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"Porque en realidad nuestro norte es el Sur" Joaquín Torres García

Knowledge sourcing, local and international spillovers and the novelty of technological innovation in developing countries. A panel data

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Resumo /Resumen

Despite a variety of knowledge sources that have been identified in the literature, the existing empirical studies tend to either focus their analysis on either a limited type of knowledge sources or on the choice of external and internal sources (the debate between complementary-substitution effects of internal and external sources). This study goes beyond the existing literature by identifying the relationships of various types of knowledge sourcing with the degree of novelty of innovation. Using a survey census of manufacturing firms in a developing country, this research identified, at the firm level, three types of knowledge sourcing spillovers: horizontal (competitors), vertical (supplier and clients), and science and technology institutions (universities and research centers). Moreover, by distinguishing the location of these sources (local or international), the relationships between local and international spillovers and the novelty of technological innovation are tested. The panel data analysis performed shows that regarding incremental innovations, spillovers from knowledge sourcing with competitors and suppliers are important, controlling for R&D investments, size and human capital variables. In contrast, spillovers from clients and science and technology institutions are significant related to radical innovations. Moreover, regarding the location of the spillover source, the analysis shows that the effect of international spillovers is higher than local spillovers on radical innovations, controlling for foreign ownership and the presence of R&D department.
Palavras Chaves / Palabras Claves: knowledge sourcing, spillovers, R&D, novelty of innovation, developing countries.

INTRODUCTION

The challenge for firms in developing countries is not only about whether or not to innovate, but also about increasing the novelty of their innovations in order to improve their competitive advantage and create opportunities to access new markets. This study pretends to contribute to advance knowledge about the novelty of innovation in manufacturing firms in developing countries by using as dependent variables both incremental and radical innovation. The research questions are: Do knowledge spillovers make firms generate radical innovations? What types of knowledge spillovers do make firms generate radical innovations in developing countries?

This study combines arguments from absorptive capacity theory and the theory of knowledge spillovers to construct a framework to investigate in what extent different types of knowledge spillovers affects the novelty of technological innovation. It build hypotheses on several specific types of spillovers by origin -local/international- and by source –customers, suppliers, competitors and science and technology institutions-. It's tested with a random-effects logit model with longitudinal data from an exceptionally large and detailed innovation survey in a developing country. Controlling for absorptive capacity, firm size, and firm ownership, this study finds preliminary support for the hypothesis that knowledge spillovers from clients spur radical innovation and partial support for the hypothesis that R&D investments spur radical innovation in developing countries.

Moreover, based on a deeper analysis were the sources of spillovers are disaggregated by their origin, i.e., local or international, the preliminary results challenge the hypothesis supporting that due to the benefits arising from interactive learning in a dense network of interactions between different local organizations - and the tacit knowledge it generates - lead to higher innovation performance of firms; one of the key ideas on which the literature on regional innovation and some approaches as industrial districts and RSI are based.

As this study support, firms relying only in repeated exchanges and knowledge from local organizations may suffer lower degree of novelty than firms' relying on international sources of spillovers. This could be explained because spillovers from local organizations can be detrimental to radical innovation, with repeated exchanges not leading to the generation of new knowledge which can be used and transformed into innovation by local firms. Too much interaction with local competitors and other organizations may lead to lock-in and therefore even

hamper novelty of innovation (Keupp and Gassmann, 2013; Boschma, 2005; Torre and Rallet, 2005).

This study has important implications for knowledge spillovers theory and the study of the novelty of technological innovation. It´s argued that as knowledge sourcing with different local organizations is established, local knowledge spillovers rises, increasing the likelihood and novelty of firm innovation, controlling for a series of related factors such as size, ownership, sector and R&D investments.

Additionally, knowledge sourcing with international organizations create benefits in form of international spillovers, which arising from technological and knowledge leading organizations, has positive influences on radical innovation. Further, in contrast to the local and knowledge spillover thesis which posits that interactive learning in a dense network of organizations in the local-cluster-regional level is important for competitive advantage and innovation, the empirical result implies that although knowledge sourcing with local organizations enhances the likelihood of innovation, it´s not sufficient to achieve a greater novelty of innovation. It is sourcing with international organizations, especially with universities and customers, that are necessary to innovate "new to the world", since they do have the knowledge at the technological frontier which can be used by firms in developing countries in their process of developing radical innovations.

To identify the factors that explain the degree of novelty of innovations for firms in developing countries, this study focused on the study of knowledge spillovers from different knowledge sources as predictors of novelty of innovation. In the empirical and theoretical literature, this kind of research is scarce. To the best of my knowledge, no empirical studies and theory linking different sources of knowledge spillovers to radical innovation in developing countries exist yet.

To the best of my knowledge, this study is the first empirical research that directly studies the impact on novelty of technological innovation of different knowledge sources and spillovers. Also, the empirical findings of this research challenge recent studies for developing countries that found significant effects on innovation of local spillovers.

Thus, this research further contributes to the understanding not only of the factors that are related to the firm likelihood to being innovative but also the likelihood of these firms to become radical innovators.

Another important contribution is linked to the reduction of empirical inconsistencies of prior studies which have not found significant evidences of spillovers measured at sectorial or regional level on firm innovation. By constructing relatively direct measures of spillovers at the firm level by means of the introduction of different knowledge sources through which knowledge is acceded, this study captures not only the spillovers mechanisms –a well-documented limitation of the "Pool" knowledge assumption and Knowledge Function Production approach-, but also the heterogeneities between firms on their reliance on external sources of knowledge, and their capacity to use it and benefit it from them.

Firm innovation in developing countries

Investigate the above questions in the context of developing countries is important because the proportion of firms that introduce innovations radically new versus those that are incremental varies significantly between developed and developing countries.

Whereas that most of the radical innovations are implemented by firms headquartered in the developed world, the innovation in the developing is often incremental in nature and behind the technological frontier. It is mainly imitative-adaptive innovation, and it is therefore more related to the acquisition of technology developed in the developed world and adapted to the local needs (Bell, 2002; Bell And Pavitt, 1993; Kim, 1997; Knell And Shrolec, 2009; Shrolec, 2008).

