

Innovation activities by manufacturing firms in a more open developing economy: the case of Argentina in the 1990s

Prepared for the Nelson and Winter Conference, Aalsborg, Denmark, 12-15 June 2001

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Abstract

Relying on detailed information on endogenous innovation activities and imported technology inputs at enterprise level, it is shown that more than half of the large firms (and especially foreign owned) made innovation expenditures as part of the reaction to the new competitive conditions. Although 27 per cent of the SMEs registered innovation efforts, the intensity of these efforts was higher than in large firms. At the same time, innovative firms had a better performance than non innovative ones and than those firms that had only relied on imported intangible inputs. It is surprising to find that most innovative firms were self reliant, though a sizeable number of firms combined imported and domestic inputs in their innovative activities. While these findings are in line with an evolutionary framework what is at odds with such an approach is the fact that Argentine firms relied very little on other domestic agents and institutions for their innovation activities.

1. Introduction

The opening of the trade and capital accounts, the privatization of public enterprises and the promotion of foreign direct investment (FDI) have been the main policy recommendations for securing the technological modernization of enterprises in the new economic model prevailing in Latin America in the 1990s.

According to its proponents, whereas in the new policy environment inefficient producers would go bust, potentially efficient firms would have a window of opportunity to improve their competitiveness. The possibility of obtaining modern technologies embodied in machinery and equipment, intermediate inputs at international prices and intangible assets via licensing agreements or through FDI would facilitate a quick catching up process by manufacturing firms to the best international practices (Chudnovsky, 1999).

In so far as technology is approached as an exogenous factor for manufacturing enterprises, the heavy reliance on imported inputs is in fact assumed as a substitute for endogenous innovative efforts. As these efforts are not considered relevant for firms in developing countries, specific policies to foster endogenous innovation activities are not envisaged by the proponents of the new economic model.

The reaction of the enterprises to changed market conditions is analyzed in a different way when an evolutionary approach is followed.

Firms' decisions are seen in part as a legacy from the past and the circumstances prevailing at that time. When these circumstances change, new decisions will be based on a search process marked by uncertainty and will depend on the specific environment in which the relevant firm is operating (Nelson & Winter, 1982).

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Changes in market conditions in developing countries undertaking significant stabilization and structural reforms programs in a short period of time are quite different from those changes occurring in industrialized countries. Until a new set of relative prices prevails in the economy and growth is considered sustainable, the transition period is very uncertain and generally not conducive for long term decisions (see Katz 2000b, for a discussion of the adjustment process). Hence the macro economic uncertainty reinforces the microeconomic one during the transition period.

At the same time, the technological capabilities accumulated before the changes in the market conditions are not the same in all firms. Neither are similar the access to the new capabilities required to meet the challenge. Size, nationality and age are basic factors that may account for differential reactions to the new conditions. In a context of great uncertainty these microeconomic factors may be more significant than sectoral ones as rightly suggested by Yoguel & Boscherini (2000).

In contrast to the mainstream view, endogenous technological efforts should be required in the catching up process. They are often complemented with imported inputs through technology transfer (such as licenses for innovations made elsewhere) to be able to keep up with technical advances abroad. Hence, imports are not considered a substitute but a complement to the endogenous efforts. Furthermore, intramural efforts should be far more effective if firms interact not only with foreign licensors but also with other firms and local technological institutions in their innovation activities.

In an evolutionary approach, the possibility of not relying on imports but only on own intramural efforts (i.e. a self reliant approach) is not ruled out in some circumstances but its limitations for long term growth of the firm are fairly obvious, especially if firms tend to innovate in isolation in their local environment.

While acknowledging the crucial role of competition as an innovation inducement, the growing uncertainties and the widespread presence of market, information and coordination failures in the innovation processes would provide, in an evolutionary approach, strong arguments for active policies in this field to remedy for those failures.

To be able to challenge the mainstream view and to give more substance to the evolutionary approach, it is important to complement the theoretical work with empirical studies. These studies may provide not only a better understanding of the current situation than that offered by mainstream economists. They should also provide a more accurate picture of the pro and cons of the new reality to be able to suggest and implement effective innovation policy measures.

