Chapter 10
Patterns of Technology Acquisition:
Upstream Linkages Between MNEs and Local Suppliers

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ABSTRACT

Although MNEs are important players in the present global world, there has been a debate regarding, on one hand, how MNEs contribute to the development of indigenous firms in host countries, and on the other hand, how indigenous suppliers are able to cope with their international technology demanding clients. This chapter analyzes the patterns of technology acquisition of 40 firms that supply eight multinational firms that belong to four different industries. It is possible to conclude that there are certain differences among foreign and indigenous suppliers as well across the industries they belong to. These differences are the result of a cumulative process over time, which reflect the different performances of the companies and their relationships with the environment.

INTRODUCTION

The erosion of barriers to international flows of goods, knowledge and products brought about new challenges for all firms and for policy makers agendas, namely in developing and sustaining competitive advantages in the international arena.

Studies analyzing foreign direct investment (FDI) and multinational enterprises (MNEs) proliferate as MNEs exercise a crucial role in international business (Ribau,

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Moreira, & Raposo, 2015). However, there are still some controversies regarding FDI and its consequences in host counties, and the contribution of MNEs to local economies (e. g. Grimes & Du, 2013; Jiang, Branzei, & Xia, 2016). Those who contend that FDI affects negatively host countries defend that MNEs jeopardize the technological leadership of indigenous firms and drive them out of business (Günther, 2002). Those in favor of FDI argue that it is as a beneficial factor as it is a source of capital, technology and new knowledge (Wang and Yu, 2008), especially for developing countries (D'Amelio, Garrone, & Piscitello, 2016) as MNEs contribute to energy poverty alleviation. However, Gorg and Strobl (2001) and Irsova and Havranek (2013) found that the results are irrelevant.

Although the controversy remains, as MNEs are important players in the present global world, there has been a debate regarding, on one hand, how MNEs contribute to the development of indigenous firms generating endogenous conditions to promote a sustainable economic development in host countries, and, on the other hand, how indigenous suppliers are able to cope with their international technology demanding clients (Moreira, 2008; Perri & Peruffo, 2016; Reis, Heitor, Amaral, & Mendonça, 2016).

If it is clear that both a cooperative behavior is mandatory for suppliers to succeed in supplying their multinational clients, and that local suppliers and foreign MNEs need to interact with each other if local suppliers are to evolve strategically in this relationship (Moreira, 2008). Moreover, as Moreira (2009) claims, knowledge flows between both firms are mandatory for a symbiotic relationship to take place.

What is not known is what the patterns of technology acquisition among SMEs in their relationship with MNEs are. As such, this chapter seeks to analyze the accumulation process among suppliers as a result of the supplier (SME)-client (MNE) interface in the supply chain. It is assumed that the external network of relationships among suppliers is the result of their need to cope with technological change generated by their clients.

Two types of inter-firm relationships are going to be analyzed: informal and formal relationships. The following patterns of technology accumulation are going to be analyzed, based on Ribault, Martinet, and Lebidois (1995): catalogue purchase; specification purchase; capital equipment purchase; outsourcing; technological scanning; reverse engineering; patenting; licensing; spin offs; network of firms; joint venture; strategic alliances; cooperative R&D; and participation in European programs.

This chapter is divided in seven sections. After this introduction, the second section presents the literature review on the importance of FDI, MNEs, and the consequences of FDI for local economies. The third section lays down the research methodology. The main results are presented in section four. Section five presents the main conclusions. Section six presents future research directions and section seven presents solutions and recommendations.

BACKGROUND

FDI has become one of the key consequences of the erosion of barriers to international flows of goods and knowledge (Moreira, 2008). Gross domestic product (GDP) grew from 7% of world GDP in 1990 to 32% of world GDP in 2012 (Sun, Lee, & Hong, 2016), which gives a clear picture of the importance of FDI for the world economy.

As referred by Ribau et al. (2015), classical theories of international business addressed the articulation of international production with international trade and capital flows (Hymer, 1976). Hymer (1976) stressed that FDI was important as way of MNEs controlling foreign assets, and exercising market power benefiting from imperfect competition or from the possession of distinctive ownership advantages. The theories of the firm were also important to study the motivation for MNEs to operate, produce and market abroad in any industry and why MNEs have a special drive towards diversification (Buckley & Casson, 1976; Hymer, 1976; Ribau et al, 2015).

The eclectic paradigm, developed by Dunning (1977; 1981) was important to explain why, where, and how MNEs operate overseas. It was based on the premise that international investment requires the fulfilment of three main preconditions firms need to fulfil to invest abroad: called the *ownership*, *location*, and internalization (OLI) advantages. Ownership advantages are unique to a particular firm and enable it to take advantage of investment opportunities abroad. Locational advantages are those that are specific to a country. These types of advantages are especially attractive for foreign investors. Internalization advantages are the benefits that derive from internal markets and that allow firms to bypass external markets and the costs associated with them.

It is clear that, from the theories so far referred to, there is little reference to the endogenous conditions of the host country perspective. However, based on the eclectic paradigm, the investment development path (IDP) model contends that firms ownership advantages interact with countries location advantages, and as a result from those interactions both host and home countries' economies are shaped (Dunning & Narula, 1996; Narula & Dunning, 2010).

Although the presence of foreign firms has negative implications on local suppliers as they cannot comply with higher standards of supplied products (Weatherspoon & Reardon, 2003; Farina & Reardon, 2000), there are positive vertical impacts among domestic firms in supplier-client relationships (Moreira, 2008), in the adoption of new technologies (Gow & Swinnen, 1998), and in improved access to finance and product quality (Dries & Swinnen, 2004).

