Learning and the Creation of Innovation Capabilities in Argentina's Auto Parts Industry

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ABSTRACT

The purpose of this article is to find out about the main sources and the learning and skills accumulation modalities in innovation among Argentine auto parts manufacturers. In particular: a) the way the firms follow to introduce new products, processes and organisational forms and the way in which, later on, such processes are improved; b) the procedures and characteristics of the relevant knowledge in each instance.

The quantitative analysis based on the results of the sector's 89 surveyed firms has been used in combination with a qualitative analysis consistent with the case study of 5 of the surveyed firms.

The starting idea states that the competitiveness process via innovation introduces characteristics which are typical of this sector: it is one of the sectors that least registers patents related to R&D activities; the international high-tech sales to independent organisations are few, except those which incorporated inputs and capital goods; the sector is strongly influenced by the strategies of key agents defined within the competitive global - not only domestic - process framework, and others. Also, attention is drawn to the existence of an important group of firms with a long history of skills accumulation for adapting and/or suiting the products and processes to the actual conditions of the firms and the domestic markets.

Beyond the diversity of the existing situation and conditions, the analysis made illustrates the complexity and richness of the learning and skills accumulation processes for innovation in the Argentine auto parts firms, and also helps to reach some general conclusions which tend to confirm the hypotheses initially introduced. The main conclusions are

- ✓ *The firms resort to a wide variety of sources in search of new knowledge. These sources tend to vary according to the characteristics of the technology used, the structure, competences and management style of each firm and of the policies implemented by the automotive manufacturers.*
- ✓ *Although it is not possible to define a "better way" to approach the learning and the competences acquisition processes valid for all or for most of the firms, the results of the study confirm the convenience of achieving an adequate complementation between internal and external knowledge and between codified and tacit/specific knowledge of the firms.*
- ✓ *Although the growing implementation of electronic equipment helps to codify part of the tacit knowledge, the importance of this kind of knowledge continues to be essential.*
- ✓ *The learning processes and the development of new capabilities differ greatly according to products and processes.*

I – INTRODUCTION

Since the start of the 1990s, the Argentine automotive industry has gone through a vigorous process of production modernisation which changed both the required technological and organisational skills of the firms and the learning process modalities.

The domestic automotive manufacturers definitely gave up efforts to launch new models and resorted to design adaptation inside the firms, following the models already discontinued in the developed countries; the introduction of automobile models of the last technological generation was started: they were totally designed and developed in the laboratories of the firms´ head quarters with the cooperation of a group of international auto parts specialists.

This modernisation process was accompanied, and supported, by an abrupt fall in the minimum requirements of the national components demanded so that the vehicles could be labelled national. The automakers enjoyed a wide margin of freedom to substitute the domestic for the foreign suppliers when the domestic supply did not suit their demands in terms of design, technological complexity, quality, price, etc. Also, this period was characterised by the arrival in the country of important international auto parts makers, by way of direct investment or joint ventures with domestic businesses.

The need to reduce cost, to improve quality and to shorten delivery time not to be displaced by internal or external competitiveness brought about an unheard of tension among the domestic auto parts makers to make production processes more modern and more efficient.

In this framework, the main firms tended to change their traditional forms of organisation and to incorporate new capital goods (Yoguel et al, 2000; Motta, 2005). Technology transfer from abroad also grew importantly in this period.

The harsh crisis of 2001/2002, which diminished production levels to less than a third of the production of previous years, completely froze investment plans and the firms´ modernisation, and a great amount of qualified human resources were ejected off the sector (Motta and Zavaleta, 2005).

Since 2003, Argentina's automotive industry started a new expansion period which was prolonged until the fourth quarter of 2008, when record production levels were reached.

As part of this general panorama, this article introduces the main results of a longer work (Motta, 2008) which analyses the principal sources and modalities of productive knowledge learning and accumulation in the Argentine auto parts firms at present and associated with: a) how the firms introduce new products, processes and organisational forms, and how improvements are later on introduced in them; b) the origin and the characteristics of the relevant knowledge in each instance.

In section II, the theoretical framework that supports the analysis is described and the hypotheses guiding the research are introduced; in section III, the methodology is described and the different information sources are mentioned; in section IV, the main results are summed up; finally, section V deals with the conclusions.

II - THEORETICAL FRAMEWORK

The new literature on the economics of knowledge has been taken as the starting point and it has been complemented with the neo-Schumpeterian and evolutionist contributions. A great deal of this literature assumes that the emergence of dynamic competitive advantages is largely derived from the creation of competences inside the firms, which, in turn, represent the outcome of accumulation and of the complementarities of different kinds of knowledge. (Ernst and Lundvall, 1997; Cowan et al, 2000; Ancori et al, 2000; Nonaka and Toyama, 2002).

The mentioned literature distinguishes between knowledge and information in the sense that the latter stands for clearly established and codified propositions on states of nature or algorithms which explain different behaviours; on the other hand, knowledge which involves cognitive categories, codes for interpreting information, tacit and heuristic abilities in problem-solving that cannot be reduced to algorithms, is highly relational and context specific.

Knowledge offers two relevant dimensions to grasp the learning processes. On the one hand, knowledge possesses explicit or codified components when it can be "transmitted by using systematic formal language"; on the other, knowledge possesses a tacit dimension originated in experience and is "personal and context specific and, then, difficult to formalise and communicate" (Nonaka and Takeuchi, 1994). This is so because it is knowledge that the individual implements without being fully aware of it; the context rules used are not entirely recognised as such by those who follow them; then, this is the reason why it is knowledge which proves hard and even impossible to transmit (Cowan *et al*, 2000).

A basic assumption refers to knowledge as not being freely available or readily for sale on the markets. Firstly, given the important tacit dimension of knowledge in some industrial sectors; secondly, because the creation of knowledge as the possibility of appropriating and using knowledge others have produced depend on the active efforts that in this sense the firms may have made and on the level of cognitive abilities existing in the organisation. Not all the firms in the same sector -although they may be located in the same geographical area- are in condition to "accumulate" the same knowledge and, consequently, to implement the same technology: they are different in skills, learning capacities and/or efforts made. The same kind of knowledge which may prove helpful to some firm may be of limited application in another, depending on the specificities typical of each firm, such as production scale, qualified labour, capital stock characteristics and others.

If the accumulated knowledge of a firm is not the same as that of other firms, if the transfer of knowledge from a firm to another (by way of licences, patents, capital goods, etc) is usually not complete, then, the study of the forms of creation, circulation and appropriation of knowledge becomes important to understand the performance of the firms, the efficiency level they may reach and the creation of dynamic competitive advantages. All this is reinforced with the increasing interrelationship between science and technology and by the speed of technological developments in today's world.