Thus, beyond the research on the innovation process focusing on knowledge spillovers, this study is important because is focused in the understanding of the main drivers of the novelty of technological innovation of industrial firms in a developing country.

The recent growth of Latin-American countries in the recent decade provided an interesting case for scrutiny to advance theoretical questions into the dynamics of technological innovation. The Latin-Americans firms are improving his performance in the international markets. It´s showed within the wide attention focused in the strategy management and international business literature to the phenomenon of "Multilatinas" (Cuervo Cazurra, 2001). With a well-known type of restrictions, Latin-American firms are becoming "global players" in some sectors and "catching up" to their advanced counterparts, after one period of drastic reforms that opened the economies. As competition in international markets is driven mainly by innovation, is logical to advance that the Latin-American firms are starting to improve their

historical internal weakness and restrictions related with R&D investments, learning and knowledge. Understand how this process is triggered by the benefits obtained from spillovers by knowledge sourcing with different organizations is an interesting opportunity to widening the knowledge about the dynamics of technological innovation in developing economies.

Another important issue is that many Latin-American countries do not have complete and varied databases, such as exist in North America or Europe. In some cases, data about some sectors or firms are simply non-existent. In those cases, the Latin-Americans scholars have been creative in selecting the source of information and in the data-gathering process, carefully selecting samples and securing high-response rates in the cases where they use a survey.

In response to these difficulties, many Latin-American scholars have used alternative empirical methods appropriate due to that large sample data are not available. Some of them include case studies, descriptive analysis, or qualitative comparative analysis. With the recent and new available data from firm innovation surveys in some Latin-American countries (for a brief review, see Castellacci and Natera, 2012) is possible to integrate firm and other level data in a research design.

This study pretends to advance the literature on the understanding of technological innovation of firms in developing countries in different ways. First, this study finds support for the hypothesis that related with spillovers and R&D investments, firms in developing countries are learning to how using the external knowledge available from many different sources in their innovation activities.

Second, most of the studies on the novelty of innovation consider either large firms or science-based firms in developed countries, focusing on R&D variables. This research contributes to advance knowledge on the degree of novelty of innovation in manufacturing firms in developing countries by focusing on one under-researched phenomenon: knowledge sourcing and it´s impacts on radical innovations.

By introducing new firm characteristics not accounted in past empirical research, this study brings new evidence about the role of knowledge sourcing spillovers and R&D investments on innovation activities. For firms performing radical innovations in developing countries is important rely not only in internal capabilities but also upon the spillovers from different agents, both national and international sources.

Because the challenge for firms and innovation policy in developing countries is not only about "being innovative", but also about increasing the novelty of the innovations, this study is among the first to empirically estimate the contribution of firm's knowledge sources on innovation. Moreover, grounding on the empirical findings of this study, is possible to formulate specific contributions to the design of innovation policies in Latin-American countries.

In terms of innovation policy in developing countries, the challenge for policy makers is to design better institutional tools in order to not only increasing the number of innovative organizations, but also to break out their historical low performance in terms of knowledge at the technological frontier: not only to increase the absorption capabilities of foreign technologies but also "catching up and leaving behind" the "under development trap". This research is just a modest attempt in the growing empirical literature on the economics of innovation focusing on Latin American countries.

The remainder of this research is structured in four sections. The second one reviews the literature. The third section develops the hypothesis on the likelihood and novelty of innovation and the expected relationships with different sources of knowledge spillovers, located at local and international levels. The fourth section describes the data and construction of the variables. The final section presents the empirical findings and the contributions.

2 LITERATURE REVIEW

2.1 The Likelihood Of Being Innovative And The Novelty Of Innovation

This study aims to investigate in what extent the determinants of "being innovative" and those related with the novelty of innovation in developing countries are different. A clearer cut definition of these related but different sides of the innovation process is important because, first, it allows differentiating innovative from non-innovative firms, as well as the determinants of product innovations. Second, by attempting to explain the degree of novelty of innovation it is possible to understand not only how the firms become innovative but also how do they become radical innovators.

The issue of novelty in technological innovation and its determinants has been present in the literature related to innovation (Becker, Knudsen and March, 2006). Since Schumpeter (1910) who made a clear distinction between radical and incremental innovations attending to his

technological content, and between creative vs. adaptative responses (1954), the degree of novelty has been related to economic and firm growth.

Radical innovations are the sources of the "creative destruction" and it's the engine of change and capitalism growth (Baumol, 2000). At the firm level, radical innovation is important because allow the firms to move away from current organizational routines (March, 1991; Miner et al., 2001), to replace current by new knowledge bases (Hill and Rothaermel, 2003; Katila and Ahuja, 2002), to develop a competitive advantage (Barney, 1991; Teece, 1996), and to redefine existing or create new markets (Abernathy and Clark, 1985; Benner and Tushman, 2003; Danneels, 2002).

Firms performing radical innovations often enjoy superior performance, whereas firms that fail are likely to lose market share (Christensen, 1997; Christensen and Bower, 1996; Leifer et al., 200). Despite the incremental innovations and the spread, diffusion and adoption of innovation seem reasonably well comprehended in the innovation literature, however what is missing is a theory of the endogenous generation of radical innovations (Becker, Knudsen and March, 2006); that is, what are the factors influencing the novelty of innovation.

2.2 The Novelty Of Innovation In Developing Countries And Knowledge Sourcing Spillovers

Starting from the statement that firms' novelty of technological innovation depends on a larger variety of internal and external sources (Amara, Landry, Becheikh and Ouimet, 2008; Amara and Landry, 2005), is important to investigate in whether specific factors for firms in developing countries are contributing to the still low but growing performance in international markets. If one assumes that innovation is a knowledge-intensive process, radical innovations imply a high proportion of newness and complexity, therefore, a higher diversity, quantity and quality of knowledge.

Maillat (1991) stated that firms that develop radical innovations reach the limits of their internal capabilities more quickly. Firms innovate on the basis of their internal capabilities and limited resources. If the limits of internal capabilities are reached, one could expect the innovation outputs to be constrained. The acquisition and use of external knowledge can overcome these internal deficits, resulting in better performance. Thus, in order to innovate successfully, they must overcome internal knowledge deficits by mobilizing and using different

external resources. So, one could expect that the complementarities between the use of internal and external resources (Cassiman and Veugelers, 2006) on novelty of innovation are high and stronger for radical innovations.

