The international surveys of FLOSS (free/libre open source software) firms

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Abstract

In the last decade, there was a substantial growth in the software and IT services sector, which generates an interest in the study of the impact that the expansion of this sector had in the development of emerging economies. At the same time, it is particularly relevant to the study the FLOSS production activity given its contribution to the Knowledge Intensive Services Sector, as software. The aim of this study is to contribute to the analysis of this activity, presenting a systematization, evaluation and analysis of the design of technological surveys available in the software activity and in FLOSS worldwide, so that it serves as antecedent for a subsequent recommendation in the design of a measuring instrument suited to the needs of the emerging economies. For that, this paper contains a review and systematization of software surveys at international level, surveys on FLOSS activity that take FLOSS developers as a unit of analysis and lastly on the FLOSS surveys at firm level, as a way to propose a questionnaire that allows to measure the particularities of FLOSS.

Keywords: Surveys; Innovation; Services; FLOSS; Developers.

Introduction

During the past decade, the software and IT services sector has grown considerably in Argentina. This was driven by a combination of factors such as the initial availability of skilled labor based on a free universal access system of higher education, the growth of the global demand, the operation of a group of dynamic firms at the local level, but fundamentally by a set of public policies aimed at strengthening the sector. In fact, Argentina's software sector has had a remarkable dynamic during the last decade: it has quadrupled the level of employment between 2003 and 2013 to a level close to the 77,000 employed in 2014 and its sales have gone from a level in 2003 from $ 830 million to more than $ 3 billion in 2014 (OPSSI, 2015).

The study of the software sector and its productive expansion is important in terms of its impact on development, not only because of the relevance of the growth of knowledge-intensive sectors that allow an economic emancipation of the export of agricultural commodities, but mainly because of its character as an industrializing industry due to its potential to exert transversal effects of productivity increases on other industries or companies under its influence (Lavarello and Sarabia, 2015).

In this context, it becomes even more important for the peripheral economies, the extension of free software or open source (or FLOSS, by its acronym Free / Libre Open Source Software), from a production point of view. Its extension sweeps many of the barriers to entry into this activity by facilitating innovation processes (given the "open" nature of the programs), and by solving many of the legal intellectual property issues linked to "piracy". On the other hand, it allows conserving of foreign currency, by the savings in the payment of foreign licenses to the use of privative software, but secondarily by its power to impel learning processes that culminate in substitution of imports. During the stage of import substitution industrialization in Argentina, imitation learning and adaptation were fundamental to local productive development. At present, FLOSS can play that role today, enhancing the possibilities of learning in the industry (Moncaut and Robert, 2016).

One of the biggest questions that the economy has had difficulty understanding is how companies can function when their developments are free, often with free access, even what motivates them to collaborate in community projects, which can then be used by other companies in their business offer. In fact, companies can obtain revenue both through the sale and distribution of FLOS software (from third parties or developed internally, custom-made or canned), and through services from FLOS software (from third parties or developed internally. Much more problematic has been the discipline's understanding of how companies can devote efforts to innovate, to create novelties, which are then disseminated in the community and can also be used and incorporated by other firms.

In general, national technology surveys are important inputs for the design of sectoral innovation and development policies. Many Latin American countries have several waves of surveys in manufacturing firms, some of them including services, such as software, in their national or in particular surveys. These questionaires serve as a basis for the design and monitoring of innovation policies in the region, so that many Latin American

innovation and development scholars have taken stock of the evolution of these surveys, its problems and its adequacy to the needs of the region, leading to a recent concern and a need to consider new metrics in the measurement of innovation (Salazar, 2015).

This is allied to, given our object of analysis, the deficiency that these technological surveys available in the software sector present at the enterprise level because they do not usually take into account the particularities of FLOSS production, and how FLOSS's consideration in the surveys shows the need to consider different types of innovations, such as social innovations, inclusive innovations and community developed solutions (like grassroots innovations). In sum, these presents the challenge of how to measure this new forms of innovations.

The objective of this study is to contribute to the design of technological surveys for FLOSS activity to be able to measure innovation and business models in the sector and generate, thus, statistical records where the particularities of the sector are taken into account in the software sector statistics. This will be done through the systematization, evaluation and analysis of the available FLOSS technology survey designs worldwide, as a prior background for the design of a measurement instrument suited to the needs of the region.

The paper is organized as follows: Section 1 develops the theoretical framework and definitions analyzed; Section 2 details the methodology carried out for the systematization of the present work. Then, section 3 advances on the systematization surveys of international innovation surveys in the software sector; section 4 collects the information from the surveys of the FLOSS activity, which presents the results of a systematization resulting from the exhaustive search of the surveys available at a firm level on FLOSS activity and its measurement instruments; to conclude in section 5 with the recommendations and a proposal of a draft questionnaire that allows to measure the particularities of FLOSS.

1. Initial concepts: Software, Innovation and FLOSS.

Software, as a product, can be distinguish accordingly to its gratuity and their opening of their source code. Therefore, four types of software can be defined (UNU MERIT & Berlecon Research, 2002). Proprietary or privative software is when the source code is not available with the product but distributed in a binary form and it is not gratuitous but distributed commercially. Also the code is closed for the shareware and freeware and, although shared that its distribution is gratuitous, in the first case this character is limited to an initial period whereas for the second one, there are no charges for license at all (at least for the freeware version). On the other hand, we have two types of FLOSS, where the product is distributed with the source code: commercial FLOSS (which is not for free-of-charge) and the non-commercial FLOSS.

Generally, one of the analytical difficulties about the study of this sector has been the diffuse boundaries between what makes a product and what it does to a service. A distinction, at least operative, is defining a product as the software license or a part of it, which is necessary for its use. When the license is unique, we are talking about a custom product. When the license can be duplicated every time you need to, it’s called a

standardized product. For its part, computer services are activities offered for customer satisfaction, around a particular software such as provision of consulting activities, support, training and application management around a particular software. This form a product and services matrices (UNU MERIT & Berlecon Research, 2002) where, by one side are the standardized products, standardized services and provision of solutions (which together involve products and services activities).

In terms of the approaches about the conceptualization of innovation in services and how this is measured, we can point out the existence of two approaches (Blanc, 2015): an assimilation approach, which implies to the treatment of services to manufacturing activities and a differentiation approach, which points out that there are specific aspects in the very nature of the production of services that make their innovation process so particular (Drejer, 2004, Gallouj y Savona, 2009).

1.2.FLOSS, brief history of Free Software and Business Models.

The free software movement emerged as a reaction in the early 1980's from academic development centers (the MIT) to this privatization process. There was born the movement inaugurated by Richard Stallman creating a way to license software (the GPL-General Public License) granting the faculty to modify the code of the program on condition that further products enjoy the same license; and creating the Free Software Foundation - FSF, a non-profit institution that provides a legal framework for the development of SL (Stallman, 1983).

Briefly, a program is considered free software if the users have the freedom to execute (freedom 0), study, modify and improve (freedom 1), copy (freedom 2) and distribute the product (freedom 3). That freedom is not referred to the gratuity of the programs but to the construction and the collective appropriation of the knowledge and tools that make the computer applications. The free licenses (like GPL) guarantee that the code remains in the public sphere without being appropriate by individuals. A program is considered *Open Source* when the source code is available with its executable versions. For it to be considered as a free software it also has to: i)- be available in the public sphere; and ii)- Respect the four basic freedoms previously mentioned. An open source program may also be free software if it complies the establishment of the sets of freedoms set by the movement.

To a large extent, the difference between the Open source and Free Software movements are philosophical. Although both distinguish free-of-charge freedom and question the business model based on proprietary licenses, one of them emphasizes the speed of development and the quality of the software and the other emphasizes much more the values associated with freedom and justice. From an operational point of view, at a productive level in firms and in terms of their economic impact, the terms can be used indistinctly or jointly, as we have adopted in this paper as Free / Open Source Software, FLOSS. That is, Free Software and Open Source point to the same model of software production in economic and productive terms.

