ciencias económicas 15.01 / enero–junio / 2018 / páginas 27–56 / Investigación

A Review of the International FLOSS (Free/Libre Open Source Software) Innovation Surveys

Análisis de las encuestas internacionales acerca de innovaciones en FLOSS (software libre y de código abierto)

Análise das enquetes internacionais respeito de inovações em FLOSS (software livre e de código aberto)

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Fecha de recepción: 10/10/2017
Fecha de aceptación: 12/05/2018

Abstract

Given the substantial growth that software and IT sector has had in the last decade, it becomes relevant to measure the impact that this expansion has had on the development of emerging economies. Specifically, the study of the FLOSS production activity is relevant given its contribution to the Knowledge Intensive Services Sector. The aim of this study is to design an innovation survey for the software sector that considers the FLOSS activity separately. Moreover, the paper describes an extensive systematization, evaluation and analysis of diverse technological surveys carried out on the software activity and the FLOSS surveys available specified at a firm level, as a way to collect all the possible background which allows proposing a questionnaire that measures the particularities of FLOSS.

Keywords
• *Innovation Surveys*
• *Software firms*
• *FLOSS*
• *Developers*

Resumen

A partir del crecimiento sustancial del sector de software y tecnologías de la información en la última década, resulta interesante medir el impacto

de esta expansión sobre el desarrollo de las economías emergentes. El estudio de la actividad productiva de FLOSS es especialmente relevante debido a su contribución al sector de los servicios intensivos en conocimiento. El objetivo de este trabajo es diseñar una encuesta de innovación para el sector de software que considere a la actividad de FLOSS de manera específica. Además, esta investigación describe la sistematización, la evaluación y el análisis de distintas encuestas tecnológicas realizadas sobre la actividad del software y de las encuestas acerca de FLOSS que están disponibles a nivel empresarial como un medio para proponer, sobre la base de todos los antecedentes que se puedan obtener, un cuestionario que permita medir las particularidades de FLOSS.

Palabras clave
• *encuestas sobre innovación*
• *empresas de software*
• *FLOSS*
• *desarrolladores*

Resumo

A partir do crescimento substancial do setor de software e tecnologias da informação na última década, é interessante medir o impacto desta expansão sobre o desenvolvimento das economias emergentes. O estudo da atividade produtiva de FLOSS é especialmente relevante devido à sua contribuição ao setor dos serviços intensivos em conhecimento. O objetivo deste trabalho é desenhar uma enquete de inovação para o setor de software que considere à atividade de FLOSS de maneira específica. Aliás, esta pesquisa descreve a sistematização, a avaliação e a análise de diferentes enquetes tecnológicas realizadas sobre a atividade do software e das enquetes respeito de FLOSS que estão disponíveis a nível empresarial como um meio para propor, sobre a base de todos os antecedentes que possam se obter, um questionário que permita medir as particularidades de FLOSS.

Palabras-chave
• *enquetes sobre inovação*
• *empresas de software*
• *FLOSS*
• *desenvolvedores*

1. Introduction

During the past decade, software and IT services sector have 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 enforce transversal effects of productivity increases on other industries or firms under its influence (Lavarello & 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 savings in foreign currency, by 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 import substitution policy. During this stage of industrialization in Argentina, imitation learning and adaptation were fundamental to local productive development. At present, FLOSS can play that role, enhancing the possibilities of learning in the industry (Moncaut & Robert, 2016). In this way, all firms have been challenged in their business opportunities and strategies by the expansion of FLOSS activity. This has stimulated a wide range of creative, organizational and business plan responses from a full range of firms, especially those that deliberately base their existence on the use and implementation of software produced within FLOSS communities. This and the substantive role that FLOSS activity has developed in the software industry at a global level and its contribution to the knowledge-intensive services sector (KIBS), it's what makes so necessary to have records of the FLOSS contribution to the software sector in Argentina.

Nevertheless, software innovation surveys in the software sector do not take into account FLOSS activity at a firm level. This could be explained mainly because it is difficult to measure a productive activity in economics terms when there isn't a clearly monetary outcome that can be quantified. How firms can function when their developments are free, often free-of-charge, or even what motivates them to collaborate in community projects that can then be used by other firms in their business offer, are some of the major difficulties of economics to approach FLOSS activity.

