

# Technological change *and industrial dynamics* in Latin America

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The subject-matter of this article lies at the crossroads between the literature on technological change and that on industrial dynamics. The analysis centers on the links between the form of accumulation of technical know-how in an industry and the likelihood that the innovation in question can become a vehicle for the entry of new enterprises into the sector. The studies on the developed countries tackle this matter through two approaches: that of technological regimes and that based on the life-cycle of industry. Both these concepts are of an evolutionary nature and are set forth in section II below. After analysing whether the different sectoral forms of innovation are associated with different rates, characteristics and survival prospects for firms entering an industry, section III seeks to determine what conclusions on dynamics can be drawn from the literature on technological change in the manufacturing firms of the main countries of Latin America. Lastly, section IV offers some final reflections. The main contributions made by this study are the following: i) it offers a different perspective for interpreting technological change in Latin America and seeks to develop a concept equivalent to that of the “innovative advantage” used in studies on the developed countries; ii) it suggests that, in a context in which enterprises mainly innovate through the incorporation of know-how developed by other organizations, established enterprises tend to enjoy advantages for the incorporation of technical progress, and iii) in view of this, it may be assumed that in those activities where product or process innovation creates competitive advantages for established enterprises, “innovative entry” will not be a frequent phenomenon.

# I

## Introduction

The improvement in the statistical bases of the industrialized countries has now made it possible to tackle new aspects of the phenomenon of the birth of enterprises, giving rise to numerous empirical studies on the birth of new enterprises and their performance (i.e., their survival and/or growth) after their establishment.<sup>1</sup>

The researchers of those countries mainly approach the problem from the standpoint of the problems of the industrial economy or one of its subject-areas such as market theory, the labour market (rotation of employment), etc. Many studies –especially the neo-Schumpeterian ones– also incorporate an approach centered on the repercussions of entrepreneurial demography on economic development, but they all take it for granted that there is a competitive dynamic in which (albeit to a different extent in different sectors) innovation is a central element in differentiation between enterprises. Interest is focussed on the primary elements of innovation and its special features both at the sectoral and enterprise level. Thus, the literature on technological regimes and the life cycle of industries offers schemes and concepts which seek to explain i) what factors determine the differences between sectors as regards the characteristics of innovation and the conditions of entry, survival and exit of enterprises, and ii) how these two elements are combined in the different types of activities.

For the semi-industrialized countries (SICs), in contrast, the studies on entrepreneurial demography open up a new area of reflection on the very nature of structural change. The possibility thus arises of integrating within a single conceptual framework the study of the determinants of entrepreneurial renewal in the most dynamic sectors, the prospects for the appearance of new activities, and the entry of firms into the market as a

means of competitive pressure which will improve the innovation capacity of the firms which are already established, among other aspects. However, the theories and stylized empirical facts given in the studies on more advanced economies need to be rethought to some extent before they are applied to the study of semi-industrialized structures.

Section II of this article looks at the conceptual schemes that link up inter-sectoral differences of dynamics (patterns of entry and survival) with the nature of the technological innovation process. The central element in these arguments (which may be considered as parts of evolution theory) is the analysis of the factors that determine which enterprises –new entrants or firms that are already established– will find it easier to introduce technological innovations. This seems a suitable way of progressing towards a comparative analysis of the dynamic attributes of production structures of unequal economic and institutional development.

Section III, which forms the main part of this study, seeks to progress in the analysis of industrial dynamics in SICs. To this end, the concepts which have been crucial elements in the relation between technological innovation and industrial dynamics in the developed countries (technological opportunity and the appropriability and accumulability of knowledge) are reviewed in the light of the literature on technological change in SICs, especially those of Latin America.

The rereading of the studies on technical change in SICs in the light of the theories presented in section II forms a useful framework for the analysis of the dynamic attributes of production structures in such countries. Finally, section IV presents the main conclusions of this study.

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<sup>1</sup> See, for example, Arrighetti (1994), Audretsch (1995a), Baldwin and Gorecki (1991), all the articles in *International Journal of Industrial Organization* (1995), Dunne, Roberts and Samuelson (1988 and 1989), Mata (1994), Mata and Portugal (1994), and Wagner (1994).

## II

### Conceptual schemes that help to explain the inter-sectoral differences in industrial dynamics

Two different theoretical approaches to the inter-sectoral differences in industrial dynamics may be distinguished. One of them is based on the study of certain features of technology and market structure.<sup>2</sup> The other centers on the differences due to the different ways of generating technological know-how, and is the approach followed in the present study.

The disparities in industrial dynamics caused by the characteristics of the technological innovation process may be explained through two main schemes: that based on technological regimes, and that based on the life cycle of industries, both of which are connected with the neo-Schumpeterian literature on technological change.

The summary given below sets forth these two approaches because they are the conceptual basis for all the empirical studies (using extensive, generally longitudinal, data bases) which have been made on the relation between technology and industrial dynamics in the developed countries. This “unicity” of the range of approaches discussed is thus due to methodological rather than theoretical considerations. Other (alternative and/or complementary) approaches could very well interconnect with the ideas presented below. However, no attempt will be made in this article to refer to and compare other approaches, since it merely aims to organize a collection of theoretical and empirical material which is quite recent and has been very little analysed in the SICs, and then put forward some ideas on possible conclusions that might be drawn from it and might be useful for those countries.

Before presenting our summary of the two approaches, it is worth specifying clearly the assumptions regarding entrepreneurial conduct that implicitly or explicitly underlie them. In spite of their common Schumpeterian roots, the authors consulted may differ somewhat in their assumptions about entrepreneurs’ profitability goals. Nevertheless, all the schemes can easily be conceived on the basis of active learning models (Ericson and Pakes, 1995): i) the agents detect opportunities for profit in the economy, and in order to check

them out they must invest and enter the market; ii) in any activity or moment in time the active enterprises have different levels of efficiency, and iii) once they are in an activity, enterprises make investments (“actively explore the economic environment they are operating in”) in order to increase their capacity to make profits; those whose “exploratory actions” are not successful suffer a decline in their profitability which eventually brings them to a situation where exit from the market is the best response.

#### 1. Technological regimes

The starting point for modern analysis of the relation between technological change and industrial change is the work of Schumpeter. It is well known, however, that Schumpeter himself gradually altered his view of industrial dynamics in his successive studies on this subject, in line with the changes undergone by industrial capitalism in the developed countries from the beginning of the century up to the Second World War. Thus, the process of “creative destruction”, carried out fundamentally by new entrepreneurs, which he posited in his *Theory of economic development* (Schumpeter, 1912) was replaced in *Capitalism, socialism and democracy* (Schumpeter, 1942) by a scheme in which the generation of innovations tends to take place within big corporations that allocate resources and apply procedures specifically for that purpose.

Possibly (at least partly) as a reaction to the gloomy outlook that Schumpeter envisaged for capitalism in his 1942 study, neo-Schumpeterian authors studying innovation theory rescued the concept of “creative destruction” and placed it side by side with the alternative pattern (big corporations as the main source of innovation) in a unified conceptual scheme.

The idea of technological regimes is closely linked with the evolutionary view of technical change at the enterprise level. This approach criticises the orthodox view, whereby firms have unrestricted access to production facilities which include a list of all the available technologies, so that they only have to choose the technology that fits in best with the price relations of the production factors involved. Evolutionary

<sup>2</sup> Outstanding examples of this approach are those by Bain (1956), Orr (1974) and, more recently, Geroski (1991).

microeconomics, in contrast, suggests the incorporation of other facets into economic analysis, especially the organizational aspect, in which the technological decision-making process is merely the last visible link. In this context, the technical options open to the enterprise are not determined exogenously: on the contrary, they are “idiosyncratic” in so far as they are the result of the firm’s own experience and, in particular, the successes and failures in its “exploratory actions” (Nelson and Winter, 1982, parts I and II).

