Paper no. 2011/01

SMEs´ absorptive capacities and large firms´ knowledge spillovers: Micro evidence from Mexico

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This is a pre-print version of a paper that has been submitted for publication to a journal

This version: January 2011

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications
ISSN 1654-3149

WP 2011/01

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ABSTRACT

The aim of this paper is to analyze the relationship between large firms´ knowledge spillovers and small and medium enterprises absorptive capacities. We build ad-hoc indicators for these two concepts following a factor analysis methodology, and we carry out a structural equations analysis to determine the relationship between them. Based on firm level original data from a survey that focuses on SMEs in a Mexican locality, this paper argues that in a low-tech and mature sector, such as the machine shop sector, that operates in a loosely articulated local system, two knowledge spillover mechanisms are relevant: the backward linkages and the employees´ mobility. Regarding SMEs' absorptive capacities they are strongly influenced by organizational capabilities and innovation and learning activities. We also argue that large firms' knowledge spillovers are strongly correlated to SMEs absorptive capacities within the sector and locality analyzed.

Keywords: Absorptive capacities, Knowledge spillovers, SME-large firms interaction, Mexico

SMEs´ absorptive capacities and large firms´ knowledge spillovers: Micro evidence from Mexico[♦]

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Abstract

The aim of this paper is to analyze the relationship between large firms´ knowledge spillovers and small and medium enterprises absorptive capacities. We build ad-hoc indicators for these two concepts following a factor analysis methodology, and we carry out a structural equations analysis to determine the relationship between them. Based on firm level original data from a survey that focuses on SMEs in a Mexican locality, this paper argues that in a low-tech and mature sector, such as the machine shop sector, that operates in a loosely articulated local system, two knowledge spillover mechanisms are relevant: the backward linkages and the employees´ mobility. Regarding SMEs' absorptive capacities they are strongly influenced by organizational capabilities and innovation and learning activities. We also argue that large firms' knowledge spillovers are strongly correlated to SMEs absorptive capacities within the sector and locality analyzed.

Introduction

During the past years, there has been a growing interest regarding the analysis of knowledge spillovers within localities. Several studies from different bodies of literature have identified a set of factors that affect the scope of knowledge spillovers, reaching consensus that one of the most important factors are firms´ absorptive capacities. Even though there is a common agreement in regard the positive and direct relationship between knowledge spillovers and absorptive capacities, there are still some gaps when trying to identify the nature of this relationship, the main knowledge spillovers mechanisms and the main determinants of absorptive capacities.

There are important contributions from the organizational and cognitive literature about the identification of different spillover mechanisms, such as demonstration-imitation effects, backward linkages, direct technology transfer, training, human capital mobility, competence, and foreign linkages (Albaladejo 2001; Chudnovsky, López et al. 2003; Dutrénit and Martínez 2004; Giuliani 2005; Jordaan 2005; Marin and Bell 2006;

♦We thank Roberto Escorcia and Salvador Zamora for computing and statistics assistance.

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Chudnovsky, López et al. 2008; Nelson 2009). Some other studies that focus on localized knowledge flows and the effects of foreign direct investment (FDI) have analyzed the importance of firms´ absorptive capacities to get the benefits of knowledge spillovers. They emphasize the role of investment in R&D, knowledge, technological capabilities, embedded technology, and firms´ innovation strategy as the main determinants for absorptive capacities (Alcácer and Chung 2003; Chudnovsky, López et al. 2003; Giuliani 2003; Escribano, Fosfuri et al. 2005; Ivarsson and C 2005; Vera-Cruz and Dutrénit 2005; Marin and Bell 2006; Chudnovsky, López et al. 2008; Escribano, Fosfuri et al. 2009).

However, most of the works that have analyzed the relationship between knowledge spillovers from FDI and local firms' absorptive capacities use proxy indicators for knowledge spillovers or absorptive capacities. The use of this type of indicators is problematic, as some of the studies have reached contradictory results regarding the relationship among these two concepts. Concluding that technology sector (Girma and Wakelin 2000; Kinoshita 2000; Girma 2003; Marin and Bell 2006), and level of aggregation and geographic distance (Blomström and Kokko 2003; Girma 2003; Jordaan 2005), play an important role in the scale and nature of knowledge spillovers and the benefits associated.

Focusing on small and medium enterprises (SMEs) from the machining industry located in Queretaro, Mexico, we aim to go further in the discussion and disentangle the specificities of the relationship between large firms´ knowledge spillovers and SMEs´ absorptive capacities. We also aim to contribute to the analysis of the main determinants of each one of these two concepts. This paper is based on original firm level data from a survey applied during 2005 to SMEs that belong to the machining industry in Queretaro. This industry is a traditional and low-technology industry integrated mostly by SMEs. The SMEs present a *hub-and-spoke* [1] type of arrangement with its clients, which are mostly medium-large domestic firms and Multinational Corporations (MNCs), 42% of them belong to the automotive and home appliances sector. Querétaro is geographically located in the center of Mexico and is one of the most dynamic Mexican cities with important industrial activity. Queretaro's main industrial activities are: metal mechanic, automotive, textile, chemistry, electric-electronic and food processing. Their

[1] In the hub and spoke productive arrangements, some large firms act as anchors or hubs to the regional economy, with suppliers that spread out around them like spokes of a hub (See Markusen, 1996). In the sector and locality analyzed, there are some key large firms, many SMEs have established around them to become their suppliers.

contribution to the Mexican GDP is around 1.8%. The local infrastructure such as electric services, industrial parks and road systems has fostered the growing of different industries.

The machining industry in Querétaro reported sales over $49 million dollars and employed more than 3,000 people during 2005. The SMEs supply around 10% of the total demand of machining products in the locality; their principal products are gears, arrows and dies (production and repairing). Most of them are low technology products in comparison to the other 90% which are imported.

Regarding the system of innovation in Queretaro, we identified several agents such as firms, public research organizations, universities, government agencies, and industrial associations that have developed certain level of linkages, but those are still in an early stage and need further interaction between agents to consolidate a system of innovation and provide a stronger support to the different firms located in the region.

This paper is divided in four sections; the next section presents the analytical framework that refers to knowledge spillovers, absorptive capacities and the relationship between these two concepts. Section two describes the methodology for data gathering and information analysis. Section three presents and discusses the empirical evidence and the main results from the analysis and section four provides the concluding remarks.

1 The importance of absorptive capacities to get the benefits of knowledge spillovers

Several studies from the organizational theory that have analyzed the impact of FDI on host countries focus on spillovers from MNCs to local firms. These studies follow different methodologies using *proxy* indicators that correlate FDI with local firms´ productivity, arguing that productivity increases are directly related to MNCs' spillovers (Sjöholm 1999; Chung 2001; Blomström and Kokko 2003). Nevertheless, the use of this type of indicators does not permit to observe whether local firms´ productivity increases are in fact due to MNCs spillovers or to other factors. Some other bodies of literature that focus on knowledge flows among agents within the same locality (Dutrénit and Vera-Cruz 2003; Giuliani 2003; Giuliani 2005), usually emphasize the heterogeneity of firms and some of them use *ad-hoc* indicators. These works stress the fact that knowledge flows cannot be diffused homogenously to different firms in a locality, as local firms need certain level of absorptive capacities to reap their benefits.