Jiang et al. (2016), based on a study of Chinese manufacturing firms, from 1998 to 2007, conclude that foreign equity dis-incentivizes endogenous knowledge while export orientation incentivizes investment on internal knowledge as there is a shift in the locus of innovation control from a firm-level dependence on imported technology to an indigenous-centered innovation perspective. This perspective is tuned with Grimes and Du's (2013) view that defend that dependence on external knowledge makes firms overly dependent on imported technology.

On the other hand, studies have shown negative economic and social impacts stemming from MNEs presence in developing countries (Günther, 2002). Some studies find that multinationals crowd out local firms and that technology, knowledge, and skills transfers do not occur over the long-term (Aitken & Harrison, 1999). In addition, MNEs pollute the environment, exploit child labor, adopt inadequate safety standards and are not effective in alleviating poverty with their social initiatives (Oetzel & Doh, 2009).

Perri and Perrufo (2016) address FDI knowledge spillovers from the international business perspective, and develop a framework that integrates macro- and micro-level antecedents spillovers and their consequences. They clearly differentiate between traditional models and new perspectives and propose that: first, consequences of FDI spillovers should be analyzed from both local (erosion of local firms' competitive knowledge and catch up process) and foreign firms perspective (subsidiaries' opportunity for knowledge sourcing, liability of foreignness, and embeddedness); second, antecedents of FDI spillovers should be analyzed from a macro level (emerging economy home context and informal institutions and coevolution); local firms level (degree of openness); MNE level (FDI motivation, effectiveness of central and lateral knowledge flows, leader vs laggard, and multiple-embeddedness); and subsidiary level (influence of social norms, knowledge strategies, and relationship with local business network). This is clearly a different view of the "dominated by economists" literature of the impact of FDI on host countries (Eden, 2009, p. 1065).

Based on the outcomes of the different studies, stablishing upstream and downstream linkages among foreign and domestic firms is one of the main concerns policy makers face (Altenburg & Mayer-Stamer, 1999; Schmitz & Nadvi, 1999; Belderbos, Capannelli, & Fukao, 2001; Costa & Queiroz, 2002; Dries & Swinnen, 2004; Andreoni & Chang, 2016; Hirsh, 2016).

Governments in many developing countries are using financial incentives (e.g. grants, subsidized credits), fiscal incentives (e.g. lower tax rates, tax holidays) and donations of land to aggressively attract FDI, which was influenced by the failure of important-substitution policies (Narula, 2014). The importance of the attraction of

FDI in Portugal has been addressed by Moreira and Carvalho (2012) and Reis et al. (2016), who claim that the benefits from attracting FDI is well beyond the obvious direct effect on job creation and income tax collection, and include the enhancement of absorptive capabilities among indigenous suppliers and of research & development (R&D) activities and fostering science and technology (C&T) partnerships between local C&T institutions and industrial players.

From a spillover point of view, Sun et al. (2016) analyzed 44,434 newly created firms in South Korea between 2000 and 2004. They found that the impact of FDI in low-tech industries is positive and significant in all four possible combinations of intra- / inter-regional and intra- / inter-sectoral channels. However, the impacts in high-tech industry are largely intra-sectoral within the host region. These differences are explained by the fact that agglomeration effects and location decisions favor regions of high quality of human quality with high wage rate. This clearly indicates that location advantages are sector specific, which has consequences for industrial policy. Moreover, if MNEs want to foster their relationships in upstream and downstream in the supply chain they need to be aware that knowledge spillovers are important but that there are spatial and sectorial differences (Sun et al., 2016).

RESEARCH METHOD

The methodology implemented was explorative in nature and was based in qualitative data, collected from semi-structured, in-depth interviews.

The research methodology involved three main steps. The first one consisted in the formulation of the patterns of technology acquisition among firms supplying Foreign MNEs in Portugal. These mechanisms are based on work done by Ribault et al. (1995) and Gomes and Kruglianskas (2009). These variables are assessed in SMEs.

The second step involved the selection of the sample. Firms were selected from four different industries – electronics, footwear, chemical, and automobile – in order to maximize the possible differences between the patterns of technology acquisition. The population of firms included two different sub-groups: the clients (MNEs) and the suppliers (SMEs). The clients were selected among the largest MNEs of the previously mentioned industries and the suppliers were selected among the set of firms supplying to those MNEs.

While the identification of the MNEs was carried out through secondary information, the identification of the suppliers was based on information released by MNEs during the interviews.

Eight MNEs were willing to co-operate in the field research. Data from the second subset of firms (suppliers) were obtained from released information from TNCs.

The objective was to select five suppliers from each multinational subsidiary and to reach a sample of forty firms. The final sample included 40 suppliers: 12 firms supplying automakers, 11 firms supplying electronics MNEs, 10 firms supplying footwear manufacturers and seven firms supplying chemical industry's MNEs. The gathering of data was carried out through in loco, semi-structured, tape-recorded interviews at both MNEs and suppliers' sites.

The interviews with local suppliers' executives addressed the following topics:

- General information about the firm;
- Evolution of production, operations and technological activities;
- Evolution of technological activities in downstream activities in the value chain with MNEs.