The need for a survey that takes into account the particularities that FLOSS production has, is based on how vital are technological surveys to an appropriate design of sectorial 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 particular surveys. These questionnaires function as a basis for the design and monitoring of innovation policies in the region, which lead to many of these countries scholars to take stock of the evolution of these surveys, its problems and its adequacy to the needs of the area, resulting in a recent concern and a need to consider new metrics in the measurement of innovation (Salazar, 2015).

The purpose of this paper is to contribute to the development of a measuring instrument (the design of a questionnaire) that takes into account the FLOSS activity and all the different types of innovation that a FLOSS process entails in the software sector. The benefits of this type of survey would include the potential generation of statistics and the impact of FLOSS in this given sector. The paper is part of a larger research project focused on making a methodological advance to the design of technological polls at FLOSS firms in Argentina (PICT 2015-2703 "*Procesos de innovación en empresas de software libre y open source en Argentina"*). This contribution is an exhaustive systematization and evaluation of previous technological surveys available in the software activity and in FLOSS worldwide.

The report is organized as follows: Section 1 develops the theoretical framework and definitions analyzed; Section 2 details the methodology carried out for the structuring of the present work. Then, Section 3 advances on the systematization of international innovation surveys in the software sector; Section 4 collects the information from the surveys of the FLOSS activity, displaying the results and concluding in Section 5 with our final remarks and recommendations.

2. Initial concepts: Software, Innovation and FLOSS' business models

To initiate a survey design in FLOSS is necessary to start with a conceptualization of what we attempt to measure; that is: what we understand as FLOSS, their economic activity, and innovation behavior. In this section, after some basic definitions below, we present some approaches of the business models in FLOSS (section 1.1) and some background in the innovation literature (section 1.2).

Software, as a product, can be distinguished accordingly to its gratuity and the 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 free, in the first case this character is limited to an initial period whereas for the second one, there are no charges for a 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 needed, it's called a standardized product. For its part, computer services are activities offered for customer satisfaction, around a particular software such as the provision of consulting activities, support, training and application management. This forms products and services matrices (UNU MERIT & Berlecon Research, 2002) that help providing solutions (which together involve products and services activities).

In terms of the approaches regarding 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 in manufacturing activities which points out that there are specific aspects involved in the production of services that make their innovation process so particular 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 (Gallouj & Savona, 2009; Drejer, 2004).

2.1. FLOSS: a brief history of Free Software and Business Models

The free software movement emerged from academic development centers (such as MIT) as a reaction in the early 1980's to a privatization process. It was inaugurated by Richard Stallman, who created a way to license software (the GPL-General Public License) granting the faculty to modify the code of the program on the condition that further products enjoyed the same license. Also, he helped create the Free Software Foundation - FSF, a non-profit institution that provides a legal framework for the development of SL (Stallman, 1983).

In a few words, we can say that 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). This 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 taken by specific 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) accept the four basic freedoms previously mentioned. An open source program may also be free software if it complies with the points established by the early movement.

To a large extent, the difference between the Open source and Free Software movements are philosophical. The first one emphasizes the speed of development and the quality of the software; and the other accentuates much more in 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, these can be used indistinctly or jointly, as we have adopted in this paper as Free / Open Source Software, FLOSS.

FLOSS has boosted a disintegration of the value chain of software production, allowing specific business models in the software activity, which can be typified in different ways (UNU MERIT & Berlecon Research, 2002). 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 these 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 & 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. Finally, the third step involves an effort to smooth the installation, generate good documentation that accompanies the system and creates productivity tools at the same time.

For Linux distributors, two market segments are recognized. On one side, the mass market, with standardized packages offered to SMEs and private consumers. This is separated from 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. Companies that have 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 an 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 is in the line between the activity of software and related services and another type of activity. Another "business model" that is in this kind of 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 absence of license fees is the common aspect of all of them, among which are some factual models related to the sale of services (support sale, facilitation of services), 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 consist in 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 are 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 a 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 alters and combine free and proprietary version of the same software. Thus, a gratuitous open source version of a commercial product is used to attract potential consumers and help the product portfolio of the firm to be known. 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 by 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 proceeds 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, sustaining 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 and driver's development is called Hardware Sales (or Widget Frosting), Raymond (1999a). In a way, this model takes over the original software development mode released for free, in order to be included as an accessory to 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 processes, machinery operations, CNC, etc. However, it may be relevant for firms that combine electronic activities, software and the provision of computer services.

