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Tracking Diffusion Patterns in Techno-Economic Paradigms: A Methodological Approach for Bolivian FLOSS-Learning

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1. Introduction

The paper examines technological 'catch-up' in the Information and Communication Technology (ICT) sector through an indigenous process of learning that is based on public software institutions and a corresponding use of Free / Livre and Open Source Software (FLOSS). Although, wealth creation is aspired at the end, indicators -such as national growth or growth of income per capita- give little insight into the various aspects of development variables and mechanisms. Creativity, innovation, imitation and diffusion processes are transdisciplinary in nature with a need for integrative approaches and methodological pluralism.

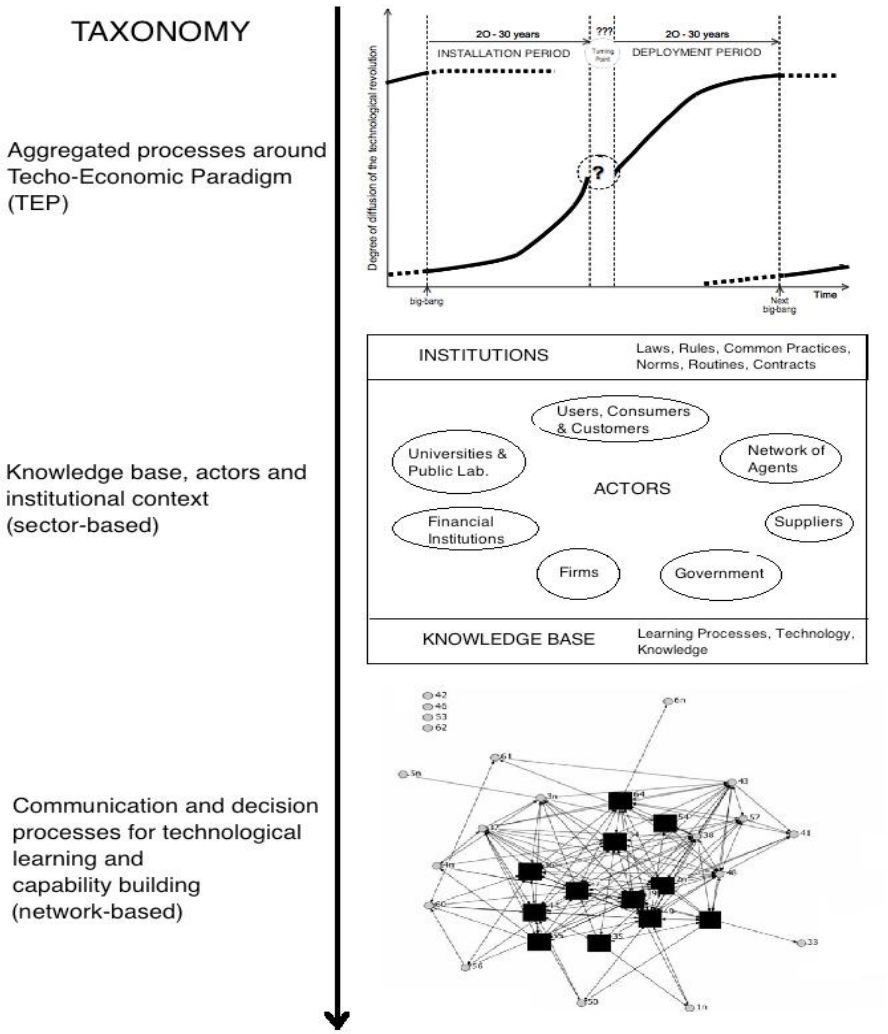
The ICT-based paradigm analyzed in this paper is a broad and accepted logic within society (including government) to exploit the open source movement and its platforms, i.e. to benefit from the common interest and practice of individuals to voluntarily exchange advice, ideas and problem solutions with others. As Perez (2012: 7) has pointed out: "The open source movement has lowered the cost of software for individuals, schools, companies but most of all it has provided a collective learning platform for potential innovators". Thus, it is not surprising that governments have tried to advocate the use of FLOSS as described by Shaw (2011) in a historical case study for the Brazilian government under President Lula da Silva. Yet, these case studies are still rare.