While several recent empirical studies have started to shed some light on the micro responses to the new model in Latin America (Reinhart & Peres, 2000; Katz, 2000a) it is important to complement them by analyzing the consequences of the new model for innovation activities at enterprise level and by shedding light on the different combination of imported and endogenous efforts in these activities.

The present paper is focused on Argentina, a country that followed the main policy recommendations of the proponents of new model in the 1990s and reached some success in terms of price stability and growth after a poor economic performance in previous decades.

Relying on detailed information on endogenous innovation activities and imported technology inputs at enterprise level, the main purpose of this paper is to shed light on the following issues:

- i) How generalized and significant have endogenous innovation efforts been in the responses of the firms to the changed market conditions brought by the new economic model?
- ii) Has the intensity of innovation differed according to the age, size, nationality and sector of operation of the firms?
- iii) To what extent have imported inputs complemented or replaced endogenous innovation efforts? How significant have self reliant innovation efforts been?
- iv) Did it pay to be innovative in the new environment? Did innovative firms performed better than those relying only on technology transfer? Within innovative firms did it pay more to rely both on imported and local inputs than to be self reliant?

Some answers to these questions are presented in the core section of the paper by processing data from a detailed survey to manufacturing firms. By classifying innovative enterprises into two main types (i.e. self reliant and innovative with technology transfer) the paper sheds new light on the phenomenon under study and goes far beyond previous research efforts done on the basis of the same data (INDEC, 1998; Bisang & Lugones, forthcoming; Yoguel & Rabetino, forthcoming).

Before doing so some basic information on the Argentine economic changes and situation in the 1990s is presented in the next section. The conclusions, policy implications and issues for further research will constitute the final section of the paper.

2. The Argentine economic changes in the 1990s

The endemic inflationary problems of the Argentine economy were dealt with a currency board scheme which pegged the Argentine peso to the US dollar (the so called Convertibility Plan) in April 1991.

At the same time, structural reforms were carried out in a quick and generalized way completely opening the trade and capital accounts, liberalizing the financial system and privatizing most State owned firms.

Regional economic integration with Brazil, Uruguay and Paraguay gained momentum with the creation of the Mercosur in 1991 and its consolidation into an imperfect custom union in 1995.

Whereas price inflation is practically non existent since 1994, the economy grew at an annual rate of 5 per cent in 1991-99, a much better performance than in the 1980s and 1970s. However, the growth record was uneven: from 8.7 per cent in 1991-94 to only 2.1 per cent in 1995-99 (the economy is in recession since the end of 1998). It was also very unequal. Income distribution deteriorated and unemployment reached record levels in 1995-96 (18 per cent) to be slowly reduced to 14.3 per cent in 1999.

Without inflation and with the resumption of growth, the new economic environment until the current recession was certainly much better than that prevailing in the 1980s and even before. None the less, it is far from being a sustainable economic environment conducive for long term decisions by enterprises. Hence it is not surprising that defensive strategies

have been the most frequent response among firms in the Argentine economy of the 1990s (Kosacoff, 2000).

In their search for higher productivity², many firms increased capacity utilization and often incorporated (mostly imported) machinery and equipment. But at the same time, they reduced their personnel and the local content of their products, weakening the domestic value chain and reducing the demand for labor. The local production of machinery declined.

Imports increased in a significant manner since 1991 while exports started to augment in 1994 to reach record levels in 1997-98. At the same time, the Mercosur became a very significant destination of Argentine exports absorbing one third of total exports and more than half of manufacturing exports.

As result of the growth in trade flows, Argentina is a more open economy than in the past but with a relatively high deficit in merchandise trade. The import coefficient increased from 3.9 in 1986-90 to 12.4 per cent of the GDP in 1996-99. Exports as percent of GDP augmented from 6.9 to 10.4 in the same period.

Furthermore, imports are far more elastic to income than exports³ and import penetration was particularly high in manufactures in the 1990s. The growth in imports was favored by the reduction in tariffs⁴, elimination of most non tariff restrictions (except in automobiles) and the overvaluation of the Argentine peso.

Inflows of foreign capital played a key role in the financing of the Argentine economic growth and of the current account deficit but led to a significant growth of the external debt. FDI played also a key role in the restructuring of the economy.