Business models from the disintegration of the value chain of software production introduced by FLOSS can be typified in different ways. The first of these that we can

identify is based on a series of generalizations about the ways in which it has been observed in different studies that companies obtain income as part of this activity. This "factual" approach has shown how FLOSS activity has disintegrated the software production value chain, with differentiated characteristics in some stages or activities depending on whether the production is proprietary or not. Thus, the first step is to distinguish when the stages of the value chain are different in FLOSS production activity.

Most of the services activities (consultancy, implementation, training and application management) do not tend to present significant differences if they are provided based on proprietary software or FLOSS. The software development activity tends to have differentiated characteristics between a "more hierarchical" organizational form (following the "cathedral" principle) or a more "horizontal and dispersed" (under the "bazaar" principle) (Raymond, 1999a), although reality tends to show predominantly the existence of hybrid models and it is not possible to be abrupt in that sense. The rest of the activities of the value chain do have very different characteristics if the production is FLOSS or privative.

FLOSS provides the opportunity to disintegrate the latter two activities of software developers, offering the possibility of many business models based on packaging and sales, with firms specialized in gathering and adding software, optimizing and selling packaging. Also, a big part of the FLOSS firms dedicates to the distribution, marketing and selling stage, both as original operating systems or specialized or niche software.

At last, there is an important distinction in the case of support activities. In the case of FLOSS, it is offered, firstly, by community forums. As this is not acceptable for all types of users, there are specialized support offers from distributors and independent OSS firms. In the privative case, it is usually offered by a specialized firm or the software developer himself.

All this productive differences of FLOSS have enhanced the possibility of disintegrating these stages/activities of the same production unit, giving origin to the opportunity of several business models specialized in one or some of these stages. Among the business models that emerge from this, we can mention the following (UNU MERIT and Berlecon Research, 2002): the distribution of original versions of Linux operating systems, the distribution of specialized open source software or niche, retailer distribution of open source software and complementary products, and in a broad sense, the provision of services and support starting from some FLOSS software.

The activity of the **original Linux distributors** (e.g.: Red Hat, SuSe, Slackware, etc.) is to provide a particular Linux system. A Linux distribution consists of the Linux core (kernel) and several files that together configure a Linux Operating System. To develop their own version of a system, distributors need to collect the newer versions of Linux and related files. Then, the second step is to proceed to test it and optimize the different pieces of software working together, with the goal of achieving good performance and reliability. Normally, these efforts return to the FLOSS community, as a test, correction, etc. Third, then, it involves an effort to smooth the installation, generate good documentation that accompanies the system, and create productivity tools at the same time.

It can be said that for Linux distributors are two market segments. On one side, the mass market, with standardized packages offered to SMEs and private consumers. This is separated in the markets of desktop software and servers. In terms of servers, FLOSS is a serious and clearly superior alternative as an operating system. In the desktop software area, the Linux market is truly small and is the biggest challenge for FLOSS firms. On the other hand, a broader segment is the individual solutions market, which is offered to medium and large firms, linked to the provision of services.

A critical success factor in the Linux distributions business is building the brand, which leads to a strong investment in **marketing** (advertising, business fairs, public relations), which is where the core competencies of these vendors are. Despite that, most distributors also offer Linux related services such as **consulting, integration, support and training**. An additional minority income can be counted in these firms through the sale of accessories (see accessing in the following section).

Niche and specialized open source software distributors develop and distribute different FLOS software, but not operating systems. Their products include applications, development tools and administrative tools; and although their software is developed to run on Linux, some products also do so on proprietary operating systems (e.g. MySQL, Zope, etc). Here, under this model, firms live symbiotically around a FLOSS project, whose core developers are usually hired by firms of this type. Here the software is collected, maintained and/or developed, and the main function of these firms is to coordinate the programming and the commitment to provide and support a particular product.

The largest range of FLOSS firms, where the size of SMEs is immense, is with a **service provider and support** business model. This is the most heterogeneous universe of FLOSS firms. Firms that having their own particular background in Linux, try to establish services based on their knowledge of the FLOSS community. In this spectrum are firms that have a special knowledge about how to provide and IT service in general: either on IT consulting, support integration services, IT training or IT recruiting; sometimes is a specific industrial segment or a vertical functionality. Their core competency is technical knowledge and the product in which they specialize.

For its part, it can be identified as a particular "business model" to **retailers of FLOSS distributions and its complementary products.** These are part of the marketing channels of the distributors. They can either sell distributors software or provide and sell additional documentation and OSS products information (and merchandising). These types of providers fall into the gray area of business from the FLOSS which are in the line between the activity of software and related services and other type of activity. Another "business model" that is in this gray area is what UNU MERIT y Berlecon Research (2002) consider the **facilitators interested in FLOSS**. This includes those who are dedicated to maintaining and organizing meeting events and business spaces, such as market places or conferences.

Others FLOSS business models are analyzed following Raymond (1999b), who tried to make a formalization of different OS business models, which was later expanded by Hecker (1999). The common aspect of all of them is the absence of license fees, among which are some factual models related to the sale of services (support sale, facilitation of

services), factual models also but whose strategy lies in the combination and the timing between free and proprietary licenses (loss leadership, liberation of already sold applications, dual licensing). Another model that is in reality consisting of the sale of hardware with open source software included or embedded and a pair of theoretical or speculative models that have a counterfactual side (software franchisee and brand sales), as well as a model that is not centered on the production of software or computer services (which is the sale of FLOSS accessoring).

Support sellers is one of the most common business models between FLOSS firms (Hecker, 1999, Castello *et al.*, 2009). In this model, the firms obtain revenues from the distribution, consultancy, training, personalization, support, application management and documentation sale, including multimedia material. The **Service Enabler** business model resembles in a way what is known as *Software as Service* but is not limited to it. It is a business model where the firms create and distributed *open source* software primarily to hold access to an online paid service (Hecker, 1999).

A model described by Raymond (1999a) is the **Loss Leader** business model. The logic behind this model is a firm strategy that alter and combine free and proprietary version of the same software. Thus, a gratuitous open source version of a commercial product is used to improve the willingness of potential consumers to approach to the commercial product portfolio of the firm. Thereby, the open source product does not generate revenue (or generates very little), but allows a positioning (even a leadership) in some markets segment, either: building the reputation of the seller and contributing to the development of its brand, improving functionality and utility of products sold in a traditional way, or by increasing the base of developers and familiarized users with the firm's complete line of products.

A FLOSS business strategy is proceeding through **Liberating Sold Applications (Sell it, free it).** Raymond (1999a) refers to this model as *"Free the future, sell the present"*, and consists of maintaining in the medium term a record in the progressive release of proprietary applications developed by the firm, maintaining alternate versions.

One alternative that seeks to empower the freedoms of software, is to maintain versions in a **Dual Licensing** strategy. That is, sell the product under a double license, where the creator firm of FLOSS becomes a consultancy and implementation center for large accounts and a training and support center for the rest of the community (Castello, *et al.*, 2009).

A business model linked to the electronic production, driver's development is called **Hardware Sales (or Widget Frosting),** following Raymond (1999a). In a way, this model takes over the original software production mode, when this was produced in for free, in order to be included as an accessory of the machines. Is hard to conceive this model as a FLOSS business model outside of other productive sectors, particularly manufacturers where in-house software development activities exist for the management of productive processes, machinery operations, CNC, etc. However, it may be relevant for firms that combine electronic activities, software production and the provision of computer services.