The authors follow the proposal of Carlota Perez (2012: 18) that evolutionary research should be a consciously "moving science" which allows to get stimulated by ideas outside of one's own science even if this is risky due to "breaking with the tradition of cumulative knowledge". The ideas that stimulated the authors stem from sociology-based diffusion models in the tradition of Rogers (2003) to better grasp awareness, acceptance and decision-making factors among individuals and actor groups in a network context. Diffusion then results from the dynamic coordination of creative agents that rather correspond with the "homo oeconomicus maturus" suggested by Frey (1997: 113) than with a homo oeconomicus whose rational utility optimization is assumed to determine human average behavior. Goal is to integrate

corresponding insights on the micro level into the discussion of the Techno-Economic Paradigm (TEP) and its implications for National Innovation Systems (macro level) and sectoral systems (meso-level). Figure 3 shows the approach on a taxonomy scale.

In the following two chapters, the authors explore the latest ICT-driven paradigm shift with regard to FLOSS while adapting the methodology of social network analysis to the Bolivian case. As this is the first step of a rather new research track, the focus of the paper remains on methodology alone. Next steps are to apply this methodology in the context of FLOSS learning and adoption in Bolivia and to finally feed the results back as an advance in future TEP-oriented discussions.

Figure 3: Tracking Diffusion Patterns in Techno-Economic Paradigms



2. Techno-Economic Paradigms, Sectoral System Approaches and the Need for Diffusion Models

Nowadays' research on economic development still profits from the insights of Atkinson and Stiglitz (1969), Rosenberg (1976), Nelson and Winter (1977), Dosi (1982), Freeman, Clark and Soete (1982) and Perez (1983) who went deep to understand technical change and its drivers from micro to macro level and to conceptualize the insights as 'technological trajectories', technological systems' or 'technological paradigms' and to foster the establishment of evolutionary theory. Yet, it was Perez who shaped the approaches into the one of techno-economic paradigms (TEPs) that at the same time tackles the understanding of instable growth patterns as well as the incentive systems and absorptive-capacity issues of all contributing organizations involved. Perez (2009: 9f.) sums it up as a "set of most successful and profitable practices in terms of choice of inputs, methods and technologies and in terms of organizational structures, business models and strategies" until a shared logic is established.

Information and communication technologies have largely contributed to such technological catch-up processes as drivers and are therefore called the basic technology of the fifth Kondratieff cycle (Nefiodow 2001: 177). It is to this background, that the authors refer to an ICT-driven paradigm.

In the course of these systemic changes, more and more locked-in practitioners either disappear or adapt to the new paradigm until this paradigm, too, alongside with its differentiations becomes less radical, shorter in product-life-cycles, more standardized and user-conditioned and finally mature and exhausted at the end. Thus, every single technology gets reduced in its variety over its lifespan through a need of simplification (micro variety) but contributes to macro variety through an increasing number of modifications and thereby an increasing complexity between corresponding technologies. It is to this systemic background, that economists have stressed the "crucial role of government policies to cope with the uncertainties associated with the upsurge of a new techno-economic paradigm" (Cassiolato / Bianchi Pagola / Martins

Lastres 2011: 52) also with regard to developing countries. Even if there is motivated doubt about the effectiveness of state action, evolutionary theory acknowledges the need for economic policy "to keep options open: to stimulate and protect technological and institutional diversity" through e.g. the educational system, the research system or other adequate means for economic and as well socio-institutional transformation (Dalum / Johnson / Lundvall 2010: 296).

Due to all these dynamic changes and shifting patterns, the analytical challenge is huge and has led to different approaches. Among these approaches is the concept of national systems of innovation that is more aggregative and offers a historical interplay of broad characteristics such as social, institutional or cultural factors. And there is the concept of sectoral studies indicating that the development of modern technologies is closely intertwined with the development of modern firm organization. It provides a better understanding of techno-economic developments that significantly differ across industries and require "to tailor practice to local circumstances" as Malerba and Nelson put it (2010: 5). By identifying (i) knowledge base, (ii) actors and (iii) institutions as main analytical elements, context-specific environmental conditions can be recognized and help to better grasp technological learning, capabilities and behavioral responses and track the agents' heterogeneity in experience and organizational solutions that result from these processes.