The third step consisted in the analysis of the patterns of technology acquisition of the suppliers of the MNEs of the four industries analyzed. The following patterns of technology accumulation were analyzed, based on Ribault et al. (1995) and Gomes and Kruglianskas (2009): catalogue purchase; specification purchase; capital equipment purchase; outsourcing; technological scanning; reverse engineering; patenting; licensing; spin offs; network of firms; joint venture; strategic alliances; cooperative R&D; and participation in European programs.

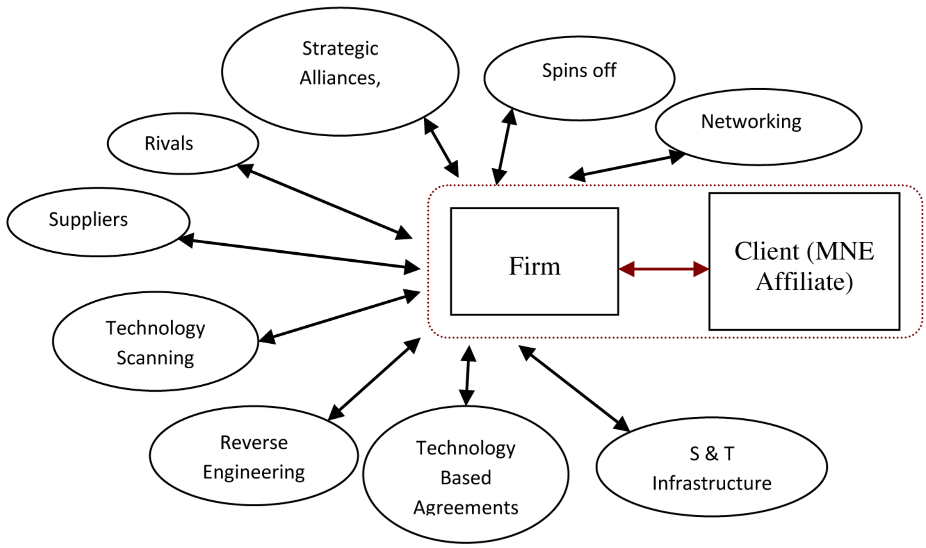
The process of know-how accumulation proposed by places the innovating firm as the center of an extended network of institutions and activities (Rothwell, 1994; Moreira, 2009). This perspective is used because it illustrates both the important interfaces between the suppliers and their clients and the various modes of external learning. While in the context under analysis the supplier-customer relationship implies learning from the direct relationship with the customer, other modes of external learning can be considered as a consequence of the supplier-customer interaction (Schiele, 2006; Moreira & Carvalho, 2015). While Figure 1 illustrates the supplier-customer interactions and their external networking relationships, Table 1 lays down the main findings.

The relationship between companies and the external environment plays a fundamental role in the technological development process. In the case of SMEs, and due to their diverse endogenous limitations, external relationships become an essential and indispensable instrument of technological accumulation.

RESULTS

There are two types of inter-firm relationship (Lowe, 1995; Veludo, Macbeth, & Purchase, 2006):

Figure 1. Client-supplier interactions and external relationships



- **Informal Relationships:** Although they are not normally made public in written contracts they involve a continuous process of exchange of information among different organizations;
- **Formal Relationships:** That normally take the form of explicit - technology, productive, commercial or otherwise - co-operation agreements or strategic alliances that involve two or more companies.

Informal Relationships

Customers

The deepest relationship is established with the customers. All the suppliers mentioned the importance of listening to clients and analyzing clients' suggestions in the innovation process as well as in the new product development (NPD) process.

The characteristics of that relationship vary according to the industry type and the firms' technological strategy.

Although in all the four industries it was clear that the contact with clients is of fundamental importance, the footwear, electronics and automobile industries have more intense supplier-client relationships than the chemical industry. This is due to the vertical structure of supplier-client relationships. Generically, customers – normally larger than their suppliers – have a superior bargaining power than that

Table 1. Patterns of technology acquisition

	Suppliers to							
	Auto Industry		Chemical Industry		Electronics Industry		Footwear Industry	
	Number	%	Number	%	Number	%	Number	%
Catalogue Purchase	12	100.0	7	100.0	11	100.0	9	90.0
Specification Purchase	12	100.0	7	100.0	11	100.0	9	90.0
Capital Equipment Purchase	12	100.0	7	100.0	11	100.0	10	100.0
Outsourcing/ Subcontracting:								
1. Non-core products	3	25.0	-	-	5	45.5	2	20.0
2. Production	7	58.3	-		-		4	40.0
Technological Scanning:								
1. Broad Scope	8	66.7	5	71.4	6	54.5	2	20.0
2. Production	10	83.3	7	100.0	11	100.0	7	70.0
Reverse Engineering	5	52.1	-	-	2	18.2	4	40.0
Patenting	1	10.4	-	-	-	-	-	-
Licensing	-	-	-	-	-	-	2	20.0
Spin Outs	3	31.3	1	14.3	1	9.1	1	10.0
Network of Firms	2	20.8	-	-	-	-	-	-
Joint Venture	2	20.8	-	-	-	-	-	-
Strategic Alliances	2	20.8	-	-	-	-	-	-
Co-operative R&D:								
1. University	7	58.3	5	71.4	4	36.4	3	30.0
2. Governm. Sponsor. Res. Ins.	2	20.8	-	-	4	36.4	1	10.0
Participation European Progr.	3	25.0	2	28.6	2	18.2	2	20.0

of the suppliers and have a fundamental role in the introduction of innovation in the supply chain imposing new products, new designs or new features in upstream activities.