Another possibility, at least theoretical, is obtaining incomes from **Software Franchising.** In this case, the business model consists in a medium term possibility of obtaining revenues from franchising their brand to a third parties for commercialize products or provided related services (or in a specific geographic or vertical segment), after the bran is recognized in the market for its FLOSS production activity. The franchise may include not only the use of the brand, but include training and support services for the franchisee. In a similar way exists **Brand Licensing,** where the firm would produce FLOSS but if can retains the trademarks rights for itself and charges other firms for the right to use it exactly in the creation of derivative products.

Finally, it has been point out **Accesoring** as a FLOSS business model, even by (Raymond, 1999a). However, this is not really a software activity. Even though community collaborators can earn revenues from the marketing of products around free software (clothing, books, marketing articles, dolls, etc.), it appears as a marginal economic-productive activity. Although it is a feasible for a firm that engages in the production of FLOSS or related services, it does obtain some additional income from the sale of accessories related to the brand its community of reference.

1.3. The literature that studies innovation in FLOSS.

The importance of FLOSS' analysis of the innovation literature is that it should be used as a basis for the design of an innovation survey in the sector. This provides a notion of community behavior, so that it is possible to select relevant behaviors that should be collected through the survey, behaviors that are not of relative importance and that common practices cannot be unrelated to the study of innovation in this type of company. In this way, this allows us to design a form that is not excessively extensive, but at the same time allows us to collect information on the relevant characteristics of the sector.

From an economic point of view, the activities from the FLOSS community raise the problem of the absence of measurable and quantifiable monetary transactions (Ghosh, 2003). The FLOSS activity, in general, presents the problem of how to measure non-monetary economic activity, which generates a great disadvantage for most researchers on this phenomenon, given the absence of empirical, factual and verifiable data on a large scale. This difficulty has naturally extended to the study of an economic phenomenon such as innovation.

Most of the literature referring the nature of the innovative process in FLOSS focuses on the development process at the project or community level (Lee y Cole, 2003, Von Grogh, 2003, von Hippel y von Krogh, 2009). Based on that, it is possible to carry out a first stylization of the development and innovation process that emerges from this literature, usually as a result of case studies.

An OS project is typically initiated by an individual or a small group in search of a solution to an individual need or firm. The organizational structure of the projects is usually divided into two main groups, one called core and the other periphery. The core consists of the projects leaders (this is where the “initiators” usually are) and a good number of maintainers whose activities are to evaluate and accept or reject the modifications, made by the periphery, of the source code. On the other hand, the periphery is formed by a large number of developers (thousands of them) whose function is to test

the software, detect and report errors and generate improvements or parches of the source code.

Both this way of organizing the process, and the development of a collective socialization infrastructure and the sharing of tools, is what makes it possible to generate high quality innovations (the successive improvements in the code) and allows participants to assimilate learning. These innovations and learning are based on a process of critical assessment by all community members (Lee and Cole, 2003). This form of development of the innovation process makes it particularly difficult to measure, since it occurs in a diffused and even globally dispersed community.

This calls for highlighting the aspects that characterize the literature of FLOSS's innovation processes at the company level, whose conceptualization contributes to the design of surveys at this level of analysis, which allow us to identify the economic presence of this activity and its impact in innovative terms.

In this way, the literature identifies a series of aspects by which software firms are motivated to participate in Open Source communities and open code developments, impacting on their innovation activity (Colombo et al., 2013, 2014).

Firms can gain knowledge from the FLOSS community. Firms accumulate knowledge about the community, through their own routines and by increasing their capacity of detecting high quality codes. In turn, they can freely download any codes and adapt it to the needs of their clients or their clients or they can contribute with FLOSS projects, authorizing their programmers to write or correct a core, write documentation, or answer technical questions from community projects, participating in your mailing lists.

According to Colombo, et al. (2013), the innovative process at a firm level includes aspects that motivate them to participate in FLOSS and in the community. Among them can be listed (Colombo, et al., 2013, 2014) that participation in the FLOSS community offers to the firms: an availability of inputs and tools that allows to develop custom tools; a strengthening of market positioning and reputation in the firm; improvements in marketing and commercialization and, along with this, allows to access to high quality programming capabilities, which could not attract for salary reasons (but because of the challenging nature of own projects led in the community).

Carry out a review of the background information about the FLOSS activity is essential to be able to carry out future studies on the sector, taking as a starting point what is already the international level on the subject and to take certain considerations about this literature in order to achieve theoretical advances in the study of innovation in FLOSS firms.

2. Methodology.

In this paper, an extensive bibliographical review was carried out on the background in measuring innovation in the software sector and, in particular, in FLOSS companies, to detect the deficiencies in the surveys at the time of collecting information on FLOSS activity and its implications.

Firstly, an extensive analysis of innovation surveys in the services sector was carried out. This analysis consists of surveys carried out in 8 different countries each one with different periods, number of survey waves and observation periods. These countries or regions were: Brazil, Canada, Chile, Colombia, The European Community, Costa Rica, United States, Japan, Mexico, OECD and Uruguay. The aim of this analysis was to highlight the different ways of approaching or measuring innovation in the software sector, the results obtained by firms and the linkages that are carried out. This will allow to came to a notion of how innovation is measure in the software sector, taking into account different national and international agencies. To complement this study, we analyzed four innovation studies, carried out by academic research teams. We have reviewed: the Utrecht University Innovation Survey 2003 (Boschma y Weterings, 2005); the UNGS 2011 survey (Barletta et al., 2012, 2013); the UTN Regional School of Concepcion del Uruguay survey 2015 (Blanc, 2015) and the UNICEN 2012 survey (Camio et al., 2014, Camio et al., 2015, 2016).

In FLOSS activity some progress was made with a systematization of the existing FLOSS literature, which uses FLOSS companies as a study unit, with the aim to determine how to collect certain information about these types of companies and use this compilation to form a conclusion on how to proceed in the future innovations surveys in the FLOSS sector. All the conclusions will be made on the basis of a set of analysis axes.

The existing surveys dates from the mid 2000's and have a lot of different approaches. The identified FLOSS firm's surveys in this study are: i) European Free Software Survey (ELISS, 2003); ii) FLOSS World (2007); iii) Business Models in FLOSS (CCTI, 2009); iv) Survey of Free Software role in the software sector (CENATIC, 2009) y; v) Survey of open source software in the Spanish SI sector (ESFA-SI, 2010/2011).

For the purpose of our study, we will try to highlight what contributions we can use from this background based on four axes of analysis: 1) the definition and identification of a FLOSS firm; 2) business model and productive specialization; 3) innovative activities and types of innovation; and 4) linkages with the FLOSS community. In first place, to what extent the surveys provide questions that allow us to identify a FLOSS firms, approaching some kind of definition of this type of signature so that it can contribute in the future to various taxonomies. However, in this first instance we are interested in rescuing criteria that allow us to distinguish a firm of this type and, on the contrary, its main business it's about private production. Secondly, we will be interested in visualizing the ways in which the different surveys can offer an approximation to the different FLOSS business models and characterize their productive specialization, in relation to the literature reviewed in the section 1.2. The latter is a particularly sensitive point in the case of software, given the great dynamics of the business schemes in this activity. However, in the approach to different FLOSS business models, this axe of analysis can contribute so much to identification of firms of this kind as much as an approximation to some kind of typology.

Thirdly, efforts have been made to stress the extent to which this background contributes to identify various innovative activities and types of innovation introduced by the firms. The ultimate objective of the study is to contribute to the design of technological surveys in the sector. Finally, in fourth place, we will try to highlight the approach to connectivity

issues and linkages, but with a particular focus on linkages with the FLOSS community. In a way, this is a recurrent axis in FLOSS surveys of all kinds (both at the developer level and at a firm level). The interest here will be to identify the different types of existing collaborations, so as the approach to a list as exhaustive as possible of the forms of interaction of firms with the community.