Following (Escribano, Fosfuri et al. 2005) who define knowledge spillovers as involuntary knowledge flows that arise when part of the knowledge generated by an organization spills over its boundaries and become available to other organizations. We adapt their concept to analyze large firms´ knowledge spillovers –that can be either from national large firms or MNC, to local SMEs. Thus we define knowledge spillovers as *the organizational and technological benefits that local SMEs get from large firms knowledge flows, which can be either intentional or unintentional, and increase SMEs productivity.*

Knowledge spillovers can be horizontal (across sectors), or vertical (within the same sector). The amount and nature of vertical and horizontal spillovers varies within sectors and regions, as found by Kinoshita (2000), Girma, Greenaway, et al. (2001), Girma (2003), Jordaan (2005), Kugler (2006), Motohashi and Yuan (2010).

Knowledge spillovers have several diffusion mechanisms, such as (i) *Backward linkages*, i.e. MNCs have certain level of requirements and local firms have to upgrade their technological and organizational capabilities and use their resources more efficiently to remain competitive (Blalock and Gertler 2004; Smarzynska Javorcik 2004; Kugler 2006). (ii) *Human capital mobility*, MNCs have the ability to increase the human capital pool. Their employees are embedded with the technology, knowledge, and organizational techniques and they are direct agents of technology transfer. This spillover mechanism can be observed through employees' mobility (Chudnovsky, López et al. 2003; Girma and Görg 2005; Jordaan 2005; Chudnovsky, López et al. 2008) and entrepreneurship by the creation of new firms (Görg and Greenaway 2001; Vera-Cruz and Dutrénit 2005). (iii) *Training*, MNCs sometimes promote the training of key employees of their suppliers, which increases local firm's technological and organizational capabilities (Kinoshita 2000). (iv) *Direct technology transfer*, MNCs also promote direct technology transfer to their suppliers to reach certain requirements (Liu and Buck 2007). (v) *Demonstration-imitation*, according to Kim (1997) this is the most common type of spillover. It usually occurs when firms observe and copy other firms´ processes, increasing their productivity to remain competitive (Liu and Buck 2007). (vi) *Increased competence*, MNCs have a strong effect on the competence behavior and this encourage local firms to keep their market shares using their technology and resources more efficiently to increase their productivity to keep and increase their market shares.[2] (vii) *Foreign linkages*: Firms can learn how to export from other firms with more

[2] Chung, *et al* (2002) argues that competitive pressure in the automotive sector is the main cause of productivity increase.

experience. Exportation processes involves a deep knowledge about markets, quality, specifications, etc. By being embedded in a global environment and having strengthened their technological and organizational capabilities, local firms can imitate more advanced techniques and learn how to supply foreign markets (Gorg and Hijzen 2004; Liu and Buck 2007). (viii) *Patents and R&D*, some authors state that spillovers occur more intensively through R&D activities and patenting rather than through production activities (Cabrer-Borrás and Serrano-Domingo 2007; Liu and Buck 2007; Kafouros and Buckley 2008; Coe, Helpman et al. 2009; O'Mahony and Vecchi 2009; Motohashi and Yuan 2010).

There are different factors that affect the level of knowledge spillovers by local firms, such as the technology level and geographical distance, but as we mentioned above, there is a strong consensus regarding the importance of firms' absorptive capacities to get the benefits from knowledge spillovers. (Giuliani 2003; Cabrer-Borrás and Serrano-Domingo 2007); mention that knowledge does not automatically spill over and result in increased competitiveness and growth. In fact it has been confirmed by several studies that the scope of technology spillovers may depend on the absolute level of local firms' absorptive capacities (Borensztein, De Gregorio et al. 1998; Durham 2004; Liu and Buck 2007). In this direction, several studies from different perspectives have contributed to the analysis of the relationship between knowledge spillovers and absorptive capacities (Albaladejo 2001; Chudnovsky, López et al. 2003; Jordaan 2005; Chudnovsky, López et al. 2008; Escribano, Fosfuri et al. 2009), stressing the fact that local firms need certain level of absorptive capacities to get the benefits from spillovers.

Absorptive capacities reflect firms´ knowledge bases and are related to the individual performance of firms (Albaladejo 2001; Giuliani 2003; Giuliani 2005). According to Cohen and Levinthal (1999, pp. 128), absorptive capacities are the ability of firms to recognize the value of new information, assimilate it and apply it to commercial ends. Thus the identification of external knowledge sources and the assimilation and exploitation of knowledge is vital to increase firms' competitive advantage. Firms with higher levels of absorptive capacity can identify and manage external knowledge flows more efficiently and stimulate innovative outcomes. Escribano, Fosfuri and Tribó (2009) argue that absorptive capacities are an important source of competitive advantage.

One set of empirical works that analyze the importance of absorptive capacities to get the benefits from spillovers relate the technology gap between MNCs´ and local firms to

the absorptive capacities of local firms (Girma 2003; Girma and Görg 2005). In some cases, the results are vague, as some studies have shown that the larger the technology gap is, there is a higher level of knowledge spillovers (Driffield 2001; Castellani and Zanfei 2003); while on the other hand, some studies have shown that firms are able to reap the benefit from spillovers only when the technological gap is moderate (Kokko, Tansini et al. 1996). Girma (2003) stresses the fact that there is certain level of technology gap or cognitive distance between firms and below that level there are not technology spillovers as firms share about the same level of knowledge. However, above that level, the cognitive distance is too large for firms to absorb higher levels of knowledge and there are no spillovers. In addition, the use of the technology gap as an indicator of absorptive capacities is sometimes problematic as it does not capture the main determinants that explain absorptive capacities at firm level. Thus, the analysis of the importance of absorptive capacities to get the benefits of knowledge spillovers remains unclear in such studies.

Other set of empirical studies (Chudnovsky, López et al. 2003; Escribano, Fosfuri et al. 2005; Marin and Bell 2006; Chudnovsky, López et al. 2008) have used other type of indicators that reflect more directly absorptive capacities, such as R&D expenditure, patents, human capital, scientific and technical training, and investment in equipment. These studies have usually found a positive and strong relationship between knowledge spillovers and absorptive capacities; however, most of them measure knowledge spillovers by the impact of FDI on firms' productivity, which is a *proxy* indicator for knowledge spillovers and does not really represent the exact mechanisms of knowledge spillovers.

We step in to analyze knowledge spillovers and absorptive capacities building ad-hoc indicators, and if there is a relationship between these two concepts in a particular sector and region in Mexico.