Another possibility, at least theoretical, is to obtain incomes from Software Franchising. In this case, the business model consists in a medium-term possibility of revenues from franchising their brand to third parties for commercialize products or providing related services (or in a specific geographic or vertical segment), after the brand is recognized in the market for its FLOSS production activity. The franchise may include not only the use of the brand but also training and support services for the franchise. In a similar way exists Brand Licensing, where the firm would produce FLOSS but if can retains the trademark 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 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 and its community of reference.

2.2. 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 conducts or actions in order to be collected through the survey, as well as behaviors that are not of relative importance and. Also, that common practices that cannot be ignored in the study of innovation in this type of firms.. 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 about the relevant characteristics of this 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 & Cole, 2003; Von Grogh, 2003; von Hippel & 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 project's 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, the development of a collective socialization infrastructure and the sharing of tools, is what makes it possible to generate high-quality innovations (constant 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 & 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 firm 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 on 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, Piva & Rossi-Lamastra, 2013, 2014).

Companies can gain knowledge from the FLOSS 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 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.

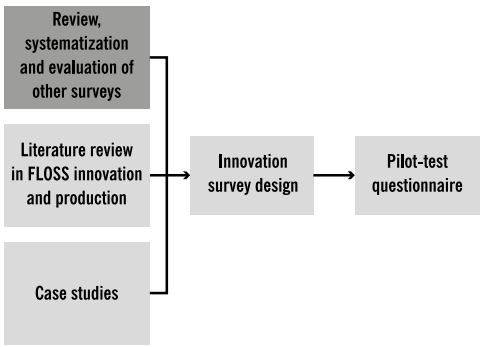
According to Colombo, Piva & Rossi-Lamastra (2013), the innovative process at a firm level includes aspects that motivate them to participate in FLOSS and in the community. Among them can be listed (Colombo, Piva & Rossi-Lamastra, 2013, 2014): an availability of inputs and tools that allows to develop custom tools; a strengthening of market positioning and reputation in the firm; improvements in marketing and commercialization and access to high quality programming capabilities, that would not be attracted based only in salary reasons, but that vision could change if we take into account the challenging nature of community-led projects of their own.

Carrying out a review of the background information about the FLOSS activity is essential in order to continue 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.

3. Methodology

The paper is part of a larger research project focused on making a methodological advance to the design of technological surveys at FLOSS firms in Argentina (PICT 2015-2703 "*Procesos de innovación en empresas de software libre y open source en Argentina"*). Figure 1 below summarizes the complete research strategy to the design: a systematization and evaluation of international innovation surveys available, a profound review of innovation and economic literature on FLOSS, case studies in a qualitative approach, and to put all their results in a comprehensive design to perform a pilot survey, to calibrate the questionnaire.

Figure 1. *Research strategy and focus of the paper.*



Source: *Prepared by the authors based on the research strategy*

The particular contribution of this paper becomes the first of these activities. Therefore, the objective of the article is to carry out an exhaustive systematization and evaluation of previous technological surveys available in the software activity and in FLOSS worldwide. The other activities were performed simultaneously and their contributions are in other papers presented elsewhere (Fernández et al., 2017; Morero, Motta & Ascúa, 2017; Morero, Motta, Ortiz & Vélez, 2017).

In that sense, the methodology of this paper is composed by the systematization and evaluation of innovation survey's background in software and FLOSS activity and its implications in order to elaborate an innovation survey to fill in these shortcomings. This systematization was done by highlighting the contributions of the surveys in four topics or "analysis axes" (identification of a FLOSS firm, business models, innovations, and linkages) and in two types of surveys (innovation surveys to software firms, and surveys to FLOSS firms).

In the first place, we conducted an extensive analysis of the available innovation survey in the software sector internationally. Surveys carried out in eight different countries, each one with different periods, a number of survey waves and observation periods were analyzed. The countries or regions studied were: The European community, Brazil, Canada, Mexico and Uruguay. The objective of this analysis was to create a theoretical background of the different ways of approaching innovation measurement in the sector, the results, and linkages that firms carry out.