However, for firms in developing countries, empirical evidence has showed also some substitution effects, as firms will choose either to invest internally or acquire outside technology (see, Zuniga and Crespi, 2013). For firms lagging behind technologically, acquiring all of their technology externally may constitute the fastest and most economical way to catch up although this may increase their dependence on external (foreign) technology over time (Zuniga and Crespi, 2013, 4).

Although complementarities vs. substitution effects between external and internal knowledge sources remains an open question for firms in Latin American -question that it's not the interest here-, is clear that external knowledge sourcing is an important driver. Taking into account this, this research addresses the following general research question: How do knowledge sourcing influence firm technological innovation? This study does so by investigating the links between knowledge sourcing and the associated novelty of innovation.

To address this general concern, this research is developed in two steps. The first objective is with the ways in which knowledge sourcing spillovers contribute to the likelihood of technological innovation. The research question is: In what extent is important the knowledge sourcing with different external organizations for the firm´s likelihood of "being innovative" in developing countries?

In the second step, it having accounted the knowledge sourcing influences on the likelihood of technological innovation, the second objective is to deepen the analysis on determinants of firm's radical and incremental innovation. The main question addressed here is, ¿How do knowledge spillovers, which arise from the knowledge sourcing with different organizations at local and international levels, affect the novelty of innovation in developing countries? This second objective is addressed by formulating two specific questions. The first one is ¿How do knowledge spillovers from knowledge sourcing with competitors, suppliers, clients and science and technology institutions affect the likelihood and novelty of innovation in developing countries? By distinguishing the origin and location of the source of the knowledge spillover, the second question is ¿How do knowledge spillovers from knowledge sourcing with

local and international organizations affect the likelihood and novelty of innovation in developing countries?

The underline thought of this research is that many radical innovators in developing countries seem commonly rely on knowledge sourcing with different external organizations located at local or international level, because this allow them to benefit with novel and different ideas without pay for it.

Building on this, a model that provides insight into how a firm's knowledge sourcing processes influence its capacity to generate new radical innovations is tested. The research focus is on knowledge sourcing and the spillover specific benefits of customers, suppliers (vertical spillovers), competitors (horizontal spillovers), and universities and R&D centers (Science and technology institutions) localized at the local and international level, which are thought to influence novelty of innovation through positive externalities in form of knowledge spillovers.

3 RESEARCH HYPOTHESES

3.1 Knowledge Sourcing And Innovation

The extent to which firms have the knowledge they need to perform their innovation activities will determine their ability to be innovative. Furthermore, access to diverse and high quality knowledge is especially critical for firm innovation, especially for those of a more complex nature like radical innovations. Often, the relevant knowledge will be found elsewhere in the local or international context than inside the organization. Understanding how firms, mainly from who and from where, acquire the knowledge they need to transform it into new products with a major degree of novelty is therefore important for scholars and managers alike.

Knowledge sourcing describes a specific mechanism by which an individual or a firm accesses others' knowledge, including the knowledge stored as documents or in repositories (Gray and Meister, 2004; Gray and Durcikova, 2006). Building on this, this study then further support the idea that the likelihood of innovation and the firm's innovation novelty is determined by the extent to which the firm accesses both knowledge spillovers from others' organizations and from knowledge sourcing with international organizations.

The Innovation Systems literature has shown that improving firm's access to external knowledge will lead to firm innovation, but surprisingly little attention has been given to explain,

in a single framework, how do different external knowledge sources, with different types of organizations, located at the local and international level, affects the novelty of innovation.

Prior research on firm innovation has focused on whether and why firm access knowledge from external organizations and it receive benefits in form of knowledge spillovers. The literature agrees and it´s conclusive on the explanation about why firms perform knowledge sourcing, and why spillovers are formed and it create positive externalities. But what it needs more empirical research are the related questions with "from who" and "from where" knowledge is acceded, and it´s impacts on incremental and radical innovations. Firms need to access knowledge relevant to their innovation activities not only from external sources, but also from many different organizations.

In fact, come up with an innovation that is new to the world requires first technical knowledge and knowledge from many related and unrelated organizations. Second it's requires a high quality of prior knowledge, because the knowledge internal capacities of the firm are limited. Moreover, some of this knowledge is usually not available within the local level or it is not readily available in an explicit and codified form. So, not only knowledge sourcing with different organizations, but also with organizations at the technological frontier, that is, organizations located in an international level, is important for the understanding of the novelty of technological innovation in developing countries.

3.2 Knowledge Sourcing, Spillovers And The Likelihood Of Innovation

A large body of the research on knowledge spillover is driven by the goal of making knowledge available/accessible to entities who need it, when they need it in the format they need it so they can make the best use of it (supply approach). Nevertheless, it is important to remark that it is not because knowledge is available ("in the air") that organizations will use it, as many approaches on spillovers literature assume.

Gray and Meister (2004) developed a knowledge sourcing theory to address a theoretical gap by helping to articulate the missing segment in the causal chain connecting knowledge availability to its creative use and exploitation in form of innovations. Firm knowledge sourcing can be understood as the process in which firms actively engage in the process of searching for, accessing, transferring, and applying others' knowledge.

As can be inferred, this concept is closely related with the popular concept of absorptive capacity proposed by Cohen and Levinthal. Firm knowledge sourcing allows firms to reflect on the sourced knowledge and to use it to perform their innovation activities. Moreover, they can then create new knowledge with a higher degree of novelty that integrates the sourced knowledge with their internal knowledge in form of R&D activities or the existence of a R&D department. If the sourced knowledge is not only from local organization but international ones, the expected benefits can be higher with respect of radical innovations.

The above arguments permit to test the following research hypothesis:

H1: The knowledge sourcing with external organizations will be positively and directly related to the likelihood of firm innovation.

3.3 Knowledge Sourcing Spillovers And The Novelty Of Innovation

As has been argued in the first hypothesis, knowledge sourcing is important for the likelihood of innovation. But another important issue on this topic is related with the relationships between spillovers from knowledge sourcing and the novelty of innovation. On this relationship, as mentioned before what is really important for firm innovation in developing countries is "from whom" and "from where" do spillovers from knowledge sourcing come from, and how do these spillovers determine the degree of novelty of firm innovation. In other words, ¿what type of spillovers from knowledge sourcing matters for the novelty of innovation? By addressing these questions is possible to determine in what extent the determinants of "being innovative" and the determinants of become a radical innovator are different.