To analyze the specificities of the relationship between knowledge spillovers and absorptive capacities, we have conceptualized two indicators to analyze knowledge spillovers of large firms, either national or MNCs, and absorptive capacities of traditional and low-tech SMEs, where R&D activities are not common, and human capital is not specialized. We focus on two spillovers mechanisms, the backward linkages and human capital mobility, employees' mobility and entrepreneurship. Regarding absorptive capacities, we build an indicator that includes owner and employees' background and experience, technology embedded in equipment,

organizational and innovative capabilities, and linkages with other local agents. This analysis will close the gap related to the most important mechanisms of knowledge spillovers and the most important determinants for absorptive capacities. These indicators are the basis to analyze the relationship between knowledge spillovers and absorptive capacities in a specific low-tech and mature sector within a specific and dynamic industrial locality.

2 Methodology

This paper is based on original data gathered from a survey applied during 2005 to the machining industry in Querétaro, Mexico. We identified two hundred twenty five firms that belong to this sector;[3] one hundred seventy nine firms answered the questionnaire, which represents 80% of the machining industry in the locality. However, we only have complete information to analyze one hundred and ten firms.

The survey included different sections related to the firm's general information, characteristics of the entrepreneur, characteristics of the employees, machinery and equipment, innovative behavior, organizational characteristics, linkages with customers, and linkages with other agents in the locality. Table 1 presents some statistics that describe the main characteristics of the sector.

A previous version of this survey was applied to SMEs of the same industry in Ciudad Juarez, Mexico, a border city with United States. Even though both localities can be compared using the surveys, this new version was modified in order to capture better the main characteristics of SMEs, and to build indicators of absorptive capacities and knowledge spillovers.

Table 1 Main characteristics of the machining industry located in Queretaro

Main characteristic	Total
% of owners with a bachelor's degree	36.4%
% entrepreneurs with experience in other organizations	90.9%
Years of experience in average	18.2
% of owners with experience in top management	4%
% of owners with experience in engineering	16.8%
% of owners with experience in quality control	21.7%
% of owners with experience in production	61.3%
Number of employees (total)	1,077
% of employees with engineer's degree	6.8%
Engineers per firm (including the owner)	0.9
Employees with experience in CNC per firm	0.6
Employees with experience in design per firm	2.1
Employees with experience in CAM per firm	0.2
Technology embedded in equipment	

[3] From these firms 206 are micro firms, 13 are small firms and 6 are medium size firms.

Main characteristic	Total
Conventional equipment per firm	4.1
Numerical control (NC) machinery per firm	0.4
Computer numerical control (CNC) machinery per firm	0.3
% of firms that use CAM	16%
Number of product innovations per firm	1.9
Number of process innovations per firm	1.3
Annual total sales (thousands USD)	$14,420.00
Average sales per firm (thousands USD)	$138.00

Source: Authors´ own.
Sample: 110 firms
Note: Product and process innovation are new to firms.

From Table 1 we can argue that the machining industry in Queretaro is a low technology sector, where most of the firms have the basic capabilities to supply low technology products to their customers. In terms of education and experience, this sector requires technicians and engineers with production, design and computational skills. However, the sample of firms we are analyzing, suggest that owners and employees have obtained their expertise mainly through experience, not through formal education. This type of knowledge acquisition can be represented mainly as a form of tacit knowledge acquisition by learning-by-doing (Nonaka and Takeuchi 1996). However, their schemes for knowledge acquisition have not provided the basis to keep building on that knowledge and reach higher knowledge levels necessary to produce more complex products and increase their market shares.

2.1 Construction of variables

To analyze the relationship between large firms' knowledge spillovers and SMEs' absorptive capabilities we perform a multivariate analysis by principal factors to build two indicators, one for SMEs' absorptive capacities and one for large firms' knowledge spillovers. Then we build a structural equations model to identify the relationship between these two concepts through.

2.1.1 Multivariate analysis to obtain absorptive capacities

We suggest that SMEs´ absorptive capacities can be analyzed using a set of indicators related to the entrepreneur and employees' background, technology embedded in equipment, organizational capabilities, learning and innovation activities, and linkages with other local agents. To build the indicator of absorptive capacities (second order factor), first we need to build the indicators associated to each one of its components (first order factors).

(i) **Entrepreneur and employees´ background**: Most of the studies that have analyzed absorptive capacities emphasize the importance of human resources and analyze education and experience as one of the most important indicators for absorptive capacities (Marin and Bell 2006; Escribano, Fosfuri et al. 2009). To build this indicator we analyzed variables related to formal education and previous experience of owners and employees. Most of the employees in the sector have a technician degree (35%) or have gained their experience empirically (13%), only 4% of them have an engineer's degree.

(ii) **Technology embedded in equipment**: Marin and Bell (2006) have analyzed this type of variable as an important indicator of absorptive capacities, arguing that machinery and equipment is highly correlated to the production of complex products, thus employees develop higher levels of expertise which represent higher levels of absorptive capacity. To build this indicator we analyzed variables related to the type of equipment and the years that firms have been using that particular equipment. As we can see from Table 1, most of the firms have conventional equipment, while a small number of firms have NC or CNC, which are necessary to produce more complex products.

(iii) **Organizational capabilities**: Within the sector and locality analyzed, we observed that organizational capabilities represent a key element for SMEs´ competitiveness, thus we incorporate some variables to analyze organizational capabilities such as control quality management, management and decision making techniques. However, only 4% of the owners in the sector have previous experience in management, and 21% of them have experience in quality control.

(iv) **Learning and innovation activities**: R&D and innovation activities are one of the preferred indicators for absorptive capacities (Cohen and Levinthal 1999). However, within a mature and low technology sector, where R&D is not very common, we consider other variables related to learning mechanisms and innovative activities, such as projects with customers and suppliers, process documentation, training programs, and product and process innovation that the firm has conveyed within a three year period.

(v) **Linkages with other local agents**: Linkages with other agents represent an important element to increase SMEs absorptive capacities. We included in our analysis linkages with other local agents (firms, technical institutions and

industrial associations) as they can be an important source to increase SMEs' absorptive capacities.

The following set of equations expresses the indicators for SMEs' absorptive capacities.

$F_{1EEE} = \gamma_{11} X_{AC1} + \varepsilon_1$

$F_{2TEE} = \gamma_{12} X_{AC2} + \varepsilon_2$

$F_{3OC} = \gamma_{13} X_{AC3} + \varepsilon_3$

$F_{4LIA} = \gamma_{14} X_{AC4} + \varepsilon_4$

$F_{5L} = \gamma_{15} X_{AC5} + \varepsilon_5$

Where:

F_{1EEE} is the indicator for entrepreneur and employees' experience.

F_{2TEE} is the indicator for technology embedded in equipment.

F_{3OC} is the indicator for organizational capabilities.

F_{4LIA} is the indicator for learning and innovation activities.

F_{5L} is the indicator for linkages with other local agents

$X_{AC1...5}$ is a vector of explanatory variables for each one of indicators of absorptive capacities. Table 2 lists each one of the variables that we used to build the five indicators associated to SMEs´ absorptive capacities.