Secondly, the international FLOSS firm surveys were analyzed and systematized. The existing surveys date from the mid-2000 and have different approaches. The analyzed surveys in this study are: i) European Free Software Survey (2003); ii) FLOSS World (2007); iii) Business Models in FLOSS-CCTI UNC (2009); iv) Survey of Free Software role in the software sector (CENATIC, 2009); v) Survey of open source software in the Spanish SI sector (EFASA-SI, CENATIC 2010/2011); and, iv) The comingled code: Open source and economic development, MIT Press Books (Lerner & Schankerman, 2013).

The conclusions from analysis and systematization were drawn in four analysis axes. First, to what extent do the surveys provide questions that allow us to identify a FLOSS firm, approaching some kind of definition of this type of firm, so that it can contribute in the future to various taxonomies. However, in this first instance we are interested in redeeming criteria that allow us to distinguish a firm of this type from one that is not and, on the contrary, its core business is in the private production mode. Secondly, we will be interested in visualizing the ways in which the different surveys can contribute to approximate the different FLOSS business models and to characterize their productive specialization. The latter is a particularly sensitive point in the case of software in general, given the enormous dynamics of the business schemes in this activity, while the approach to different business models FLOSS contributes both to the identification of firms of this type, as to approach some type of typology.

Third, we will try to highlight the extent to which this background contributes to identifying various innovative activities and types of innovation introduced by firms. The interest here is that the ultimate goal of the study is to contribute to the design of technological surveys in the sector. Finally, in the fourth place, we will try to highlight the approach to connectivity issues and linkages, but with a particular focus on links with the FLOSS community. In a way, this is a recurring axis in FLOSS surveys of all kinds (both at the developer level and at the enterprise level). The interest here will be in identifying the different types of existing collaborations, in order to get closer to a list as exhaustive as possible of the ways in which firms interact with the community.

4. 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 kinds of surveys: 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 1, and surveys performed by academic teams in the software sector.

Table 1. *International Innovation Surveys in Services*

COUNTRY	NAME OF SURVEY	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 y 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 ed.)
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

Source: *Prepared by the authors based on the surveys reviewed*

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 vary 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 measure innovation. On the contrary, 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 to measuring innovation as revised by Tacsir (2011).

Two cases that abandon the rule where identified as the OECD KISA project and the Mexican National Survey of Innovation 2001; both follow a differentiation approach.

The KISA survey, on the one hand, has a unique design for the software sector, which represent the first diversion. Secondly, it's designed 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) 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, the differential strategy was abandoned in the following edition and the Mexican survey 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 taken 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 are highlighted. In Table 2 we can also find these surveys in a concise manner.

Table 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, Moreno y Borrastero, 2013, Morero, Ortiz y Wyss, 2014; Morero, Wyss y Sonnenberg, 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)

Source: *Prepared by the authors based on the surveys reviewed*

The main objective of 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 & 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 is 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, its estimation of innovation indicators (assimilation vs. differentiation approach) we consider that his biggest contribution relays in the survey design. The recommendation in this regard is useful when constructing descriptive statistics of innovation rates rather than constructing the indicators that combine various vectors that address those 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 a reference only the last year. This should be considered in due course.

5. International surveys of FLOSS activity

As mentioned above, the principal contributions in order to understand the innovation process carried out by FLOSS firms will be presented in four analysis axes: I) identification of FLOSS firms; II) approach to FLOSS firms business model and productive specification; III) innovation process and innovative activities and; IV) linkages with the FLOSS community. Table 3 below summarizes the contribution of each of the FLOSS surveys analyzed to these topics, which are explained in the followings subsections.

Table 3. *International FLOSS firms surveys*

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.	Productive specialization: Maintenance, support, development of ad hoc solutions, distribution, marketing of software products developed by other companies, consultancy, training and R & D services	Cooperation agreement for innovatios	Department of Engineering of PISA University	Types of innovation (new or improved products) amount and degree of innovation.
			Supply of FLOSS solutions	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	Degree and type of participation in FLOSS community		Proportion of the billing of innovation
			Authorization for employees to cooperate on FLOSS projects during the working time	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	Participation in FLOSS promotion activities		Innovation activities, R&D activities and external acquisition of technology
				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			
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

[Continued on next page]

Table 3. *International FLOSS firms surveys [cont.]*

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
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

