	binary	1 if “selling own hardware with further-developed software” is a start-up business field.
selfHW_selfSW	binary	1 if “selling own hardware with self-developed software” is a start-up business field.
extHW_extSW	binary	1 if “selling third-party hardware with third-party software” is a start-up business field.
extHW_furthSW	binary	1 if “selling third-party hardware with further-developed software” is a start-up business field.
extHW_selfSW	binary	1 if “selling third-party hardware with self-developed software” is a start-up business field.
extSW	binary	1 if “selling third-party software” is a start-up business field.
furthSW	binary	1 if “selling further-developed software” is a start-up business field.
selfSW	binary	1 if “selling self-developed software” is a start-up business field.
Service_othSW	binary	1 if “service for software bought from a third-party” is a start-up business field.

Table A2: Descriptive statistics

Period 2005–2008

Variable	*Mean*	*Median*	*Minimum*	*Maximum*	*Standard deviation*	*Number of observations*
OSS	1.551		0	4	1.434	198
Size (staff)	1.617		0.25	11	1.142	198
Size (capital*)	1.218		0	8	1.717	135
Lack of capital	0.369		0	1	0.484	198
Convince financiers	0.207		0	1	0.406	198
Education	0.581		0	1	0.495	198
Experience	0.903		0	1	0.297	196
Necessity motivation	0.510		0	1	0.501	198
Age of firm	4.051		2	5	1.001	198
New media and Internet	0.429		0	1	0.496	198
Further develop-ment of software	0.081		0	1	0.273	198

2005–2007

Variable	*Mean*	*Median*	*Minimum*	*Maximum*	*Standard deviation*	*Number of observations*
OSS	1.522		0	4	1.452	182
Size (staff)	1.644		0.25	11	1.176	182
Size (capital*)	1.275		0	8	1.784	123
Lack of capital	0.385		0	1	0.488	182
Convince financiers	0.203		0	1	0.404	182
Education	0.566		0	1	0.497	182
Experience	0.911		0	1	0.285	180
Necessity motivation	0.516		0	1	0.501	182
Age of firm	4.23		3	5	0.829	182
New media and Internet	0.423		0	1	0.495	182
Further develop-ment of software	0.077		0	1	0.267	182

2003–2006

Variable	*Mean*	*Median*	*Minimum*	*Maximum*	*Standard deviation*	*Number of observations*
OSS	1.365		0	4	1.430	343
Size (staff)	1.507		0.2	11	1.072	343
Size (capital*)	1.185		0	8	1.615	260
Lack of capital	0.338		0	1	0.474	343
Convince financiers	0.184		0	1	0.388	343
Education	0.636		0	1	0.482	343
Experience	0.921		0	1	0.270	341
Necessity	0.397		0	1	0.490	343
Age of firm	5.743		4	7	1.017	343
New media and Internet	.388		0	1	0.488	
Further develop-ment of software	.0875		0	1	0.283	

* Capital is in 10,000 EUR.

Table A3: Spearman rank correlations between variables (2005–2008)

	Size (staff)	Size (capital)	Lack of capital	Convince financiers	Education	Experience	Necessity motivation	Age of firm	New media & Internet
Size (staff)	1.000								
Size (capital)	0.173*	1.000							
Lack of capital	0.030	-0.023	1.000						
Convince financiers	0.215*	0.115	0.385*	1.000					
Education	0.237*	0.167*	-0.025	0.111	1.000				
Experience	0.005	0.029	-0.185*	-0.227*	0.109	1.000			
Necessity motivation	0.144*	0.141	-0.081	-0.036	0.097	0.003	1.000		
Age of firm	-0.132	-0.018	-0.012	0.029	0.023	-0.003	0.047	1.000	
New media & Internet	-0.121	-0.012	-0.027	-0.138	-0.009	-0.152*	-0.008	-0.164*	1.000
Further development of software	0.107	0.130	-0.015	0.084	0.002	0.040	0.188*	0.010	-0.251*

Table A4: Characteristics of software start-ups (2005 to 2007) according to use of OSS in their business model (ordered logit analysis)