The exploratory actions (through expenditure on research and development, for example), for their part, immediately suggest the need to recognize that there is a variety of “sources” of technical information and innovative ideas that the agents use to bring their techniques in line with their goals in terms of profitability and ranges of production. New knowledge can come from outside the firm or it can be the result of processes of in-house accumulation and research activities carried out by its own members. The role of the different sources of information needed to gain access to technical innovations varies significantly in the different manufacturing sectors and types of technology, however. It is this wide variety of technological and innovative environments within the production structure which gives rise to the concept of technological regimes.

According to Winter, “Along with differences in the relative importance (however measured) of the different sources, there are differences in a variety of related aspects, including such matters as the intrinsic ease or difficulty of imitation, the number of distinguishable knowledge bases relative to a productive routine, the degree to which successes in basic research translate easily into successes in applied research (and vice versa), the size of the resource commitment typical of a ‘project’, and so forth. To characterize the key features of a particular knowledge environment in these various respects is to define a ‘technological regime’” (Winter, 1986, p. 205).<sup>3</sup>

The next step is to understand the two Schumpeterian innovation patterns as expressions of different underlying technological regimes. Thus, in the “entrepreneurial regime” new firms are the vehicle for innovative progress and the rotation is very intense because the established firms never manage to put their advantages on a solid, lasting basis that can withstand the disruptive capacity

of the new entrants. In the “routinized regime”, in contrast, the opposite pattern is observed: the established firms are always in a better position to innovate because they have access to a growing set of innovation opportunities and are in a position to cash in to the full on the technical advantages thus obtained. This is the situation of activities where innovation comes basically from the research and development laboratories of the established (generally dominant) firms. The innovative advantages of these firms are further heightened if technological opportunities are expanded and the conditions for private appropriability are strengthened (patents, difficulty of imitation, etc.). The innovative position of the new entrants, for their part, is improved if they have ready access to relevant technical information coming from sources outside the established firms.

The contributions by Malerba and Orsenigo (1995 and 1997) are along the same lines, emphasizing the wide range of forms that the organization of innovative activities can take in the different industrial sectors and suggesting that they can nevertheless be adequately covered by the two Schumpeterian archetypes.

These authors have made empirical studies in which they analyse the evolution of the list of innovative enterprises<sup>4</sup> in the different industrial sectors. In the sectors grouped together under the heading of Schumpeter Mark I, technical progress takes place through *widening*: the list of innovative enterprises constantly expands with the entry of new organizations (generally quite small), and the innovation race among enterprises is very even, with the order of the leading successful firms continually changing. Here, a process of “creative destruction” is at work. The key features in this pattern are ease of entry and the central role played by new firms in innovation.

In contrast, in the sectors grouped together as Schumpeter Mark II the technical process advances through *deepening*: innovative activity is dominated by a small group of firms which continually introduce improvements, making use of the technological capacity they have built up over time. Here, the industrial dynamic is represented by a process of “creative accumulation”. The big firms have institutionalized the innovation process with the establishment of research and development laboratories and the recruitment of researchers, technicians and engineers.<sup>5</sup>

<sup>3</sup> The concept of technological regimes was already described in Nelson and Winter (1982, chapters XI and XII). However, the model presented there does not provide for the entry of new firms and is thus not capable of exploring the inter-sectoral diversity as regards the role of innovative entry. Winter (1986) shows substantial progress in this sense.

<sup>4</sup> Generally on the basis of information on patents applied for.

<sup>5</sup> Naturally, these two patterns must be seen as the extremes in a broad range of situations. Furthermore, as we shall see below, a production activity or technology may undergo changes in the way its innovative activities are organized in the course of its life cycle.

Malerba and Orsenigo find that these archetypes reflect systematic differences between the different technologies; generally speaking, each industrial branch always tends to be listed under the same pattern in each of the different national cases. This link between the characteristics of the innovation process in the different sectors and the Schumpeterian patterns is in line with the concept of technological regimes; this notion provides a synthetic representation of some of the most important economic properties of technologies and the characteristics of the learning processes involved in innovative activities (Malerba and Orsenigo, 1997, pp. 84-85). The basic hypothesis is that there are factors related with the forms of accumulation of knowledge which have a critical influence on the way innovative activities are organized in a given class of technology. The technological regime would be the result of a particular configuration of i) certain features of the technology, such as the conditions of opportunity and appropriability and the degree of accumulativity of the technological knowledge in question, and ii) certain characteristics of the knowledge base.<sup>6</sup>

Thus, the two Schumpeterian archetypes can be reformulated in terms of these concepts. The “creative destruction” pattern of innovation reflects conditions of high opportunity but low appropriability and accumulativity. The low appropriability means that firms can build up appreciable advantages of innovation, but not on a lasting basis. The low accumulativity suggests that the technological advantages are not associated with experience in the activity, which clears the way for innovative entry. The “creative accumulation” innovation pattern, for its part, reflects conditions of high opportunity, appropriability and accumulativity.<sup>7</sup>

The concept of technological regimes is also adopted by Audretsch (1991, 1995a, 1995b and 1997) in order to explain inter-sectoral differences in the rates of birth and subsequent performance of new firms.

Audretsch (1995a) considers that the main role in the process of technological change is played by the individual (not the firm) who possesses innovative knowledge. He defines the problem of appropriability as the search for an organizational solution which offers the

most profitable conditions for developing the new idea commercially. The agent must choose between selling his knowledge to an existing firm or starting a firm of his own. Here, the key question is whether there is i) uncertainty about the economic value of the potential innovation and asymmetrical access to information by the parties involved, and ii) agency costs associated with the development of the idea within an existing organization.

If there are, the organizational solution to the problem of appropriability will depend on the existence of economies of scale or scope. If there are serious problems of information, however, the inventor and the enterprise will tend to differ in their appraisal of the expected profitability of the project. Furthermore, if there are problems of asymmetrical information this will mean that the enterprise will only be able to incorporate the project within the framework of a follow-up and control scheme, which means that there will be agency costs. Audretsch says that it is the appearance of these frictions which often make it more difficult to transfer a new item of knowledge from an individual to an established firm and thus open the way for the establishment of a new innovative firm.

The presence of these factors varies from one industrial branch to another, as a function of the underlying knowledge conditions. This is so “not only because the relative importance of innovative activity varies systematically across industries, but also because the opportunities for new [or established] firms to generate that innovative activity also vary from industry to industry” (Audretsch, 1995b, p. 448). In some activities, the search for innovation is routinized and the new knowledge generated can be processed within the framework of the typical organizational structures of large enterprises. In others, however, innovations usually originate in items of knowledge which are not accumulated in a routine manner and are therefore difficult to absorb in this way.<sup>8</sup> In this latter case, the existence of the problems of information and agency costs in question will oblige an individual who has a potential innovation to form a new enterprise in order to try to exploit it commercially. These two situations reflect the conditions referred to by Winter (1986): an entrepreneurial regime (which favours innovative entry but discourages the introduction of technical progress by established firms) and a routinized regime (which has the opposite characteristics).