3.3.1 The effects of spillovers from knowledge sourcing with different organizations

Critical knowledge for firm innovation activities can be obtained from varied sources. The literature about spillovers has identified some types of spillovers (see recently, Cappelli, Czarnitzki and Kraft, 2013), such as spillovers from vertical organizations (customers, suppliers), horizontal organizations (competitors) and spillovers from science and technology institutions (universities and R&D centers).

Despite the generally recognized importance of these different kinds of spillovers, the empirical literature is essentially silent on the novelty of innovation stimulated by. To date, there have been few econometric studies that examines whether or not a firm can use the knowledge

from other organizations to improve the degree of novelty of their innovations (Cappelli, Czarnitzki and Kraft, 2013).

Recently, Jirjahn and Kraft (2011) has attempted an empirical examination of this issue. They show that firms use outside knowledge from competitors for incremental rather than for radical innovations (Jirjahn and Kraft, 2011, 522). Firms using spillovers from competitors tend to specialize in a follower role. They use spillovers from rivals primarily for incremental innovations and are less likely to be leaders engaging in radical innovation activities.

It could be that firms use knowledge spillovers from competitors and suppliers for incremental rather than for radical innovations. As firms face difficulties using knowledge that comes from areas they are not familiar with, they are likely to exploit outside knowledge for improving their products rather than for producing completely new products. Thus, spillovers primarily serve the diffusion of new products across firms. In that case, a firm primarily exploits knowledge spillovers to imitate rivals' products and, hence, to launch products which are only new to the adopting firm.

Thus is possible to establish the hypothesis that when knowledge from competitors is important, the firm is more likely to be either a follower or an imitator with respect to innovation. Therefore, firms in the same industry are more likely to catch up by accessing relevant state of the art technology (Cassiman and Veugelers, 2006). Thus, is reasonable to expect that firms with incremental innovation are benefit from competitor knowledge spillovers.

H2a: The knowledge sourcing spillovers from competitors and suppliers will be positively and directly related to incremental innovation.

Another scenario is that a firm does not simply imitate rivals' products based on spillovers from knowledge sourcing with competitors or suppliers. Science and technology organizations and clients also have found being important sources of spillovers. Thus, spillovers from universities, research centers and can be related to firm innovation activities. In this case, knowledge spillovers can also stimulate incremental innovations that are new to national market and, even in some conditions, new to the international. Although empirical findings (Jirjahn and Kraft, 2011) suggests that the firm will usually only imitate products that are closely related to its

old products, it's also possible that firms using knowledge from different sources are better allowed to introduce an innovation with a higher degree of novelty.

Empirical literature does not provide conclusive propositions about the effects of knowledge sourcing with science and technology institutions and other firms such as clients on radical innovation. It's a topic that needs further exploration (Jirjahn and Kraft, 2011). Thus, although Jirjahn and Kraft advance empirically on the understanding of the role of spillovers in enhancing the quality of the firm's innovation, they focused only in the role of spillovers from competitors without taking into account other potential different sources of spillovers (i.e., from universities, customers and suppliers) that has been identified in the literature. To investigate this issue, empirically spillovers from universities, research centers and clients are allowed separately in the analysis and thus allowing for potential differences.

Recently, Cappelli, Czarnitzki and Kraft (2013) have found that spillovers from universities and from customers contribute significantly to a firm's sales with market novelties, but have no effect on imitation. The authors explain this because knowledge from rivals is used for imitation, as the knowledge is probably about already developed products. In contrast, knowledge inflows from research institutions and customers will rarely be about products and processes already in use. More likely is it an input which induces additional innovative activities. In case of inducement from a customer the company in question will probably get information on market potential and this is in turn used for developing the asked for products (Cappelli, Czarnitzki and Kraft, 2013). Based on this previous research, is reasonable to expect that:

H2b: The knowledge sourcing spillovers from clients, universities and research centers will be positively and directly related to radical innovation.

3.3.2 The effects of spillovers from knowledge sourcing with local and international organizations

Firm innovation is concerned with idea generation and development. It could be understood as a social process of acquisition of external knowledge that builds on and incorporates firm internal knowledge and capabilities. The highest levels of firm innovation (both in terms of quantity and quality) are a result of different related factors coming together.

Innovation activities must draw on and integrate the knowledge available from different organizations and knowledge localized at different levels, both local and international.

Firms, often start out with their own internal knowledge to carry on innovation activities, which are limited by their limited resources, knowledge and experiences. To generate innovations, the firm first needs to identify and evaluate the external knowledge available from different organizations by establishing knowledge sourcing and knowledge access. Knowledge sourcing with some organizations can in fact improve firm innovation in several ways: by replication, adaptation, and invention. These different possible outcomes are expected to arise depending on the newness of the sourced knowledge.

In the economics of innovation literature, there are two alternative explanations for the firm innovation performance. One stream focuses on local knowledge spillovers arising from a dense network of organizations located in at RIS, ID or innovative milieu. Other stream or research based on FDI literature on spillovers support the idea that for technological lagged firms is important to benefit from international outflows of knowledge.

Moreover, it's possible to advance that not only the source of the spillover matters in different ways for innovation, but also the location of the spillover, that is, spillovers from local or international organizations. Knowledge sharing between firms embedded in the same local context could not be enough to innovate in international markets.

Although existing theoretical literature has tended to emphasize the importance of geographical -local- proximity for spillovers from other organizations -university and vertical-horizontal linkages between firms-, empirical evidence suggests that this type of proximity in reality plays a limited role in setting them up (Lawton Smith, 2007).

In contrast with regional approaches to knowledge spillovers, geographical proximity per se is neither a necessary nor a sufficient condition for learning and innovation to take place. Nevertheless, it facilitates interactive learning, most likely by strengthening the stock of knowledge of firms. However, proximity with local organizations may also have negative impacts on novelty of innovation due to the problem of lock-in, redundant knowledge and information (Asheim et al., 2007; Fitjar and Rodríguez-Pose, 2011; Torre and Rallet, 2005). Accordingly, not only too little, but also too much proximity may be detrimental to interactive learning and innovation.