In this article, the initial idea establishes that the "adequate" accumulation and assimilation of productive knowledge is the main factor for the firms, or, at least, one

of the main ones, affecting the organisation's performance related to the introduction of innovations. The use of the adjective "adequate" derives from the fact that a good innovative (productive) performance generally demands the complementation of different kinds of knowledge, especially codified knowledge (the kind derived from sources both outside and inside the firm) and the tacit specific knowledge of the firm (exclusively inside it).

Learning is seen as a social interactive process. The development of new knowledge inside the firm and the appropriation and adaptation of knowledge generated outside it depends, to a large extent, on the intensity and on the modality of the interaction between the firm's inside agents as well as between the latter and the outside agents (Yoguel et al, 2005).

The SECI knowledge conversion model, developed by Nonaka and Takeuchi (1994) helps to explain the various aspects of the learning process and of the creation of new competences for innovation. The model identifies four knowledge conversion modes or processes which form a spiralling cycle permitting the uninterrupted creation of new knowledge, both tacit and codified. Such modes are: a) *socialisation*, by means of which experience is shared and tacit knowledge between different individuals is spread; b) *externalisation*, consisting in the articulation of tacit knowledge through discussions and reflection upon the modes to express the empirical experience in terms of abstract concepts; c) *combination*, which is generated from reflecting, systematising and merging the different kinds of explicit (codified) knowledge and d) *internalisation*, in which takes place the transformation into new tacit knowledge of the codified knowledge resulting from the former stage. This conversion is reached following the need to adequate the codified knowledge to the reality of the organisation and of the operating market. This is the way the conditions for the start of a new cycle are created.

The four kinds of knowledge -that is to say, *know what*, *know why*, *know how* and *know who*- distinguished by Lundvall also serves to describe and explain the learning and capabilities accumulation processes (Lundvall and Johnson 1994; OECD, 1996; Lundvall 1996).

The *know what* refers to that kind of knowledge related to concrete facts and is the knowledge closest to what is generally known as information, essentially made up of data.

The *know why* is linked to scientific knowledge of the principles and the laws of nature and is the sort of knowledge underlying in technological development, related to products and processes in most modern industries. The production and re-production of this kind of knowledge is usually organised around specialised organisations such as laboratories and universities, and can be accessed by the firms by means of interacting with the institutions mentioned or through capturing the human resources in them.

The *know how* is related to the abilities or capabilities necessary to do something and is typically the kind of knowledge developed and preserved inside the firms. It is essentially the tacit knowledge developed through daily practical experience, by interacting with other experts in the field and by *learning by doing*.

Lastly, the *know who* represents the knowledge involving who knows what and who knows how. It is the socially embedded knowledge linked to the social relations network with other agents and institutions, which allow the organisation to access external experts.

The first two kinds of knowledge, *know what* and *know why*, are fundamentally the rather explicit kinds susceptible of being easily codified. Thus, if the right institutional instruments are developed, they may be transferred as information in the market. Instead, the final two kinds, *know how* and *know who*, refer to the kinds of knowledge where the tacit dimensions are relatively more important and originate in practical experience. Neither of the last two may be easily transferred in the market without losing some of their essential functions.

The development of information technologies may be regarded as the reply to the need to ease and make more effective the transfer of knowledge portions related to know what and know why. The digital revolution has intensified the knowledge codification processes; it has steadily modified the gap between tacit and codified knowledge. However, the particularities of the know how and of the know who have made codification and transmission very difficult, even accepting the great progress and development of the ICTs over the past decades.

Because different kinds of knowledge are required for the creation of innovation capabilities in the firms, it is to be expected that the sources to obtain them are also diverse. On the one hand, the firms may obtain them from the Technical Assistance and/or the Technology Transfer received from other agents, mainly automotive manufactures, the firm's headquarters, customers, suppliers and public and private science and technology institutions.

In their production processes, the firms may introduce new knowledge by acquiring technology, incorporated in the form of capital goods or non-incorporated (licences, software and other forms) or through internally generating it via activities directed to innovation (R&D, training, others). In this article, the generation and new knowledge acquisition modalities have been grouped under the name of Learning and Accumulation and Knowledge Development Efforts, (or simply, Learning Efforts) because they require conscious efforts demanding resource allocation, in some cases for very significant amounts.

A firm's innovating capacity does not only depend on obtaining new productive knowledge, be it from inside or outside it; it is also affected by Endogenous Competences developed over time[1]. Such include not only the productive, technological and business management knowledge and routines but also the abilities to develop knowledge conversion processes. Since technology is not defined exclusively in terms of information or codified knowledge communicable from one

[1]- Available productive knowledge and the creation of capabilities are not the only factors affecting the introduction of innovation. Other factors –the existence of an adequate set of incentives for the implementation of such knowledge, the characteristics of national and sectoral innovation systems, businessmen's personal characteristics, etc- may be equally important. In any case, the analysis is focussed on the study of the generation, accumulation and knowledge circulation processes and it is implicitly assumed that the remaining factors tend to affect the innovative performance of the firms in the same way.

individual to another, the capacity to identify and seize the opportunities to transform the new knowledge into innovation will usually differ depending on the firm. It will likewise be different depending on the level of the endogenous competences in each firm, and on its capability for appropriating, accumulating and articulating the different kinds of knowledge.

It must be noted that the relationships concerning the endogenous competences, the learning efforts and the technology transfer variables are complex. It is near impossible to define a priori the relationship existing between the first variable and the two remaining ones. In principle, if an organisation does not make learning effort nor receives technology transfer, it is highly improbable it will be able to strengthen its endogenous competences. Although great endogenous competences favour the knowledge conversion processes, they are not necessarily related to big efforts or large transfers.

Similarly, it proves near impossible to define an only way to relate the intensity of the efforts in the learning activities to the magnitude of the technology transfer received. In some cases, both sources may prove mutually excluding. This is the case, for instance, when receiving assistance or transfers from other organisations leads to abandoning the internal learning efforts and to dismantling or reducing the R&D groups, or vice versa. In such cases, larger transfers or bigger efforts do not necessarily imply increased learning. In other cases, both sources may be complementary and be directly related: it is when the firms being transferred the technology must make the efforts to adapt the external technology to the specificities of the firm in question.

In all other cases where adapting to the technology received is a necessary condition to reach substantial improvement of the product or of the receiving firm process, the mere existence of transfer processes may prove little relevant to generate learning and technological improvement processes if the learning efforts are not made.

In brief, the endogenous competences, learning effort and technology transfer variables are not independent from one another. It is not unusual that the magnitude a given variable reaches only acquires significance to explain the generation of innovation and learning processes when the value of the others surpasses a given minimum threshold. Similarly, a high level in one of them may enhance the effect of the others.