The privatization of public enterprises in energy and telecommunications attracted most FDI inflows in 1990-93. Later on take overs of local private firms gained momentum and accounted for more than half of FDI in 1997-99.

FDI into manufacturing industry increased its share in total flows from 21 per cent in 1992-93 to 42 per cent in 1994-96 to be reduced to 26 per cent in 1997-98, when banking became the main sector of destination.

² The labor productivity gap between Argentina and the world leader, the United States, was reduced in industry as productivity rose from 41-42% of the US levels between 1970 and 1980, to 55% in 1990, and 67% in 1996 (Katz, 2000b).

³ It is important to bear in mind that Argentine exports are dominated by agricultural commodities. However, the share of manufactures of industrial origin in total exports increased from 24 to 32 per cent between 1992 and 1997. This is mostly due to the growing importance of exports of automobiles and autoparts. In contrast, exports by specialized suppliers and by branches intensive in R & D hardly increased their share and accounted for only 4.3 and 3.3 per cent of Argentine total exports in 1997, respectively.

⁴In the case of imported capital goods, tariff protection reached zero in the period 1993-95, an unusual policy measure to favor imports in a country with local production of such goods. The negotiation of the Mercosur common external tariff gradually raised it: to 10 per cent in March 1995 and to 14 per cent in August 1996.

As result of the FDI boom⁵, foreign firms sharply increased their participation and economic importance in the Argentine economy. The share of foreign controlled firms in the sales of the 1000 largest firms increased from 34 per cent in 1990 to 59 per cent in 1998. In the same period the number of foreign firms among the 1000 largest enterprises augmented from 199 to 472 (Chudnovsky & López, 2001). This is very high participation, only lower than that registered in Singapore and Brazil (75 and 60 per cent, respectively).

The growth in internal demand has been the main locational advantage to induce recent FDI in Argentina both in non tradables and in tradables. However, in contrast to what happened in the import substitution industrialization (ISI), most recent investments have been not only internal market seeking but also efficiency seeking. In comparison with national firms, foreign firms are able to get financial resources at much lower cost. They have a quicker access to product, processes and organizational innovations. None the less, they often need to allocate human and financial resources to adapt and modify the received process and product innovations to the local environment.

The transition to a more open and competitive economic environment has meant a greater challenge for domestic enterprises. Whereas many indigenous entrepreneurs have not been able to upgrade the technological and management capabilities accumulated during the ISI process and either went bust or sold their businesses to foreigners, a significant number of domestic enterprises have been able to meet that challenge through processes of restructuring and modernization in which innovation activities have played a role. This is the issue to be examined in the next section.

3. Innovation activities by manufacturing enterprises

The growing reliance on foreign technological inputs has been a key feature of the new economic model⁶. Besides the significant increase in imports of machinery and equipment and FDI inflows, payments for technology transfer also augmented⁷. At the same time, the proportion of non residents in total patents requests⁸ increased from 67 per cent in 1990 to 82 per cent in 1998

Local resources for Science and Technology have also increased in the 1990s, though the gap with other countries is still very significant.

Science and technology expenditures as percentage of GDP have increased from 0.33 in 1990 to 0.51 in 1998 in Argentina. If only R&D expenditures are considered the situation is less encouraging. As shown in Table 1 Argentina and Mexico are among the countries devoting relatively less financial resources to R&D. They are clearly surpassed not only by the industrialized countries and Korea but also by Brazil and Chile.

⁵ FDI inflows increased from 1.6 to 4.6 per cent of the GDP between 1992-94 and 1997-99 (Chudnovsky & López, 2001).

⁶ In fact, the reliance on foreign technological inputs has been a feature of the whole Argentine development process

⁷ From u\$s 551 million in 1992 to u\$s 873 million in 1998. Imports of capital goods increased from u\$s 1.4 billion in 1991 to reach u\$s 8.3 billion in 1998, accounting for 27 per cent of total imports.

⁸ A new patent law was passed in 1995 and came into effect in 2000. The new legislation on patents which lengthened the protection period for inventors from 15 to 17 years, eliminated the compulsory domestic production of patented products and introduced patents for pharmaceutical products.