3. The international innovation surveys in the software sector.

A starting point for the design of technological surveys for the FLOSS activity is the backgrounds of the software itself. At an international level there are two contributions. First are the efforts made by the national and transnational statistics agencies as part of the innovation surveys in the services sector, which can be summarized in table 3.1.

Table 3.1: International Innovation Surveys in Services

Country	Survey name	Sector where software is included	Observation Period	Number of waves	Last Survey Conducted	Responsible Agency	Applied Manual
Brazil	Pesquisa de Inovação (PINTEC)	Services (IT)	Triannual	5 (2000; 2003; 2005; 2008; 2011)	2011	Brazilian Institute of Geography and Statistics (IBGE) and Ministry of Science and Technology and Innovation	Oslo Manual
Canada	Encuesta de Innovación y Estrategia de Negocios	Services (Information: Software Edition)	Triannual	2 (2009;2011)	2012	StatCan (Statistics Canadá)	Oslo Manual
Chile	Encuesta Nacional de Innovación	Services (Informatical and related activities)	Biannual	5 (2005-2006; 2007-2008; 2009-2010; 2011-2012; 2013-2014)	2014	Ministry of Economy, Development and Tourism	Oslo Manual
Colombia	Encuesta de Desarrollo Tecnológico en la industria manufacturera (EDIT)	Services (Informatical and related activities)	Biannual	4 (2006; 2008; 2010; 2012)	2012	National Administrative Department of Statistics (DANE)	Bogotá Manual
European Community	Community Innovation Survey (CIS)	Services (Software)	Triannual	6 (1997; 2001; 2005; 2006; 2008; 2012)	2012	Statistical Office of the European Communities (EUROSTAT)	Oslo Manual (2th Edition: CIS 1, 2, 3 and 4; 3th edition: CIS 2006, CIS 2008, CIS 2012
Costa Rica	Encuesta Nacional de Ciencia Tecnología e Innovación	Services (Tourism, Health, Sofware and Finance)	Annual	2 (2012; 2013)	2013	Ministry of Science, Technology, and Telecommunications	Oslo Manual
United States	Business R&D and Innovation Survey	Services (Information: Software Edition)	Annual	8 (2008;2009;2010;2011;2012;2013;2014;2015)	2015	US Census Bureau and US National Science Foundation	Oslo Manual
Japan	Japanese National Innovation Survey (J-NIS)	Services (IT services)	Triannual	4 (2003; 2009; 2012; 2015)	2015	National Institute of Science and Technology Policy (NISTEP)	Manual de Oslo (2th Edition 2003 survey, remaining used 3th edition)
Mexico	Encuesta sobre Investigación y Desarrollo Tecnológico (ESIDET)	Services (Propertye,Business and Renting activities)	Biannual	4 (2001; 2006; 2008; 2010)	2012	National Institute of Statistics and Geography (INEGI) and CONACyT	Oslo Manual
OECD	KISA Project	Services(Software, Medical Services,Tourism and Leisure, Renewable Resorses based Industries)	Ocassional	1	2005	Statistical Agency of each Country.	
Uruguay	Encuesta de Actividades de Innovación (EAI)	Services (Information and Communicatios)	Triannual	3 (2004-2006; 2007-2009; 2010-2012)	2012	National Agency for Research and Innovation (ANII) and National Institute of Statistics (INE)	Bogotá Manual

From the analysis of surveys carried out by statistical agencies, it should be noted that, the CIS survey generally sets a standard. For example, although the observation periods range from one year to three years, most national surveys follow the CIS criterion of dealing with three-year observation periods and all of them adopt the Oslo Manual to measurement of innovation. On the other hand, it is foreseen that the software activity is usually diluted and grouped in another activity group, as part of innovation surveys in services or in surveys of innovation in manufacturing and services.

The main point to be stressed, based on the theoretical review presented in Section 1.1 on ways to approach innovation in the software sector and services in general, is that most surveys address an assimilation approach to innovation in manufacturing services and there is no survey that takes a systemic approach for measuring innovation as revised by Tacsir (2011).

The two cases that abandon the rule in this sense, following an approach of differentiation are the OECD KISA project survey and the National Survey of Innovation in the Services Sector 2001 in Mexico.

The KISA survey, on the one hand, has a unique design for the software sector, which represent the first diversion. Secondly, it´s design does not follow the standards of the Oslo manual in the measurement of innovation, but focuses its analysis of the firm's innovation from a single product or service, the most innovative one of recent years. From there different aspects were consulted, such as its distinctive aspects, how long it took the innovation process to launch it to the market, ways of financing, etc.

The 2001 service survey in Mexico was separated from the rule by presenting a differential design for the services sector, in a clear case of differentiation approach (the only one we identified in a survey carried out by a national statistical office, which Innovation surveys on a regular basis). Its approach focuses the analysis on innovation projects. It is also requested to disaggregate what type of innovation was achieved: 1) New methods of generating services; 2) Use of radically new technology; 3) Fundamentally new functions; 4) New methods of presentation to the public; 5) Organizational innovations following the introduction of new technologies; And 6) New professional software; among other. This is a specific contribution to be considered as an antecedent of the attempts of differentiation between services and manufacture sector.

However, Mexico abandons that strategy in the following edition and adopts a unified design for the service and manufacturing sectors. In this way, it becomes assimilated to manufacturing and services following the criteria of the Oslo Manual. This is explained by reasons of international comparability. In particular, the CIS has set a standard for innovation surveys around the world, which enables comparability between the statistics of different countries, but which runs counter to the approach of specific designs for the services sector.

On the other hand, several efforts were carried out by academic research groups scattered throughout the globe. These surveys are always carried out within the framework of a specific research objective, which gives them their particular imprint.

Academic research teams conduct different innovation studies in particular four teams that made an effort to have primary information were identified. In Table 3.2 we can also find these surveys in a concise manner.

Table 3.2: Academic research teams Surveys

Survey name	Geographic coverage / sample size	Study focus	Studies issues / study variables	Papers and publication related
Utrecht University 2003	Netherlands n= 256	Innovative performance and capability; regional differences and their implications	Innovative productivity as a proxy measure for software firms performance The innovative productivity of firms was measured by dividing the turnover percentage by sales of new products by the proportion of full-time employment that led to the creation of that new product	Boschma and Weterings (2005)
UNGS 2011	Argentina n=257	Connectivity, capabilities and innovation	The role of the firm's capabilities; type and amount of innovative efforts; result of innovation; connectivity with others firms and institutions	(Barletta et al., 2012, 2013, Motta et al. 2013, Uriona et al. 2013, Morero et. al. 2014, 2015)
UTN Regional Concepción del Uruguay 2015	Argentina, Entre Ríos n=23	Measure of innovation, development	Age, size, of the firms; if they export; innovation degree.	(Blanc et al. 2014, Blanc 2015)
UNICEN 2012	Argentina n=103	Level of innovation of the firms	Capabilities (measured by structure, strategy, leadership, motivation, Software Libre); activities, technological capacities, innovation incentives, strategies and business model	(Camio et al., 2014, Camio et al., 2015, 2016)

The main objective for the study of this type of surveys is the interest to analyze as research teams that do not have the need to collect homogenized data or have comparability, they have the freedom to design a survey without explicitly following the guidelines of the most used manuals, and thus be able to design questions that fit the needs of their study and be able to cover a wider spectrum of information about the sector to analyze.

Academic research groups have a greater margin of maneuver in this regard. Of the few surveys of this type that we have evaluated, only one performs a fully standard survey (Weterings and Boschman, 2009), two use questions regarding innovation measurement typical of the Oslo Manual (UNGS 2011 and UNICEN 2012), although with novel extensions in other sections of their form, and one tackles a proposal to measure innovation from an approach of differentiation (Blanc, 2015).