<sup>6</sup> For example: generic or specific, tacit or codified, complex or simple, independent or systemic.

<sup>7</sup> The existence of high opportunity is a necessary condition for there to be widely differing levels of performance by firms. Only in an environment of this type can there be firms with broad and potentially lasting advantages in their production operations and innovative activity.

<sup>8</sup> Audretsch cites the examples of Xerox and Apple, which were created as a result of this type of process (Audretsch, 1995a, pp. 54-55).

Thus, for Audretsch the factors which determine the pattern of innovation prevailing in a given production activity are: i) the origin of the innovative knowledge (routine research within established firms or sources external to them), and ii) the degree to which uncertainty and asymmetrical information will give rise to agency costs if established firms decide to develop projects generated by outside inventors.

It is possible to give a more precise description of Audretsch's version regarding the differences between activities associated with the two types of innovation regimes. Thus, there are three levels on which important differences may be observed:

i) *Technology*. In a static perspective, there are certain features of the production function which take on importance according to the technological regime. In particular, the existence of substantial economies of scale and the use of highly capital-intensive technologies are associated with the routinized regime. From the dynamic point of view –that is to say, in terms of the evolution of technology– an important role is played by the forms of accumulation of knowledge (routinized or not) and their relation with the two innovation regimes.

ii) *Market structure*. Highly concentrated activities are associated with the existence of a routinized regime, while those where small firms have a substantial share of the market display a form of operation closer to the entrepreneurial regime.

iii) *Dynamic features*. As regards the entry of new firms, the branches whose form of innovation is similar to that of an entrepreneurial regime register a high rate of birth of new firms. As explained earlier, individuals who have new ideas will find it difficult to transfer them to established firms, so they will tend to channel them through the formation of new firms of their own. The branches with entrepreneurial-type regimes may be viewed as environments where it is generally relatively easy to generate innovations and, in particular, where innovative entry is a frequent phenomenon. In contrast, this will not be so frequent in activities with a routinized regime, because in them technical progress tends to be generated in the research and development laboratories of the (generally large) enterprises of the sector.

The entry conditions are also affected by the interaction of the following features of an industry: the existence of growing returns to scale, and the relative “generosity” of the sector in question in terms of the growth opportunities for new entrants and small firms. Audretsch identifies the latter feature with the degree of innovativeness of the industry. The probability that a new firm will remain active in a given period and sector is

determined by the interaction between, on the one hand, the existence and intensity of the cost disadvantages involved in operating at a smaller scale than the minimum efficient level (which is the typical situation of most newly-created firms) and, on the other hand, the receptiveness of the environment to the innovative initiatives of the new entrants.

This position has some implications for entry conditions, such as: i) entry may not be seriously discouraged, even when economies of scale are important, if the potential entrepreneurs perceive that once they are operating they will have opportunities for expansion and innovation, and ii) the environments of entrepreneurial-type regimes in terms of competition are perceived by new or potential entrepreneurs as being more abundant in these types of opportunities.

Nevertheless, according to Audretsch (1995a), this greater attraction exerted by highly innovative entrepreneurial-type regimes has ambiguous effects. On the one hand, the receptiveness of the industry in terms of the opportunities for innovation by small firms stimulates the entry and retards the exit decisions even of firms which are far below the minimum efficient scale, but on the other hand, in environments where a process of intense technological change is under way and there is a high level of uncertainty as regards technical matters and the level and structure of future demand, there is less likelihood that an individual firm will be able to innovate successfully.

Audretsch draws the following conclusions from these arguments (which he tests empirically in the studies referred to) regarding the probability of exit or growth of the firms that survive:

i) in industrial branches marked by the existence of economies of scale the probability of survival will be low (because of the strong competitive affect of the entry of firms of sub-optimal scale), but the growth of those that survive will be high because their survival will depend precisely on whether the typical new entrants (of small scale) expand until they can reverse their cost disadvantages, and

ii) something similar will occur in branches where small firms have access to opportunities for growth and innovation. The likelihood that an individual firm will succeed in its innovative plans is low, and so also is its probability of survival. Those firms which achieve successful innovation (and thus survive) will grow fast, however.

With regard to the features of the growth processes, it must be asked whether these processes are a horizontal phenomenon (entry and exit of firms of similar ages)

or a vertical one (differences in the average ages of the firms that enter and exit). Audretsch suggests two metaphors for getting an idea of the different forms of industrial dynamics in keeping with the different technological regimes. In some industries the rotation of firms is similar to the growth pattern of the trees in a forest: the new firms displace the older ones, in this case because the new ones introduce novel and better ideas, whereas the oldest organizations become increasingly rigid and are unable to adapt to a constantly changing environment. This metaphor of the forest applies to activities whose innovation conditions correspond to those of an entrepreneurial regime, because the high probability of introducing an innovation favours the survival of the new entrants and increases the vulnerability of the older firms, which are already committed to a technical paradigm. In other industries (the great majority), however, the rotation of firms is more like that of a conical revolving door, whose broad base revolves as a function of the rate of entry of small firms which exit from the market quite soon after entering it, while its upper part, where the older and more firmly established enterprises are located, hardly revolves at all. Only a small proportion of the new firms manage to survive and subsequently grow. Environments of a routinized nature, in which the established firms have advantages in terms of innovation, are usually associated with this second type of rotation.

## 2. The life cycle of an industry

In the economic literature, the concept of the life cycle of a product is associated with the work of R. Vernon, especially in one of his articles (Vernon, 1966). Broadly, the article in question shows how the changes that take place in production methods and the characteristics of the product from the time when it is first marketed give rise to a process of relocation of production units from the original innovative country (the United States, in the basic pattern used by Vernon), first to other developed nations and later to semi-industrialized regions. On the basis of a highly stylized division of this cycle into periods, Vernon held that the processes of manufacturing new products are marked at the beginning by:

- i) high requirements for flexibility (in so far as the techniques are not definitively specified);
- ii) demand conditions which are determined by differentiation of the product, with, in the final analysis, some tolerance for moderate differences in costs between producers, and
- iii) the need for efficient means of communication with clients, suppliers and even competitors, because of

the high degree of uncertainty about the real size of the new market, the efforts that rivals will make to capture portions of it, the specifications of the inputs required, and the relative performance of the different versions of the product.

Generally speaking, as time passes and demand for the product increases, both the product itself and the methods for its manufacture become more standardized, thus altering the cost structure and market conditions. Finally, this opens the way for the spatial relocation of the production activities (Vernon, 1966).

The literature on technological change and industrial demography has adopted the life-cycle approach but focuses it on the evolution of entry and exit rates and the total number of firms in a specific market, from the first appearance of a product on the market until its maturity. Very briefly, we can say that it identifies five stages in this process:

- I. A firm or small group of firms initiates the activity;
- II. The net rate of entry and hence the total number of producers rises abruptly;
- III. The flow of new entrants then slows down until it is completely offset by the outward flow of firms and the net rate of entry sinks to approximately zero, while a peak is reached in the number of producers;
- IV. A very low rate of entry and an increase in the rate of exit give rise to a negative net rate of entry, and
- V. The rate of exit then declines until a rate of entry around zero is restored, with an intermediate number of producers in the market (compared with the minimum level in stage I and the maximum in stage III).