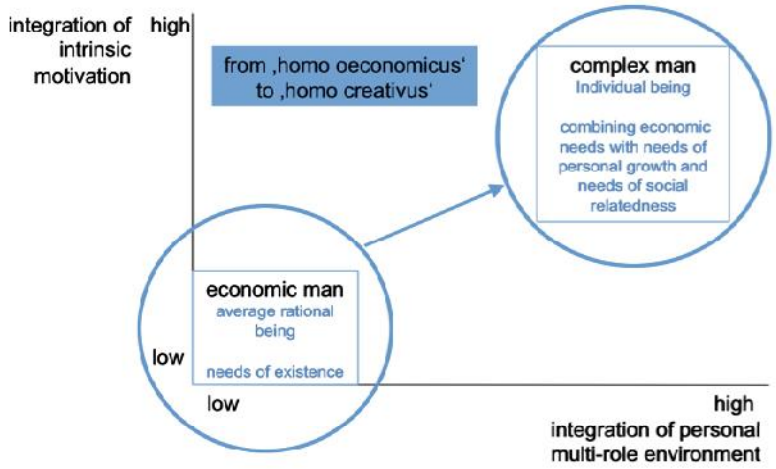
The ICT sector itself comprises several industries which support the production, processing, archiving and retrieving of information through computers, telecommunication and semiconductors (Low 2002: 21) and which despite of their differentiated features are technologically related. Within the ICT sector, it is especially the FLOSS-based markets which reflect the sector's network characteristics and dynamic changes.

Like in evolutionary economics, diffusion approaches reflect the incentive systems of actors for adoption and emphasize the importance of interpersonal linkages and network structures because successful diffusion needs awareness and acceptance among all actor groups. Yet, innovation system approaches on a national and sectoral level still tend to neglect motivational factors (like Preiser 2006; Frey / Neckermann 2008; Burger-Menzel 2011) and the fact that

there is a social embeddedness behind formal network structures that is informal in nature (e.g. trust networks) and can lead to a multi-role function of an individual (Cross / Parker / Sasson 2003). Thus, as to Blau and Scott (1962: 69): „It is impossible to understand the nature of formal organization without investigating the networks of informal relations".

Sociologists have worked upon how to make invisible networking visible and by doing so to reveal ways how expected utility is transmitted among individuals, groups and networks. Using these insights can help to enrich diffusion strategies within new techno-economic paradigms through aspects that include motivational structures (e.g. the value of individual autonomy) and personal multi-role environments (e.g. being entrepreneur and opinion leader at the same time). The authors assume that it is this complex individual (figure 2) and not the average rational being who technologically learns and creates solutions which are specific to situations and can give momentum to a new economic and socio-institutional development.

Figure 2: Technological learning and the idea of man



Own figure

The 'homo creativus' is not a simple man but rather the 'complex man' of Schein (1980: 94f.) who states: "…rational-economic, social, or self-actualization assumptions … may be wrong in some situations and with some people. Where we have erred is in oversimplifying and overgeneralizing."

Software developers traditionally have a high degree of cross-border cooperation triggered by a rather standardized infrastructure, common programming features and globe-spanning practices with needs of exchange.

Yet, FLOSS communities have created a new type of virtual networking with dynamic social groups that function in a cooperative self-organized way. By taking their specifics into account, diffusion patterns can be tracked a lot more precisely. In the following, the introduction into Free/ Livre and Open Source Software is structured according to the sectoral system approach of Malerba and Nelson (2010).

3. FLOSS within the ICT-paradigm: The Visibility of Diffusion Patterns

As mentioned above, learning dynamics and capabilities development are partly sector-specific (Malerba / Nelson 2010). The following sections analyze the elements of the sectoral innovation system for FLOSS: (a) actors, (b) knowledge base, and (c) institutions. In addition to that, reference is made to the situation in developing countries.

a. FLOSS Knowledge Base

Innovation in software and ICT-related sectors is mostly incremental and knowledge exchange is their main innovation mechanism (UNU-MERIT 2006: 116). FLOSS communities generate continuous improvements in the source code by online interactions. In addition, there are agile interchanges to coordinate further developments of a project. Innovation in FLOSS development is characterized as follow (Feller et al. 2002: 84):

- It is parallel rather than linear;
- it involves large communities of globally distributed developers;
- it utilizes truly independent peer review;
- it provides prompt feedback to user and developer contribution;
- it includes the participation of highly talented and motivated developers;
- it includes increased levels of user involvement;
- it makes use of extremely rapid release schedules.

These characteristics denote ongoing exchange and high coordination among FLOSS community members. As a result, FLOSS projects create a learning environment where tacit knowledge switches continuously to codified knowledge (Burger-Menzel / Cabero 2007). Community members have access to the source code and can take part in the online interactions (e.g. via public repositories, concurrent versions systems, or mailing-lists).