Expenditures by the business sector as a share of total expenditures in R&D have increased from 20 to 29 between 1990 and 1998, but in proportion to the GDP they are still very low: 0.12 per cent. This is a very low ratio, though higher than in Chile and Mexico (table 1).

As mentioned in the introduction, to shed light on the innovation expenditures at enterprise level under the new model in Argentina a survey with data for 1992 and 1996 is available⁹. In both years the level of economic activity was quite high and in 1996 the effects of the implementation of the structural reforms were well visible.

The sales of the surveyed firms augmented 38 per cent 1992 and 1996. Total employment was reduced by 7 per cent and sales per employee increased 45 per cent. Hence, the economic performance of these firms was on the whole quite good, although at the expense of employment. However, large firms and especially foreign owned ones have done much better than the SMEs¹⁰ (see below table 4.)

It is important to take into account that the majority (60 per cent) of the surveyed enterprises were founded before 1970¹¹. Only 3 per cent were created in the 1990s, though this percentage is underestimated¹².

Near half of the enterprises (44 per cent) founded before 1970 changed ownership. These changes mostly occurred in the 1990s¹³ and generally involved the acquisition of indigenous firms by TNCs contributing to the mentioned denationalization process of the Argentine economy.

In consequence, these are firms mostly born during the ISI process. The accumulation of technological and organizational capabilities allowed them to survive in the difficult 1970s and 1980s and to do rather well in the demanding 1990s.

This is clearly against the orthodox view that firms that flourished under the ISI were largely inefficient and would disappear in the new economic model. None the less, to keep them going, the capabilities accumulated in the past have also required in a substantial number of firms not only a new management and changes in ownership but also growing innovation efforts.

In this connection, it is encouraging to find that between 1992 and 1996 overall innovation outlays¹⁴ increased in a significant way: 48 per cent, a bit more than R&D expenditures

⁹ The survey was done to 1639 firms representing 54 per cent of sales, 50 per cent of employment and 61 per cent of exports of the manufacturing sector in 1996. Comparable and consistent data for 1992 and 1996 was available for 1475 firms that were used for the statistical tests.

¹⁰ SMEs were defined as those with annual sales up to \$ 20 million or 200 employees.

¹¹ SMEs are younger than large firms: 47 per cent of SMEs (as against 28 per cent of large firms) were founded after 1970.

¹² It is known that a number of new manufacturing firms (e.g. in the automobile sector) were not incorporated in the survey by the Statistical Office. Furthermore, services is the economic activity where presumably more firms have been created.

¹³ Changes in ownership in the 1990s (43 per cent of all changes) were more frequent than in the 1980s (26 per cent) and in the 1970s (15 per cent).

¹⁴ These expenditures include R&D plus technical assistance to production, project engineering, technological management of production and sales of new products. Informal innovation activities are thus not captured by this indicator.

(45 per cent). In contrast to the overall reduction in employment, personnel in R&D activities augmented 14 per cent and reached 4684 employees in 1996.

As expected, overall payments on licenses and technology transfer from abroad¹⁵ and imports of capital goods required for new products or processes augmented far more (79 and 105 per cent, respectively) than local expenditures for innovation efforts between 1992 and 1996.

In this way, a higher reliance on imported technology inputs is clearly visible among surveyed firms as a whole. This does not necessarily mean that innovation efforts were replaced by imported inputs or that self reliance was an infrequent response among innovative firms (see below).

How generalized and significant were innovation activities?

As shown in table 2, 35 per cent of the firms had formal innovation expenditures¹⁶.

It is also important to mention that 42 per cent of the firms founded before 1970 registered innovation expenditures in 1992-96 clearly indicating that this is an activity more frequent in older than in younger firms¹⁷.

Innovation efforts were more extended among large and foreign firms. More than half of the large enterprises and only 27 per cent of the SMEs carried out innovation activities, suggesting that size was clearly an advantage for undertaking these efforts. Large firms have access to cheaper resources to finance their innovation activities and to hire skilled personnel.

The lack of adequate financing was the main obstacle mentioned by the surveyed firms to increase their innovation efforts. This is an area that called for government action and some measures started to be implemented later on.

This positive association between size and innovation (reported as well in Yoguel & Boscherini, 2000) does not necessarily mean that the intensity of innovation in SMEs was lower than in large firms (see below).