Another stream of research support the idea that leading firms and organizations can have positive effects on less advance firms in developing countries, through the knowledge exchange in form of international spillovers. International spillovers are important sources of innovation activities (Coe and Helpman, 1995), especially to firms in developing countries (Aiken and Harrison, 1999).

In the mentioned before sources of spillovers, local or international linkages play a crucial role in the novelty of innovation. Firms benefiting from international sources of spillovers may maximize the returns of their internal knowledge inputs, gaining access to new knowledge beyond the limits of their local context, acquiring better knowledge inputs and enhancing the novelty of the innovations process, without falling into the trap of excessive repeated interaction.

Excessive reliance on local sources of spillovers without non international linkages may lead to repeated interaction in which no one new knowledge is exchanged and can therefore be detrimental for innovation (Asheim et al., 2007; Fitjar and Rodríguez-Pose, 2011; Torre and Rallet, 2005). The detrimental effects for radical innovation of excessive knowledge sourcing with local organizations are likely to be stronger for firms that not rely on international spillovers. So, is also reasonable to expect that local and international spillovers to be linked to different degrees of novelty of innovation.

According with the FDI spillover literature, is reasonable to expect that the effect of international sources of spillovers is higher than local sources on radical innovations. Thus, this study hypothesizes that spillover from local organizations, where agents and firms share the same technical knowledge, will be more prone to the generation of incremental product and process innovation, whereas spillovers form international organizations, by creating new combinations of knowledge and technologies stemming from different sectors, will lead to more radical products.

Thus, firms relying only on knowledge spillovers from knowledge sourcing with local organizations may suffer lower degree of novelty than firms' relying on international sources of spillovers. This could be explained because spillovers from local organizations can be detrimental to the novelty of innovation, where repeated sourcing couldn't lead to the acquisition of new and complex knowledge which can be used and transformed into radical innovations. Too much interaction with local competitors and other organizations may lead to lock-in and

therefore even hamper novelty of innovation (Keupp and Gassmann, 2013; Boschma, 2005; Torre and Rallet, 2005).

H3b: The knowledge sourcing spillovers with international organizations will be positively and directly related to radical innovation.

In order to test these different hypotheses, this study distinguishes between local and international sources of spillovers across the sources considered in this research: spillovers from science and technology institutions (university and R&D centers), customers and suppliers (vertical spillovers) and competitors (horizontal spillovers).

3.4 The Role Of R&D Activities

From the point of view of this study, innovation process in firms is primarily internal in nature. External factors and organizations can play a role in this process (Von Hippel 1988), but the firm uses them based on his internal capabilities. According to this, the management literature recently stresses the importance of firm competences and resources, especially related to a firm's internal knowledge base as enhancing productivity (Foss, 1998; Grant, 1996).

When a firm experiences some knowledge deficits related with the performance of radical innovations, it may choose not to seek out knowledge recombinations or use its limited internal capacities more efficiently, but to absorb missing knowledge from the firm's other external organizations instead (e.g., Ahuja, 2000; Cassiman and Veugelers, 2006; Powell et al.,1996; Rothaermel, 2001; Dierickx and Cool, 1989). This approach may represent a valid alternative or complementarities to the spillovers mechanisms proposed before, therefore, control for absorptive capacity is added by measuring the firm's R&D activities. This measure is a valid representation of absorptive capacity (Cohen and Levinthal, 1990; Stock et al.,2001; Tsai, 2001) in the context of technological.

Cohen and Levinthal (1989) argue that R&D activities enhances the firm's absorptive capacities. This Firms' absorptive capacity, both in terms of understanding where the potential sources of knowledge reside and in terms of the ability to absorb and deploy external knowledge, is thus important (Cohen and Levinthal, 1989). The ability to identify, assimilate and apply for commercial ends expertise generated outside a firm's own organization is not only determining

in the innovation performance of firms (Nieto M, Quevedo, 2005) but also related to the degree of novelty of technological innovation.

A basic measure of absorptive capacity is R&D investments. Thus, an increase of R&D investments increases the probability of being innovative. Another indicator for a high degree of organizational structure related with R&D activities within a firm is the existence of a R&D department. Is also reasonable expect that the existence of a R&D department has a positive impact on firms' likelihood of being innovative. But more important yet, if the firm's learning capacity depends on the relatedness of its past and present activities, there will be a direct link between the existence of formal and stable R&D activities and the launch of radical technological innovations. Thus, related with the degree of novelty of the firm innovation, is reasonable to expect that the existence of an R&D department has higher effect on radical innovation than R&D investments.

4 DATA AND VARIABLES

Firm surveys at the firm level are scarce for developing countries. Many Latin-American countries do not have complete and varied databases, such as exist in North America or Europe. In some cases, data about some sectors or firms are simply non-existent. Among other factors, this has lead to a situation in which the study of technological innovation in the context of Latin American countries at the firm level is almost absent in the international debate. Although many investigations focusing in Latin American countries have made notable contributions to the understanding of the factors that have restricted or enhanced technological innovation, most of them are based in case studies without large firm samples.

With the recent and new available data from firm innovation surveys in some Latin-American countries (Castellacci and Natera, 2012), is possible to investigate the innovation activities in this part of the world at the firm level.

This research uses firm level variables, constructed by matching different surveys. Regarding the data sources, the research retrieved the firm level data from the surveys carried out by the National Statistic Department of Colombia (DANE). Based on Bogota Manual (2002), the Survey on Development and Technological Innovation (EDIT I-IV) ask about related aspects with innovation activities (investments, links and collaboration, human capital, intellectual

property, funding, obstacles) of Colombian manufacturing firms with 10 or more employees or an annual production of $130.5 million Colombian Pesos. The survey is mandatory which ensures a high response rate (97%).

This survey is Colombian's official innovation survey and structurally comparable and conceptually close to the to the EU's Community Innovation Survey (CIS); in many cases even more detailed. It is conducted every two years since 2003 by DANE. The survey covers all sectors of the economy.