Following this theoretical framework, the hypotheses introduced in this work are [2]:

1) The technological level reached by the firms in the Argentine Auto Parts Sector does not exclusively reflect the incentives system and the relative price structure in use but is the result of an evolutive process.

2) The firms resort to a wide diversity of sources in search of completing the knowledge available and of obtaining new productive skills. To innovate and to produce efficiently, different kinds of knowledge are required; it is, then, to be expected that a firm decides to resort to different sources to obtain knowledge. Because different firms possess different structures, objectives, capabilities and needs,

[2]- Although some hypotheses may perhaps appear as unnecessary, particularly the first two, their treatment helps with a better description of the characteristics of the learning and the skills development processes for innovation in the Argentine Auto Parts Sector.

they do not always require the same kind of knowledge or estimate convenient to resort to identical sources.

3) Different forms and different levels of knowledge accumulation are associated to different performances. As a general rule, to the extent the firms receive more transfers, make more important efforts to develop and/or adapt productive knowledge and have more endogenous competences, their innovative performance will be better.

4) The power to introduce innovations and/or significant improvement is positively linked to an adequate complementation between the accumulation of knowledge internally generated by the organisation (in some cases, tacit and specific) and the knowledge from sources external to the firm. In other words, the innovative performance does not depend only on the amount of knowledge accumulated but also on the degree of complementation reached by the tacit and the codified kinds of knowledge.

5) Although the digital revolution has made the codification of knowledge easier, tacit knowledge continues to be significant.

6) The learning processes are mainly oriented to the creation of capabilities in the processes area and only in a limited way to the design of new products.

III- METHODOLOGY AND INFORMATION SOURCES

The complexity of the object of analysis plus the very few specific studies on the matter suggests a combination of quantitative and qualitative methodologies is advisable. Such combination of methods is aimed essentially to two objectives: on the one hand, to give the results of this work greater reliability, to the degree the qualitative study allows the corroboration of the conclusions reached with the available statistics analysis; on the other, to introduce a more thorough presentation of the object of the research, because the use of more than just one method helps to capture certain phenomena which would otherwise remain concealed if an only methodology were the case (Jick, 1979).

The quantitative analysis is based on data from a survey conducted over 2006 with 89 firms in Buenos Aires Capital District, Greater Buenos Aires, Córdoba and Rafaela, the main auto parts production centres in Argentina. Two-thirds of the firms surveyed represent national capital, predominantly those firms with sales above US$ 5m annually and with over 50 headcount.

79% of the surveyed firms supply, mainly, the original auto parts and/or spare parts market, which means that the sample includes little above 25% over the total auto parts industries with production plants in Argentina supplying the automotive manufacturers directly or indirectly. The remaining 21% of the sample represent firms which sell almost exclusively to the spare parts market and mean little under 5% over the total Argentine auto parts businesses which destine their production principally to the mentioned market segment[3] [4].

[3] The sample bias reflects the option to focus the study on that segment of the firms that operates in the original auto parts market. Also, and equally, it should be noted that approximately half the firms that at

In order to complete and improve the results obtained with the quantitative analysis, a study of the form for obtaining and implementing productive knowledge in the Argentine auto parts businesses was enlarged in the year 2008; other interviews with the managing directors, professionals and workers from the formerly mentioned surveyed firms in reduced groups (5 in all) were added. In particular, how the firms managed to modify their productive practices, where the required knowledge was obtained and how it was incorporated to the productive process were part of the questions made.

No pre-established questionnaire was used for the interviews in order not to restrain and/or suit the answers to the preconceived moulds of the researchers; the complexity and richness of the shades of meaning in the analysed processes would this way be better captured. The following stages were always borne in mind: new products design, improvement of the existing products, new processes design, improvement of the existing ones and changes in the structuring of the work processes.

IV – MAIN RESULTS

IV.1 Hypothesis 1: Characteristics of the technology employed

Each one of the "narratives" in the qualitative analysis clearly shows that the technological level reached by each firm does not simply depend on the "state of technology" and the current market incentives (technology relative prices, capital and labour), but on the result of an evolutive process built over time.

Consequently, the technology employed by each firm shows a series of typical specificities which can be explained with facts and the decisions adopted by the organisations in the past. For example, significant equipment investment generally determine - for the complete useful life which, in the case of the 5 firms analysed in detail, may be 30 to 40 years – some characteristics of the productive process, such as the kind of techniques used, the number of process stages, the kind of required qualifications, the importance given to workers´ experience, etc.

Similarly, it may be advisable to remember that technological knowledge accumulation and the creation of new productive competences inside the firms represent processes which, generally, require long maturing periods and demand efforts which should be continued over time. The most representative example in this

the time of surveying appear as operating mainly in the replacement market had been suppliers for the original auto parts market some years before.

[4]- Given the different technological demand levels the firms selling to the original auto parts market face, with respect to those firms mainly selling to the spare parts market, it was initially thought pertinent to divide the differentiated analysis into both market types. However, the results obtained did not show significant differences in the fundamental aspects (possibly due to the transfer of firms from a market segment to another, as pointed out in the previous footnote). It should also be noted that the small size of the sub-sample of the group of firms selling to the spare parts market in various instances prevented or made the statistical analysis difficult. Consequently, the use of the complete sample has been the criterion adopted in this article. See Motta (2008) for a detailed analysis of the differences and similarities in the characteristics of the learning and knowledge accumulation processes between firms operating in each of the mentioned markets.

sense are the R&D activities; even in apparently much more simple jobs as qualifying workers may demand a long time and lots of resources. In four out of the five firms closely analysed, training an experienced worker required between 3 and 5 years.

Implementing certain techniques over more or less prolonged periods, performing R&D activities with specific purposes and developing certain manual workers´ qualifications generate a set of technological complementarities and learning experience which ultimately build technological evolution paths which prove irreversible for the firm.

Finally, it should also be noted that the economic policy effects on an industry's firms are hardly ever automatic but are rather determined by the -to some extent- non-predictable actions the firms may follow (Nelson, 1999). A very illustrative example of this situation was provided by a firm whose owners did not accept to invest in some significant modernisation, although they admitted that a great deal of their equipment was obsolete and were facing high demand, were operating virtually at full capacity and were enjoying profits considerably higher than their historic average. Looking back on former crises, which pushed this firm almost to disappearance years back, made the owners adopt an extremely cautious behaviour concerning investment, especially in the cases requiring long periods to recoup the invested capital.