The FLOSS learning environment covers all different types of software. There are several distributions of the Linux operating system (e.g. RedHat, CenOs, Debian, Ubuntu, etc.), complex middleware and server applications (e.g. Apache Axis2, Jakarta Tomcat, JBoss etc.) as well as desktop tools (e.g. GNOME, Open Office, Geeqie, Fedora, etc.). FLOSS products also include numerous applications for specific usage related to business, education, engineering and others. The thousands projects available at FLOSS repositories like Sourceforge demonstrate how diverse and rich this knowledge base is.

Since the FLOSS environment is not restricted by paid licenses, prices or the power of countries and corporations (UNCTAD 2004), actors have access to the knowledge base and can become part of the FLOSS learning environment with own contributions.

However, to be able to participate in FLOSS communities, actors in developing countries must have enough technical capabilities, English language skills and adequate internet access. To fulfill these basic requirements at country level, FLOSS adoption has to be fostered by the state. Based on the requirements for public policy in a learning society named by Dalum, Johnson and Lundvall (2010: 299), Table 1 provides examples for policy guidelines towards ICT and FLOSS learning platforms.

Table 1: Policy implications for a learning ICT-economy and society

Requirements	**Examples**
Dalum / Johnson / Lundvall 2010: 299	Low 2002; Burger-Menzel / Cabero 2007; Burger-Menzel / Assadi 2010
Means to learn	Education and training in ICT and FLOSS, including English training.
Incentive to learn	Reduction of regulatory barriers to apply FLOSS-barriers; reduced assistance to multinational enterprises which enhance proprietary software alone; investment incentives.
Capability to learn	Flexible access to a broad variety of services with compatibility, accessibility, installation, upgrading and payment options.
Access to relevant knowledge	Advanced ICT and energy infrastructure; architecture and connectivity; capital inflow and technology transfer with focus on ICT- and FLOSS-related science-industry linkages.

Remembering and forgetting Compensation schemes for ‚victims' of an ICT-based society through options to share scarce resources.

Utilizing knowledge FLOSS-related e-government and e-administration to change national culture.

Source: Burger-Menzel / Cabero (2011)

While policies to foster FLOSS across the economy are important, they are complemented through economic, social and political relationships. These relationships determine the incentives and possibilities of learning (Johnson 2010: 705). In the following sections, the authors describe the actors of the FLOSS arena and the dynamics of FLOSS institutions.

b. FLOSS Actors

On the supply side, there are FLOSS communities (like Linux, Firefox), FLOSS foundations, educational organizations and ICT firms that work on the software production and its distribution. On the demand side, end-users are firms, governments, organizations in general and individuals around the world. Within FLOSS communities, programmers develop new functions or bug fixes; these contributions are tested and evaluated by the core group and eventually included in the new release. There are other community members responsible for code integration and code submission to users or commercial suppliers. To avoid chaos –as there might be in any project management– there are many cultural norms that govern the management of FLOSS (Feller et al 2002: 95-99) which are described in the section on institutions.

It is to note that FLOSS foundations (e.g. Free Software Foundation, Apache Foundation, OSAF, etc.) and large corporations (RedHat, Novell, IBM, Intel, Oracle etc.) substantially support the development of some projects (Corbet, 2007). The foundations are formed to promote the FLOSS principles, support communities and products for the somehow public good. In addition, firms in the FLOSS arena stimulate the adoption of products among other actors by supplying professional services. These professional services include the distribution of stable versions, training, support, documentation, and custom development. FLOSS firms can be specialized in one product or several products. Depending on their knowledge base, firms can extend the product functionality through integrations (as plug-ins, or add-ons) with other

products. FLOSS firms can also have partners in different locations to supply services on a broad scale and specialized FLOSS firms from developing countries have the chance to participate in these partnerships. These firms can then profit from the exchange with other FLOSS firms and communities.

End-users around the world (i.e. firms, governments, organizations and individuals) can download FLOSS products from the Internet and get support directly from online communities. End-users can also hire services from firms to get FLOSS products in usage. It could be expected that the more familiar the end-users become with the product, the more their awareness of other FLOSS benefits grows.