Table 2 Variables associated to the indicators for SMEs´ absorptive capacities

First order factor	Variable	Kind of variable	Missing values	Mean	SD
Entrepreneur and employees´ background	Entrepreneur's degree	Ordinal	8	-	-
	No. of employees	Numeric	0	11.13	22.43
	No. of engineers	Numeric	1	0.72	1.57
	% of engineers	Numeric	0	0.10	0.23
	Employees with experience in CNC	Numeric	0	2.19	5.41
	Employees with experience in design	Numeric	0	11.77	16.71
	Employees with experience in computer aided manufacturing (CAM)	Numeric	0	1.20	6.56
	Employees with experience in measurement	Numeric	0	15.11	31.05
	Employees with experience in quality control	Numeric	0	3.82	17.00
Technology embedded in equipment	CAM programming	Dummy	31	-	-
	No. NC and CNC equipment	Numeric	0	0.71	1.66
	Years of NC and CNC equipment	Numeric	0	1.61	3.23
	Tolerance for products	Ordinal	2	-	-
Organizational capabilities	Years in the market	Numeric	11	11.11	9.21
	Past experience for decision-making processes	Dummy	0	-	-
	Technical knowledge for decision-making processes	Dummy	0	-	-
	Formal contracts with clients	Dummy	1	-	-

First order factor	Variable	Kind of variable	Missing values	Mean	SD
	Sells per employee	Numeric	0	3.01	2.01
	Quality certification	Dummy	0	-	-
	Materials quality certificates	Ordinal	4	-	-
	Time delivery certificates	Ordinal	3	-	-
Learning and innovation activities	Projects with suppliers	Dummy	0	-	-
	Projects with clients	Dummy	0	-	-
	Process documentation	Dummy	0	-	-
	Acquisition of machinery and equipment	Dummy	3	-	-
	Documentation of changes in process	Dummy	3	-	-
	Training programs to develop new products	Dummy	6	-	-
	New marketing programs	Dummy	7	-	-
	Product innovation	Numeric	14	1.59	5.85
	Process innovation	Numeric	16	1.10	4.45
Linkages with other local agents	Importance of linkages with suppliers	Ordinal	0	-	-
	Importance of linkages with customers	Ordinal	0	-	-
	Importance of linkages with competitors	Ordinal	0	-	-
	Importance of linkages with technical organizations	Ordinal	0	-	-
	Importance of linkages with industrial associations	Ordinal	0	-	-

Source: Author's own.

3.1.2 Multivariate analysis to obtain knowledge spillovers

We analyze large firms´ knowledge spillovers in a broad sense; we include in the analysis knowledge spillovers from subsidiaries of MNCs, and from medium and large firms owned by domestic capital. We consider that knowledge spillovers can be analyzed by three main sets of indicators (first order factors), associated to different variables in the survey. Thus to build the indicator of knowledge spillovers (second order factor) first we built the indicators associated to three types of knowledge spillovers, secondly we built the indicator of knowledge spillovers. We focus on knowledge spillovers that are diffused by three main spillover mechanisms:

i) Backward linkages: This type of spillovers is mainly observed by direct technology support and by the need of local firms to use their resources more efficiently to reach their customers' requirements (Lall 1980; Jordaan 2005). We suggest that in the sector and locality analyzed this type of knowledge spillover is particularly important for the type of vertical integration that we observe between SMEs and their customers. We analyze variables such as the type of knowledge and information that firms get from their customers and if those linkages are formal or informal. In general terms, SMEs have an average relationship of 6 years with their clients; they usually do not establish formal

contracts, which can represent a barrier for their investment projects. The most common types of interaction are access to customers´ installations; joint projects to increase products quality; and transfer of design and production capabilities.

ii) Training: Kinoshita (2000) has emphasized the role of backward linkages to promote the training of key employees of supplier firms. The main purpose of training is to increase their abilities to reach customer's demands. We analyzed the number of employees that have been trained by their customers, the importance of training, and previous experience of employees in other firms. We argue that this is an important spillover mechanism, as employees get more involved with the techniques and requirements from their customers and several MNCs have either formal or informal training programs for their customers. We observed that large firms have trained 4% of SMEs´ employees.

iii) Human capital accumulation and mobility: According to Blomström and Kokko (2003) and Görg and Greenaway (2001) this form of spillover is one of the most important knowledge spillover mechanisms. We analyze the mobility of employees to SMEs, and the role of entrepreneurship, i.e. the creation of new firms by large firms´ former employees. We expect that entrepreneurship plays an important role as a mechanism of knowledge spillovers in the sector analyzed, as 91% of entrepreneurs have experience in other organizations (mainly large firms), and they have worked in those organizations for 18 years in average. Their experience has been mainly in production, quality control and maintenance; only 16% of them have engineering experience and 4% have managerial experience. Regarding employees mobility, almost 39% of the employees have had experience in large firms. Their experience has been mainly in production, quality control and maintenance.

To build the indicator of knowledge spillovers, first we build four indicators associated to three mechanisms of knowledge spillovers: i) owners and employees´ mobility; ii) training; and iii) backward linkages (formalization of linkages with clients and type of linkages established with clients). The following set of equations expresses the indicators for large firms' knowledge spillovers.

$F_{1OM} = \beta_{11} X_{KS1} + \varepsilon_1$

$F_{2EM} = \beta_{12} X_{KS2} + \varepsilon_2$

$F_{3FL} = \beta_{13} X_{KS3} + \varepsilon_3$

$F_{4TL} = \beta_{14} X_{KS4} + \varepsilon_4$

Where:

F_{1OM} is the indicator of entrepreneurs' mobility.

F_{2EM} is the indicator of employees' mobility.

F_{3FL} is the indicator of formalization of linkages with clients.

F_{4TL} is the indicator of the type of linkages with clients.

$X_{KS1...4}$ is a vector of explanatory variables for each one of the indicators of knowledge spillovers. Table 3 presents the variables that were used to build these four factors.

Table 3 Variables employed to build the indicator of large firms´ knowledge spillovers