The forces behind this process stem from certain features of the industry which evolve together with the market structure in the course of the life cycle, particularly the level of uncertainty, the intensity of innovative activities, and the specific forms of innovation (of products or processes) and hence the sources of knowledge and the innovative agents.<sup>9</sup>

We will first of all set forth a stylized version of the basic elements in this sequence. After the initiation of a market, at quite an early moment in its evolution there will be an intensive entry process. Usually, the new entrants seek to open up a space in the new activity by introducing different versions of the basic product, so that there is a proliferation of product innovations. With time, the entry rate slows down, while the exit rate in-

<sup>9</sup> Another of the features of the industry which evolves with the life cycle is the degree of specialization at the plant level. This aspect will not be dealt with here, however (see Klepper, 1997).

creases, so that at first the two rates are balanced, but later the outward flow of firms even exceeds the entry rate, so that there is a pronounced reduction in the total number of producers (known as a “shakeout”),<sup>10</sup> stabilization of the market shares of the survivors, and a shift in technological change from product to process innovations.

Klepper (1997) gives a more detailed account of this. In an initial, embryonic stage of the market, there is a high level of uncertainty, product design is primitive, and the manufacturing process is carried out with non-specialized machinery. Numerous firms enter the market, and there is intense competition based on product innovations. In an intermediate or growth stage, production expands rapidly, product design begins to stabilize (that is to say, there is a gradual reduction in the frequency and importance of product innovations), and the production process becomes more sophisticated (human labour is gradually replaced by specialized production equipment). The entry rate goes down, as does the total number of producers.<sup>11</sup> Finally, in the stage of maturity, production grows slowly, the entry rate declines still further, and the market shares of the main firms become stabilized, while at the same time innovations of all types become more sporadic, since management, marketing and production techniques have reached a high degree of refinement.

In addition, the changes that accompany each of these transitions give rise to a redistribution of innovative advantages among the different types of producers. In the initial stages of the development of a new product, there is a great deal of uncertainty about the results of the new technology and activities tend to be subject to trial-and-error procedures, so in these circumstances the big firms do not have any special advantage in terms of innovation. The absence of advantages of scale, together with the prospects of high profits for successful innovation, attract a large number of new entrants. With time, however, two processes take place: first, as the technological frontier shifts, the search for innovations becomes more sophisticated and is divided up into well-defined tasks, giving rise to economies of scale in research and development spending, and second, the stock of knowledge built up by producers increases, raising the amount of such spending that new entrants must make in order to attain the level of capabilities of the

established firms. Both these processes are equivalent to entry barriers.

It is interesting to note that the origin of technological information is a key factor in this evolution. There are two types of sources of information whose relative weight changes in the course of the life cycle of an industry (Gort and Klepper, 1982):

i) firms which are already established in the activity in question ( $I_1$ ): information from this source is made up of transferable and non-transferable knowledge. The latter is generated through practice (learning by doing), tends to accumulate with time, and functions as an entry barrier, and

ii) alternative sources of information ( $I_2$ ), such as firms operating in technologically related industries, independent inventors, equipment producers, etc.: the existence and size of these sources have a positive effect on the entry rate by reducing the value of practical experience in the activity in question – an effect which is further strengthened by the difficulty of carrying out market transactions of such knowledge. As explained earlier, when agents outside the established firms possess valuable information on a new product, the best solution for taking advantage of such knowledge is probably the formation of a new enterprise.

The hypothesis put forward by Gort and Klepper (1982) may be summed up as follows: in the first stages of the cycle most innovations come from  $I_2$ , but as from stage III the balance favours  $I_1$  and the stock of this type of knowledge accumulated by the established firms begins to operate as an entry barrier.

The kinship between this hypothesis and that based on technological regimes is clear. Indeed, to a large extent the life cycle may be interpreted as the history of a transition from an entrepreneurial regime to a routinized regime.

Finally, we may say that many, although not all, of the products dealt with in the empirical studies display the pattern of industrial evolution described above. Klepper and Miller (1995), for example, classify a set of products in terms of whether or not their stylized cycles contain the intensive shaking-out process typical of stage IV. Klepper (1997) also analyses industries which have displayed other patterns, marked basically by the fact that the entry flow does not stop and there is not therefore a pronounced reduction in the number of firms.

### 3. Sectoral patterns of innovative entry

In short, if we combine the approach based on technological regimes with that based on the life cycle of in-

<sup>10</sup> For alternative views on the origin of shakeouts, see Klepper and Miller (1995) and Klepper (1996).

<sup>11</sup> A typical shakeout involves the exit of 40-50% of the number of producers that existed at the highest point of stage III (Gort and Klepper, 1982).



dustries, we see that the two situations in which the established firms have advantages in their access to knowledge and are therefore in a position to impede the entry of new firms are as follows:

i) in certain activities in which technological change is very important, routinization occurs when innovations can only be achieved through big investments in physical and human assets (research and development departments, laboratories, etc.) and the gradual accumulation

of knowledge that these assets generate (the pharmaceutical industry is one example of this), and

ii) in many industries, after an initial period when there is a considerable increase in the number of producers and product versions, a phase is reached in which technology stabilizes around a dominant product design and a set of production methods and the firms which are already using those methods are in a better position to make gradual improvements and refinements in them.

### III

## Technology and industrial dynamics in the semi-industrialized countries

In this section, we transfer the theoretical analysis of the links between technological change and industrial dynamics to the particular conditions of the manufacturing sectors of developing countries, especially those of Latin America. In order to do this, we need to link up the findings of the literature on technological change in those countries with the main concepts on the links between technology and industrial dynamics, between the opportunity and sources of technological change, and between the accumulation of knowledge and the appropriability of the benefits of the technical progress generated by the firms. The studies on technological change in Latin America and other semi-industrialized countries (SICs) provide valuable information on these concepts, although they do not usually relate them with industrial dynamics phenomena such as the presence or absence of “innovative” advantages in new firms, or else in established ones.

At this point, we must briefly analyse a methodological question that cannot be ignored when dealing with the matters described in the following pages. The notion of changes in the (economic and institutional) environment on which the theoretical schemes and models conceived in the developed countries for identifying the patterns of microeconomic and industrial behaviour are based naturally reflects the particular experience of those economies. It is easy to imagine the potential difficulties that would arise if the concepts and theories developed for that environment were applied indiscriminately to the SICs, where most of the agents are often confronted with economical and political changes of a particularly intense and unpredictable nature. This is especially so because, in a competitive environment which has suf-

fered a succession of disturbances of this type in the past, the agents must adapt their individual behaviour by developing decision-making rules and strategies in keeping with this situation. In so doing, they develop special patterns of aggregate response (at the meso-economic and macroeconomic levels) which, like the rules for their individual behaviour, are different from those observed in countries with more stable economic and institutional environments. These matters have been under discussion for some years now in Latin American academic circles.<sup>12</sup> What we should note here is that the implications with respect to industrial dynamics that can be drawn from the literature on technological progress in the SICs are usually based on a supposedly stable economic and institutional environment.

Finally, before entering on the heart of the analysis, the following subsections: i) provide some details of the specific forms that technological change can take in the SICs and the reasons why they are of interest to this study; ii) analyse the main sources of knowledge on which technological progress in manufacturing is based in those countries, and iii) deal with the link between the institutional structure (in which there are dramatic contrasts between the SICs and the most highly developed economies) and industrial dynamics, through the role played by that structure in providing technical information from sources outside the established firms.

<sup>12</sup> See, for example, Fanelli and Frenkel (1996). Kosacoff and Ramos (1998) deal with these matters from the point of view of the industrial policy debate in the semi-industrialized countries.