What has been mentioned in earlier paragraphs does not mean that the macroeconomic and sectoral contexts are not significant or are only minimum relevant. On the contrary, the technological modernisation processes and the introduction of innovation in the firms analysed are strongly influenced by the continuous and abrupt variations of the sector's activity level over the last 30 years and by the changes in the sector's promotion systems, by the greater or lesser direct foreign investment flows and by the access possibility differential and foreign capital goods cost (Motta, 2005; Yoguel et al, 2005). The experience of the five firms closely analysed clearly shows that in recession periods the firms tend to interrupt, or, at least, weaken the research, training and innovation processes; on the other hand, during growth periods, technological modernisation is eased, improvements are introduced and the experienced workers, bearers of a considerable amount of the firm's tacit and specific knowledge, are retained. The cycles of activity levels have in this way been accompanied by modernisation and skill accumulation/loss cycles.

In short, attention must be drawn to the fact that the level and the technological particularities of the firms are not only affected by the current macroeconomic and sectoral contexts but also by discretional business decisions - many of them adopted in the past, others at present - in the sense that they are not automatically determined by the current incentives system.

IV.2 Hypothesis 2: Sources for obtaining knowledge

The survey involving 89 firms from the sector mentioned enquired into the magnitude and the characteristics of the technical assistance and technological transfer processes received and into the efforts made by the firms, directed to buying technology (capital goods, software, patents, consultancy services, etc) and the adaptation and development of new knowledge inside the firms.

71% of the sampled firms stated they received technical assistance and/or technological transfer from external agents. Such transfers, although very diverse, tended to concentrate on improving technical processes and quality.

40% of the firms received some kind of transfer from the automakers, a striking low percentage because it indicates that only half of the total firms directly or indirectly supplying the automotive manufacturers received some kind of transfer. Also, the percentage of firms receiving assistance or transfer from their head quarters o from other related businesses was 29% of the sample[5]. Some 24% received technological transfer from the science and technology local system, mainly public institutions and universities. Finally, a group of businesses - 29% of the sample – was identified as not receiving any transfers at all.

From among the firms receiving technological assistance or transfer, less than 40% had more than one source. Around half the firms receiving transfers from the automakers also obtained knowledge from the local Science and Technology System or from their head quarters and related businesses. Similarly, around 50% of the firms receiving transfers from their head quarters and/or related businesses and a similar percentage of those resorting to the science and technology system also obtained transfers from other sources.

In general terms, it may be seen that the firms concentrating assistance or transfer exclusively from the automakers or related businesses tended to receive a more significant transfer volume from the sources than those firms which resorted to more than one assistance source.

A Transfer Indicator was elaborated with the purpose of assessing the technical assistance and the technological transfer the sampled firms received; the scope of the mentioned activities was considered; that is to say, the areas where transfer occurred as well as the significance of the transfer activities in each area[6]. For more than half of the firms, the indicator showed a high transfer level received, which reveals how important this way of obtaining knowledge is for the firms in the sector.

[5]- 77% of the firms belonging to foreign or national economic groups received transfers from other firms in the groups.

[6]- This indicator is the result of combining the number of areas where the firms received transfer (the form distinguished product technology, process technology, design, quality, human resources training, work organisation and commercialisation) and the importance given to transfer actions. Both sub-indicators showed low, medium and high modalities. The extension sub-indicator follows the low modality when the firm did not receive any transfers at all or when it received it in only one area; the medium modality when it received transfer in 2 to 4 areas; the high modality when transfer was received in 5 or more areas. The transfer indicator follows the *small* modality when the firm received a small extension transfer of little significance, when it received a small extension transfer of medium importance or when it received a medium extension transfer of little importance. The *medium* modality occurs when the firm received a medium extension transfer of medium importance, it received a small extension transfer of great importance, or when it received a large extension transfer of little importance. Finally, the indicator exhibits *large* modality when medium extension transfers of high significance and when large extension transfers of great importance were received or when large extension transfers of medium importance was the case.

TABLE 1. Received Transfer Indicator

Small	Medium	Large
31,8%	14,8%	53,4%

Apart from receiving technical assistance and transfer, the firms made great extended concrete efforts for the generation, acquisition, incorporation and/or accumulation of new productive kinds of knowledge. For example, in the 3 years before the survey, 74% of the firms had invested in capital goods related to the introduction of new or improved products and/or processes; 58% had spent on developing and adapting products and processes and 53% had invested in continued improvement programmes. Almost half the firms manifested having spent on R&D activities, 39% on buying manufacturing licences, consultancy services and software, a similar percentage destined money to developing training activities oriented to innovation and 25% to organisational changes and finding new commercialisation channels.

The Knowledge Development, Accumulation and Learning Efforts Indicator[7]was based on the information contained in the previous paragraph; it helps to assess the extension of the efforts made. 45% of the surveyed firms followed the big effort modality according to the wide variety of areas or activities in which investment was directed to purchasing, generating and/or adapting knowledge. For 33%, the indicator assumes the medium effort modality, which means investment in different areas, although less diverse than in the former case. Finally, only 22% did not spend on obtaining knowledge or if they did so, they did it on one activity only and, then, exhibit very small or no effort at all (Table 2).

Although the learning and the accumulation of knowledge efforts were made to buy technology from foreign agents and to develop knowledge inside the firm, in general terms, it was the efforts of the former type which prevailed. For 35% of the sampled firms, the efforts to buy technology may be considered big, while for a 44%, the level of such efforts was medium[8] [9] (Table 2).

[7]- This indicator was calculated using the number of areas or activities where the firms made investments oriented to learning and knowledge accumulation over the three years previous to the survey. The form included 8 activities: purchase of capital goods related to improved products and/or processes, manufacturing licences, consultancy services and software, expenditure on R&D, on continued improvement programmes, processes development and adaptation, restructuring and commercialisation channels and on training for innovation. Then, if the firm did not make any investments or did so in only one activity, a *small effort* value was computed; when the firm spent on 2, 3 or 4 activities, a *medium effort* value was computed; when the firm spent on 5 or more activities, a *big effort* value was the case. It should be noted that when elaborating the indicator, the size of the expenses destined to each activity was not taken because such information was unavailable for a considerable number of firms.

[8]- The significance of these efforts was measured with the Technology Purchase Indicator. This indicator follows the *small technology purchase* modality when the firm has neither bought capital goods related to improved products and/or processes nor invested in manufacturing licences, consultancy services and software; the *medium technology purchase* modality occurs when the firm has spent on one of the two cases mentioned just before; the *large technology purchase* modality means the firm has invested in capital goods as well as in licences, consultancy services and software.

In a considerable number of cases, the new knowledge development and adaptation efforts inside the firm were also important. 28% of the firms made big efforts to develop technology inside the firm and 33% made a medium effort[10]. It must be pointed out that 51% of the organisations included formal groups for innovation activities and 17% possessed informal groups.