Although the UNGS survey 2011 introduced broad considerations for the connectivity approach through networking techniques, it inquired about innovation in the typical way (introduction of new products, services, etc. and their degree of novelty). Likewise, while the UNICEN 2012 form introduced very detailed questions on capabilities (including concerns of the administrative sciences, such as issues related to business strategies, leadership and motivation, etc.), including the use of free software as a part of this, cultural aspects of the organization, the contribution of his research is to develop an indicator of global innovation, which mixes competences, innovative inputs and

innovative outputs. The latter are measured according to the known standards of the Oslo manual and the research does not make any contribution in this regard.

The main contribution is the proposal of Blanc (2015), especially its survey design. Besides it´s estimation of innovation indicators (assimilation vs. differentiation approach); we consider that his biggest contribution is in the survey design. The recommendation in this regard is useful when constructing simple descriptive statistics of innovation rates, rather than constructing the indicators that combine various vectors that address the questions (changes in the business model, changes in the cycle of life of the Products / services of the firm and modifications in the core of the products / services); this prevents the problems that entail weighting each of them.

The proposal is to maintain the method of computing innovation rates that are followed by the typical questions in the Oslo Manual (e.g.: proportion of firms that have introduced new products, proportion of firms that have done so with novelty for the international market, etc.); but based on new questions (e.g. the proportion of firms that have introduced changes in the interface of their products, the proportion of firms that have introduced new modules, etc.). Another point to adapt is the observation period, taking as reference only the last year. This should be considered in due course.

4. International surveys of FLOSS activity

Regarding to the surveys destined to firms, we have worked to highlight what contributions we can use from this background in four aspects, as detailed in section 2. Table 4.1 summarizes the main results in each axis of each survey, which are detailed below.

Regarding the different contributions for the identification of a FLOSS firm, the most outstanding and potentially useful contributions are in the CENATIC surveys and the various definitions that emerge from the ELISS project studies. Three aspects are combined: i) whether the firm provides solutions, products or services based on FLOSS (Bonaccorsi et al., 2006, CENATIC, 2011, Colombo, et al., 2013); ii) If the firm offers software products, the issue of the license used for this marketing (Bonaccorsi, et al., 2006, CENATIC, 2011); And iii) the proportion of sales from revenues from FLOSS services or products (CENATIC, 2011).

Of these contributions, the first two are complemented around the supply of the firm in the mode of licensing of the products. Both are clear and demarcating criteria of a type of firm that works with free software or open source, one that bases its business only on proprietary software. The latter, around the revenue share of the free software activity, potentially contributes to the identification of FLOSS intensity in a firm. At the same time, it supports the empirical evidence pointing to the predominance of hybrid provisioning methods that combine closed-source and open source software. However, a later work is in working the criteria of cut, what proportions of sales from FLOSS are more or less binding with respect to the intensity of free software for the firm.

Table 4.1: International surveys of FLOSS firms.

Survey name	Geographic coverage/sample size	Year of realization	FLOSS firms distinction	Approach to FLOSS business model and productive specialization	Linkages and cooperation with FLOSS community	Responsible Agency	Creative and innovative activities
European Software Libre Suvey (ELISS)	Italy, Findland, Spain, Portugal and France n= 361(FLOSS)/917 Total	2003	Supply of products or services FLOSS-based and under FLOSS licenses. Supply of FLOSS solutions Authorization for employees to cooperate on FLOSS projects during the working time	Productive specialization: Maintenance, support, development of ad hoc solutions, distribution, marketing of software products developed by other companies, consultancy, training and R & D services Strategic importance of FLOSS: Provision of FLOSS / private solutions, percentage of sales from FLOSS revenues, percentage of FLOSS products over the total portfolio and intensity of use of GNU GPL licenses FLOSS activities: 1) Services based on pre-packaged FLOSS products 2) Adaptation of pre-existing FLOSS programs to custom solutions 3) Integration of FLOSS modules with previous programs into new FLOSS solutions 4) Design of customized solutions with FLOSS licenses 5) Design of new solutions launched under FLOSS licenses Variety of services provided: consulting, Integration, Installation, Assistance, Maintenance, System Administration, Training, Application Management, Adaptation of Codes written by third parties, Custom software development from scratch and Generation of documentation	Cooperation agreement for innovatios Degree and type of participation in FLOSS community Participation in FLOSS promotion activities	Department of Engineering of PISA University	Types of innovation (new or improved products) amount and degree of innovation. Proportion of the billing of innovation Innovation activities, R&D activities and external acquisition of technology.
FLOSS WORLD 2007	Argentina, Croatia, Brazil, Bulgaria, India, Malaysia, China and South Africa n= 716 (employers)	2007	Employers of FLOSS developers. Firms that use or develop FLOSS	-	Effect on the experience of employeers	UNU - MERIT	Not Adresseed
Modelo de Negocios en FLOSS	Argentina n=131	2009	*ad hoc*	Distribution of income by type of activity of origin (sales of own or third party licenses, consulting, support, training, development, maintenance, IT support) and billing mode (by hours or by products)	Participation in colaboratives projects	Centro de Computación y Tecnologías de Información FCE-UNC	Not Adresseed
Survey of free software role in spanish TIC sector	Spain n= 141	2007	Carryng out production activities, R&D, distribution or sail of products and services containing FLOSS, in a partial or exclusive way	Services provided by the company (software distribution, support, custom development, canning development, consultancy, infrastructure, outsourcing, training, code authoring) as performed by FLOSS, private soft, or both	Types and intensity of participation Contributions to FLOSS community	CENATIC	Internal R&D linked to FLOSS Porcentage of internal R&D linked to FLOSS. Socioeconomics aplication fields of FLOSS
Survey of open source software in spanish SI sector	Spain n= 755 FLOSS/1932 Total	2010-2011	Commercialization of products under FLOSS license or services provision FLOSS-related. Sales amount respectives to FLOSS-based products and services	1. Development of own software, distributed with FLOSS license and services provision from it. 2. Provision of technological consultancy services (custom development, integration, parameterization, support, etc.) from FLOSS products. 3. Provision of systems consulting services (infrastructure, servers, networks, data processing center, Etc.) around FLOSS products.	Having a support community for a own FLOSS product Partner relation with other FLOSS firms.	CENATIC	Internal trainnong in FLOSS

There are, in addition, two other contributions to point out. One broader than those we have indicated and one more restricted. The first one is contained in the 2009 CENATIC survey. In this case the distinction of what constitutes a FLOSS case contemplates not only the production and provision of products or services but also the carrying out of R & D activities that contain FLOSS (as a result, it includes cases where, although the firm does not develop a business model that provides income from FLOSS, it does research and creative activities that contain it). Either partially or totally. It is necessary to be very careful with this criterion, since it will include, for example, those Multinationals that without being FLOSS firms, have workers collaborating in the communities (like Intel, or CISCO), for strategical reasons. This design does not allow, at least in an anticipated way, to distinguish a FLOSS firm from one that is not and, on the contrary, its core business is in the private mode of production. On the other hand, the criterion of whether the activity is performed in a partial or total way, is acceptable by the proportion of sales that the FLOSS activity originates, so the design of the ESFA-SI 2011 is overcoming in that sense.

The other distinction identified is contained in the article by Colombo, et al. (2014) based on the ELISS II survey, which is the criterion of considering FLOSS as companies that authorize their employees to collaborate with community FLOSS projects during working hours. This is a very narrow criterion that hardly holds back the enormous diversity of types of FLOSS ventures. Not all business models will involve participation in the community during working hours, or these contributions may have been prior to the constitution of the firm, it is feasible that not all companies contribute, but build their business model from the design of services from free software to which they do not contribute, among many other possibilities. In this sense, it is not shown as a criterion that could be generalized.

Regarding the approach of the FLOSS business model and the characterization of the productive specialization of the firm, the contributions are very varied and should be analyzed in conjunction with the theoretical literature reviewed in section 1.2.