## 1. Technological change in the semi-industrialized countries

The term “technology” refers to the activities involved in the processing of inputs into products or the technical information package containing a list and description of those activities. Thus, technological change must be understood as the introduction of changes in production activities or –which amounts to the same thing– in the set of technological information on which they are based. The knowledge base underlying this progress is fed through the formal or informal research activities carried out by the firm in question and the learning process stemming from its own production experience.

However, industrial enterprises in SICs generally only engage in certain types of innovative activities, which are basically the following:<sup>13</sup>

- i) introduction of products and processes which are new to the local economy;
- ii) adaptation of new products and processes to local conditions, and (possibly)
- iii) introduction of improvements in process performance and/or in the products manufactured.

This classification is based on the specific content of innovative activities. If they are regrouped according to their effects on industrial dynamics, this gives two major sets of activities of this type which give rise to different industrial evolution processes.

The first of these is linked with the inauguration of local production of a good. An agent or small group of agents imports a technology package (product and process engineering and industrial organization scheme) and adapts it to local conditions, thus initiating local supply and very likely displacing imported products to some extent. The nature and intensity of this first wave of entrants will depend on a wide range of factors related to demand (size of market, profitability, expected growth, trade and tax policy) and supply (number of firms operating in related activities for which the new line of business represents an attractive means of diversification or integration, existence of other sub-groups of agents possessing the necessary capabilities for engaging in the new activity, ease of access to the necessary factors and technical and financial resources, etc.).

The second one involves the introduction of changes in the production process or product characteristics in an existing market. An agent or group of agents introduces a technical novelty, generally developed by a firm

located abroad. In this case, the industrial dynamic takes place in one of the following alternative ways: the local agent making the innovation consists of one or more already existing firms which, among other objectives, seek to increase their profits and expand their share of the market, or the innovation represents the means by which one or more new local firms hope to take over a part of the market currently supplied by existing firms.

It is this second type of innovative episode which is of interest to us here. Consequently, the analysis must be aimed at determining if the established firms or the potential new entrants display systematic differences in terms of their access to the technological know-how needed to introduce the type of innovations made in SICs. This in turn makes it necessary to adjust the notion of innovative advantage on which the literature on the developed countries is based, in order for it to reflect the different nature of innovative activities in the SICs. It is suggested here that the capacity of firms in the latter countries to undertake this type of technical changes depends on the degree of progress they have made in two types of technological activities:

- i) those which are related with imitation (search, assessment, implementation and adaptation) and which determine the capacity of firms to assimilate technical progress generated by other agents, and
- ii) those associated with the achievement of incremental improvements of processes or products within a given type of technology.

The existence in SICs of systematic differences between new and established firms in terms of access to these types of capabilities is the central element in the following sub-sections. Studies on technological change in SICs usually concentrate on identifying episodes of such change in local plants, on its organizational (in-house) and institutional (links with external agents) sources, and on its impact on productivity and export performance. In contrast, the relationship between the form of accumulation of technical knowledge, innovation and the rotation of firms at the sectoral level has been given little attention.<sup>14</sup>

<sup>13</sup> See Fransman (1985), Katz (1976 and 1987) and Teitel (1987).

<sup>14</sup> This is probably due to the features which predominated in the competitive environment of SICs up to a few years ago. The relationship between innovation and industrial dynamics is only important in so far as the effectiveness in introducing new products or the level of technological excellence determine the patterns of profitability and/or survival among the population of firms. It seems clear that, in the present conditions of competition defined by the structural reforms resulting from the Washington Consensus, the capacity of innovation and imitation possessed by firms, as well as market structure and dynamics, have become more interdependent.

## 2. External sources of knowledge and the capacity for imitation

As already explained, industrial activities differ as regards the form of their processes of creation of new knowledge. The differences in technological opportunity and conditions of appropriability help to define what we described earlier as technological regimes and have also given rise to the well-known taxonomy developed by Pavitt (1984). According to this classification, the types of manufacturing activities that exist in SICs mostly fall into three categories: “supplier-dominated”, “scale-intensive” and “specialized suppliers”.<sup>15</sup> However, whereas in the advanced countries the firms in the last two groups are normally generators of innovations, in the relatively less developed countries they are typically imitators of imported technology. Thus, it is usually considered (Cooper, 1991) that, because of the way they incorporate technological change, most of the manufacturing enterprises in SICs actually fall into the category of “supplier-dominated” activities. The firms classified in this group are marked by their adoption of innovations incorporated in production equipment and/or the intermediate inputs they use. They are imitators of innovations made by other firms, so that the intensity of their “innovative-imitative” activities is associated with the rate at which they incorporate the most modern equipment and materials, generally developed in the most advanced countries.

It was argued earlier in this article that in the developed countries the industries where there are abundant sources of technological know-how outside the established firms offer greater opportunities for innovative entry. It should be noted that the literature on technological regimes and the industrial life cycle in the developed countries mostly presupposes that the new entrants have the capacity to generate and implement innovations, that is to say, to translate the available information into novelties with economic value. In the SICs, however, innovation consists mainly of imitation, and the capacity for such imitation cannot be taken for granted.<sup>16</sup>

This is so because the technological know-how incorporated from the outside is largely complementary to

that which the firms possess themselves, so that, as Nelson (1987) notes, imitation is not by any means a trivial technological activity. This complementarity takes two forms (Bell and Pavitt, 1993):

On the one hand, the acquisition of technology may be only the first step in a more extensive process of technological change which also includes the achievement of improvements in the performance of the new methods or products, and the efficacy with which these subsequent phases are carried out depends on the technological capabilities already accumulated by the firm (this aspect will be further developed in subsection 3 below).

On the other hand, the experience accumulated through the repeated execution of imitative activities gives the management and shop-floor staff a substantial advantage when it comes to selecting new acquisitions in the future and adapting them to local technical and economic conditions: the search for new products and processes requires that the firm should possess the necessary technological capabilities, so that in order for a firm to acquire additional know-how through such a search it needs a certain amount of prior knowledge (Fransman, 1985, p. 584).

The complementarity between external know-how and that which the firms have built up themselves is due to two main reasons.

The first is the need to adapt the technologies incorporated (Fransman, 1985; Katz, 1976 and 1987; Teitel, 1987). A firm in a less-developed country cannot invest in a technique used in a developed country without modifying it in one way or another: it cannot use that technique (begin to produce with it) without some kind of modification.<sup>17</sup> Indeed, the set of small adaptations made by an imitator located in an SIC can give rise to a new production function: once the various limitations and problems of the original technological designs from the developed country have been overcome through ‘minor’ local innovations, the new technology package will necessarily be different (and in many respects more ‘appropriate’) than that originally acquired abroad (Katz, 1987, pp. 46-47). This means that even if there is abundant technological know-how coming from sources outside the firms already established in an industry, this will not result in a situation where the new firms have a permanent stimulus to adopt the latest versions or try new permutations of such know-how in order to enter the market and compete with the established firms.

<sup>15</sup> For a more detailed explanation, see Pavitt (1984).

<sup>16</sup> The actual mode of access to technological know-how usually takes various forms. Although this aspect is not analysed in the present article, the different ways of access to knowledge are probably associated with different technical capability requirements on the part of the recipient and therefore also have different implications in terms of industrial dynamics.

<sup>17</sup> Nelson, quoted in Teitel, 1987, p. 113, footnote 10.