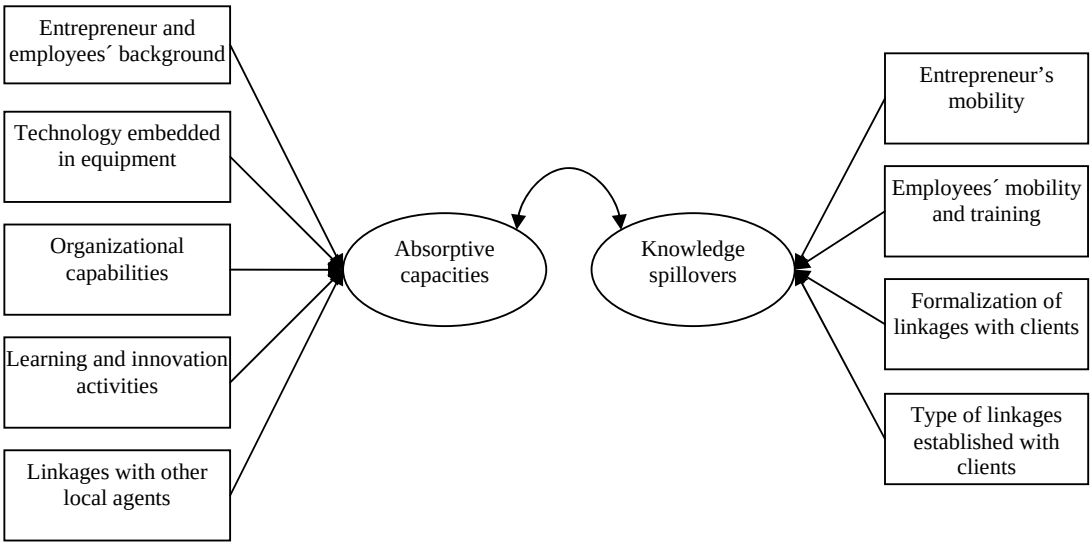
First order factor	Variable	Kind of variable	Missing values	Mean	SD
Entrepreneur's mobility	Years of experience	Numeric	6	17.04	11.54
	Experience in large firms	Dummy	10	-	-
	Experience in management	Dummy	5	-	-
	No. of training courses in large firms	Numeric	0	1.36	1.82
Employees´ mobility and training	Number of SMEs´ employees trained by large firms	Numeric	0	1.33	12.89
	Importance of training by large firms	Ordinal	0	-	-
	No. of employees with experience in large firms	Numeric	11	3.65	12.50
Formal linkages with clients	Years of customer-supplier relationship	Numeric	9	7.49	7.95
	Formal contracts	Dummy	1	-	-
	Informal relationships	Dummy	0	-	-
Type of linkages established with clients	Calibration of equipment	Dummy	0	-	-
	Product certification	Dummy	0	-	-
	Sharing design capacities	Dummy	0	-	-
	Sharing production capacities	Dummy	0	-	-
	Supporting the incorporation of technologies	Dummy	0	-	-
	Recommendations related to the lay out	Dummy	0	-	-
	Sharing machinery and equipment	Dummy	0	-	-
	Letting SMEs to access large firms´ plants	Dummy	0	-	-
	Technical advice	Dummy	0	-	-
	Joint projects	Dummy	0	-	-
	Sharing knowledge to export	Dummy	0	-	-
	Geographic proximity	Dummy	0	-	-
	Other recommendations	Dummy	0	-	-

Source: Authors´ own.

2.2 Structural equations analysis to identify the relationship between knowledge spillovers and absorptive capacities

During the second stage of the analysis we build a structural equations model by causal modeling to identify the relationship between absorptive capacities and knowledge spillovers using the indicators of knowledge spillovers and absorptive capacities. Using the technique of causal modeling is possible to incorporate both, first and second order factors and identify the most important determinants for knowledge spillovers and absorptive capacities and the relationship between them. However, due to data size restrictions, we divided the construction of the model in two stages. The results from this second stage of the analysis provide information to identify the most important knowledge spillovers mechanisms, and the most important determinants of absorptive capacities. We will also identify the fine determinants of the relationship between knowledge spillovers and absorptive capacities. Figure 1 presents the structural equations model to identify the relationship between absorptive capacities and knowledge spillovers and the importance of each indicator for knowledge spillovers and absorptive capacities.

Figure 1 Structural equations model for SMEs´ absorptive capacities and large firm's knowledge spillovers



Source: Authors´ own

The following equation expresses the structural equation model to identify the relationship between them absorptive capacities and knowledge spillovers.

$$F_{KS} = \alpha_1 F_{AC} + \varepsilon_1$$

Where:

F_{KS} is the indicator of knowledge spillovers.

F_{AC} is the indicator of absorptive capacities.

3 Main findings

3.1 Large firms´ knowledge spillovers

To obtain the indicator of knowledge spillovers we included the different variables related to three of the mechanisms of large firms' knowledge spillovers (human capital mobility, training and backward linkages). We identified four main factors related to large firms´ knowledge spillovers. Table 4 presents the rotated component matrix with the factorial charges for each one of the variables.

Table 4 Rotated component matrix for knowledge spillovers

Indicator (First order factor)	Variable	Factor			
		Technical (1)	Managerial (2)	Joint projects (3)	Mobility (4)
Entrepreneur's mobility	Years of experience	-.033	-.298	-.181	**.414**
	Experience in large firms	.065	.041	.141	**-.689**
	Experience in management	.095	**-.375**	.169	-.224
	No. of training courses in large firms	.035	.126	.145	**.700**
Employees´ mobility and training	Number of SMEs´ employees trained by large firms	-.126	.122	**.599**	.243
	Importance of training by large firms	-.076	**.413**	-.050	-.028
	No. of employees with experience in large firms	**.577**	.104	.353	.297
Formal linkages with clients	Years of customer-supplier relationship	**.220**	-.076	-.007	-.066
	Formal contracts	-.181	-.228	-.162	**-.490**
	Informal relationships	-.149	.352	**.370**	.310
Type of linkages established with clients	Calibration of equipment	**.585**	-.029	.006	-.059
	Product certification	.208	.006	**.541**	-.225
	Sharing design capacities	**.506**	.460	-.074	-.153
	Sharing production capacities	**.484**	.224	.204	-.257
	Supporting the incorporation of technologies	**.615**	.287	.234	-.083
	Recommendations related to the lay out	.150	**.347**	.321	-.068
	Sharing machinery and equipment	**.506**	-.024	-.048	.237
	Letting SMEs to access large firms´ plants	**.583**	.277	.085	.216
	Technical advice	.429	**.503**	-.075	.040
	Joint projects	.101	-.023	**.765**	-.049
	Sharing knowledge to export	.323	**.592**	.022	.046
	Geographic proximity	.006	**.716**	.164	.054
	Other recommendations	.079	**.492**	.247	.065

Indicator (First order factor)	Variable	Factor			
		Technical (1)	Managerial (2)	Joint projects (3)	Mobility (4)

Source: Authors´ own.
Software: SPSS
Extraction method: Principal factor analysis.
Rotation method: Varimax with Kaiser Normalization.
Rotation converged in 6 iterations
Variance explained 39.4%

i) Human capital accumulation and mobility

The highest factorial charges for each variable indicate a high correlation with the other variables in the same factor. We can observe from Table 4 that most of the variables considered for the entrepreneurs' mobility mechanism are grouped in factor four (Mobility), except for experience in management that is grouped in factor two (Managerial). This variable is closely related to the importance of training by larger firms and different types of interactions with customers, such as: recommendations related to the lay out, technical advice, sharing knowledge to export, geographic proximity, and other recommendations by customers. This result suggests that owners with more experience in management have the abilities to establish more efficient networks with clients and have a positive influence to benefit from knowledge spillovers. Similar results were found by Vera-Cruz and Dutrénit (2005). Thus, accumulation of experience, particularly related to management play an important role for knowledge spillovers in the sector and locality analyzed.