The proportion of foreign firms with innovation activities was higher than in the case of domestic firms. This is against the generalized view that foreign affiliates are only passive recipients of innovations made in their parent companies and refrain from undertaking any innovative activity in the host country.

While the intensity of innovation decreased a bit in large firms in the period under analysis, it augmented in a significant way in the case of SMEs (table 3). However, it cannot be overlooked the fact that, on average, the intensity of innovation was still quite low: 0.61 (and 0.39 for R&D).

¹⁵ They include payments to foreign sources for product and process technologies, technical assistance, patents and trademarks.

¹⁶ A quarter of all firms had R&D activities. This proportion was higher in large firms than in SMEs and in foreign owned than in domestic enterprises.

¹⁷ Unfortunately it is unknown when these old firms started to carry out innovation activities in a systematic way.

What is surprising to learn from table 3 is that the intensity of innovation was higher in SMEs than in large firms (especially in national firms) and that the differences between both types of firms increased over time. This is mostly a reflection of the relatively high intensity of innovation in the Argentine context of those few SMEs devoting resources in this field. It suggests an interesting innovative potential in this segment of the business population.

Among large firms, the intensity of innovation was a bit higher in foreign owned than in national firms in 1996 while the opposite was found in 1992 (table 3). As already mentioned the proportion of foreign firms with innovation activities was much higher than among domestic firms (table 2).

The picture is quite different among SMEs (table 3). The intensity of innovation is higher in national than in foreign firms, despite the fact that the proportion of foreign SMEs with innovation activities is much higher than among national SMEs (table 2).

To verify in a more rigorous way the discussion so far several econometric exercises were carried out to find which variables (i.e. size, age, nationality) are more relevant to explain the intensity of innovation expenditures¹⁸.

H1: Intensity of innovation = C + B₁ size + B₂ age + B₃ nationality + u_i

As shown in the statistical appendix, size and age are relevant variables (10 % and 5 % of confidence, respectively). They are negatively associated with the intensity of innovation at enterprise level. In contrast, nationality was a variable not statistically significant.

The significant number of firms with endogenous innovation efforts and the negative association between size and age and intensity of innovation are findings well in line with an evolutionary approach to the matter. What is at odds with such an approach is the fact that Argentine firms relied very little on other domestic agents and institutions for their innovation activities.

Only 73 firms (out of 534) with innovation activities reported contracts and/or collaboration agreements with national scientific and technological institutions. In these 73 firms there was a relatively high participation of large enterprises (60 per cent).

The expenditures for these technology agreements amounted to only 0.07 of their 1996 sales (as compared with 0.62 for intramural innovation outlays). They were more significant in the case of SMEs: 0.68 per cent of their sales, though far less relevant than the in house innovation efforts of these 29 firms (which amounted to 1.52 per cent).

To translate the suggestive case in favor of collective innovation efforts that is so popular in the received evolutionary literature into the so different business reality prevailing in developing countries certainly is one of the big policy challenges for building national and local innovation systems.

¹⁸ Other variables such as expenses on imports of capital goods, agreements with national technological and scientific institutions, change of ownership and branches of industry were also tested in the regressions. As they were not statistically significant under any of the hypotheses, they were excluded from the analysis.

In which branches did innovation activities prevail?

More than 60 per cent of the firms with innovation activities are concentrated in six branches: food and beverages; electrical and non electrical machinery; pharmaceuticals; other chemical products; textiles and footwear and autoparts. The remaining innovative firms are found in many other branches.

Innovation activities in pharmaceuticals, other chemicals products, machinery and autoparts is to be expected everywhere, though of course the intensity of innovation in these branches in Argentina is far less important than in industrialized countries. Given the tradition and importance of the food industry in Argentina it is also understandable that some innovation efforts are made in this branch.

The intensity of innovation is the highest in autoparts, pharmaceuticals and machinery and the lowest in food. However, whereas in other chemicals, food and textiles the intensity increased over time, the opposite is visible in autoparts, machinery and pharmaceutical products (table 5).

What sort of innovation efforts were made?