The supplier-client articulation grows deeper when clients successfully work with their suppliers the adaptation of existing products to new specific market conditions / applications or in the development of brand new products. Suppliers are then able not only to satisfy industrial production capabilities, but also to provide supporting activities in the NPD process, which enhances the long-term supplier-client relationship.

The suppliers' technological strategy has a very important role because it either underpins or hinders supplier-client relationships.

Innovative firms have very close relationships with their clients. These companies' scope goes beyond the mere development and production of a component/product; they have managed to accumulate enough technological capability to develop new products/new innovative solutions that satisfy the customers' needs behaving as credible, long-term partners with competencies of their own to create added value for the client.

In summary, despite the bargaining power differences between suppliers and clients and the industry's unique demands, the customers constitute the dynamic engine of the suppliers' external relationships.

Suppliers

The relationship with suppliers can be considered positive and quite widespread among the visited firms. Nevertheless, suppliers' influence seems to be lower than that of the clients. The main upstream relationships with the suppliers' suppliers were, as shown in Table1: catalogue purchase; specification purchase; capital equipment purchase; and outsourcing.

The relationship with capital equipment suppliers has been one of the primary ways used by Portuguese SMEs in their struggle for technological development. In the sample studied, capital equipment suppliers are important players because they transmit the technological novelties forward in the value chain, as well as supply an entire range of services that help to update firms. The dialogue with capital equipment vendors is important, above all, due to the introduction of improvements and adaptations to equipment and systems and to the introduction of new hardware technical solutions. Although the relationship with capital equipment suppliers is important, it was possible to notice that there were several sectoral differences. Its importance is felt above all, in the footwear industry and in companies that follow traditional and dependent strategies, *i.e.*, those that are likely to base their technology competence in production technology.

A factor that should not be ignored is the training provided by capital equipment vendors: it allows firms to overtake barriers without which the equipment would not be used in the best conditions; to access technical knowledge; and to diminish learning time, all of which are difficult to quantify due to their very intangible nature.

Raw materials and components suppliers also play an important role in technology accumulation among SMEs. All, except one firm, from the cork industry, expressed the importance of assessing input suppliers news and novelties as a means of being updated. Suppliers from the plastics and chemical industries showed a larger interest in their upstream relationship with input suppliers than the rest of the firms. The importance of this relationship lies in the importance that technical change has in the creation of new products.

The two chemical suppliers (one SME and one larger firm) supplying the shoemakers stated that input suppliers were crucial for keeping abreast of knowledge. Their suppliers of raw material were multinational firms with a wide accumulated technical knowledge that should not be disregarded as important technical source relevant to the creation of new products. Although this technical knowledge is passed on to the two chemical suppliers as new raw materials and new components both firms have different attitudes towards their suppliers. Whilst the SME has an internalization attitude towards novelties transmitted by vendors, the large firm has no development department. Although some technology flows from vendors of raw materials and components do occur, the large firm seems unable to make those technology flows endogenous due to lack of technical capability.

The rest of the chemical firms supplying the chemical industry, having large MNCs as suppliers of input materials as well, showed a lower dependence on their suppliers. This is not surprising taking into account that they are part of large conglomerates and consequently they acquire technology from various sources.

Outsourcing policies have been used differently across all sectors. Whilst suppliers to the automobile industry (seven firms) were the most active in subcontracting production capacity, suppliers to the electronics industry (five firms) were more oriented towards outsourcing non-core products. Not a single supplier to the chemical industry followed an outsourcing policy.

Outsourcing production capacity was more concerned with extending the firms' boundaries upstream in the supply chain than with accumulating technology. The eleven firms that outsourced part of the production claimed that had they had the possibility to produce it in-house they would have done it, i.e., they resorted to outsourcing due to their lack of capacity to serve the market.

For the suppliers, outsourcing non-core products and processes seem to be much more important than outsourcing production capacity: firms claimed they not only learned with subcontracted firms but that they also extended the firms' competencies.

Of the four upstream relationships studied the most important one was with capital equipment suppliers. Suppliers that belong to the metallic and plastics industry seem to have a deeper upstream relationship than other firms do. The suppliers to shoemakers showed a weaker upstream relationship with capital equipment vendors due to the lower complexity of production equipment and to the more labor-intense production systems.

Summing up, capital equipment suppliers influence a wide range of firms in a broad range of industries. The more complex the production equipment and the larger the variety of technologies incorporated the more intense seems to be the relationship with capital equipment suppliers. It can be argued that in those companies that base their technology competence on production equipment the influence is harder on hardware, while in companies that base their technology competence on product engineering the influence is more intangible in nature.

Formal Relationships

Technology Scanning

The firm's technological scanning reflects the degree of involvement the firm has in the assessment of certain technologies, as well as the company's awareness to assess the external environment.

Among the most mentioned mechanisms of technology scanning are: technical magazines and journals, national and international fairs, seminars, congresses, industrial associations and the firms' technical literature.

Although technological assessment activities were performed in all four industries, there are several important differences in their nature: in some firms the only technological activities assessed were the production-related ones, whereas in other firms the technological scope was broader. In order to help explain the situation two different perspectives were used: one taking into account only production activities and another with a broader scope.

In general, almost all suppliers were concerned with the assessment of production technology activities. Only two suppliers to the automotive industry and three suppliers to the footwear industry mentioned they were not assessing these activities. In four situations – two foreign suppliers to automakers and two foreign suppliers to footwear producers – the reason behind this lack of assessment was that these activities were normally performed at headquarters level. In the fifth situation, the firm has followed a retrenchment strategy.