The variable for employees' mobility is grouped in factor 1, together with formal linkages with customers and different forms of interaction that require certain level of technical expertise, such as calibration of equipment, design and production capacities, incorporation of technologies and sharing machinery and equipment. This result suggests that employees with previous experience in larger firms facilitate technical interaction with customers and bring positive effects to establish formal contracts.

ii) Training

The variables associated to training have been grouped in factors 2 and 3. The number of employees trained by large firms is grouped in factor 3, which is related to informal relationships with clients, but also to some formal interactions, such as joint projects. The importance of training by large firms is linked to some specific types of interactions with large firms such as technical advice, knowledge to importance of export geographic proximity and other recommendations. These results suggest that training is an important channel for knowledge spillovers.

iii) Backward linkages

The variables associated with linkages with clients are distributed in factors 1, 3 and 4. The variable about length of the relationship is grouped in factor 1, which encloses most of the variables related to more knowledge intensive types of interaction with clients. Thus we can argue that longer time relationships with clients promote a virtual circle type of interactions that can lead to upgrade SMEs' technological capabilities. Formal contracts with clients are associated with factor 4, which suggest that more experienced managers tend to establish more formal contracts with their clients, which could lead to a better planning of SMEs' activities.

Regarding the variables associated with the type of linkages with clients, we found that the different variables group in factors 1, 2, and 3. Factor 1 groups all the variables associated with technical skills that can foster technical capabilities, grouped also with employees' experience and length of the relationship. The variables related to managerial linkages are grouped in factor 2, such as knowledge to export and openness to other recommendations. Factor 3 includes more knowledge intensive activities such as interactions to perform joint projects. These results suggest that backward linkages play an important role for knowledge spillovers.

3.2 SMEs´ absorptive capacities

To obtain the indicator of absorptive capacities we identified the significant variables and obtained five factors related to SMEs´ absorptive capacities using the extraction of principal factors technique. Table 5 presents the rotated component matrix with the factorial charges for each one of the variables.

Table 5 Rotated component matrix for absorptive capacities

First order factor	Variable	Component				
		Technical capabilities (1)	Organizational capabilities (2)	Firms' characteristics (3)	Linkages (4)	Innovation (5)
Entrepreneur and employees´ background	Entrepreneur's degree	.171	.065	.275	.184	**-.318**
	No. of employees	.288	.104	**.572**	.141	-.045
	No. of engineers	.083	.054	**.746**	-.093	-.242
	% of engineers	-.161	-.053	**.341**	-.085	-.259
	Employees with experience in CNC	**.748**	-.003	.083	-.076	.009
	Employees with experience in design	**.518**	.128	-.116	.207	-.187
	Employees with experience in computer aided manufacturing (CAM)	.302	-.087	.157	**.765**	-.226
	Employees with experience in measurement	**.838**	.140	.009	-.045	.092
	Employees with experience in quality control	**.807**	.172	.077	-.104	.194

First order factor	Variable	Component				
		Technical capabilities (1)	Organizational capabilities (2)	Firms' characteristics (3)	Linkages (4)	Innovation (5)
Technology embedded in equipment	CAM programming	**-.535**	.080	-.343	-.341	.250
	No. NC and CNC equipment	**.659**	.026	.198	-.066	.029
	Years of NC and CNC equipment	**.348**	-.032	.351	.215	-.183
	Tolerance for products	**.240**	.159	-.155	.129	.143
Organizational capabilities	Years in the market	**.260**	-.073	.217	-.114	.173
	Past experience for decision-making processes	-.010	**-.634**	-.144	-.002	.290
	Technical knowledge for decision-making processes	-.065	**.587**	.087	-.002	-.304
	Formal contracts with clients	**-.358**	-.108	-.063	-.064	.016
	Sells per employee	-.032	.113	**-.398**	.088	-.307
	Quality certification	-.011	.021	**-.649**	-.197	.201
	Materials quality certificates	.068	**.701**	.140	-.076	.154
	Time delivery certificates	.216	**.655**	.244	-.013	-.024
Learning and innovation activities	Projects with suppliers	.208	**.595**	-.163	.237	.084
	Projects with clients	.163	**.637**	-.044	.226	.036
	Process documentation	.107	**.638**	-.025	.042	.141
	Acquisition of machinery and equipment	.254	.214	**.435**	.014	.105
	Documentation of changes in process	.364	.295	**.430**	.054	.170
	Training programs to develop new products	.304	.306	**.622**	.081	.252
	New marketing programs	-.180	.091	**.512**	.054	.256
	Product innovation	.025	.084	-.009	.068	**.738**
	Process innovation	.083	-.007	.038	.073	**.716**
Linkages with other local agents	Importance of linkages with suppliers	-.112	.135	.074	**.713**	.059
	Importance of linkages with customers	-.056	.264	-.025	**.633**	.161
	Importance of linkages with competitors	-.194	.428	.041	**.407**	.105
	Importance of linkages with technical organizations	-.012	.028	.030	**.631**	.076
	Importance of linkages with industrial associations	.100	-.024	.007	**.705**	-.072

Source: Authors´ own.
Software: SPSS
Extraction method: Principal factor analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 6 iterations
Variance explained: 45.72

i) Entrepreneur and employees' background

The high factorial charges for each variable indicate a high correlation to each one of the other variables grouped in the same factor. From table 6 we can observe how each one of the variables is grouped in the factors. The variables associated with entrepreneurs' and employees' background are grouped mainly in factors 1 and 3. Factor 1 is associated with employees' technical knowledge and experience. These variables are also correlated to technology embedded in equipment and formal contracts with clients. These results suggest higher employees' technical experience is linked to

the use of more sophisticated equipment and to the production of more complex products (Marin and Bell 2006), which is also linked to the establishment of formal contract with clients. Factor 3 is associated with firms' structural characteristics, such as firm size and distribution of employees; these variables are also correlated to some learning and innovation activities such as acquisition of machinery and equipment, documentation, training and new marketing programs.

ii) Technology embedded in equipment

All the variables associated with technology embedded in equipment are grouped in factor 1, which are also connected to employees' technological capabilities. This suggests that the equipment acquired by firms is directly related to the employees experience, thus, we can argue that these two indicators are important to differentiate SMEs and their access to other type of market niches.

iii) Organizational capabilities

On the other hand, the variables associated with organizational capabilities are distributed mainly along factors 1 and 2. Formal contracts with clients and SMEs' age have been grouped in factor 1, together with technology embedded in equipment and employees' technical experience, which suggest that firms with higher absorptive capacities related to technical capabilities and technology embedded in equipment establish more formal contracts with clients. The variables that have been grouped in factor 2 are associated with the importance of the decision making process and quality certificates; they are also correlated to knowledge codification, projects with suppliers and clients, where activities are more knowledge intensive. These results suggest that organizational capabilities can be important determinants of absorptive capacities.

iv) Learning and innovation activities

Learning and innovation activities are grouped in three main factors, engagement in projects and process documentation activities are grouped in factor 2, these activities are associated with more interactive and advanced activities that can lead to virtual circles of knowledge flows between clients and suppliers; these variables are also related to organizational capabilities associated to the decision making process. The variables grouped in factor 3 are associated to shorter term type of activities that can have an immediate impact on SMEs such as acquisition of equipment, process documentation, training and marketing. These variables are also linked to the number of employees and engineers in SME. Activities grouped in factor 5 are associated with more innovative activities, either product or process innovations.

v) Linkages with other local agents

The last indicator of absorptive capabilities is grouped in factor 4. Linkages with other local agents require certain level of absorptive capacities, but the actual level of SMEs' absorptive capacities also increases with higher interaction.