Software markets in many developing countries are characterized by reduced size of local demand due to a low diffusion of ICT and a typical size of software firms that is small and medium (UNCTAD 2004). This has relevant implications. First, governments in developing countries generally are the largest consumers of ICT, therefore governmental action is crucial in setting up the required interaction for the diffusion of FLOSS. Second, when relevant local demand is in place, the local software industry might have the incentive to also turn to FLOSS and develop capabilities. This could also be fostered by broad government adoption. Third, universities and educational organizations play an important role not only as end-users, but also by supporting the building of local technical capabilities for the software industry.

In addition, there is evidence that FLOSS supports the upgrade in ICT performance in SMEs, i.e. small and medium enterprises (Gosh 2006: 92-94). Although this evidence is not totally conclusive, it shows a positive contribution of FLOSS adoption to the learning dynamics within the SME-sample. Thus, in general SMEs actors in developing countries could benefit from FLOSS in relation to their learning dynamics.

As learning is anchored in the institutions of a society (Johnson 2010: 705), the following section introduces into the characteristics of the software institutions in general.

c. Public FLOSS Institutions

Institutions can be understood as "humanly devised constraints that shape human interactions" (North 1990: 3). They can be formal or informal and can

affect the behavior of the actors by changing either actors' choice sets or their preferences. Effective institutions make certain forms of cooperation possible that would be impossible without them (Schwarz 2010). Indeed, the FLOSS system of institutions presents a substantial evolution by defining norms and practices that guarantee the cooperation, exchange and interaction among online communities. These institutions make possible the participation of a massive number of actors in FLOSS projects. Actors contribute their resources for a wide variety of reasons which include both altruistic and self-interested motivations.

Schwarz (2010) argues that FLOSS institutions originate to solve inefficiencies of proprietary software. Proprietary software is distributed without the source code. It has copyrights and paid licenses for usage. Therefore only the proprietary software vendor, who has access to the source code, can perform product changes and improvements. Users, who paid licenses, must rely on the ability of the vendor for fixing bugs and develop functionalities on time and effectively. However, possible problems and limitations of the software are often discovered naturally by the users while the vendor may have to undertake prolonged testing. For the latter, errors may occur with low frequency or only when the software is used in specific ways that the programmers could not anticipate (Raymond 1999/2001). In addition to that, a high dependency on the proprietary software vendor causes underinvestment in complementary investments due to the fear of hold-up (Schwarz, 2010). Last but not least, when proprietary software is already adopted, actors have to pay switching costs to migrate to FLOSS such as training and support.

Software network externalities might increase migration costs when transversal applications only run in proprietary platforms. In such cases, it is required to develop FLOSS-compatible versions with such platforms, otherwise migrations to FLOSS could be blocked like it happened in the case of a Bolivian ministry that wanted to totally switch from Microsoft Windows to a FLOSS operating system called Ubuntu Linux. The migration was blocked because a software called DaVinci was only available for Windows and the vendor refused to develop a FLOSS-version of this software. Unfortunately, as

all Bolivian employees have to use the DaVinci software for monthly reports, the ministry's whole migration project in favor of FLOSS had to be stopped (Lima, interview with one author; June 15, 2013). This is an example of the hold-up problem mentioned above.

These inefficiencies can be solved when the source code is available. On the one hand, users are able to improve a product by themselves. On the other hand, if the new source code is shared, other users could also benefit from those improvements. Due to the strong network externalities common in software (Katz / Shapiro 1985, 1986), the larger is the user network, the bigger are the benefits of sharing. Source code access and sharing could also lead to a substantial reduction of the total social costs in software production.

Yet over time, the free distribution of a source code has required the definition of rules of the usage of the code. FLOSS institutions involve "licensing arrangements that prevent many forms of opportunistic behavior, new organization forms such as non-profit FLOSS foundations and new technical means for reducing the cost of collaboration" (Schwarz 2010). One relevant example of FLOSS institutions is the Free Software Foundation Manifest which outlines the software liberties, the copyleft definition and the rules for source code distribution among FLOSS projects under the GNU license.

Understanding the evolution of the FLOSS institutions highlights some challenges related with FLOSS diffusion. When governments initiate policies towards FLOSS, the diffusion of FLOSS should overcome established institutions of proprietary software.

d. Conclusions for Visible Diffusion Patterns

The sectoral innovation system outlines diffusion by defining the dynamics of knowledge exchange, the actors involved and how institutions influence the diffusion patterns. In the case of FLOSS, over the last decades FLOSS institutions have been evolved to guarantee and foster the free access to source codes. FLOSS communities that follow these norms and use corresponding online tools constitute the main medium for knowledge creation. Together with these communities, foundations and firms actively contribute to the virtual production of software. At the same time, end-users can download

FLOSS products from the Internet and can get support either from the communities or from firms that provide professional services around FLOSS.