The first point to highlight is that several of the surveys allow to approach its some extend to business models from the disintegration of the value chain of software production introduced by FLOSS presented in section 1.2 on the basis of the study of UNU MERIT and Berlecon Research (2002), although with variations in the stylization of activities, which overlaps with the specification of the productive profile of the firm; while there are no acceptable approximations for the business models outlined in section 1.2.

It is striking that in the case of the CCTI survey 2009 the specification of the business model is addressed through the distribution of income according to the type of activity (which is more appropriate to approach business models via the composition of the chain of value). Nevertheless, proposes to identify business models such as those stylized by the literature that we have reviewed in section 1.2, where some empirical cases (e.g. support sellers, loss leader, dual licensing, etc.) are collected and some proposals as feasible (such as the franchisee and trademark licensing).

However, there isn´t a specification of the cutting criteria for identifying the business models. In any case, we consider that this constitutes a better contribution to the specification of the productive specialization of the firm. To do this, the percentage of revenues from: the sale of own licenses, the sale of third party licenses, consulting, technical support, training, development, maintenance, IT administration and others are specified. This classification is made by establishing ex ante to the firm as FLOSS, so for our purposes an additional criterion is necessary.

CENATIC 2009 introduces a criterion to this approach that needs to be taken into account. It lists the activities carried out by the company, but distinguishes whether it is carried out only under FLOSS, only under proprietary software, or both. It lists the activities performed by the firm, but distinguishing if it is done only under FLOSS, only under proprietary software, or under both. The productive activities that are considered are: Software development (distinguishing customized developments, development of standard products), software distribution, technology consulting, training, software support, infrastructure, service outsourcing and code auditing. These last three would not be part of the value chain of software production as we have presented in 1.2, but rather would be modalities of services. The activities included in the CENATIC 2009 survey, completed with those contemplated by the stylization of UNU MERIT and Berlecon Research (2002): the activities of documentation, packaging, Implementation / Integration and management of the application (versioning, etc.) could be added).

CENATIC's 2011 ESFA-SI advances a little further, as well as proposing a characterization of productive specialization through the activities carried out by the firm (computer software publishing, computer programming, computer consulting, outsourcing, other IT services, Data services and hosting, web portal services and training); Proposes *a priori* three business models within which the firm must be located. These are: a) the development or maintenance of a proprietary software product, with the use of a free software license to distribute and provide services related to said product; B) provision of technological consulting services (custom development, integration, parameterization, support, training, etc.) around FLOSS products; And c) provision of systems consulting services (infrastructure, servers, networks, data processing center, etc.) around open source software products.

From the ELISS project can be highlighted two contributions to characterize the productive structure. Bonaccorsi, et al. (2006) characterized the productive profile of the firm according to whether it provided the following services: maintenance, support, development of ad hoc solutions, distribution, marketing of software products developed by other firms, consultancy, training and R & D services. In Harison and Koski (2010) the services provided by the firm are classified according to whether they are carried out through FLOSS, private software, or both: software distribution, support, custom development, canning development, consulting, infrastructure, outsourcing, training and code auditing.

In summary, there are no surveys that effectively implement identification of business models such as the postulated by Raymond (1999a) presented in 1.2. The most common approach has been trying to characterize the productive specialization or stages of the value chain of software production in which the firm intends to perform totally or partially

with FLOSS. This seems the most productive way to approach the business model of the firm in a firm level survey.

It remains to try to integrate the different proposals of classification of the productive activity of the firm / activities of the chain of value that it performs and to ponder the degree of relevance / probability of answer that has to investigate them through the proportion that they represent of the turnover of the firm. In the final results section, we make a proposal to integrate the different contributions of productive activities, combining in it the insights of the theoretical literature.

In some cases, in the specification of the business model, the above is complemented with aspects such as the use of FLOSS licenses (Bonaccorsi, et al., 2006, CENATIC, 2011), the proportion of the firm's product portfolio composed of FLOSS software (Bonaccorsi, et al., 2006), or subjective management judgments about the strategic role of FLOSS or degree of adherence to free software (Bonaccorsi, et al., 2006).

The first two complements (use of FLOSS licenses and participation in the product portfolio) become relevant in cases where firms supply products as part of their productive activity.

Subjective appraisals of the FLOSS role for the enterprise are often measured on lickert scales of importance. Our assessment is that this is an aspect whose generalization suffers from problems of rigor and comparability. Its handling will necessarily involve and process the results through some statistical method of reduction of dimensions, particular and specific to each sample. Therefore, we believe that there should not be an aspect to be included to define the business model, at least through surveys. The possibilities offered by the qualitative analysis are overcoming in this sense, which is outside the focus of this study.

In the area of innovative activities and types of innovation is where the background of surveys to FLOSS firms tend to be poorer. Either the issue is not addressed (as in the Floss World 2007 or the CCTI survey 2009), or it is addressed very narrowly (CENATIC, 2011), or follows the typical standards of the Oslo Manual, even without we can ensure that effectively the information published on the form (case of the ELISS Project) has been applied. The CENATIC 2009 is the one that makes the most significant contribution in this area, although maintaining the typical European focus in R & D activities, within the innovative ones. The design considers both the realization of internal R & D linked to FLOSS, and the proportion that it represents of total R & D. No survey of those evaluated makes a significant contribution to the types of innovation introduced specifically by FLOSS firms.

Regarding external interactions, and in particular in linkages with the FLOSS community, practically all the surveys carried out to firms make some remarkable approximation. As a result of a comparative evaluation, the most important contributions for the future design of technological surveys in this regard are: a) consideration of participation in collaborative projects in the community; b) the typifications of the different forms of participation in the community; And c) the inclusion of linking actors that are not usually included among the typical options of the innovation surveys that are carried out in the sector.

In this sense, it is important to emphasize the importance of identifying whether the firm participates or has participated in community projects, whether they are led by members of the firm or by external (third party) members (Bonaccorsi et al., 2005, Castello, et al., 2009, CENATIC, 2009). The ELISS project is the one that makes the most significant contribution in this aspect, investigating not only the number of own and third-party projects in which the firm has participated (since the birth of the firm and in the last year), but also the amount of contributions you have made and the percentage of lines of code of the FLOSS projects you have contributed. The CCTI 2009 survey inquiries about whether or not it has participated, while the CENATIC 2009 survey includes as a way to collaborate in the community disaggregated activities that are often part of the participation of projects (e.g., contribute with code, fix bugs, etc.). This is best grouped in the next point.

Secondly, it is necessary to emphasize from the analysis a first list of the existing collaboration modes with the FLOSS community. This is an important point for the future design of surveys, so as to approach a list as exhaustive as possible of the forms of interaction, to achieve conform some measure of intensity. The most important contributions in this regard are the CENATIC 2009 survey and the ELISS project, and we have completed it with contributions from the literature review (section 1.3). The list includes the following modes of collaboration: 1) participation in promotional activities of FLOSS; 2) the contribution of code to the community and the writing of complementary modules; 3) the socialization of experiences in associations; 4) the release of old software; 5) participation in blogs; 6) creating artwork for projects; 7) software packaging; 8) maintenance of repositories; 9) the making of donations and monetary contributions; 10) writing of documentation; 11) Sponsorship, 12) participation in forums; 13) correction of errors or bugs; 14) provide assistance in answering technical questions; and 15) translation of applications.

Thirdly, we must highlight the inclusion of linking actors that are not usually included among the typical options of innovation surveys that are carried out in the sector, even in surveys designed specifically for the software sector, such as can be appreciated to review section 2 of this report. This calls for the inclusion of Open Source Community or FLOSS as actors, on the one hand, and to distinguish what is usually included in links with other firms. There is a distinction between other non-sector firms, other FLOSS software firms, and other proprietary software firms. This distinction is due to the approach taken as part of the ELISS project.