3.3 Relationship between knowledge spillovers and absorptive capacities

To identify the relationship between knowledge spillovers and absorptive capacities and the specificities of this relationship, first we build a correlation matrix that explains the relationship between the different indicators (see Table 6).

Table 6 Correlation matrix of absorptive capacities and knowledge spillovers

	FORMA	TECNO	CAPORG	INNOVA	VINC	EXPERP	EXPERE	VCP	TIPO
FORMA	**1.000**								
TECNO	0.503	**1.000**							
CAPORG	0.309	0.084	**1.000**						
INNOVA	0.502	0.323	0.594	**1.000**					
VINC	0.084	0.092	0.252	0.365	**1.000**				
EXPERP	-0.103	-0.246	0.124	0.005	0.116	**1.000**			
EXPERE	0.065	-0.068	0.386	0.340	0.191	0.067	**1.000**		
VCP	0.281	0.324	0.366	0.509	0.525	0.066	0.310	**1.000**	
TIPO	0.322	0.261	0.298	0.565	0.395	-0.098	0.471	0.466	**1.000**

Source: Authors´ own. Survey applied to SMEs machining shops located in Querétaro, México, UAM-X, 2005.
LISREL
Note:
For absorptive capacities. FORMA: Entrepreneur and employees´ background; TECNO: technology embedded in equipment; CAPORG: organizational capabilities; INNOVA: learning and innovation activities; VINC: linkages with other local agents.
For knowledge spillovers. EXPERP: entrepreneurs´ mobility; EXPERE: employees´ mobility and training; VCP: formal linkages with clients; and TIPO: type of linkages established with clients.

The entrepreneur and employees´ background has a direct and important relationship with the technology embedded in equipment, and with innovation and learning activities. On the other hand, innovation and learning activities have a direct relationship with the backward linkages and SMEs´ organizational capabilities. Employees' experience has a high correlation with the type of linkages established with firms.

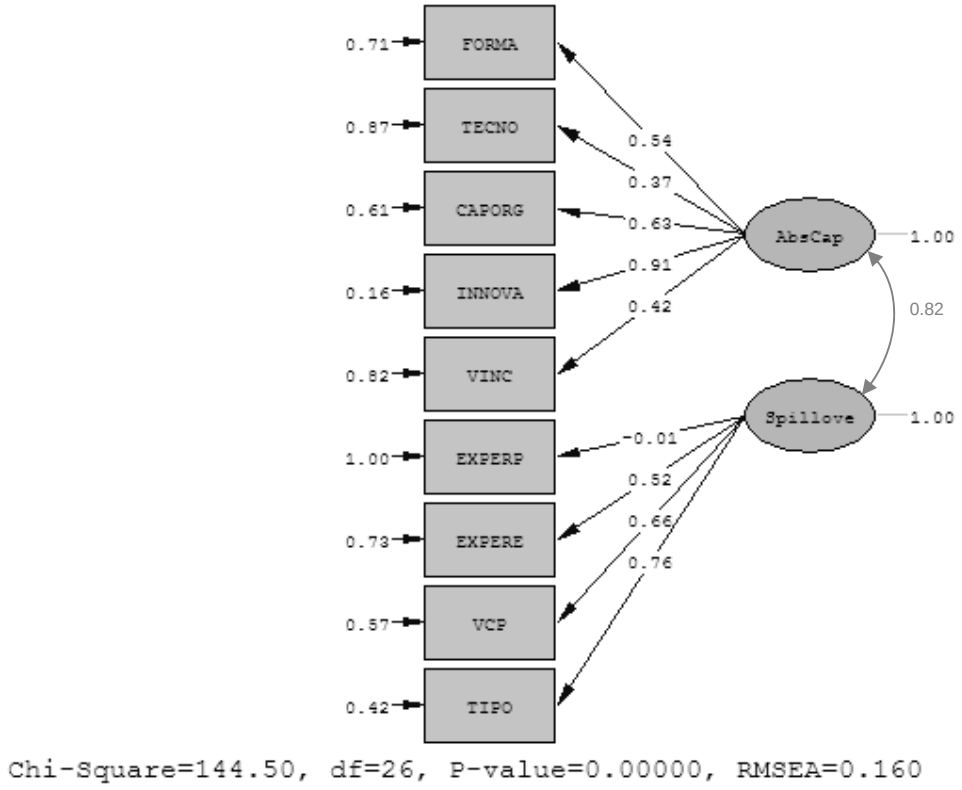
Secondly we build a structural equations model to identify the most important determinants for absorptive capacities and the most important mechanisms for knowledge spillovers, and also the correlation between knowledge spillovers and absorptive capacities. The following correlations are analyzed:

i. Between absorptive capacities and: i) entrepreneur and employees´ background; ii) technology embedded in equipment; iii) organizational capabilities; iv) learning and innovation activities; and v) linkages with other local agents.

ii. Between knowledge spillovers and: i) entrepreneurs´ mobility; ii) employees´ mobility and training; iii) formalization of linkages with clients; and iv) type of linkages established with clients.
iii. Between absorptive capacities and knowledge spillovers.

The indicators of knowledge spillovers and absorptive capacities (second order factors) are placed at the right side of the diagram; and each one of the different indicators for knowledge spillovers and absorptive capacities (first order factors) are placed at the left side of the diagram. The arrows show the relationship between second and first order factors.

Figure 2 Structural equations analysis diagram between SMEs´ absorptive capacities and large firms´ knowledge spillovers



LISREL
Sample size: 110 observations.
Note:
For absorptive capacities. FORMA: Owners and employees´ background; TECNO: technology embedded in equipment; CAPORG: organizational capabilities; INNOVA: learning and innovation activities; VINC: linkages established with other local agents.
For knowledge spillovers. EXPERP: entrepreneurs´ mobility; EXPERE: employees´ mobility and training; VCP: formal linkages with clients; and TIPO: type of linkages established with clients.
According to the indexes of goodness fit statistics this model is acceptable. Our sample size was 110, and the indexes CFI, IFI, and GFI are higher than 0.81, RMR and RMSEA indexes are 0.105 and 0.160 respectively.

The structural equations analysis indicates the impact of first order factors on second order factors and the correlation between absorptive capacities and knowledge spillovers. In relation to absorptive capacities, the indicators that have the highest impact are innovation and learning activities, and organizational capabilities, 91% and 63% of these indicators explain SMEs´ absorptive capacities respectively. Entrepreneur and employees´ background has a medium impact on absorptive capacities. The indicators that have the lowest impact on absorptive capacities are linkages with other local agents and technology embedded in equipment, 42% and 37% of these factors explain SMEs´ absorptive capacities respectively.

In relation to large firm's knowledge spillovers, the indicators that have a higher impact are related to the backward linkages mechanism; 76% of the type of linkages and 66% of the formality of linkages explain large firm's knowledge spillovers. This correlation suggests that the SMEs are strongly influenced by their clients.