[Continued on next page]

Table 3. *International FLOSS firms surveys [cont.]*

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
Software Developers Survery 2010	Brasil, Chile, China, France, Greece, India, Israel, Kenia, Mexico, Polonia, Rusia,South Africa , Singapur, Taiwan, Turkey n= 1894	2010	If the company participate in the development or customization of open-source operating systems or applications The proportion of the total software development or custumization devoted to open source software. And hors devoted to open source The proportion of developers experienced in open source software developement or customization	1.Pure Developers: A company that develops new or original software. The software your company develops is then sold to either the final users or to hardware manufacturers who then install the software on machines they manufacture. 2.Custom Developers: A company that adapts or customizes software that has been developed by another company. The software that is adapted or customized by your company is then sold to either the final user or to hardware manufacturers who then install the software on machines they manufacture 3.Bundle Developers: A company that manufactures computer hardware and develops original software or customizes software that has been developed by another company. 4.Support Developers: A company that provides software support services to customers that have software developed by another company. Although the company's focus is to provide software support services, the company develops or customizes software in the process of providing those services	Not Adresseed	Lerner and Schankerman	Not Adresseed

Source: *Prepared by the authors based on the surveys reviewed*

5.1. FLOSS firm identification

Regarding the different contributions within the identification of a FLOSS firm, the most outstanding and potentially useful contributions are in the CENATIC surveys, Lerner and Schankerman survey and the various definitions that emerge from the ELISS project studies. Four aspects are combined: I) whether the firm provides solutions, products or services based on FLOSS (Bonaccorsi, Giannangeli y Rossi, 2006, CENATIC, 2011, Colombo, et al., 2013); II) if the firm offers software products, the issue of the license used for this marketing (Bonaccorsi, Giannangeli y Rossi, 2006, CENATIC, 2011); III) the proportion of sales from revenues from FLOSS services or products (CENATIC, 2011) and; IV) hours developer devoted to open source developments and applications (Lerner & Schankerman, 2013).

Among these contributions, the I, II and IV proposals could be 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, from those which bases its business model on proprietary software. The remaining contribution based on the revenue share from free software activity, which potentially contributes to an identification of FLOSS intensity in a firm. At the same time, it supports the empirical evidence pointing out to the predominance of hybrid provisioning methods that combine closed-source and open source software.

It needs to be emphasized that the Lerner and Schankerman study indicates that taking the developer hours to identify FLOSS firm it's preferable to share of revenues as it is directly linked to an effort indicator. However, these conclusions reinforce when analyzing the percentage of income from open source projects (Lerner & Schankerman, 2013).

There are two other contributions to be pointed out. First, the 2009 CENATIC survey presents a distinction of what constitutes a FLOSS case by considering not only the production and provision of products or services but also the development of R & D activities within FLOSS (it means that it includes cases where the firm does not develop a business model that provides income from FLOSS, but does conduct research and creative activities that contain it), either in a partial or total way. 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 specific 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.

Other identified distinction is contained in the article by Colombo, Piva & Rossi-Lamastra (2014) based on the ELISS II survey, which is the criterion of considering FLOSS as firms that authorize their employees to collaborate with community FLOSS projects during working hours. This is a very narrow view 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 firms 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.

5.2. Business Model and Productive Specialization

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 franchise and trademark licensing).

However, the cutoff criterion for identification of the business model was not provided. In any case, we consider that this constitutes a better contribution to the specification of the productive specialization of the firm. To do this we take into consideration: 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. 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 firm but distinguishes whether it is performed only under FLOSS or proprietary software (or maybe both). The productive activities that are considered are software development (distinguishing customized developments and 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). It puts forward, *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.

Two contributions can be highlighted from the ELISS project in order to characterize the productive structure. Bonaccorsi, Giannangeli y Rossi (2006) described 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 Harrison and Koski (2010) the services supplied by the firm are organize 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) shown 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 effective way to approach the business model of the firm in a firm-level survey.

It is necessary to try to integrate the different proposals of classification of the productive activity of the firm or the activities of the value chain that are carried out by the firm, and to weight the relevance or probability of response in a survey that asks this through the proportion that these activities represent of the company's income, sales or invoicing. In the final section, we make a proposal to integrate the different contributions made by those productive activities, combining in it the insights of the theoretical literature.