The second reason derives from the implicit and tacit nature of the technological know-how transferred. As the information received by the buyer is always less complete than that possessed by the seller, the capacity of the former to incorporate new principles and production practices will depend on his skill in deciphering the instructions and turning them into a set of effective and efficient routines and procedures. The more completely “embodied” the know-how is, however, the less vital this complementarity is likely to be. In many manufacturing sectors there are firms which have little technical experience but have access to the most modern equipment. However, their capacity to reach (or even surpass) pre-set levels of performance or to subsequently make incremental improvements (the second component in the capacity for imitation) will depend in part on the technological experience they have accumulated.

According to Fransman, “one important aspect of the ‘selection environment’ [the features of the environment that affect the selection of production technology in the SICs] is the knowledge possessed by the selector and the costs of alternative ways of obtaining knowledge. Furthermore, technological capabilities will play an important role in facilitating adequate choice of technology and in making the technique work in a satisfactory manner, once chosen” (Fransman, 1985, p. 583). In other words, “importing technology and generating technology domestically are usually not mutually exclusive alternatives” (Fransman, 1985, p. 615).<sup>18</sup>

Evenson and Westphal (1988) concur that the tacit nature of most technological know-how means that the effectiveness of technology transfers to firms in less developed nations depends on the technological capabilities of the recipients. These capabilities are also crucial for overcoming what those authors call the sensitivity of technology to circumstances,<sup>19</sup> that is to say, for carrying out the adjustments and adaptations needed for it to operate in circumstances different from those for which it was developed.<sup>20</sup>

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<sup>18</sup> Naturally, the degree of complementarity between the know-how acquired and that already possessed (the amount of in-house know-how needed to incorporate external know-how) will vary as a function of the characteristics of the technology (its complexity, the degree to which it contains implicit elements, etc.). It is also very likely that the degree of complementarity will be different for each of the two components of the capacity for imitation (incorporating technology developed by other agents or generating one’s own flow of minor innovations).

<sup>19</sup> I.e., its sensitivity to changes in the environment in which it is used.

<sup>20</sup> The relative weight of the two factors differs from one sector to another: in general, sensitivity to circumstances particularly affects

Most of the authors also emphasize that the capacity of the manufacturing firms of SICs to imitate technology successfully cannot be taken for granted.

According to Bell and Pavitt, the difference with the firms of developed countries lies in the fact that there “those adopting and using the technology transferred normally already possess (albeit to different degrees) the particular type of knowledge and skills needed to play a creative technological role. In the developing countries, however, these capabilities usually need to be built up in order to take full advantage of the dynamic advantages of the spread of technology” (Bell and Pavitt, 1993, p. 162).

Lall expresses similar views, stating that in SICs technological change is more “localized” than in the more advanced countries, because the SICs have a less complete knowledge of the range of technological options available. He adds that “firm-level differences in technical efficiency persist everywhere, but firms in developing countries generally display both wider dispersions and lower average levels of efficiency in given activities than firms in developed countries” (Lall, 1994, p. 2). Subsequently, the same author explains that, unlike the industrialized countries, in the less developed countries the capacity to handle the existing technologies cannot be taken for granted but, on the contrary, is in fact the goal of technological activity.

For Lall, the endogenous accumulation of know-how has a crucial impact on the capacity of firms to imitate technologies right from the start of the transfer process: “Part of the difference [between the markets for technology and for goods] resides in the inherent difficulty of valuing the product and in the unequal distribution of knowledge between buyer and seller. In developing countries, this is exacerbated by the inadequacy of buyer skills and knowledge in both buying and implementing technologies” (Lall, 1994, p. 14).

In short, the capacity for imitation is associated with the past accumulation of know-how within the firms. This means that in order to be able to take advantage of the technical information available in the world at large it is necessary first of all to build certain technical capabilities. Thus, firms with experience in a particular production activity will be at an advantage for successfully incorporating exogenously generated technical progress

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transfers of technology in agriculture, whereas the tacit nature of know-how is relatively more important in flows of industrial know-how. “Nevertheless, more often than not, in order to reach adequate levels of productivity industrial processes must be adjusted to suit the particular circumstances in which they are to be used” (Evenson and Westphal, 1988, p. 2248).

and adapting it to local technical and economic conditions.

It must be clearly understood that while the innovative advantage which favours the established firms does not rule out the establishment of other new firms with relatively more advanced technologies, the first-named firms will systematically be in a better relative position to carry through the incorporation of technical progress. Innovative entry could adversely affect established firms financially, because of the sudden obsolescence of assets which must now be renewed but are not yet amortized, but –and this is the most important argument– it is much less likely that they will be at a technical disadvantage compared with new entrants in terms of identifying, evaluating, acquiring, assimilating and adapting the new techniques.<sup>21</sup>

### 3. Incremental improvements in products and processes

It has been said that innovative advantage is based on the capacity for the effective imitation of technology and on the skills needed to generate incremental technical improvements which will secure increases in productivity and/or modifications in the products. In the previous sub-section we showed that in order to take advantage of the technical information available in the environment (capacity for imitation) it is necessary first of all for the firms to have built up certain technical capabilities of their own. We will now analyse the origin of the knowledge needed in order to gain access to this second form of innovation.

It is important to bear in mind that, generally speaking, when a new product begins to be manufactured or a new production technique is used for the first time in an SIC the new technology has already ceased to undergo substantial modifications in the markets where it was originally developed and has entered on a mature stage in which any improvements and refinements are only marginal. Whatever the technological characteristics of the sector, however, these minor technological changes are precisely those that firms with production experience in the activity in question are most likely to introduce, and that new firms will find it most difficult to imitate (Agarwal and Gort, 1996; Gort and Klepper,

1982). In this sense, the literature on technological change in Latin America seems to suggest that incremental improvements are the result of the accumulation of know-how and endogenous efforts by established firms and that they are not therefore usually used by new firms in order to break into an activity.

As far back as the late 1960s and early 1970s, in a study on manufacturing in Argentina, Katz (1976) showed the importance of enterprise-level technological efforts in the SICs as sources of productivity gains. Firms had to build up their own technological capacity in order to make proper use of imported technology, and that capacity was responsible for a significant proportion of the efficiency gains obtained. Such gains were also aided by the increase in production (through the Verdoorn effect and/or spontaneous learning processes like “learning by doing”) and were therefore also associated with the production history of the firms.

Katz admitted that in practice the firms studied did not generate “new and better” innovations, but many of them allocated resources to the provision of a certain amount of “minor but independently generated” innovations, not only in order to adapt but also to marginally improve production processes or product designs obtained from imports. While not overlooking the fact that the dynamism of innovation slackened in the course of the commercial history of the products concerned, Katz emphasized that the manufacture of mature products in SICs was associated with the introduction of improvements which were in turn the result of the learning process that took place in the firms involved.

A very extensive set of studies<sup>22</sup> on technological change in Latin American manufacturing plants comes to the same conclusion: endogenous technical efforts generate a flow of minor technical improvements which account for most of the increases in productivity.

According to Katz (ed.), 1987, after they have begun to operate firms pass through a sequence of technical learning processes. First of all they develop product-related innovative capabilities. Skills in the fields of process engineering and industrial organization (planning and control of the production process, etc.) begin to build up very slowly, in an informal manner, and only make a substantial leap forward a good deal later, generally as a result of some sudden important development

<sup>21</sup> However, the investment required in order to enter the market usually contains a proportion of sunk costs, and if these exceed the expected post-entry benefits the possibility of competing would be ruled out (Stiglitz, 1987). The need for this clarification became evident thanks to the observations of an anonymous referee.