Although the EDIT survey is carried out from 1994 (Edit I), the analysis is restricted to three panel waves between 2003 and 2008. While this approach could reduce the number of useable observations, it maintains a high level of measurement consistency and continuity of the measurement of the variables. The EDIT surveys collect data on all variables, dependent and independent, in one and the same timeframe per survey wave (every two years). Thus, some of the variables are measured in a consistent and regular interval, producing a highly balanced panel since the time lag between the waves is consistent.

With the selected three waves (2003-2004, 2005-2006 and 2007-2008) of the survey, a new panel database of industrial firms in a developing country (4.753 firms) is constructed to address the research questions. To an extent alleviate common method bias, the survey uses several procedural remedies that are recommended by Podsakoff et al. (2003), such as the spatial separation of dependent and independent variables (questions), the use of cover stories, and extensive explanatory texts for all the questions. Moreover, the survey uses proximal remedies, in that it collects data on the different variables by different information qualities. Thus, it implemented different types of variables (ordinals, categorical, nominal, likert scales). It also uses a multiple-informant approach where there are different informants answering depending of the specific questions of the questionnaire.

4.1 Dependent Variable: Likelihood Of Innovation And Novelty Of Innovation.

Given the features of innovation activities in developing countries, where firms do not exhibit an strong patent behavior, the patents or R&D investments (although it is available) indicators was not chosen as the variable to measure firm innovation outputs, because of the limitations of such measurements (Feldman, 2000, 375; Geroski, 1994), and the disadvantages when it comes to capturing the innovation outputs for firms in developing countries. So, a

measure that captures innovation outputs, it measured as a dummy variable, is chosen as explanatory variable. For developing countries, instead of patents or R&D investments, the literature has been discussed that innovation outputs are more appropriated measure of innovation performance of firms.

It's important also make a distinction between innovation efforts and innovation outputs. Research on the determinants of technological innovation has used both innovative outputs and innovative inputs as measures of innovation (Cohen & Levin, 1989). However, the two factors differ (Fisher & Temin, 1973; Henderson, 1993; Link, 1980) because the issue of innovation inputs or efforts is a question of incentives (Tirole, 1988) and wherewithal (Galbraith, 1952; Schumpeter, 1942): what factors affect the incentives and the ability to support research? The issue of innovation output on the other hand is concerned with research productivity (Kamien & Schwartz, 1975; Kamien & Schwartz, 1982): given a research effort, however determined, what factors determine the resultant level of output? To the extent that these are different questions, and may therefore have different answers, there is a need to distinguish between them (Henderson, 1993). Technological innovation as a type of innovation output thus is the measure applied here.

According to the Oslo (2005) and Bogota Manual (2002), and expanding Schumpeter's classification (1910) between incremental or radical innovation, an innovation is new to the world if the firm has introduced a new or significantly improved good or service onto the global market before competitors . It is new to the market or industry if the firm is the first in that specific market or industry to have implemented it. It is new to the firm if the innovation was already available from its competitors in its market.

Based on Bogota Manual, the survey used in this study asks firms about the introduction of innovations in the period of reference according to the degree of novelty constructed by the Bogota Manual. The questionnaire provides respondents with detailed explanations about the concepts of new and improved innovation, the concepts of new to the firm-national-international market, and it distinguishes them from each other. Direct measurements were made of the innovation outputs as measured by new and improved products. This variable captures the presence/absence and the number of innovations during the period of reference. Based on this section of the survey, the indicators were constructed to measure the

innovation outputs of the firms. This variable includes innovation based both on invention (radical innovation) and imitation (incremental innovation).

Thus, the dependent variables constructed to measure the innovation output of the firm is the likelihood of being innovative and the degree of novelty. It can take different possible values depending on the novelty of the innovation developed: 0, if the firm did not introduce any new or improved products into the market during the period of reference; and 1, if the product introduced into the market in that period was new to the firm, or if the product introduced into the market was new to the national market, or finally, if the product introduced into the market was new to the international market. New to the firm and new to the national market are considered as incremental innovations, and new to the international market is interpreted as radical innovation.

These different variables allow to identify the factors that not only influence the likelihood of one firm to become innovative, but also those that are relevant for the novelty of technological innovation, and it distinguish which among them have the greatest effect on the development of major innovations (incremental or radical). It is important remark that few empirical studies have used indicators of this type as measures of innovation output (Jurado, Garcia, Fernandez de Lucio, Henriquez, 2008; also see, Amara and Landry's, 2005 and Oerlemans et al.'s, 1998); this detailed dependent variable haven't been explored for Latin American countries in a panel dataset.

One important issue about the novelty measure is that this study is relying on questions that ask firms to qualify the degree of novelty of their innovations as new to the international, national market and new to the firm. Because of this subjective approach, firms may tend to overestimate the degree of novelty of their innovations or the uniqueness of their innovations. Such overestimations are likely because some firms could have inaccurate perceptions of the products available on markets. SMEs tend to have inaccurate perceptions of the existing products on the markets or have less information about the competitive environment (Danneels and Kleinschmidt, 2001). Although this measure problem of novelty rises important questions about the typological approaches to capture innovation (see a discussion in Amara, Landry, Becheikh and Ouimet, 2008), the indicators used here are the best approximation available for Latin-American countries.

4.2 Independent Variables

The proposed analytical model considers firm level factors as possible determinants of the likelihood and novelty of technological innovation. Thus, the explanatory variables were measured at the firm level. The firm-level variables captured the heterogeneity of Colombian firms in relation to their internal capacities, their reliance on different knowledge sources and their absorptive capacities to benefit from knowledge spillovers. The main variables included knowledge sourcing spillovers, , R&D investments, R&D department, human capital, ownership and size.

4.2.1 Knowledge sourcing spillovers

While the indicator of incoming spillovers is a subjective measure, it has at least two advantages. First, it is a direct and firm-specific measure, allowing for heterogeneity among firms (Cassiman and Veugelers, 2002). It captures the importance of external knowledge sources for the firm and it takes into account that firms may differ in their ability to benefit from spillovers. Usually, based on Knowledge Function Production framework (Grilliches), knowledge spillovers are indirectly measured by the total pool of external knowledge that is potentially available (for a review of different measures, see Kaiser, 2002) and by patent citations (Jaffe, 1986).