TABLE 2. Learning, Internal Development and Technology Purchase Efforts Indicators

	Large	**Medium**	**Small or None**
Learning, Knowledge Accumulation and Development Effort	45%	33%	22%
Technology Internal Development	28%	33%	39%
Technology Purchase	35%	44%	21%

The results of the qualitative analysis also confirm the existence of different ways the firms resorted to in order to obtain productive knowledge. At least tentatively, they help to find some explanation about the factors or variables influencing the choice of the alternative adopted[11]. Among other reasons, the case studies throw evidence that the ways selected were affected by:

i) The characteristics of the technology chosen, its maturity degree and transmission level. For example, in activities which may be qualified as "dominated by their suppliers" because of the characteristics of the generation patterns and use of innovation, the incorporation of new capital equipment and new inputs played a key role, while R&D played a limited role, which coincides with the ideas stated by K. Pavitt (1984). This is clearly seen in three of the analysed firms. Instead, in those activities in which scientific-technological development encouraged new products and in which, at least, temporarily, the firm introducing

[9]- The magnitude of the investment made in each activity was not considered for the elaboration of this indicator. However, the partial data available clearly tend to confirm the conclusion that the biggest efforts were directed to Technology Purchase; especially, the purchase of capital goods for the introduction of new or improved products and/or processes.

[10]- The Internal Technology Development Indicator was based on the number of areas linked to internal technological development in which the firm made investments (R&D, continued improvement programmes, processes development and adaptation, restructuring and commercialisation, training for innovation). The *small internal technology development* modality occurs when the firm has not made investments of this kind or has invested in only one area; when the firm has invested in 2 or 3 items, then, the modality is of *medium internal technology development*; when investment has been in 4 or 5 areas, the modality is of *large internal technology development*.

[11]- - Undoubtedly, the number of firms analysed in detail is small in order to establish general and generalising robust conclusions. Quite probably, other also important factors may have gone unnoticed. In spite of such limitations, the qualitative analysis made has thrown light on a series of relationships, consistent with the theory, which remain concealed in quantitative studies.

those activities may have appropriated a substantial part of the benefits brought about by innovation, R&D or technology transfer grew more important.

ii) The characteristics of the auto parts industry:

a) Structural aspects. For example, belonging to a foreign group favoured receiving technical assistance or technological transfer from related firms in the group.

b) Differences in the accumulated competences in each firm, particularly with respect to *know who*. There were firms with severe limitations to identify the key agents who could supply them the knowledge they did not have inside their organisation, while there were others which resorted to a wide range of actors to obtain the knowledge and the capabilities required.

c) Management characteristics. The cases analysed show that innovation, to a large extent, is an organisational phenomenon. A firm's capability to introduce innovations, apart from depending on the particular features of the firms concerning their inclination to accept risk, to try new ways and methods, etc., is also strongly affected by the form they organise the work process and by the incentives system, especially those incentives related to current salaries and wages. If the general atmosphere in the work place favours communication between workers and between workers and their superiors, experience is transmitted, knowledge is spread and new tacit knowledge is created, all of which plays in favour of introducing improvements. Similarly, wage incentives may stimulate or may get in the way of transmitting and spreading knowledge. The systems based on rewards according to individual productivity performance may hinder the knowledge circulation and the experience transmission processes[12].

iii) The policy of the automotive manufacturers. As a general rule, the automotive industries have, in many areas, a higher technological level than that of the auto parts manufacturers. By transferring part of that knowledge to the suppliers, the automakers may get important benefits, depending on their bargaining power and can appropriate a large portion of the benefits of the improvements introduced by the auto parts industries. Also, some of the characteristics of the production methods prevailing in the automotive industry, such as the "just in time production", implementation of the quality control norms and others, tend to enhance the advantages for the automakers to count on efficient suppliers. But such transfer processes are also costly, not only economically but also strategically: by strengthening the bargaining position of the auto parts manufacturers, the latter can derive specific assets benefits from the relationship. Therefore, transferring technology to the auto part manufacturers forms part of the business policy.

In general terms, the influence of the automakers policies on the learning process of the auto parts firms is relevant; it varies and differs according to the automotive industry taken: there are cases in which the support offered is almost nil, or cases

[12]- This was precisely the case with one of the analysed firms, which had to cancel such system some time later because of the negative effects on the firm's productivity.

where the excessive rules established force the suppliers to waste resources; in a large number of cases, the suppliers´ productive process is audited and assessed and eventually suggestions are made to improve it; generally, the complete design of the required pieces is transferred, although there are occasions when the cooperation of the auto parts suppliers is required for the definition of given specificities of the new pieces.

IV.3 Hypotheses 3 and 4: Learning, Knowledge Accumulation and Innovative Performance

Quantitative analysis helps to statistically demonstrate that the firms receiving more transfers make bigger learning, accumulation and development of knowledge efforts, possess more endogenous skills and are the most innovative organisations.

With the help of the Multiple Correspondence Factorial Analysis (MCFA), the firms were classified into five groups according to the values assumed by the Transfers, Efforts and Endogenous Competences Indicators[13]. This method helps to consider the qualitative variables associated with the phenomenon studied in conjunction, to reduce the dimensions between the modalities of the different variables, to calculate the distance between individuals (the firms) in order to later have groups of firms which represent a high intra-group homogeneity (with respect to the active variables modalities) and high extra-group heterogeneity.
Once the groups have been formed, it is possible to analyse the particular characteristics of each one of them by means of the study of the variables used. Which modalities from the different variables taken are over or sub-represented with respect to the sample values can be seen at different levels of statistical significance; also, the active variables can be appreciated. In other words, it is possible to see the cases when the proportion of the indicators modalities reaches levels significantly different from the proportion in the sample. An over-represented modality in a group acquires significance statistically higher than the mean for the whole sample, and the under-represented modality takes on significance statistically lower in the group in relation to the sample mean[14].

The main characteristics of the groups concerning Endogenous Competences, Efforts, Transfers and Introduction of Innovations can be seen in Table 3.

In Group1, which shows 32.6% of the sample, the firms receiving large transfers are over-represented, offer very good endogenous competences, have made important efforts and have reached a high innovative performance.

None of the firms in this group exhibits poor competences. The fact that all the firms in it show medium or very good competences particularly in this last case, enhances the assimilation capacity of the transferred knowledge and of the knowledge which is

[13]- The Endogenous competences Indicator, which measures accumulated knowledge and learning capacity, was elaborated combining variables which reflect aspects of work organisation, training structure, quality management and R&D groups. It was taken from Yoguel *et al* (2007). It may assume three values: very good competences value, a modality covering 46.1% of the sampled firms; medium competences value (40.5%) and poor competences value (13.5% of the sample).
[14] - It refers to a proportion difference *test.*

circulated, strengthening the positive aspects of the innovation process in those organisations.