5. Final results: Recommendations for the design of innovation surveys in FLOSS firms.

After the exhaustive systematization of the different studies carried out to study innovation, it is possible to recognize some central aspects that will allow to approach future surveys designs that have the object the studying innovation in FLOSS firms. All these recommendations are a basis for proposing a questionnaire design that captures the particularities of the FLOSS sector and also be able to adapt to the needs of each region in terms of innovation measurement in order to truly capture its impact on developing economies. The proposed form can be found in Appendix 1.

As regards to the recommendations for the approach to the innovation axis, it is possible to be rescued that through the analysis of the systematization of international surveys in software and the academic surveys it is recommended to use the design used by Blanc (2015), indicated in section 3. For a survey module of innovation that combines standard questions according to the assimilation approach and these contributions in the direction of a differentiation approach. Therefore, in table 5.1 with our recommendations for this module are also the standard question about types of innovation and innovative activities. This will allow keep indicators and statistics comparable in international terms, while venturing specific models of measurement of innovation, designed for the activity of the software.

The recommendation also goes in the line of using the questions in the Blanc (2015) questionnaire, but to construct simpler descriptive and innovations rates, both based on typical Oslo Manual questions, and emerging from new ones. Table 5.1 details the questions we recommended to take into account, and in particular to his aspect.

Our recommendations in this point are influenced by the results shows in section 3, which shows the shortage in terms of dealing innovation activities from surveys identified globally in FLOSS firms. None of the reviewed surveys makes a significant contribution to the types of innovation introduced specifically by FLOSS firms. This underlines the importance of advancing in a qualitative analysis, through case studies that allow to elucidate the particularities of innovation in this type of activity. Several preliminary investigations have pointed out the pertinence of specifies that must be deepened (Borrastero & Morero, 2014, Morero et al., 2014a, Morero et al., 2015a).

Table 5.1: Recommendations for the design of an innovation module in technological surveys to FLOSS firms.

Aspects to analize	Recommendation	Proposal for questions design
Innovative activities and types of innovation	▪ Incorporate contributions from international software innovation surveys	• Types of Innovation: Introduction of new products and significant improvements, new services and significant improvements, new modes of marketing and organizational changes. Degree of Novelty (new for company, domestic or international market) • Innovative Activities. If you perform any of the following activities: Internal R & D; External R & D; Acquisition of machinery or equipment to develop new or improved products or services; Purchase of licenses or patents; Training for innovative activities; Marketing activities for the introduction of innovations; Design activities.
	▪ Combine standard questions from the Oslo Manual (assimilation criterion) with questions for a differentiation approach to the Blanc survey design (2015)	•Changes in the business model. If you have made changes to the way you sell your product, the way you distribute it, the license agreement, the services you offer the customer. Degree of novelty (new for the company or the market) • Variations in the life cycle of the product / service. If you have made changes to requirements taking, project planning, tracking, modeling, testing, implementation or software support. • Variations in core components of the product / service. If you have introduced new functionalities or modules to the program, partial or radical changes to the interface, changes to the access devices, the OS running your software, the development programming language, framework or tools, or the database.
	▪ Incorporate clarification on the use of R & D in FLOSS as use in ESFA-SI 2011 ▪ Conduct qualitative analysis on types of innovation in FLOSS	• Particularities of R & D Activities related to FLOSS: Implementation of internal R & D linked to FLOSS. Percentage of internal R & D linked to FLOSS

An important question that can be highlighted from the analysis of innovation surveys in FLOSS is the possibility of including in future work, an integrated module where the definition of FLOSS can be combined with business models. Therefore, table 5.2 summarizes our recommendations regarding these two aspects.

Table 5.2: Recommendations for identification of FLOSS firms and business models in technological surveys to FLOSS firms.

Aspects to analize	Recommendation	Proposal for questions design
Identification of FLOSS firms	▪ **Integrate contributions from the CENATIC surveys (ESFA-SI 2011 and CENATIC 2009) and FLOSS firms definitions from the studies that emerge from the ELISS Project Survey. Do it in a joint module with the characterization of the business model**	• Supply characterization: provision of solutions, productss or services based on FLOSS • Provision under FLOSS licenses • Proportion of sales from revenues for products or services based on FLOSS
Productive specialization and FLOSS business models	▪ **Define the business model by specifying in the software production, a value chain following the UNU MERIT and Berlecon Research (2002) criterion, the partial or total provision of the productive activities carried out with FLOSS.** ▪ **To synthesize and integrate the specifications of the productive specialization of the CENATIC surveys (ESFA-SI 2011 and Cenatic 2009), the CCTI 2009 survey and the characterizations of the studies that emerge from the ELISS Project survey; Together with the theorization of UNU MERIT and Belecon Research (2002).** ▪ **Complete this definition with specific contributions from the ELISS project (Boncaccorsi et al, 2006) and from ESFA-SI 2011 for product provision cases**	• Characterization of the business model through: 1) Specify which of these activities are provided in the company. Detail which are provided only via proprietary software, which totally or partially with FLOSS: ▪ Development of custom FLOSS ▪ Development of standarized products ▪ Documentation ▪ Packaging ▪ Distirbution, Sales and Marketing ▪ Consulting ▪ Implementation / Integration ▪ Training ▪ Support ▪ Application management and Maintenance (versioning, etc.) ▪ Systems and infrastructure management ▪ Outsourcing services ▪ Other services. Specify 2) Use of FLOSS licenses 3) Proportion of software product portfolio

In addition, regarding the identification of the FLOSS business model, our recommendation is to try to characterize the productive specialization or stages of the value chain of software production in which the firm undertakes to perform fully or partially with FLOSS. To do this, we have made a synthesis that seeks to integrate the various proposals for classification of the productive activity of the firm / activities of the value chain that performs, both the surveys we have reviewed and the theoretical literature. This proposal, to be counteracted empirically, is summarized in table 5.2. In principle, this proposal is not intended to be addressed through the proportion they represent of the firm's turnover. To make such an approximation, some adaptations must be made in this regard.

Also, we consider that the definition of the business model when the firm provides products is enriched if it’s completed it with questions about the use of FLOSS licenses for provisioning and the proportion of the firm's portfolio of products composed by FLOSS software.

Regarding external interactions, and in particular linkages with the FLOSS community, our recommendation is detailed in table 5.3 which explains how to address these points, as well as an exhaustive list of the forms of participation in the FLOSS community, that stressed not only the contributions of surveys, but also the bibliographic review.

Table 5.3: Recommendations for the design of questions about linkages and collaborations with the community in technological surveys to FLOSS firms.

Aspects to analize	Recommendation	Proposal for questions design
Linkages and collaboration with the FLOSS community	▪ Inquire about participation in FLOSS collaborative projects, based basically on the contributions of the ELISS Project	• Participation in community collaborative projects (led or third parties). Number of projects in which the firm has participated. Number of contributions you have made (approved by the community). Percentage of lines of code contributed
	▪ Inquire about the modes of collaboration with the FLOSS community. Combine a list of forms of collaboration between the contributions of the Cenatic Survey 2009 and the theoretical revision on the innovation process in FLOSS (section 1.3)	• Forms/Types of participation in the community: **1)** participation in FLOSS promotion activities; **2)** contribution of code to the community and the writing of complementary modules; **3)** socialization of experiences in associations; **4)** release of old software; **5)** participation in blogs; **6**) creation of artwork for projects**; 7)** packaging software; **8)** maintenance of repositories; **9)** donations and monetary contributions; **10)** preparation of documentation; **11)** Sponsorship; **12)** participation in forums; **13)** correction of errors or bugs; **14)** provide assistance in answering technical questions; **15)** translation of applications
	▪ Implementation of linking questions according to Oslo Manual, based on the CIS	• If you have cooperated in innovative activities with other companies or institutions: other companies of the corporation, suppliers, clients of the private sector, clients of the public sector, other companies of the sector, private consultants, universities and institutions of higher education and public or private technical assistance.
	▪ Incorporate these linkages questions into linking actors based on the ELISS survey	•Inclusion of types of actors. The FLOSS Community and distinguish within linkages with other companies: other non-sector firms, other FLOSS software companies, and other private software firms.