Yet, such an aggregate indicator cannot take into account that firms are heterogeneous with respect to the use of the potentially available knowledge. Kaiser (2002) and Knott, Posen, and Wu, (2009) empirically demonstrate the bias resulting from this spillover miss specification. Direct measures constructed from innovation survey used here data appear to work reasonably well while the most frequent measures at the aggregated level of the Euclidean technological distance and of the geographical distance lead to counterintuitive results (Kaiser, 2002, 125). Thus, as were mentioned in the literature review, the variables for incoming spillovers are constructed attending the different knowledge sources –customers, suppliers, competitors and science and technology institutions- and the location of those sources –local or international-.

4.2.2 R&D investments and R&D department

Cassiman and Veugelers have confirmed the importance of having an in-house basic R&D capability for creating the environment to exploit the complementarity between internal

and external sourcing (Cassiman and Veugelers, 2006). However, especially in developing countries, innovative activities are often undertaken by firms even when they do not have institutionalized R&D (Kleinknecht, 1987; Brouwer and Kleinknecht, 1997). Also, R&D investments are no frequent and constant over time.

The dataset also provides information on the firm's R&D activities both in form of formal R&D and R&D investments. To capture this, R&D department and R&D investments are two dummy variables equal to 1 if the firm has a R&D department and it performs R&D investments, respectively.

4.2.3 Human capital an control variables

It should be noted that firms are highly heterogeneous with respect to their human capital endowments, and that workers differ in terms of embodied skills. Different authors suggest that skills are embodied in human capital. Technological innovation also depends on the qualifications of the workforce. Nickell and Nicolitsas (2000) provide evidence of a link between the human capital and the rate of accumulation of knowledge capital. This research captures the employees' initial human capital by different variables. The shares of employees with technical, professional and posgraduated degrees are introduced as a measure of employee's human capital.

Finally, this study includes different set of controls at firm level. The industrial organization literature and early Schumpeterian approaches suggest the importance of firm size, ownership and sector membership. Firm size largely determines a firm's resource base, competencies and scale advantages. For instance, due to internal economies of scale causing a reduction in per-unit costs over the number of units produced, efficiency advantages emerge from larger firm sizes (Jovanovic, 1982; Caroll and Hannan, 2000). Small firms, due to their limited initial size, have to overcome these disadvantages, unlike larger firms. Also, scale economies in the R&D process benefit firms with larger R&D budgets and R&D is more productive in large firms due to complementarities between R&D and other activities.

However, the size of the firm is an indicator of the bureaucratic and incentive structure of the firm, and by itself might imply only a negative effect on innovation activity. On the other hand, smaller firms are associated with less bureaucracy and thus may be more innovation efficient (Acs and Audretsch 1987). According to this, firm size may have negatives effects because the bureaucratization of inventive activity in large firms stifles the creative instincts of

researchers, and in large firms, incentives of individual scientists become attenuated as their ability to capture the benefits of their efforts diminishes. This conflictive arguments shows that size might have both positive and negative effects on innovation. Therefore, a priori, it is not clear that the thesis of a positive impact of size on innovation should unambiguously hold (for a review see Ahuja, 2007). Despite this, there is a consensus that both large and small firms are critical and complementary to the process of innovation (Ahuja, 2009), and studying the relationships between firms is likely to yield significant insights into the process of innovation (Cohen & Levin, 1989).

The type of sector activity is also important for firm innovation because industry effects capture various technology and knowledge dimensions such as technological opportunity, appropriability regimes, or the emergence of dominant designs along the life cycle of technologies (Breschi, Malerba and Orsenigo, 2000). This implies that there are differences in innovation performances driven by sector membership. To control for this, firms are classified into four sectoral categories, based on the taxonomy of patterns of technological change proposed by Pavitt (1984), which distinguishes types of firms according to sectors (1) supplier-dominated; (2) large-scale producers; (3) specialized suppliers; and (4) science-based. A logit pooled data model is performed to test the main propositions of this research.

5. EMPIRICAL FINDINGS AND CONTRIBUTIONS

To analyze the effect of knowledge sourcing on the likelihood and novelty of firm's technological innovation, this study uses data at the firm level with a large-scale data set on innovative activities in a census sample of Colombian manufacturing firms. Three models are performed. In table 1 the results for the likelihood of innovation with spillovers and control variables are presented. Table 2 and 3 presents the preliminary results for novelty of innovation, by the origin and location of spillovers, respectively.

The overall empirical findings suggest that spillovers from external knowledge sources are significantly related not only to the likelihood of innovation but also to the novelty; that is, to incremental and radical innovations. An empirical finding that is similar to the recent study of Cappelli, Czarnitzki and Kraft (2013). Firms that have invested in absorptive capacity in the form of internal R&D activities (both R&D investments and formal R&D) are more likely to introduce an innovation new to the firm or new to the market. Specifically, regarding

technological innovation new to the international market, formal R&D activities, measured as the presence of an R&D department, are more important than R&D investments. Interestingly, foreign ownership is positive and highly significant for new to international market but no for new to the firm and national market. Size and human capital variables are also positive.

Spillovers from external knowledge sources have a significant effect on the likelihood of firm innovation as was expected from past research. However, regarding the degree of novelty, interesting results emerge. From new to the firm and new to the national market, spillovers from competitors and suppliers are more important than spillovers from clients. Inversely, for new to the international market spillovers from clients are more important. These results are aligned with new recent empirical evidence on spillovers from competitor, suppliers and clients (Cappelli, Czarnitzki and Kraft (2013).

Regarding the location of the knowledge sourcing spillovers, new empirical results emerge. As can be inferred from the regression analysis, the location of the knowledge sourced is significant related to novelty of innovation. As was expected from the theoretical discussion, spillovers from international organizations are more important drivers of radical innovation than spillovers from local organizations. The process of technological innovation necessitates combinations of a variety of new and existing knowledge sources located outside the focal firm, inside and outside of the country.

This empirical investigation exploits between firm variations to investigate the effects of knowledge sourcing with different organizations on the degree of novelty of firm innovation. Also, the process of technological innovation necessitates combinations of a variety of new and existing knowledge sources located inside and outside the firm's country.