The firms of this group have made important efforts to buy technology and to reach their own developments and/or adapt the transferred knowledge to the needs of their business. It is a group in which the firms with formal groups devoted to innovative work (76% represent R&D) are over-represented

The technology transfer usually comes from different agents; among the sources, the local Science and Technology System is over-represented

Following the above ideas and according to the framework introduced, it is to be expected that the firms with a high innovative performance are over-represented. 48% of these firms have introduced almost all kinds of innovation. Virtually all the firms in this group have introduced innovations or substantial improvements in their different processes and around 80% have obtained product and organisational innovations while approximately 60% have introduced innovations in commercialisation[15].

TABLE 3. Firm typology according to knowledge accumulation

	Endogenous Competences	**Learning Efforts**	**Technology Transfers**	**Innovation Indicator**
Group 1 (32.6%)	Very Good **	Big*	High **	Large *
Group 2 (13.5%)	Very Good**	Big**	Medium *	Similar to the sample
Group 3 (23.6%)	Medium ***	Medium *	High **	Similar to the sample
Group 4 (13.5%)	Poor *	Small**	Similar to the sample	Small ***
Group 5 (14.6%)	Medium **	Small*	Little ***	Small **

Note : * Over-represented at 1% significance level.
** Over-represented at 5% significance level.
***Over-represented at 10% significance level.

In Group 2, which covers 13.5% of the sampled firms, those firms receiving medium importance transfer (100% of the firms in the sample) are over-represented; they made big efforts and exhibit very good endogenous competences.

[15]- In this group, the small firms are under-represented and the national-capital independent firms are over-represented.

All the firms in this group receive medium knowledge transfer. Among the agents transferring technology, the public sector's Science and Technology System appear over-represented.

Also, all the firms of this group have made medium and big innovation efforts, the firms showing big efforts being over-represented. With respect to external technology purchase, half the firms have made great efforts and the remaining 50% made medium efforts. Those firms showing they made big efforts for developing internal technology (50% of the group) are also over-represented: 83% of them possess formal groups for innovation and 75% conducted R&D activities. One fourth of the firms in the group made small or no efforts. This group - just like the previous one – exhibits important relatively balanced efforts between technology purchase from external agents and their own developments. However, there is a difference with respect to Group 1 in this point: for a reduced number of firms (25% of the group) the efforts tended to be limited to buying capital goods.

Concerning the endogenous competences, the firms of this group do not show significant differences with Group 1. No firm exhibits poor competences, which favours the capability to get involved in learning processes inclined to the introduction of innovations.

The innovative performance of the firms of this group, measured with the Innovation Indicator, is not statistically different from the sample mean, although the percentages which correspond to each modality of the indicator apparently suggest a slightly higher purpose[16].

In Group 3, with 23.6% of the sampled firms, those firms receiving large transfers are over-represented, have endogenous competences and have made medium efforts. With respect to the introduction of innovations, a similar performance to the sample mean can be seen, but smaller than in Group 2[17].

As concerns transfers, this group is similar to Group 1, the one with the best innovative performance. The Transfer Indicator is large for about 70% of the firms, while for the remaining ones transfers are of little importance or none at all. The main difference between the two groups, referred to the characteristics of the transfers received, is the fact that the firms in this group tend to relate to an only agent (71%), usually an automotive terminal or businesses in their own economic group, which give them assistance. 95% of these firms do not relate to the public sector's Science and Technology System.

This group is characterised for making medium efforts. Almost half of the firms in this group have bought technology - mainly through purchasing capital goods – of medium level; a similar proportion conducted internal technology developments of the same medium significance level. Between these two kinds of efforts, less balance can be seen in this group than in the former two groups, in favour of buying external

[16]- It is not possible to characterise the firms in this group in terms of structural values, such as size, capital origin, location of the automotive network; neither is it possible in terms of performance variables as, for instance, the exports coefficient, employment evolution, etc.

[17]- Fisher's Exact Test helps to reject the innovative performance equality hypothesis between the two groups with 10% probability.

technology. Another difference with the other two groups indicates that in this group the firms involved in R&D activities appear as under-represented.

These firms predominantly show medium competences. Almost 60% of them exhibit medium level competences, and the remaining ones in this group enjoy high level competences.

In innovation, this group does not throw significant differences with the mean in the sample. Theses firms´ innovative performance is situated below that of Group 1 and Group 2, although for over half of them the Innovation Indicator assumes a medium or high value[18].

Although the firms in this group tend to receive important transfers, the fact that most of them enjoy medium level endogenous competences and have made medium efforts reduces their capability to appropriate such knowledge, to combine it with the tacit and codified kinds of knowledge enjoyed by the firm and to adapt it to their own requirements and those of the market for which they manufacture. The innovative performance of this group, despite receiving large transfers, is of a lower level if compared with the former two groups; this should not be considered a striking fact.

All the firms in Group 4, which includes 13.5% of the total sampled firms, exhibit poor endogenous competences and 50% of them made small or no learning, knowledge accumulation and development efforts. Such efforts tended to concentrate on buying capital goods while the internal efforts for developing and/or adapting technology were few in 75% of the cases. The Efforts Indicator is not significant for any of the firms in this group; only 17% of them are involved in R&D activities. Also, the transfer level received is not significantly different from the sample mean. Half of the firms did not receive transfers or were not significant, while 42% obtained highly important technical assistance and/or technology transfer.

Although the percentage of firms having received important transfers is considerable, the capability to undertake knowledge conversion processes to best implement such transfers was limited by the poor level of their endogenous competences. The innovation efforts were small, especially in relation to internal developments and adaptation of external technologies; then, the poor innovation performance of these firms can be understood. In fact, the Innovation Indicator is small for most of these firms (58%) and large only for 8%. The introduction of four kinds of innovations - product, process, organisational and commercialisation – are under-represented in this group (with respect to the sample mean) [19].

Group 5 involves 14.6% of the sampled firms, is characterised by the fact that those firms receiving large transfers are over-represented, make small or no innovation efforts and enjoy medium level endogenous competences.

The same as with the former group, there are a number of firms receiving large transfers (46%) and others receiving small transfers (54%). One of the differences with the former group indicates that in this group there are no firms with poor endogenous

[18]- As to the structural features of this group, the firms forming part of a business group, the large ones and those with a big exports coefficient are over-represented.

[19]- There are no large firms in this group; the small ones and those not exporting directly are over-represented.

competences. 69% exhibit medium level competences and the remaining ones possess very good competences. Another difference shows that the Efforts Indicator is small for all the firms in this group. Only 38% made some concrete efforts to buy capital goods, but none of the firms conducted internal activities directed to the development or adaptation of technology.