<sup>22</sup> These studies form part of a very broad IDB/ECLAC/UNDP programme carried out in the early 1980s. A large part of the case studies are contained in Katz (ed.), 1987. The studies dealt in general with medium-sized and large industrial firms.

(such as the entry into the market of a serious competitor). Through these types of learning processes, together with their practical production experience, firms eventually acquire the capacity to generate a flow of minor innovations.

The set of studies in question also showed that most of the firms studied started off with technologies of low complexity and capital intensity and subsequently progressed, on the basis of the gradual accumulation of technical skills, to more complex and automated forms of production.

Similar views are expressed by Evenson and Westphal, who consider that technology always needs time to begin to operate at its highest level of productivity. The crucial point is that accumulated experience is a fundamental factor of differentiation: "the initial level of productivity, as well as the time and resources required to achieve the potential productivity, depend on the starting level of mastery" (Evenson and Westphal, 1988, p. 2262).

Taken together, the studies referred to above suggest that there is a process whereby the rate and quality of technical learning determine the overall present and potential technological possibilities of the plant, its products and its services. They also suggest that, in the total universe of established firms in a given activity, the solidity of their innovative advantages is positively associated with their age. In short, the established firms with experience in the activity in question not only enjoy advantages in terms of the incorporation and adaptation of new technology (imitative capacity) but are also in a better position than potential new entrants both to put variations of the standard product on the market and to operate with production methods more appropriate to local conditions or more efficient than those that agents outside the industry can import.

In some sectors (especially in the production of capital goods) there are other important sources of technological information. This is basically information stemming from inter-firm relations (Fransman, 1985): relations between the user and the producer of the equipment (a very important relation because, as already noted, in order for the SICs to use technologies developed in other countries they must adapt them to local conditions) and between the producer of the equipment and the supplier of parts and components. It seems clear that here too, in terms of access to these sources of technical information, established firms are bound to be in a better position than firms in related sectors or other potential entrants.

Nevertheless, a couple of additional elements must be borne in mind. These concern the less and less auto-

matic nature of "learning" through "doing". The two processes of change implicit in this formula (production experience which turns into know-how and know-how which evolves into technical change) are subject to the specific actions of the firms (Fransman, 1985, p. 595). Consequently, production experience *per se* can only be considered as a necessary but less and less sufficient condition for guaranteeing a flow of minor innovations which will have appreciable effects on productivity and on product qualities and performance.<sup>23</sup>

Cooper (1991) and Bell and Pavitt (1993) concur in finding that a characteristic feature of the present conditions of generation of new technical know-how in the developed countries is the growing gap between the type of information required by firms for using a technology and that required in order to modify it. It is increasingly difficult to build up innovative capacity without taking measures, and above all making investments, explicitly aimed at that purpose.<sup>24</sup> Thus, the skills and experience needed to generate and manage technical change are increasingly connected with the activities of specialized research and development laboratories, design offices, project management teams and production engineering departments. In the terminology used in the literature on industrial dynamics, this may be described as a tendency towards the "routinization" of technological change.

Increasingly, production experience *per se* can only serve to expand the capacity for innovation and/or imitation if it is backed up by measures and expenditure deliberately aimed at learning, thus adding another dimension to the analysis of innovation/imitation advantages in industrial dynamics. Thus, while it has already

<sup>23</sup> Whereas investment in operational know-how is a necessary condition for entry (and also, in certain conditions, for survival), investment for the development of technological capabilities is discretionary. According to Bell and Pavitt (1993), as the return on such capabilities is uncertain or very difficult to evaluate, firms will tend to under-invest in them. Cooper (1991) finds that in SICs the learning process is very often a failure: firms content themselves with simply attaining the conditions needed for applying the technology and do not bother to familiarize themselves with its basic principles; the resources allocated to the assimilation of knowledge are insufficient, and this explains why the learning process fails more frequently than in the developed countries. Thus, the trade-off between the degree of advance of the technology acquired, its ease of assimilation and the amount of new local knowledge it can generate is solved by seeking the lowest level of risks: the technological objectives are modest and therefore relatively easy to attain, but the technical progress and productivity gains are only small.

<sup>24</sup> One of the reasons for this is the growing difficulty in carrying out reverse engineering of parts, sub-assemblies and components (this note was included in response to the observations of an outside referee).

been noted that there is a difference in terms of imitative capacity between firms of different ages (potential entrants and newly-formed firms as compared with experienced established firms), what is suggested now is that (in conditions of imperfect capital markets) there is an increasingly marked difference between firms of different economic size, because of the growing need to “formalize” the process of searching for new technology.

Thus, in short the capacity for imitation/innovation is linked with production experience and the deliberate learning efforts made by firms in the course of their production history, so that innovative entry is relatively difficult.

#### 4. Institutions and learning

The recent literature on innovation in the developed countries highlights the importance of the depth and quality of the institutional infrastructure<sup>25</sup> linked more or less directly with industrial learning processes. From the point of view of industrial dynamics, institutions play two types of roles.

Firstly, in line with the concepts of the life cycle of industries and technological regimes, institutions can help –as the depositaries of relevant technological information– to offset to some extent the technological and innovative disadvantages of firms which are new entrants or have as yet little experience in the activity in question. The effectiveness with which the institutional infrastructure fulfills this function will depend on its capacity to limit the private appropriability of the knowledge generated by existing firms, thus facilitating

the spread of technology to new firms and those with less production experience.

Secondly, in the context of the current debate on industrial and technological policy, institutions are acknowledged to have a leading role as facilitators of learning processes. In the developed countries, universities, public research laboratories and similar bodies complement the search for new knowledge being made by industrial firms. This relationship is complementary because of the nature of the interchange involved. Research bodies do not usually generate complete innovations that firms can appraise and possibly adopt, but rather provide some elements that firms can combine with the results of their own technological search processes. The example of Taiwan’s technology policy cited by Bell and Pavitt (in Taiwan the public institutions “socialize” the learning process by acquiring foreign technology, making the initial assimilation effort, and then providing training services for disseminating it to private firms) clearly illustrates the kind of externalities that the institutional infrastructure can generate.

The precarious nature of the system of institutions connected with technological learning in Latin America has often been noted: the absence or weakness of such institutions can cause irreparable harm in this field. Although the allocation of specific resources is a necessary condition for proper learning processes in firms, the absence of suitable external institutional conditions can also inhibit the appearance of such processes (Cooper, 1991, p. 15).

Weakness of the institutional system appears to have implications in connection with the first of the aspects mentioned, in so far as the absence of an abundant flow of technological information from sources outside the established firms gives the latter an advantage in terms of innovation over firms that have little production experience.

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<sup>25</sup> The term “institution” is used here with reference to the depth and quality of the system of intermediate organizations rather than the existence, efficacy and efficiency of rules and standards.

## IV

### Final remarks: imitation and industrial dynamics

This section sums up the central thesis on the construction of innovative/imitative advantages in SICs and then goes on to comment on the implications of this for industrial dynamics.

#### 1. Possibility of innovative entry

Generally speaking, by the time process and product technologies are imitated for the first time by firms in SICs they are already in a phase of incremental improvements. These are precisely the kind of innovations that usually originate in firms that are already well established in the market and are difficult for new or less established firms to imitate.

This first approximation to industrial dynamics in SICs can be supplemented through the theories set forth in section II. In order to do this, however, it is necessary to reformulate the concept of innovative advantages on which the concepts of technological regimes and life cycles of industries are based in order to take account of the nature of the innovative activity typical of SICs. Here, a notion of innovative advantages has been suggested which is based on two fundamental capacities: the capacity to imitate (mainly through acquiring and incorporating new technologies) and the capacity to generate a flow of minor product and process innovations.