Taking into account a broader technological scope, some differences arise. The suppliers to the chemical, automotive and electronics industries show a superior performance than those supplying to the footwear industry: whilst eight of the twelve suppliers to the automotive industry, five of the seven vendors to the chemical industry and six of the eleven suppliers to the electronics industry declared doing technological assessment beyond production activities only two of ten vendors to the footwear producers declared doing so.

Although this difference expresses the production orientation of most suppliers to the footwear producers, when compared to the rest of the suppliers the following should also be taken into account:

- Some foreign suppliers have reduced control over technological activities performed at headquarters' level; and
- The internal technology base of most small local suppliers is still production technology-based, which conditions most of their technology assessment activities.

Reverse Engineering

Only eleven suppliers claimed to practice reverse engineering activities. Taking into account sectoral activities some differences arise among suppliers:

- No suppliers to the chemical industry reverse engineer their products;
- Only two suppliers to the electronics industry have used reverse engineering activities;
- Four out of 10 suppliers to the footwear producers have reverse engineered products; and
- Five out of 12 suppliers to the automakers have frequently used reverse engineering activities.

In the chemical industry, all firms have a unanimous opinion: reverse engineering activities are hardly applicable because there is hardly any room to differentiate the commodities they produce.

Only two suppliers to the electronics cluster industry used reverse engineering activities. One is an automation engineering firm. One of the partners claimed that all developmental activities have competitors' activities and products as a starting point, and the firm's main objective is to improve upon them. The other firm produces high precision plastic components for the electronics industry. According to the firm's managing director, the firm has usually analyzed its competitors' products to try to come up with better solutions.

The suppliers to footwear producers are almost as active as automakers suppliers in reverse engineering activities. This is not surprising taking into account that the textile and the footwear industry are considered among the most active industries in reverse engineering products.

The automakers suppliers are those that most frequently reverse engineer. Nevertheless, some differences arise among them. Three of the seven metallic components suppliers extensively practice reverse engineering activities, while the other four suppliers claim there is hardly anything to reverse engineer in metallic products. This difference might be explained by the type of product and by the type of firm. Whilst metallic components producers that cater for assemblies or sub-assemblies normally depart from the client's assemblies or sub-assemblies those that cater for mere components do it at the client's request. While the former are used to depart from something that already exists (and sometimes have to compare the different designs/categories of the products) the latter normally depart from the clients' specification. Consequently, it is not surprising that the former are more used to reverse engineering activities than the latter.

Another feature that might be taken into account is that of the developmental activities. Firms that normally use developmental activities are those that have a more acute practice of reverse engineering activities, i.e., the pressure to assess what the clients and competitors are normally doing leads firms to reverse engineer in their search for new products/solutions.

Patenting

The fact that only one firm has been granted a patent reflects a low technological orientation among the suppliers analyzed. The firm is a supplier to the automotive industry which has a strong orientation towards technology-based activities.

Licensing

Within the sample studied, only two suppliers of the footwear industry have signed licensing agreements. While one produces glues and hot melts the other one produces a wide variety of synthetic foams.

The firm that produces synthetic foams produces a wide range of products, mattresses, car seats, pillows, cushions and insoles. The firm has used this license contract to have access to certain types of technologies and knowledge the firm lacks. Its concern has been concentrated on the development of new products. The firm does not have a development department. In a broad sense, despite this technology transfer contract the firm has not been able to take advantage from it: as the company lacks a development department the creation of new solutions has been quite static in nature.

Contrary to this first case, the second firm has taken advantage of its license agreements to accumulate technology. It has allowed the firm not only to accumulate on technological leaps generated by the technology transfer agreement, but also to make the knowledge transferred endogenous. Commercially, the firm has also yielded from this agreement. Part of the know-how generated has been used to enlarge the range of products offered in varied industries.

New Spinoffs

Spinoff as a result of an entrepreneurial process was not very popular among Portuguese suppliers. There are only seven cases of new spinoffs and in all of them the creation of the new firms was related to two different situations:

- The production of different types of products (product specialization); and
- The generation of new production capacity.

In any case, the creation of new spinoffs was associated with: the will of a young researcher to exploit the creation of new technologies/products developed within the firm, and the will to exploit the degree of exclusiveness of new products or new technologies. This situation reveals some of the fragilities associated with the R&D functions in SMEs.

The suppliers to the auto industry were the most active in the creation of spinoffs. Three among the 12 suppliers to the auto industry have created new spinoffs as a means of acquiring new technologies.

Among the 11 suppliers to the electronics industry, only two have spun off new firms. One to produce new plastic products based on new technologies. Another case is a firm of the package & label industry that has two different production sites, manufacturing different products.

Joint-Ventures

The participation in joint-ventures is low, though in the near future may grow due to the involvement of some suppliers to the automotive industry in broader, international markets.

Only two firms in the sample have signed joint-venture agreements. Both firms are suppliers to the auto industry.

Network of Firms

Although there are several types of relationships between suppliers and clients it is clear that there are some sectoral differences that must be taken into account. The work done by Lamming (1993) and Veludo et al. (2006) reveals how important the supplier-customer relationship is.

Only two firms, both from the auto industry, participated in a network of firms. Both firms exemplify how firms might evolve from learning-by-doing to learning-by-using to learning-by-interacting to finally learning-by-learning in a complex, competitive world, taking advantages of their accumulated experiences and of their relationship with other institutions to innovate and position themselves differently in the supply chain.