The innovation performance of this group is similar to that of the former group. The Innovation Indicator is small in 62% of the cases and medium for the remaining cases. In no case is the mentioned indicator large.

Although almost half of the firms receiving technical assistance and/or large transfers and although all of them exhibit medium or very good endogenous competences, the reason for a poor innovation performance seems to lie in the absence of innovation efforts, particularly inside the firms. Again, the results of the analysis show the "need" to adequately complement the different kinds of knowledge.

Also, the results of this qualitative analysis provide plenty of empirical evidence on the advantages of complementing different forms or different sources of knowledge to reinforce the learning process and for the creation of competences. A given source of knowledge may prove very convenient to obtain a certain kind of knowledge, but not other kinds of knowledge.

In this sense, the case studies show that even when the technology transfer may today mean a virtually irreplaceable key element in the modernisation process of the auto parts industry in any peripheral country, certain conditions must be met in order to implement the knowledge efficiently used in the production processes of domestic firms. These conditions are related to the potentialities of the firms to develop learning processes and to the magnitude of the adaptation efforts made.

In other words, the transfers prove significant if they are accompanied by explicit efforts and by the competences required to incorporate technology. The firms which concentrated their forms of obtaining knowledge from external sources without complementing such knowledge with their own adaptation efforts with the aim of reaching general improvement have admitted the difficulty of reverting inertia in their production routines and transformation processes. Knowledge transfer, even from other firms in the same business group, is neither mechanically automatic nor thorough[20]. Technology means a lot more than information or universal, codified and easily transmittable knowledge. Implementing the developed knowledge in other plants demands not only the efforts for implementation but also the efforts for adapting to the specific conditions of the domestic firm (production scale, characteristics of the equipment and manual labour, and others); it also demands the development of complementary tacit knowledge.

[20]- An aspect that arose in the interviews with one of the branches of an international important auto parts industry was the confirmation of the relative ease with which a domestic production plant, following their "own free will", may remain almost completely isolated from the technological process enjoyed by the rest of the corporate group. It is enough if the mentioned plant meets certain standards which are typical of the activity and does not request financial assistance from the rest of the group. Knowledge transmission from a firm to another in the same group does not occur automatically: it requires active efforts to attain the desired goal.

Similarly, knowledge transfer related to "what to produce", seen in the demand for spare parts according to completely pre-determined designs by the automakers, demands of the receiving firm the development of skills to interpret the *know what* they receive, adapt it to the real conditions of the firm, detect the possible failures and communicate the identified flaws.

The case studies also show the limitations of using, almost exclusively, the knowledge generated inside the firm. For the firms to reach the mastery of the technologies they employ, acquiring experience and conducting the internal learning processes required proves essential. All the firms in the qualitative analysis enjoy an important "stock" of tacit and specific knowledge. If this form of creating and getting knowledge is not adequately complemented with other forms which may favour the incorporation of external knowledge, the learning process is strongly conditioned because it remains limited to incremental improvements within a determined path. In such a case, the possibilities to develop in different directions away from those determined by the previously acquired knowledge are almost none. This constitutes a strong restraint to going in a different direction. If experience may be considered essential to obtain the know what and know how, it is not enough to have access to the know who and, in many cases, to the know why.

IV.4 Hypothesis 5. Tacit and Codified Knowledge

The case studies help to document how automation displaces the limits between tacit and codified knowledge. On the one hand, incorporating automated technology makes the incorporation of new knowledge necessary; generally, of the scientific nature and related to electronics and pneumatics, in which the importance of the tacit components is substantially less significant. On the other, the advance of automation makes an important portion of the tacit knowledge not indispensable. For example, tuning a conventional machine without electronic mechanism is a typical job which demands of highly experienced workers a high amount of tacit knowledge, reflected in the number of hours, even days, employed. In such cases, the incorporation of numeric control mechanisms simplifies and eases the machine operator's job as he/she can store in mind the exact specifications of former tuning operations.

Nevertheless, tacit knowledge continues to be fundamental, especially in developing production processes, in understanding how a machine works and how to do maintenance. In all the cases analysed, concrete examples of the jobs or activities demanding tacit knowledge were identified; "experience", in the language of the interviewed, was important. Taking up the example in the former paragraph, even when knowing how to tune a machine may be stored in the mind, the need to resort to complementation with tacit knowledge is not eliminated because different characteristics typical of the steel being used, or the differences in the kind and the degree of the tear and wear of the matrices or tools used make the mentioned tuning not entirely adequate for a new series; usually, modifications requiring tacit knowledge must be introduced.

IV. 5. Hypothesis 6: Learning Processes and Product and Process Innovation

The results of the quantitative analysis show that the sampled firms introduce product and process innovation in similar proportions. During the 2001/2005 years, 78% of the firms introduced innovations or significant improvements in their products, and 80% did so in their processes. In other words, the available empirical evidence does not mean that some kind of innovation is more important than another among the sampled firms.

However, the case studies reveal that the significance of the learning processes and the development of new skills is quite different in both cases.

At present, for the auto parts manufacturers, the development of processes capabilities enjoys core importance. Instead, at least for most firms, possessing or not specific skills to design a new product does not appear as a factor which may fundamentally affect their innovative performance.

This is closely related to the technological requirements that the automotive manufacturers impose on their auto parts suppliers, centred essentially on modernising their production processes, on the implementation of continued improvement mechanisms, on cost reduction, on production according to certified quality norms, on the capability to deliver just in time, etc. On the contrary, the fact that the design of new products, as a general rule, originates in the customer significantly diminishes the competences the firms require to introduce new products in the market.

The production processes of the firms analysed tend to be quite idiosyncratic[21]. Since there are significant differences in production scales and in the modernisation degrees of the equipment used as concerns the principal international producers[22], the domestic firms need to make their own efforts to adapt the machinery and the techniques employed and to generate specific knowledge. Then, knowledge conversion processes are introduced which can be described according to the model by Nonaka and Takeuchi.

The specific knowledge accumulated in a firm concerning their equipment potential and operation and the acquired capabilities proved essential at the time of designing a new process. Then, the characteristics adopted by the socialisation and by the tacit knowledge externalisation/articulation processes tended to be critical for the definition of the end product. In this respect, it should be noted that in three of the analysed firms, different experienced skilled workers participated in the design and improvement of the professional processes, while in the two remaining ones this activity related exclusively to the knowledge and the experience of the higher cadres.

The knowledge process that the firms obtain was combined and enhanced with the explicit knowledge from various sources: the customers´ suggestions following the

[21]- In this sense, certain features of the production processes typical of the Argentine manufacturing industry, described by J. Katz since the start of the 1970s, are still held.