The literature on the characteristics of technological change in the SICs which we have consulted seems to suggest that:

i) the capacity for imitation is associated with the past accumulation of knowledge within firms, and in order to be able to take advantage of the technical information available in the environment it is necessary first to have built up certain technical skills: thus, firms with experience in a given production activity will be at an advantage for successfully incorporating exogenously generated technical progress and adapting it to local technical and economic conditions;

ii) established firms are also in a better position than potential new entrants to place variations of the standard product on the market or operate with production methods which are better adapted to local conditions or more efficient than those that other agents could import, and

iii) furthermore, the relative weakness of the institutional infrastructure for giving support to the learning

process of firms accentuates the leading position of the established firms as regards access to technological information: in other words, it reduces the availability of “socially appropriable” technical know-how.

In short, in manufacturing activities where technical change is an important factor in competitiveness, the entry of new firms will tend to play a smaller role as a vehicle for the technological modernization process.

Naturally, for firms which are already established in an activity the actual content of their innovative advantages will depend, among other things, on the specific and general conditions of competition in the activity in question (in other cases, competitiveness may depend on the launching of new products) and the stage the product or technology is at within its life cycle. It may be conjectured that when the international technological frontier is moving forward quickly, innovative advantage will reside rather in the capacity for imitation, whereas in the opposite case it will depend on the capacity for the endogenous generation of a flow of minor innovations and improvements in the product and/or process.

Some of the remarks made by Katz on market structures in the SICs may be interpreted as examples of the main thesis set forth here. Looking at the situation from a historical standpoint, Katz noted that the market structures of those countries had tended to converge towards oligopolistic forms, not only in activities which had begun in monopoly conditions but also in those which had originally been developed by a substantial number of small producers. In the first of these cases, after the activity in question had been set up there had only been a very low level of entry of reasonably large firms. In the second case, what happened was rather more complex “We have noted that either a financial and/or a technological advantage permitted one of the firms eventually to outgrow its competitors, raising its market share and finally becoming a market leader” (Katz (ed.), 1987, especially p. 41).

The reformulation of the concept of innovative advantage proposed here appears to offer a suitable setting for understanding this process better.

Finally, it should be clearly understood that the thesis put forward here does not mean denying *a priori* the existence of inter-sectoral differences in SICs as regards



ease of entry in general. Firstly, because the entry of new firms represents the culmination of investment projects which must contain not only a given amount of technical and economic knowledge (whether novel or not) but also various additional elements, and the differences between sectors as regards the ease with which potential entrants can gain access to those elements, together with other structural features which differ from one industrial branch to another, open up the way for the study of a variety of dynamic regimes. Secondly, because the fact that the innovation that takes place in SICs is generally associated with a high degree of accumulativity of technological know-how (which generates unfavourable conditions for innovative entry) does not prevent the production activities from nevertheless having different underlying learning conditions and, hence, also differing in other aspects of their economic selection mechanisms.<sup>26</sup>

## 2. Effects of the entry of new firms on industrial dynamics

The most marked effect in this respect will depend on the role played by the appearance of new local firms within the broader evolution of the population of industrial enterprises in the SICs. If innovative entry is structurally impeded by the knowledge conditions underlying the type of innovations that take place in the SICs, then their role will tend to be linked with the relation between installed capacity and present and expected demand. In this case, the main contribution of local new entrants will be to add production capacity, since their technological packages will tend to be the same as those used by the established firms. With time, the arrival of new competitors may force the latter to speed up their technological modernization process, but it seems unlikely that the new entrants will be able to set off an episode of “creative destruction” which will force out all or part of the established firms. The two scenarios are radically different in terms of the profitability expectations of the potential new entrants. Thus, the “neo-classical case” (entry as a factor tending to bring the supply conditions into balance) would appear to prevail rather than the “Schumpeterian case” (entry as a vehicle for innovation).

This also means that the industrial dynamics will tend to be governed by the evolution of the quantitative

<sup>26</sup> For an exposition on the diversity of learning channels and their connection with different incremental technical change paths in United States industry, see Malerba (1992).

imbalances in the supply conditions, rather than by the introduction of innovations (with respect to the local economic environment) which would set off adjustment processes in the composition of the population of existing enterprises. Quite apart from the decisive weight acquired in it by the strategies of the leading firms in each sector, this pattern would appear to be particularly sensitive to macroeconomic fluctuations and to the particular way that each manufacturing activity links up with the different components of aggregate demand.

Some descriptions of the evolution of manufacturing enterprises in SICs after their initial establishment give at least a hint of what might be considered as the paradigmatic post-entry performance path, as do the passive and active learning models for developed countries.<sup>27</sup> Although it is necessary to bear very much in mind the differences between the present context and that which prevailed when he was making his study, Katz (ed., 1987) finds that from the moment of their establishment firms make gradual progress in terms of the type of technological capabilities they develop<sup>28</sup> and slowly deepen their technological commitment in terms of the degree of automation and continuity of the production process and technical complexity in general. He also finds that, after the entry of pioneering firms using relatively simple techniques, with little automation, with time “most of them, as well as newly arriving competitors in the same industries, opt for more capital-intensive technologies” (Katz, 1987, p. 30). In an industrial dynamics context like that described here, this passage suggests that the rate of technological change is dictated by the rate of the learning process of the firms which are already in the business rather than by the entry of new and innovative firms.

The better conditions of access to new equipment and foreign technology offered by the present macroeconomic and regulatory setting –after the structural reforms in Latin America in the 1980s and 1990s– have expanded the technological opportunities for established firms (rather than for potential new entrants), especially for those which are most active in their search for new technology.

It is also interesting to reflect on the ways in which the generic pattern of industrial dynamics described here

<sup>27</sup> The passive learning model most frequently cited is that of Jovanovic (1982). Extensions of that theory may be found in Frank (1988) and Hopenhayn (1992). Active learning models are presented in Ericson and Pakes (1995) and Pakes and Ericson (1998).

<sup>28</sup> In the 1980s the situation described by Katz was that first of all firms progress in the field of product technology and subsequently in the areas of process technology and organization of production.

inhibits or promotes the different forms of entrepreneurship.

Various different forms of entry into the market by new local manufacturing firms in the SICs may be envisaged.<sup>29</sup> One of them is pioneering entry, when a firm begins local production of a product which is new for the domestic market. Another is entry into an existing production activity, which may take two different forms, depending on whether or not the new enterprises bring substantially new technologies with which to challenge the market shares of the established firms.

It is precisely the form of entry which innovates on the technical, commercial and organizational practices of the established firms which is most inhibited by the better access of the latter to knowledge which would be

useful for purposes of innovation. In other words, the characteristics of the process of innovation in the SICs appear to militate against the type of entry which would mean a competitive challenge (based on innovations) to the position of the existing firms.

Finally, there is a clear need to extend the analysis to another form of entrepreneurship which is consistent with the theories set forth here. This is the creation of innovative enterprises on the basis of staff who have left other organizations (generally large ones) already operating in a given line of business. This form of creation of new enterprises is an aspect of what has been called *intrapreneurship* (Wennekers and Thurik, 1999).

(Original: Spanish)

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<sup>29</sup> As already noted, there are few cases where firms from SICs generate new products or processes that are also innovative with respect to the more advanced economies.

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