The factor of employees´ mobility explains 52% of large firms´ knowledge spillovers, which indicates that previous experience of employees is an important mechanism for knowledge spillovers within the sector and locality analyzed. On the other hand and in contrast with the findings by Görg and Greenaway (2001), Andrea, Motta and Ronde (2001), and Vera-Cruz and Dutrénit (2005)[6] the factor that has the lowest impact and even has a negative value is related to entrepreneurs´ mobility. We argue that the variables used to build this indicator do not explain knowledge spillovers through the entrepreneurs´ mobility. Different arguments contribute to explain such result: i) there is a small percent of entrepreneurs with professional background in the sector, the lack of formal education hinders knowledge absorption and the application to their own new firms; and ii) as they do not have formal education, they usually do not have access to top management positions in large firms, and they cannot absorb more complex organizational and technological knowledge.

Regarding the correlation between absorptive capacities and knowledge spillovers, Table 7 lists the correlation level that was obtained by the structural equations analysis. The correlation between SMEs´ absorptive capacities and large firms´ knowledge spillovers is 0.82, which indicate a positive and strong relationship between these two concepts within the sector and locality analyzed.

[6] Vera-Cruz and Dutrénit (2005) analyzed the same sector in another Mexican locality; they concluded that owners' mobility from MNCs to SMEs is one of the most important mechanisms for knowledge spillovers.

Table 7 Correlation of absorptive capacities and knowledge spillovers

	Absorptive capacities	Knowledge spillovers
Absorptive capacities	**1.000**	
Knowledge spillovers	0.820 (0.054)	**1.000**

Number of Iterations = 22
LISREL Estimates (Maximum Likelihood)

As we found a strong correlation between absorptive capacities and knowledge spillovers, our empirical evidence suggests that it is easier for SME with higher levels of absorptive capacities to reap the benefits from large firms´ knowledge spillovers. SMEs with higher absorptive capacities have a higher number of engineers per firm, which leads to a better task distribution, thus owners can spend more time in activities related to management and planning. SMEs with higher absorptive capacities usually have employees with higher skills in CNC, CAM, design, measuring, calibration, and quality systems. These SMEs have a higher proportion of advanced equipment, such as NC and CNC equipment, and they use CAM to program their production, which permits a more efficient use of the machinery and to produce more complex products, which is important to increase their market shares. A higher percent of firms with higher absorptive capacities have formal contracts with their clients.

On the other hand, SMEs with lower levels of absorptive capacities have more owners with technician's degrees than with engineer's degrees, and a smaller percent of employees have engineer's degrees. These firms have less than one engineer per firm in average, thus it is difficult to distribute the activities within the firm. Employees from these firms have experience in design, measuring and calibration and a very small proportion of the employees have experience in CNC and CAM. SMEs have conventional equipment, they usually do not have NC and a small number of them have CNC, they do not use CAM programming for their production. These characteristics hinders the technological upgrading of SMEs and production of more complex products that require a higher level of precision and quality which are necessary to increase their market share.

4 Conclusions

This paper contributes to identify some of the large firms' knowledge spillover mechanisms and the main determinants of SMEs´ absorptive capacities within a specific sector and locality. We also contribute to demonstrate the specific relationship among these two concepts.

We focus the analysis of SMEs´ absorptive capacities in a low-tech and mature sector and on large firms' knowledge spillovers from the automotive and home appliances sectors. Drawing on the existent literature and exploring the use of ad-hoc indicators, and structural equations to analyze this relationship, it has been possible to have a better understanding on the determinants of absorptive capacities, the mechanisms of knowledge spillovers, and the relationship between these two concepts within a specific sector and locality.

The most important channels that explain knowledge spillovers are related to the backward linkages mechanism, which suggest that there are important knowledge flows that increase SMEs´ production capabilities during the interaction, and that SMEs are strongly influenced by their clients. Thus, to strengthen large firms´ knowledge spillovers, it is important to increase the level of backward linkages between large firms and SMEs and the type of interaction from these linkages. Employees' mobility is the second most important mechanism for knowledge spillovers. On the other hand and in contrast with the findings by Andrea, Motta and Ronde (2001) and Vera-Cruz and Dutrénit (2005), the entrepreneurs´ mobility does not represent an important mechanism for knowledge spillovers in the sector and locality analyzed. This result can be explained by the characteristics of the local system, the inclusion of large domestic firms and not only MNCs, and the type of experience that entrepreneurs accumulate, which is mostly related to production and quality control activities, and to a lower extent to managerial activities.

With the information collected from the survey we did not identify more characteristics of large firms that promote higher levels of knowledge spillovers. However, through evidence collected during interviews, we identified that some MNCs have more schemes for suppliers' development than national firms.

The most important determinants for SMEs´ absorptive capacities are organizational capabilities and innovation and learning activities, which are strongly related to the entrepreneur and employees´ background. On the other hand, technology embedded in equipment and linkages with other local agents have a lower impact on SMEs´ absorptive capacities. This result suggests that to increase SMEs' absorptive capacities it is necessary to reinforce their organizational capabilities and innovation and learning activities, by strengthening the owners' managerial abilities, and employees' technical abilities. As most of the knowledge within this sector is tacit, firms and industrial associations can design and implement new schemes that promote knowledge sharing

within the firm and apprenticeship programs. These mechanisms can have a positive impact on technology embedded in equipment, as we observed above this indicator is closely linked to the employees' expertise.

We found that large firms´ knowledge spillovers are strongly correlated to SMEs´ absorptive capacities within this specific sector and locality. More specifically, we found that the spillover mechanisms of backward linkages and employees´ mobility have a strong and direct impact on the absorptive capacities determinants of innovation and learning activities. Thus we can argue that SMEs' with higher absorptive capacities get more benefits from knowledge spillovers, upgrading their technological and organizational capabilities and accessing other market niches that demand more complex products. However, it is necessary to pay closer attention to the different variables that determine learning and innovation activities, and organizational capabilities to foster the development of SMEs with higher absorptive capacities.

On the other hand, SMEs with lower levels of absorptive capacities are seem to be trapped in a vicious circle, as most of them lack human resources and equipment or organizational capabilities necessary for upgrading and access other type of market niches that demand more complex products, thus they are usually not considered by their clients to be key suppliers.

The variables considered in this study focus on the analysis of this specific sector and locality, but they can differ across sectors. Further studies can focus on identifying a set of variables that can fit the analysis of knowledge spillovers and absorptive capacities from a variety of sectors and regions to perform comparative analysis. Further analysis should also consider the exploration of more knowledge spillover mechanisms that have been identified by other authors. Another important aspect that was not considered in this paper due to data restrictions is the direction of the correlation between knowledge spillovers and absorptive capacities. We can argue *a priori* that absorptive capacities determine knowledge spillovers, and only SMEs´ with a minimum level of absorptive capacities can get the benefits of such spillovers. At the same time, the absorption of such knowledge spillovers increases SME´ absorptive capacities, creating a sort of virtual circle or spiral between absorptive capacities and knowledge spillovers.

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