Co-Operative Agreements With Universities

Co-operative agreements with universities and other higher education institutions can be considered as moderate though there is some sectoral variation. In any situation the relationship with universities was considered as a priority. Suppliers to the chemical industry have better performance than the rest of the suppliers: five of the seven suppliers to the chemical cluster have co-operation agreements with universities.

In most situations contacts between universities and companies happen in a formal way, contrary to what Simões (1995) suggested. This may be the result of the industrial / innovation policy that has been taking place lately in the Portuguese industry.

36% of the suppliers to the electronics industry maintain contacts with universities. Of the four firms, three belong to the plastics industry and the other firm belongs to the metallic industry. Only one firm has an active involvement with the university. The firm has two projects with three universities. The first project involves the planning and control of production and logistics activities involving the U. of Minho. The other project involves the Technology Center of Marinha Grande and the Católica and Independente Universities.

Two companies have contacts with to U. of Minho involving the use of the laboratories for raw materials characterization. Finally, in the fourth case the contacts involve in-company university trainees mainly with the University of Lisbon.

The remaining suppliers to the electronics industry have kept a certain distance from universities.

Among suppliers to the automobile industry the panorama is slightly different. Although seven firms have had co-operative R&D projects with universities, only four of them have continued using the university as a means of acquiring technology. Three of the four companies that use universities do it systematically. The fourth one has had sporadic successful contacts with universities. One of the companies – a mold maker – has a protocol with the U. of Minho. It had a project with another university that was unsuccessful: it consisted of an image acquisition system installed within the mold. The firm knew that it was extremely difficult to carry it out. Another company has a contract with the University of Minho for the development and improvement of the production process. According to the firm, it has been a success. The firm also has projects with the Universities of Lisbon and Coimbra.

The third produces batteries and has contacts mainly with the universities of Lisbon and Évora. The fourth company with co-operative projects with universities is a metallic parts producer. Its contacts are with the University of Oporto. All these contacts have been sporadic in nature and have always had good results.

There are three cases of negative experiences. Three companies mentioned they had some projects with universities and that those contacts were complete fiascos. In all three situations it was mentioned that it had been the first contact with the university and that the firms did not intend to resort to universities again. They claimed that universities are very bureaucratic and have a time concept that is not adequate to the industry.

Five suppliers to the auto industry declared they have never had any contacts with universities. Four of them are foreign companies whose R&D strategy is centralized at corporate level. The fifth company is an SME whose technological competence is based on production technology.

Three of ten suppliers to footwear producers have contacts with universities and only one has regular contacts with the University of Minho. The other two firms have had projects with universities on a situational basis. One firm has developed several projects with the universities of Minho, Aveiro and Beira Interior for the development of laces and strings with different textile and plastic materials. The third firm has had several projects with the University of Oporto, namely the development of different types of leather.

Finally, the suppliers to the chemical industry seem to be the most active in exploiting university knowledge. Initially all the contacts were developed on a project basis. Successful results led firms to continue to resort to universities. This situation resulted in the creation of positive relationships among them. Chemical suppliers were normally working with the universities of Oporto, Coimbra, and Lisbon.

Co-Operative Agreements With Government-supported Research Institutions and Technology Centers

Relationships with this type of institutions have generally not been intense. Most of the firms resort to these institutions to test either product characteristics or product quality. Consequently, the research and/or developmental component is very reduced. Very few firms fall back upon the technological centers in a systematic way.

Only one supplier to the footwear industry uses the technological center of the footwear industry – CTC. Although the firm and the technology center have a common project – the recovery of rubber waste – the firm claims that the project has not had great progress.

The suppliers to the electronics industry have more active behavior than the suppliers to the footwear industry. Four suppliers have had projects with technology centers.

Only two suppliers to the auto industry claimed to have resorted to technology centers. In both projects, the major aim was to take advantage of the laboratory equipment of those institutions rather than of R&D activities.

No supplier to the chemical industry manifested any contact with technology centers or any other research institutions.

Participation in European Programs

The participation in European programs involving R&D projects has been embraced with moderate enthusiasm. Nine companies have been involved in European technology transfer projects. Three firms supply automakers. The other six firms are evenly distributed among the chemical, footwear and electronics industries.

The companies claimed they have an active involvement in this type of programs. Several companies have participated in more than one program and all firms claimed to have achieved the proposed objectives.

All companies manifested that they were involved in these projects to achieve long-term results, which demonstrates a certain technological maturity in the approach to possible solutions.

A company that participated in European programs for the first time showed a *sui generis* a point of view:

…at the beginning were we quite reluctant. It was the first time and we were not sure about the other partners' real objectives and their involvement. As time went by, we realized that not only were we not technologically behind them, but also they [project-partner firms] had the same doubts we had. …. the involvement has been quite positive: we have been improving. We realized they had different methodologies, and approaches and this helped us to question ourselves. If a new opportunity appears we intend to participate in a search for new, joint solutions.

All companies involved in European programs have played an active role in the search for new solutions as opposed to what Simões (1995) calls an "interested assessment role". The following interesting comment stresses the active role "… in this project everybody has to be involved actively, otherwise everybody loses. It is not advantageous to participate without having defined objectives. Curiosity plays no part here…".