Developing countries can benefit from free access to FLOSS knowledge base and from interaction with the worldwide FLOSS communities, firms and foundations. But in order to be able to diffuse FLOSS as a learning platform also for potential innovators, developing countries have to overcome challenges related not only to basic infrastructure (as adequate Internet access) or the development of technological skills but also to overcome challenges related to established institutions which e.g. still favor proprietary software. These challenges are not fully explained by the visible diffusion patterns as described by the sectoral system approach as the latter still remains too detached from personal or group decision processes. The following section proposes a framework to research the invisible diffusion patterns FLOSS for developing countries.

4. Diffusion Processes on the Micro Level: The Invisibility of Diffusion Patterns

Rogers (2003: 5) defines diffusion as "the process in which an innovation is communicated through certain channels over time among the actors of a social system". As highlighted in chapter 2 within a TEP a "vast diffusion is what really transforms what was once an invention into a socio-economic phenomenon" (Perez 2004). This diffusion affects social systems and actors across the economy for decades. Although a TEP span can be characterized and divided between installation and deployment periods (Perez 2006), the dynamics are explained on a more aggregate level. A closer approach is to analyze the sectoral system of innovations, as developed for FLOSS in chapter 3. But the complex and dynamic social systems, including their organizations and networks, their interrelatedness in knowledge exchange, learning and adaption processes as well as their including or excluding interactions to encourage or discourage changes still pose theoretical and empirical questions without answers. To reveal these invisible patterns of diffusion it is necessary to analyze the actors and their communication networks at the micro-level in more detail. The focus is to grasp the factors that make some actors of a social system adopt an innovation while others do not.

Within this context, the authors want to research the FLOSS diffusion process in Bolivia and to exemplarily reveal not only its visible but also its invisible patterns. Aim is to understand how the communication networks among FLOSS actors are built; which factors are interrelated and help to adopt FLOSS and if so, to which degree do they refer to a multi-role environment (especially to FLOSS opinion leaders and change agents); what are the institutions and norms that regulate the relevant networks; and how do FLOSS actors create a critical mass that is self-sustaining enough to simulate FLOSS diffusion and ICT-learning among policymakers.

The following paragraphs describe the methodology proposed for this research on Bolivia, outline its relevant actor networks for FLOSS diffusion and delineate the research scope.

a. Diffusion Processes and Social Network Analysis

The authors want to address the research questions through a sociological model of diffusion based on social network analysis (SNA). From a micro-level point of view, any diffusion process has four main elements: (1) an innovation as an idea perceived as new by the potential adopting unit, (2) which is communicated through channels, (3) over time, (4) among members of a social system (Rogers 2003). Due to its nature, sociological diffusion studies are focused on the adopting units (i.e. persons) and their embeddedness in communication networks (i.e. interpersonal relationships). Sociological research then provides concepts, models and sociometrics to map and measure the dynamics of diffusion processes. These approaches have greatly benefited from SNA and its insights on the nature of linkages among the units (as nodes) in a given network. The evolution of SNA-related sociological studies is introduced next.

As diffusions have an interactive nature and innovations are communicated between and across adopting units, early diffusion studies came up with a multi-role description of diffusion environments like in its focus on *opinion leadership*. This was measured as the number of sociometric choices received by an individual from the network partners. *Opinion leaders* are defined as those individuals with the highest number of nominations and

theorized to be a significant influence on the rate of adoption (Rogers 2003; Coleman et al. 1966; Rogers and Kincaid 1981).

The diffusion research in the 1970's has focus-shifted from studying the providing and the adopting unit to studying the communication network itself and interpersonal relationships and thereby trying to solve empirical challenges related to dyad, clique, network or system constellations (Rogers and Agarwala-Rogers 1976; Lin 1975). This context was further enriched by Granovetter (1973, 1982) through the concept of weak ties. *Weak ties* are network actors loosely connected to others in the network while allowing diffusion to occur across subgroups within a system (the so-called strength of weak ties). As next step, Burt (1980, 1987) concluded that there can be *structural equivalence* between constellations that means equivalent roles or positions in one social context can be used to understand diffusion in another.