Dependent Variable: OSS					
	(1)	(2)	(3)	(4)	(5)
Size (staff)	-0.408**	-0.327*	-0.414**	-0.316*	-0.410**
	(0.036)	(0.089)	(0.035)	(0.097)	(0.042)
Size (capital)	-0.435***	-0.426***	-0.438***	-0.402***	-0.432***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Lack of capital	-0.813*		-0.844**	-0.754*	-0.822*
	(0.070)		(0.040)	(0.078)	(0.071)
Convince financiers	-0.0966	-0.538		-0.0550	-0.175
	(0.865)	(0.334)		(0.923)	(0.760)
Education	0.715*	0.671*	0.712*		0.767**
	(0.055)	(0.077)	(0.056)		(0.044)
Experience	0.598	0.612	0.612	0.723	
	(0.328)	(0.320)	(0.315)	(0.202)	
Necessity motivation	-0.251	-0.183	-0.242	-0.147	-0.255
	(0.546)	(0.659)	(0.556)	(0.715)	(0.547)
Age of firm	-0.0299	0.0548	-0.0370	0.0488	-0.0661
	(0.907)	(0.828)	(0.884)	(0.850)	(0.792)
New media & Internet	2.334***	2.273***	2.340***	2.310***	2.241***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Further development of software	1.488**	1.471*	1.479**	1.439**	1.529**
	(0.030)	(0.059)	(0.029)	(0.028)	(0.026)
cut1					
Constant	-0.512	0.240	-0.530	-0.126	-1.218
	(0.743)	(0.870)	(0.733)	(0.935)	(0.369)
cut2					
Constant	0.549	1.287	0.531	0.933	-0.167
	(0.728)	(0.383)	(0.735)	(0.550)	(0.903)
cut3					
Constant	1.258	1.978	1.241	1.629	0.536
	(0.429)	(0.187)	(0.433)	(0.296)	(0.698)
cut4					
Constant	2.946*	3.594**	2.930*	3.255**	2.219
	(0.072)	(0.022)	(0.073)	(0.043)	(0.121)
Number of observations	123	123	123	123	123
Pseudo R^2	0.164	0.153	0.164	0.154	0.161
df_m	10	9	9	9	9
probchi2	1.98e-08	6.65e-09	7.71e-09	6.85e-08	1.36e-08

Table A5: Characteristics of software start-ups (2003 to 2006) according to use of OSS in their business model (ordered logit analysis)

Dependent Variable: OSS					
	(1)	(2)	(3)	(4)	(5)
Size (staff)	-0.0705	-0.0465	-0.0236	-0.0311	-0.0705
	(0.565)	(0.691)	(0.834)	(0.804)	(0.565)
Size (capital)	-0.215**	-0.242***	-0.233***	-0.198**	-0.215**
	(0.012)	(0.003)	(0.006)	(0.018)	(0.012)
Lack of capital	-0.598*		-0.284	-0.641**	-0.598*
	(0.057)		(0.304)	(0.033)	(0.056)
Convince financiers	0.787**	0.457		0.852**	0.787**
	(0.026)	(0.122)		(0.014)	(0.026)
Education	0.576**	0.615**	0.624**		0.576**
	(0.024)	(0.017)	(0.013)		(0.024)
Experience	0.00242	0.0583	-0.0401	0.151	
	(0.995)	(0.887)	(0.920)	(0.699)	
Necessity motivation	0.301	0.335	0.292	0.337	0.301
	(0.235)	(0.181)	(0.256)	(0.186)	(0.231)
Age of firm	-0.365***	-0.325***	-0.357***	-0.299**	-0.365***
	(0.006)	(0.009)	(0.005)	(0.016)	(0.005)
New media & Internet	1.277***	1.243***	1.232***	1.254***	1.276***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Further development of software	1.018**	0.990**	1.116**	1.061**	1.018**
	(0.024)	(0.031)	(0.024)	(0.016)	(0.023)
cut1					
Constant	-1.737**	-1.304*	-1.705**	-1.477*	-1.738**
	(0.041)	(0.090)	(0.041)	(0.075)	(0.034)
cut2					
Constant	-0.765	-0.344	-0.749	-0.517	-0.767
	(0.361)	(0.650)	(0.364)	(0.526)	(0.341)
cut3					
Constant	-0.243	0.176	-0.236	-0.00345	-0.244
	(0.771)	(0.816)	(0.775)	(0.997)	(0.761)
cut4					
Constant	1.064	1.472*	1.056	1.279	1.063
	(0.198)	(0.050)	(0.197)	(0.115)	(0.183)
Number of observations	260	260	260	260	260
Pseudo R^2	0.075	0.069	0.068	0.068	0.075
df_m	10	9	9	9	9
probchi2	1.26e-07	3.75e-07	1.85e-07	1.65e-08	5.52e-08