Comparisons Between Foreign and Indigenous Suppliers

The patterns of technology acquisition among foreign suppliers are also very poor when compared with indigenous firms, as shown in Table 2. Cooperative agreements with universities and government sponsored research institutions were only present among foreign suppliers to the chemical industry.

In general, the orientation towards the low end of technology competence among most foreign suppliers is a clear indication of the low importance technological and innovative activities have among them.

Table 3 categorizes the type of factories among foreign suppliers, based on White et al (1984) typology. Table 3 characterizes the role of foreign suppliers and

Table 2. Comparison of patterns of technology acquisition between foreign and indigenous suppliers

	Foreign Suppliers		**Indigenous Suppliers**		**Total**	
	Number	**%**	**Number**	**%**	**Number**	**%**
Catalogue Purchase	11	100.0	28	96.6	39	97.5
Specification Purchase	11	100.0	28	96.6	39	97.5
Capital Equipment Purchase	11	100.0	29	100.0	40	100.0
Outsourcing/Subcontracting:						
1. Non-core products	2	18.2	8	27.6	10	25.0
2. Production	2	18.2	9	31.0	11	27.5
Technological Scanning:						
1. Broad Scope	4	36.4	17	58.6	21	52.5
2. Production	7	63.6	28	96.6	7	17.5
Reverse Engineering	3	27.3	8	27.6	4	10.0
Patenting	0	-	1	3.4	-	-
Licensing	0	-	2	6.9	-	-
Spin Outs	0	-	6	20.7	1	2.5
Network of Firms	0	-	2	6.9	-	-
Joint Venture	0	-	2	6.9	-	-
Strategic Alliances	0	-	2	6.9	-	-
Co-operative R&D:						
1. University	3	27.3	16	55.2	19	47.5
2. Governm. Sponsor. Res. Ins.	1	9.1	6	20.7	7	17.5
Participation European Progr.	1	9.1	8	27.6	9	22.5

Table 3. Type of factories among foreign suppliers

	Suppliers to Automakers	Suppliers Electronics Industry	Suppliers Chemical Industry	Suppliers to Shoemakers
Manufacturing Replica	2		4	2
Rationalized Manufacturer	1	1		
Production Specialist	1			

the scope of their activities, following Ferdows' (1997) typology. Clearly, most of the foreign suppliers play a secondary role in the creation of new products as well as in innovative activities, which is a consequence of the R&D policies of most of their mother firms. Following Ronstsdt's (1977) categorization, three suppliers to the chemical industry have mother firms with global technology units (GTU), one supplier to the auto industry has an indigenous technology unit (ITU) and all the rest use the mother firm transfer technology units (TTU) to access technology.

When comparing the types of factories of foreign suppliers and clients it is clear that they are closer to what Ferdows (1997) calls *offshore* factories than to *lead* factories, which is a clear indication that the *raison d'être* of those factories is the exploitation of operational/production investments rather than the creation of technology/knowledge investments. Nevertheless, at industry level, the clients play a more important role than the suppliers. A plausible explanation for the different technology management level is the type of product they produce: while the foreign clients analyzed – a clear exception is the chemical sector – are product-centered oriented, the foreign suppliers are component-centered oriented.

Table 4. Role and scope of foreign suppliers

	Suppliers to Automakers	Suppliers Electronics Industry	Suppliers Chemical Industry	Suppliers to Shoemakers
Offshore Factory	3	1	1	2
Source Factory	1			
Server Factory			3	
Contributor				

SUMMARY AND CONCLUSION

As described in the beginning of the chapter both formal and informal relationships between the companies and the external environment play a fundamental role in the process of technological development.

There are certain differences among suppliers as well as among industries they belong to. These differences, as it is obvious, are the result of a cumulative process through time, which reflect the different performances of the companies and their relationships with the environment. The analysis of the different components of the patterns of technology acquisition has led to the following conclusions:

1. The firms' capabilities to endogenize technology as a result of opportunities generated by either formal or informal relationships depends upon the internal technology base. Nevertheless, as was put forward throughout chapter it is plausible to say that the greater the technical context the greater the firms capabilities.
2. Informal relationships play an important role as technology acquisition mechanisms. The task environment – the clients and the suppliers, basically – is of fundamental importance for the suppliers to gain access to a continuous process of exchange of information.
3. The intensity of the relationships with the clients is of crucial importance. The interactions established with the clients are particularly important in the process of the creation and development of new products.
4. Although the intensity of the relationships with the suppliers is deep they are not as crucial as the relationships with the clients. The relationship with the capital equipment suppliers stands out among the relationships with the suppliers basically due to the tangible consequences in terms of modernization of equipment and productivity evaluations.
5. Formal relationships among firms are not as frequent as informal relationships. The lack of extensive use of formal technology transfer relationships stems from the low technological level of most Portuguese firms. Nevertheless, as some indigenous firms have managed to make use of formal relationships it is plausible to contend that those firms have not only seen added value on those relationships, but have also managed to accumulate technology from a wider variety of sources. The lack of interest of foreign firms in technology added value activities from the science and technology (S&T) institutions in Portugal stems not from the lack of offer from indigenous institutions, but from the easiness those firms have in using mother and sister firms in transferring technological assets.