Later, Valente (1996) incorporated threshold effects to allow for a modeling of critical mass. *Critical mass* is the point at which enough people have decided in favor of an adoption and thereby do sustain diffusion to the remainder of the population. Along with these sociometrics, there are other personal and social network features such as *centrality*, *density* and *reciprocity* (Wasserman, 1994; Valente, 1995) that can help to distinguish between a non-FLOSS-based and a FLOSS-based diffusion. More recently Giuliani (2009, 2011, 2012) applied SNA models to explore cluster-based learning processes. Such studies explored *absorptive capabilities* as social structure within clusters as well as dynamics related to *knowledge networks* and the role of *technological gatekeepers* within the clusters.

This evolution of SNA research with its exploration of learning dynamics in a systemic context offers an appropriate framework to pursue the research proposed by the authors.

b. Research on the Bolivian FLOSS Diffusion Process

The proposed empirical study will be contextualized through relevant Bolivian actor groups that as a starting-point will be described as networks for FLOSS diffusion such as:

- Software firms;
- Universities;

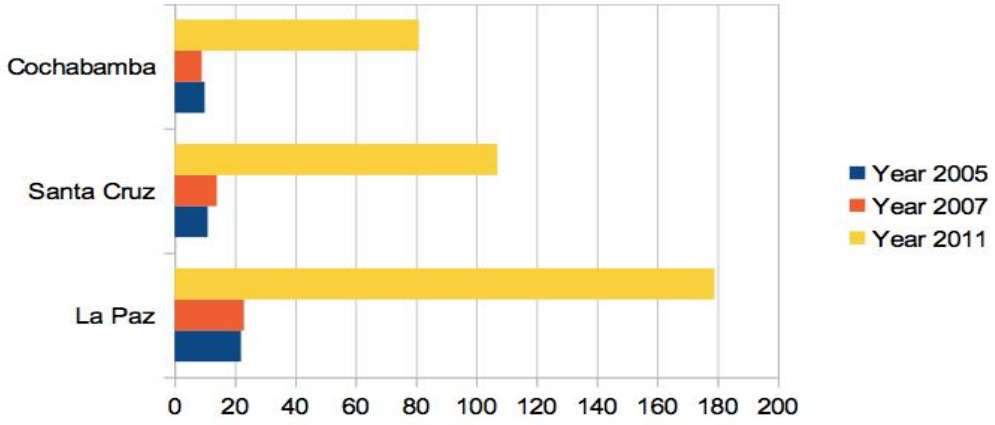
- Civil initiatives around ICT and Internet;
- Government.

In the following, we briefly introduce relevant characteristics of these network actors:

Software Firms

The Bolivian Chamber of Information Technologies (CBTI) reports at least 500 registered companies that develop software (Juarez Zeballos 2011). In 2011, a total of 367 new ICT companies were registered in FUNDAEMPRESA in La Paz, Cochabamba and Santa Cruz. This represents a relevant increase as shown in Figure 3. The majority of these firms is small- and medium sized and mainly specialized in equipment, software services and content.

Figure 3: Registered Companies in the IT Sector in FUNDAEMPRESA - Bolivia, Years 2005-2011.



180 200 Source: Ricaldez (2013)

As pointed out in section 3.b., FLOSS firms play a relevant role in the diffusion. Yet, they are not distinguished in the data presented in figure above. Therefore, during the study the authors will identify FLOSS-related firms which can be expected to cooperate internationally through their virtual channels as well as firms with international customers. As the latter have gained experience

in international markets, they have accumulated adequate technological capabilities for FLOSS diffusion.

Universities

There are 33 universities that offer computer science courses with about 1000 students graduating each year (MINEDU, 2007). Since 2006, students from Bolivian universities can participate of the international ACM International Collegiate Programming Contest (ICPC) (Pimentel interview with one of the authors, April 7, 2013). This worldwide contest is an annual multi-tiered competitive programming competition among universities. The contest fosters creativity, teamwork, and innovation in building new software programs and enables students to test their ability to perform under pressure [ACM-ICP, 2013]. Student teams around the World train themselves on online platforms in the resolution of problems applying complex algorithms. Training materials and online platform use English language.

In 2011, Bolivia participated in this world competition for the first time with one team that outperformed 80 others in a national selection process and was one of the 12 best teams in the Latin American round (Pimentel interview with one of the authors, April 7, 2013). Now, every year hundreds of Bolivian students are upgrading not only their technical but also their English skills by participating in local and regional ACM-ICPC contests. These skills are required to enter FLOSS communities (See section 3.a.). For this reason, the authors will analyze the network behind the organization of the ACM-ICPC contest in Bolivia. This network affiliates not only the Bolivian universities, but also firms and civil initiatives around ICT.