These results are important because despite the generally recognized importance of knowledge spillovers, the empirical literature is essentially silent on the type of innovation stimulated by spillovers. To date, there have been almost few econometric studies, in a developing country context, that examines whether or not a firm can use the knowledge from other firms to perform different kinds of innovations (Jirjahn and Kraft, 2011).

The degree of novelty is almost unexplored in knowledge spillovers literature. Little is known about how do spillovers affect the degree of novelty of the innovations outputs of the firms. Moreover, there are not empirical studies for Latin-American countries focusing on different kinds of knowledge spillovers and firm performance. To my best knowledge, this is the

first study that uses a census from Latin-American manufacturing firms with survey data; most of the studies are for European and North American regions.

This study makes several novel contributions to the knowledge spillover-knowledge sourcing literature which deals with the problem of novelty of innovation in developing countries. First, it addresses the problem of knowledge sourcing and spillovers, and it's influences on the novelty of innovation in developing countries to the firm level of analysis. Second, in contrast with the pool knowledge spillover and the knowledge stock literature (based on the highly accepted and recognized theory of Knowledge Production Function), this study conceptualizes the thought that external knowledge influences innovation primarily through the process of knowledge sourcing with different organizations at the firm level. This is an important contribution, because it highlights the important role of knowledge sourcing in facilitating and increasing knowledge spillovers. Third, it shows how firm knowledge sourcing enhances the novelty of innovationn through the spillovers with organizations at the international level.

Table 1. Likelihood of innovation and spillovers

Likelihood of Innovation	(1)	(2)
VARIABLES	eq1	lns1_1_1
Customer	1.208***	
	(0.103)	
Competitor	0.624***	
	(0.122)	
Supplier	0.451***	
	(0.110)	
University and Research Centers	0.221	
	(0.155)	
R&D department	1.302***	
	(0.117)	
R&D investments	1.927***	
	(0.148)	
Employees	0.000917***	
	(0.000257)	
Foreing capital dummy	-0.0121	
	(0.153)	
Employees technical	-0.000490	
	(0.000782)	
Employees graduated	-0.00128	
	(0.00184)	
Employees posgraduated	0.0141**	
	(0.00580)	
Constant	-1.871***	-1.433***
	(0.0874)	(0.333)
Observations	5,269	5,269
Number of groups	24	24
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Table 2. Novelty of innovation and spillovers by source

Novelty of Innovation	New to the firm	(2)	New to the national	(4)	New to the international	(6)
VARIABLES	eq1	lns1_1_1	eq1	lns1_1_1	eq1	lns1_1_1
Customer	1.018***		1.163***		1.108***	
	(0.101)		(0.122)		(0.183)	
Competitor	0.519***		0.404***		0.272*	
	(0.115)		(0.125)		(0.165)	
Supplier	0.593***		0.243**		0.0576	
	(0.105)		(0.124)		(0.173)	
University and Research Centers	-0.0903		0.395***		0.503***	
	(0.144)		(0.145)		(0.173)	
R&D department	1.003***		1.242***		1.303***	
	(0.110)		(0.117)		(0.172)	
R&D investments	1.585***		1.181***		0.752***	
	(0.128)		(0.125)		(0.163)	
Employees	0.000985***		0.000601**		0.000988***	
	(0.000240)		(0.000254)		(0.000276)	
Foreing capital dummy	0.0968		0.365**		0.646***	
	(0.143)		(0.164)		(0.194)	
Employees technical	-0.000469		-0.000237		-0.000871	
	(0.000728)		(0.000715)		(0.000744)	
Employees graduated	-0.00125		0.00109		-0.00238**	
	(0.00130)		(0.00140)		(0.00106)	
Employees posgraduated	-0.000591		0.00107		0.00306	
	(0.00240)		(0.00307)		(0.00210)	
Constant	-1.922***	-1.422***	-3.354***	-0.788**	-4.390***	-17.49
	(0.0877)	(0.337)	(0.156)	(0.352)	(0.128)	(4.160e+06)
Observations	5,269	5,269	5,269	5,269	5,269	5,269
Number of groups	24	24	24	24	24	24
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Table 3 Novelty of innovation and spillovers by location

Novelty of Innovation	New to the firm	(2)	New to the national	(4)	New to the international	(6)
VARIABLES	eq1	lns1_1_1	eq1	lns1_1_1	eq1	lns1_1_1
Customer (Local)	1.081***		1.181***		0.801***	
	(0.105)		(0.127)		(0.200)	
Customer (International)	0.650***		1.072***		2.208***	
	(0.206)		(0.213)		(0.241)	
Competitor (Local)	0.539***		0.383***		0.266	
	(0.122)		(0.134)		(0.194)	
Competitor (International)	0.453*		0.504**		0.0142	
	(0.250)		(0.241)		(0.272)	
Supplier (Local)	0.528***		0.239*		-0.0910	
	(0.114)		(0.134)		(0.202)	
Supplier (International)	0.833***		0.254		0.393*	
	(0.195)		(0.203)		(0.238)	
University and Research Centers (Local)	-0.0602		0.411***		0.323*	
	(0.146)		(0.149)		(0.191)	
University and Research Centers (International)	-0.530		0.225		1.214***	
	(0.488)		(0.446)		(0.436)	
R&D department	1.019***		1.244***		1.237***	
	(0.111)		(0.117)		(0.178)	
R&D investments	1.598***		1.182***		0.735***	
	(0.128)		(0.125)		(0.171)	
Employees	0.000988***		0.000607**		0.000900***	
	(0.000240)		(0.000255)		(0.000284)	
Foreing capital dummy	0.0987		0.367**		0.605***	
	(0.143)		(0.164)		(0.201)	
Employees technical	-0.000471		-0.000246		-0.000675	
	(0.000730)		(0.000717)		(0.000801)	
Employees graduated	-0.00127		0.00109		-0.00263**	
	(0.00131)		(0.00140)		(0.00107)	
Employees posgraduated	-0.000414		0.00106		0.00323	
	(0.00235)		(0.00307)		(0.00218)	
Constant	-1.926***	-1.428***	-3.357***	-0.780**	-4.337***	-15.62
	(0.0877)	(0.336)	(0.157)	(0.350)	(0.128)	(690,057)
Observations	5,269	5,269	5,269	5,269	5,269	5,269
Number of groups	24	24	24	24	24	24
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

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