In some cases, in the framing 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 likert 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.

5.3. Innovation and Innovative activities

Is 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). Another possibility is that it might follow 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 on 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.

In order to measure innovation in FLOSS, is preferable to include typical standards of innovation surveys in the software sector that follow Oslo Manual (as the reviewed in section 3), with improvements coming from the qualitative analysis (see, for example, Morero, Motta & Ascúa, 2017).

5.4. Linkages with FLOSS community

Regarding external interactions, and particularly the 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 to the future design of technological surveys in this regard are: a) consideration of participation in collaborative projects in the community; b) the typification of the different forms of involvement 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, Rossi & Scateni, 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 one have made and the percentage of lines of code of the FLOSS projects it has 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 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 catalog as exhaustive as possible about the forms of interaction and to achieve measures of intensity. The most significant 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 comprehended 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.

6. Final remarks: some recommendations to design a pilot FLOSS firm innovation survey

After an exhaustive systematization of different researches that study innovation, it is possible to recognize some central aspects that will allow capturing the particularities of the innovation process in FLOSS firms. All these conclusions form the basis of a questionnaire design that suits the needs of each region in terms of innovation measurement and truly captures its impact on developing economies. The proposed questionnaire form can be found in Appendix 1; it captures the advances not only of this review of past surveys but also complementary qualitative work performed in cases of SMEs FLOSS firms of Argentina (included in Appendix). As final remarks, we highlight the contributions to the actual questionnaire that is being implemented.

A relevant issue in the proposed form that needs to be highlighted is the possibility to include an integrated module where FLOSS firm definition can be combined with business models.

Furthermore, to the identification of the FLOSS business model, the recommendation that arises 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 need 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 that has been presented in section 1.

Also when the firm provides products, the definition of the business model is enriched if it's completed with questions about the use of FLOSS licenses for provisioning and the proportion of the firm's portfolio of products composed by FLOSS software. This can be seen in the questions A.3 and A.4 (see Appendix).

As regards about the findings from the innovation and innovative activities axis, it has become evident that through the analysis of the systematization of international surveys in software and the academic surveys, it is recommended to follow the design used by Blanc (2015), indicated in section 3, as a complement to traditional measures of innovation. For a survey module that combines standard questions according to the assimilation approach and these contributions in the direction of a differentiation approach. Therefore, questions in module D on the questionnaire (see Appendix) combines these new methods to measure innovation and also includes the standard question about its types and innovative activities. This will allow keeping 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 establish simpler descriptive and innovations rates, both based on typical Oslo Manual requests and emerging from new ones. Our recommendations at this point is driven by the results shows in section 4.3, which describe 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 elucidating the particularities of innovation in this type of activity. Several preliminary investigations have pointed out the pertinence of this specification and there were taken into account in the design (Borrastero & Morero, 2014, Morero, Borrastero & Ortiz, 2014; Morero, Borrastero & Motta, 2015; Morero, Motta & Ascúa, 2017; Morero, Motta, Ortiz & Vélez, 2017). Another important question that can be highlighted from the analysis of innovation surveys in FLOSS is the possibility of including, in a future work, an integrated module where the definition of FLOSS can be combined with business models.

Concerning external interactions, and in particular linkages with the FLOSS community, our recommendations are based on an extensive inquire on FLOSS collaborative projects, either by using FLOSS software or by working with the community. One interesting aspects that are worth mentioning are related to questions C.3 and C.4 in which is asked not only the different of the forms of participation in the FLOSS community but also of the firm has cooperated in any innovative activities with other companies, suppliers, clients of the private sector, clients, universities or institutions of higher education, in a way of collection as much information on linkages and the actors involved in it as possible.

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 innovation types was enriched through a deep 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 a

module of analysis of this paper). In addition, in our study, there are background cases related to surveys that take into account in order 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	YES
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	YES
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	YES
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	

MODULE 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) Yes ( )

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 ( ) Yes ( )

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

	NO	YES	WAS NEW TO			
			GLOBAL MARKET	LOCAL MARKET	THE FIRM	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	YES	NO	IS IT NEW IN YOUR PRODUCT SOFTWARE CONTEXT?	YES	NO
a)New features to the program			a)New features to the program		
b)New modules 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	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 ( )