Civil Initiatives around ICT and Internet

Civil initiatives have played an important role for the FLOSS diffusion in Brazil under the administration of Lula. Shaw (2011) analyzed the process of FLOSS mobilization through a group of elites that achieved to "mobilize the state" and the IT sector behind their agenda. This study analyzes the rise of FLOSS advocates, their network mobilization within Lula's administration, the discursive mobilization conducted to change the public opinion and the level of institutional transformation achieved.

In the last decade, also in Bolivia civil initiatives have been formed around ICT and internet that tackle a variety of topics such as the support to software entrepreneurship, the presence of native languages in the internet, FLOSS, improvement of internet access, awareness of internet opportunities, and others.

While some civil initiatives are legally constituted (e.g. Software Libre Asociation, iFaro Foundation, Voces Bolivianas, Runasimi, Maya Foundation, etc.), others are not (e.g. Bloguivianos, Startup.bo, WebPrende, Comunicacion con Derechos, GDC, etc.). Active persons usually belong to more than one initiative, thus, there are strong personal connections among them.

In 2011 four civil initiatives constituted the "Committee of Technological Decolonization". This committee positively influenced the inclusion of article 77 into the Law 164 for Telecommunication (Beltran, interview with one of the authors, March 5, 2013) that states: *"The Executive, Legislative and Judicial Organs in all their levels will promote and prioritize the usage of Free Software and open standards for the national soberanity and security"*. The normative for implementing this article is not published yet. The authors want to explore how and whether these civil initiatives can effectively influence further implementation through their diffusion mechanisms. Here, effectiveness would be the creation of a critical mass that is self-sustaining enough to simulate FLOSS diffusion also among policymakers.

Government

As expressed in section 3.b., governments are extremely important in the socio-economic diffusion of FLOSS. The Bolivian government has started several initiatives towards ICT, for instance a National ICT Development Plan, the acquisition of a satellite to improve internet access, a new Telecommunication Law. But awareness and acceptance with regard to these measures still seems to be a critical (Burger-Menzel / Cabero, 2011). The authors want to explore FLOSS-relevant networks within the Bolivian government and analyze their norm-setting behavior as well as the institutions themselves that regulate further FLOSS-diffusion.

Research Design

The networks described will be analyzed as single-mode network and two-mode networks. A "mode" refers to a distinct set of entities on which structural variables are measured (Wasserman, 1994). Single-mode networks are when structural variables are measured within a single set of actors. Two-mode networks focus on two sets of actors, for example universities and firms respectively universities and government.

Structural variables measure certain types of ties between actors while composition variables help to analyze actor attributes such as personal characteristics. Both types of variables are important and will be included in this study.

The study will focus on the cities of La Paz, Cochabamba and Santa Cruz as these cities concentrate the majority of the network actors described above. The data collection will be through interviews with representatives of these networks. Apart from qualitative contextual information, the interviews will also be exploited to get quantitative indicators for the diffusion process. Prior to the main fieldwork, exploratory face-to-face interviews will be conducted with selected actors and FLOSS representatives to obtain in-depth information and data to build the roster required for SNA research.

It is expected that the study will be carried-out over a three-year period, thus, having to cope with dynamic changes that might occur in the FLOSS network meanwhile. It will be analyzed why actors in a group and network context take the decision to learn and adopt or not and to use these insights for improved policymaking.

c. Conclusions for Invisible Diffusion Patterns

The process of how a new technology diffuses throughout a society is extremely time-consuming because in the course of this diffusion old techniques, professions, habits and norms are destroyed. The same is true for ICT-based learning and corresponding technological catch-up processes which can take evolutionary unpredictable steps and directions as observed in the progression of FLOSS movements.

From the micro-level point of view, diffusion occurs in social systems with own dynamics and governed by specific norms. Sociological studies using networks models, concepts and sociometrics help to better understand diffusion processes at actor level and their nature of interrelationship. These models will be applied in the proposed research in order to further explore FLOSS diffusion in Bolivia.

By making the invisible web of relationships and action and reaction between people and networks visible for the Bolivian case, the authors want to empirically add to the multi-disciplinary understanding of the TEP framework.

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