[22]- The closely analysed firms are those ones in the Small Businesses Sector, which usually produce in limited series. Similarly, it should be noted that even in larger plants in Argentina, the production scales tend to be much smaller if compared with those typical of the international market.

auditing they conduct[23], the information contained in the norms, the contributions of the firm's R&D groups, publications and others.

The definition of the initial design process is, this way, arrived at. To conduct it, the new explicit knowledge contained in the design must be internalised. The implementation and adaptation efforts of such explicit knowledge are usually accompanied by training processes, *learning by doing*, *learning by using*, and *learning by failing*, which help to implement the learning and the new tacit knowledge generation processes. This is the manner the conditions are re-created in order to start a new cycle (knowledge creation and conversion) which ends with the introduction of later improvements in the processes.

In relation to product design, the capabilities required by the firms to introduce innovations and/or improvements are generally limited to the essential ones to be able to interpret *what* the terminal desires and *how* to meet its demands with their existing equipment and experience.

Consequently, the conversion and new knowledge creation processes for product design are rather more restrained than those described for process design. This stage, generally, is begun with the codified knowledge transfer from the customer by means of layouts. As from this point, the firm must assess the possibility of producing the spare part required, for which specific knowledge of the available equipment, the materials to be employed and the skills required of labour are necessary. This involves the process of socialisation of tacit knowledge and, later, its externalisation. It is not infrequent that this knowledge, once it has been articulated, helps the firm to establish *feedback* with their customers, which give way to product improvement. The improvements can be seen in the use of cheaper or alternative materials, different form those originally proposed by the automotive manufacturers; also, in materials which prove more available in the local market or in identifying mistakes in the layouts supplied by the customers.

The mentioned exchange of knowledge between the auto parts suppliers and their customers are usually little relevant for the generation of dynamic learning and new competences creation processes. It is as though, inside the Argentine auto parts firms, the knowledge conversion process related to product design were frozen.

Consequently, whenever these firms must assess the possibility of producing a new part, they tend to repeat the same rules and procedures used in former opportunities[24].

The situation varies in the only analysed firm which often participates in co-designing the spare parts it produces[25]. This firm has been able to develop a high level of the competences required in this area, the result of the work done by its R&D team as well as of the experience and training enjoyed by its staff, the knowledge obtained by interacting with the automakers and the implementation of specific software. Such

[23]- As a general rule, the automotive terminals must give their approval of the design of the production process proposed by the auto parts producer before the latter starts manufacturing.

[24]- At least until it becomes necessary to change such procedures, which takes place, for instance, each time the firms incorporate more modern capital goods than those it possessed before.

[25]- Although the cases in which the firms that design or co-design products exclusively upon their customers´ demand are very few, in the Argentine auto parts sector new exceptions to the rule have gradually appeared.

combination of different kinds of knowledge and the knowledge from different sources constantly renewed over time, favours internal learning and obtaining new knowledge for product design.

V – CONCLUSIONS AND FINAL WORDS

The auto and spare parts industry has not been included as part of the most dynamic group of manufacturers in terms of technological development; however, in particular, over the past decades, the technical support and the production processes the industry has implemented have gone through permanent changes which are reflected in the growing technological complexity of the processes and the products, and in the key role innovation plays in the competitive strategies the firms have implemented.

Competing by resorting to innovation introduces its own characteristics in this sector. Additionally to being influenced domestically by the strategies of the automakers and by the agreements made between different automotive producers´ head quarters and the head quarters of large international auto parts makers, it should be noted that this is one of the sectors with fewer patents (in relation to R&D spending) and where selling the international high-tech to independent firms is limited, excepting those which incorporated inputs and capital goods.

This article discusses and illustrates the complexity and richness of the learning and the skills accumulation processes implemented to innovate in the Argentine auto parts firms. A two-fold quantitative and qualitative analysis has been taken as the main approach. Beyond the diversity of the existing conditions, this analysis helps to reach the following general conclusions:

- ✓ The technological level reached by the producers is an evolutive process, which is affected by numerous factors both internal and external to the firms. The differences among firms are not limited to the different production scales and/or relative prices. To clearly grasp the competences level reached by a given organisation, at any given moment in time, it is necessary to know its history, how and why it arrived at the current conditions. The decisions made in the past concerning the purchase of machinery, the choice between alternative technologies, establishing or not R&D groups, adopting or not training policies, etc., affect both the kind and the level of the capabilities that the firms, in fact, develop.

- ✓ The firms, according to the characteristics of the technology employed and of their structure, objectives, skills and needs, resort to a wide range of sources in search of new knowledge. Although in this search they appeal, more often and principally, to external sources (especially, the purchase of capital goods associated to the introduction of product and/or process innovations, and technical assistance and/or technology transfer), most of them also make their own technological development internally in various areas (adaptation and development of products and processes, continued improvements, R&D, training oriented to innovation, and others).

- ✓ There is a positive association between the intensity of the learning and competences accumulation processes on the one hand, and, on the other, the innovative performance. The quantitative analysis shows that the groups of firms which achieved development of endogenous competences at higher levels receive a

larger volume of technology transfers and make greater efforts to incorporate new knowledge in their production activities; they are the groups which have innovated the most, according to the Innovation Indicator.

- ✓ Although it is not possible to have a definition of the "best way" to approach the learning and competences acquisition processes valid for all or for most of the firms, the results of the study confirm the convenience of reaching the right complementation between internally generated knowledge and the knowledge coming from external sources. In the quantitative analysis, this need for complementation between internal and external knowledge and between codified and tacit/specific knowledge is manifested by the importance of the endogenous competences level and the efforts made to develop technology inside the firm as complement to buying capital goods and receiving transfers. Although the knowledge from external sources may be fundamental and irreplaceable if the domestic industry is to follow the pace of the technological development prevailing in international markets, it must generally be adapted to the specific conditions of the firms and the markets. The qualitative analysis, instead, helps to show both the role played by experience, especially the tacit/specific knowledge of each firm, in adapting external knowledge and the limitations for developing new technological capabilities of processes centred almost exclusively on internal learning sources.
- ✓ The ever increasing use of electronic technology helps to codify part of the tacit knowledge, displacing, then, the frontiers between the two kinds of knowledge. However, the importance of the tacit knowledge continues to be essential, particularly in developing production processes, in understanding the operation of machines and in their maintenance.
- ✓ Although the available empirical evidence shows that the sampled firms analysed introduce product and process innovations in similar proportions, the results of the qualitative analysis reveal that the significance and the characteristics of the learning and new capabilities development processes are very different in both cases. In processes where the development and accumulation of new capabilities enjoys a crucial importance, significant knowledge conversion processes are observed inside the firms. Instead, with respect to new product design in most firms, having or not having specific skills does not mean a factor which may substantially affect their innovative performance; then, the learning processes tend to be more limited.

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