6. Some firms have managed to accumulate technology from informal as well as from formal relationships. They have not only managed to complement their internal technology base with proper R&D departments, but have also extensively used other S&T institutions as well as joint-ventures and strategic alliances to reinforce their internal technology base. Then, it is plausible to argue that though the client is of fundamental importance, the firm's role in properly generating and internalizing technology from both informal and formal sources is crucial in endogenizing technology in the value chain.
7. Co-operative agreements with higher education institutions reached interesting figures when compared to other figures among formal relationships. Although it is generally acknowledged that universities and the industrial sector in Portugal are 'divorced' it is clear that while some successful relationships reinforce the virtuous cycle of the relationships, the negative experiences – especially the first one – create a barrier for future, continuous relationships.
8. Some of the formal relationships with universities and some government sponsored research institutions are underpinned by laboratory tests and not by research or development. The former, though positive, do not represent a great technological impact for companies as would be the case of either research or development.
9. For *technologically-oriented* companies, universities and government sponsored research institutions constitute one of the first priorities for future technological developments. The same cannot be said for *technologically-weak* firms. In a general way, it can be said that if the universities can offer some windows of opportunities to the companies the only form of surpassing the differences between the industrial and the academic world is the existence of an appropriate communication channel and a proper understanding of the logic of both partners' operation. This appropriate communication channel would involve: (a) more skilled human resources capable of internalizing knowledge and technology, on the part of the firms; and (b) a lower dependence on the state, *i.e*. a more acute tuning to the needs of the business world, on the part of the academic world.
10. Public policy needs to address not only the attraction of FDI of large MNEs of the auto, electronics, footwear, and chemical industries. However, when after comparing suppliers to those large MNEs, it is possible to conclude that certain foreign suppliers are less technologically endowed than indigenous suppliers. This calls for a public policy to support not only the attraction of FDI, but also the support of the relationship between suppliers and MNEs in upstream activities of the supply chain.

A point that also deserves to be addressed is the evolutionary conditions of foreign firms. If they are able to evolve technologically and organizationally it is because the production and the organization of knowledge-based assets among them have changed and thus, the boundaries of the firms as a consequence of the dissemination of those assets have changed as well. Addressing this point, Dunning (1997) claimed that the raison d´être for most initial conditions for FDI are tuned to resource-seeking and market-seeking investments, while the main motives for sequential investments are tuned to efficiency-seeking and strategic-seeking investments. Consequently, there is a considerable difference between initial and sequential conditions. While the former seeks an initial foreign entry the latter seeks to acquire resources and capabilities to augment core competencies in regional or global markets.

As a result, host governments have to properly address not only what investments are more likely to upgrade competitiveness of the indigenous economy, but also, and perhaps more importantly, how to foster upstream supply linkages to enhance the competitive advantage of the local suppliers in order to create the conditions for sequential foreign investments.

The challenges for host governments are increasing, rather than diminishing, because the demands for technology and the competitive pressure are becoming more pluralistic with the globalization process. Thus, the "buying" of foreign investment so popular until a decade ago is clearly insufficient. In order to generate a virtuous cycle of initial and subsequent investment, host governments must properly address the supply chain so that the indigenous conditions are more prevalent in the decision of MNC corporations.

SOLUTIONS AND RECOMMENDATIONS

The activities of MNEs are difficult to assess as markets are more volatile than over. However, it would be important if public policy could address FDI from a more holistic perspective taking into account not only initial conditions to attract FDI but also to consider sequential investments that are tuned to efficiency-seeking activities with local suppliers, which would allow local firms to augment and explore their core competencies creating endogenous condition for sustainable economic development.

FUTURE RESEARCH DIRECTIONS

Future research direction needs to seek new perspectives in which innovation- and knowledge-centered perspectives are addressed from the suppliers' point of view so that the supply chain might be aligned with the needs of MNEs in host countries, which is tuned with Perri and Perrufo's (2016) findings.

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KEY TERMS AND DEFINITIONS

Capital Equipment Purchase: It normally starts with a project justifying the investment. Once it is economically justified, the purchase happens. This technology-transfer mechanism has important repercussions for firms because it might change the production efficiency, the production flexibility, and the vertical integration across the supply chain.

Catalogue Purchase: The purchase of standard materials or components that can easily be acquired in the market.

Foreign Direct Investment: A foreign direct investment (FDI) is an investment made by a company or entity based in one country, into a company or entity based in another country. It normally includes mergers and acquisitions, building new facilities, reinvesting profits earned from overseas operations and intra company loans.

Joint Venture: A business arrangement in which two or more parties agree to pool their resources to accomplish a specific task that involves normally a new project or a business activity.

Licensing: A business arrangement in which one firm gives another firm permission to manufacture its product for a specified payment.

MNE: A multinational enterprise is a firm that has facilities and other assets in one country other than its home country. Such firms may have offices and/or factories in different countries but are usually centralized in the home country where they have the headquarters.

Outsourcing: A practice used by different companies to reduce costs by transferring portions of work to outside suppliers rather than completing it internally.

Reverse Engineering: The processes of extracting knowledge from anything competitors' products or reproducing anything based on the extracted information.

SMEs: Abbreviation of small and medium-sized enterprises. Although there are plenty of definitions across the world, the working definition used in this document is the one that was created by the European Commission to permit a coherent and effective access of SMEs to European community funds.

Specification Purchase: It is more complete than catalogue purchase as it involves information transfer as well as knowledge transfer. Although the know-how might not be accessible, it may be possible to know both what the key points and the limits of the technologies are and, consequently, be aware of the minimum limits that must be reached to be a potential competitor.

Technological Scanning: It is a technology transfer mechanism that allows the forecast of future technologies. It is normally done either by technology non-leaders that want to assess technology development without having to massively invest in research activities, and by technology leaders that want to keep abreast of technology.