These thematic and analysis axes are relevant for the study of FLOSS firms and have been practically exhausted by the analysis of this paper. The area of types of innovation requires a deepening with qualitative analysis to evaluate if there are specificities of the free software activity that must be considered. Moreover, these recommendations allow the design of an innovation survey, together with the consideration of a module of competencies and capabilities of the firm, which has not been an axis of analysis of this paper. In addition, in our study there are antecedents in relation to surveys to take into account to initiate a design of this module. There are no previous studies that systematize the FLOSS surveys in such a comprehensive way globally, so this study sets a major contribution in the field on which to designs innovation surveys for the sector.

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Appendix: Preliminary draft for an Innovation Questionnaire for FLOSS firms

Module A: General Information

Name	
City	
Percentage of foreign capital ownership	……(%)
Business activity starting year	

A1. During the last year, has your firm sold FLOSS products, or does it provide services upon a FLOS product?

Yes ( ) No ( ) → pass to A.3

A2. Please specify the type of activities you develop in relation to open source software. Answer yes or no in each of the three activities.

	Provided exclusively with FLOSS	**Provided exclusively via propietary software**	**Provided both with propietary and FLOSS software**
1.The firm develops or keeps its own software product, uses a free software license to distribute and provides services around that product			
2. The firm provides technology consulting services (custom development, integration, parameterization, support, training, etc.) around open source software products.			
3. The firm provides systems consulting services (infrastructure, servers, networks, data processing center, etc.) around open source software products.			

A3. Specify which of the following activities are provided in the firm. Detail which are provided only via proprietary software, which total.

	Yes	No
Custom Software Developement		
Standardized Software Developement		
Documentation		
Packaging		
Distribution, sales and Marketing		
Consultancy		
Implementation /integration		
Training		
Support		
Application Management and Maintenance (versioning, etc.)		

System and Administration management		
Services outsourcing		
Other Services (specify)		

A4. Could you specify the type of services provided related to open source software?

	Yes	No
1.Software Edition		
2.Software Programming		
3.Software Consulting (on computer equipment, on systems and programs, in support of information technologies)		
4. Management of computer resources(outsurcing)		
5.Other services on TI and software		
6. Data processing, hosting and related activities services		
7.Websites Services		
8.Training		
9.Other services and activities		

A6. Of the total sales of the firm, estimate the percentage that corresponds to the sale of services and products based on FLOS software in 2017.
……. %

A7. What was your enterprise's total turnover for 2017?

A8. What was enterprise's total number of employees in 2017?

Module B: DEMAND

B1. Distribute the percentage of sales of the last two years according to the sectoral membership of its clients

Customer Type	Total
Primary Sector	
Industry	
Services	
Public Administration, Goverment	
End Consumer	
Total	100%

B1.1. Indicate in which area your customers use your products

Software is used to :	Yes	No
Administration and Management		
Goods production, soft and/or services		

Logistics, Transportation		
Advertising and Marketing		
IT Security		
Quality Management		
Sales and/or Purchases		
Training		
Customer Service		
Other:		

Module C: Linkages with FLOSS community

C1. Has the firm participated in FLOSS collaborative projects (led or third-party)?

C2.1 Indicate the number of projects in which the firm has participated.

C3. Indicate which of the following the form of participation in the FLOSS community was.

FLOSS promotion activities participation	
New code to the community and complementary modules writing	
Experiencies in asociations of socialization	
Old software release	
Blogs participation	
Projects Artwork	
Software packaging	
Database maintenance	
Donations and monetary contributions	
Documentation writing	
Sponsorship	
Forum participatiom	
Error or blugs fixing	
Supporting quiestions assistance	
Applications Translation	

C6. Indicate whether you have cooperated in innovative activities with the following institutions

Other firms group member	
Suppliers	
Private Sector Customers	
Public Sector Customers	
Private Consulting Firms	
Universities and Higher Education Institutions	
FLOSS community	

Other firms that not belong to the sector	
Other FLOSS firms	
Other proprietary software firms	

Módulo D: Innovation

D1. During the last years, any of the following innovative activities were carried out by the firm?

Activity	**No**	**Yes**
a. Acquisition of licenses related to new or improved products and / or processes		
b. Incorporation of generic / off-the-shelf software that implies improvements for the firm		
c. Acquisition of specific software for the firm		
d. Development of specific software for the firm		
e. Implementation of continuous improvement programs		
f. Reverse Engineering and Adaptation		
g. New products or process design		
h. Internal R+D: creative work carried out systematically within the firm to generate new knowledge		
i. External R+D: activities mentioned in *h* but where carried out to the firm by third party		
j. Consultancy received (to innovation on product or processes)		
k. Training oriented to the introduction of improvements in products and processes		

D2. Could you identify a group or a person from your firm that performs any of the "d" to "h" activities mentioned in the previous question?

No ( ) (goes to D5) **Si ( ),**

D3. If yes, how many people, on average, make up the group? ( )

D3.1 How often do these activities take place? Permanently ( ) or Depending on specific situations ( )

D3.2 Indicate whether this group constitutes a formal research and development department.

No ( ) Sí ( )

D4. Indicate whether the firm has introduced innovations and its degree of novelty during last three years

	No	Yes	Was **new to**			
			To global market	Local Market	To the Firm	To the Community
a) New Products						
b) New Services						
c) Significant improvement products						
d) New or significant improvement processes						
e) Marketing innovations						
f) Organizational changes						

D5. **Estimate the share of the following items in the total sales**

(If you have not obtained the results indicated, indicate the value zero where appropriate)

Product or service introduced to the market	% on sales
a)**NEW** products or services	%
b)**MODIFIED** products or services	%
c) Products or services that the firm sold before that **did not have changes until now**	%
Total sales	100%

D6. Indicate whether you have made changes to the business model

Modifications in the last year	Yes	No	Improvement
a)On how you sell your product			Yes ( ) No ( )
b)On how you distribute your product			Yes ( ) No ( )
c)Product license agreement			Yes ( ) No ( )
d) Services offered to the customer			Yes ( ) No ( )

D7. Indicate whether there have been variations in life cycle of the product / service

Modifications in the last year	Yes	No	Improvement
a)Requirements			Yes ( ) No ( )
b)Project Planning			Yes ( ) No ( )
c)Project Tracking			Yes ( ) No ( )
d) Molding (analysis and desing)			Yes ( ) No ( )
e)Testing			Yes ( ) No ( )
f)Implementation			Yes ( ) No ( )
g)Software Support			Yes ( ) No ( )

D8.1. Indicate whether there have been variations in components of the product / service

Modifications in the last year			Is it new in your product software context?	
	Yes	No	Yes	No
a)New features to the program				
b)New modules to the program				

D8.2 Indicate which of the following changes in the interphase have been made

Modifications in the last year	Yes	No
a)Partial Changes (i.g.change on a button)		
b) Radical change (i.g. Changes with regard to the user or program. Office 2003 to 2007)		
c) A customer request		
d)New modules or functions needs		
e)Have you made changes on the devices from which your software accessed (i.g.smart phones, tablets)		

D8.3 Indicate whether there have been changes to the platform and data

Modifications in the last year	Yes	No	Had improvement
a)System on which runs your software (i.g.Linux, Windows, IOS)			Yes ( ) No ( )
b)Programming language (i.g.C,C++,.NET,Java,Php)			Yes ( ) No ( )
c)Framework or hardware			Yes ( ) No ( )
d)Database engine			Yes ( ) No ( )