In view of the relatively low intensity of innovation it is not surprising to find that the firms have reported that innovation efforts were aimed mainly at:

- i) improving the quality of products
- ii) product development and widening the product range and
- iii) reducing labor costs.

Product innovations were mainly new in the Argentine context but not at international level. They did not generally lead to patents. In this connection, only 38 firms registered patents in the period 1992/96. These firms had 321 patents in Argentina (i.e. 0.78 patents per firm) and 88 patents abroad during the same period¹⁹.

Given the mentioned heavy reliance on imported technological assets, have innovation activities been undertaken jointly with technology transfer and imported capital goods to increase their technological capabilities of the firms as an evolutionary approach would suggest?

To shed light on this crucial question, innovative firms were subdivided in two categories: a) self reliant and b) firms relying on their own efforts but complementing them with technology transfer from abroad. And a third category of firms c) only relying on technology transfer was introduced.

Contrary to our expectations, the self reliant is the largest category among the innovative group of firms. The participation of SMEs in this category is higher than in the other ones (table 2). Since foreign firms have access to the technology of their parent companies even without formal technology agreements or payments for such inputs, they were

¹⁹ In 1996 patents requested by all residents reached the annual figures of the 1980s: one thousand per year. Most Argentine patents are requested by individuals and by government institutions. Very few domestic enterprises have registered any patents. Argentina had only 46 patents in the US patent office in 1999. Brazil and Mexico had 98 and 94, respectively while Chile had only 12 patents.

excluded from this group²⁰ and included in the group of innovative firms with technology transfer.

These 303 enterprises relied only on their own innovation efforts and did not import any intangible technological input during the period under study (though they may have had a technology license before 1992). Only 132 firms imported technology embodied in capital goods for launching new products or processes. And only ten per cent of the self-reliant enterprises had agreements with local technological institutions. Hence, they are undoubtedly self-reliant innovative firms.

In the self-reliant group the intensity of innovation grew among SMEs and decreased in large firms in the period of analysis (table 3). At sectoral level, the intensity of innovation increased in all branches except in pharmaceuticals and in other chemicals (table 5).

To find so many self-reliant firms in the 1990s is certainly surprising. Although their in-house innovation efforts are certainly a valuable asset, in our view these efforts may not be always sufficient to keep them going and grow in the new very demanding environment. More interaction with foreign technology sources should be required in these firms to strengthen their innovative efforts, especially in a context in which very few linkages are established with domestic technology institutions.

This interaction is precisely what has happened in the second group of innovative firms. There were 213 firms that complemented their own efforts with foreign inputs through licenses and technology transfer. In contrast to the self-reliant category, large and especially foreign firms have a much higher participation than SMEs in this group (table 2).

Some of these 213 firms (in fact 93) had also imported capital goods for introducing new products or processes. And only 33 enterprises in this group had agreements with local technology institutions.

As shown in table 3, the intensity of innovation was higher than the intensity of expenditures on technology transfer though the gap between them was reduced over time and hence the relative participation of imported inputs increased. At sectoral level the same picture can be observed in autoparts, machinery and equipment and textiles (table 5).

The intensity of technology transfer augmented in domestic firms, both large and SMEs, and in 1996 was higher than the intensity of innovation. Expenditures on technology transfer were higher than innovation outlays in pharmaceuticals in 1996 and in both years in food and other chemicals.

Finally, a group of 78 firms only used imported intangible inputs to meet their technological requirements²¹. Only 23 of these 78 firms imported capital goods for introducing new products or processes. The reduced number of enterprises in this group suggests that what can be considered the purely orthodox strategy of technology acquisition was not very popular in the case under study.

²⁰ 87 foreign firms had innovation activities and no formal technology transfer agreement or payments for that concept.

²¹ As these firms did not report domestic innovation expenditures, they were not classified either in the group of innovative firms or in the non-innovative ones.

In this small group also foreign and large firms had a relatively higher importance than SMEs. The intensity of technology transfer slightly decreased in the period under consideration (table 3). At sectoral level, this intensity was very high (though decreasing) in autoparts, textiles and in 1996 in pharmaceuticals (table 5).

Did it pay to be innovative in the new environment? The data on sales growth (table 4) would suggest a positive answer.

The sales of the 516 innovative firms increased far more than the sales of the 881 firms that did not report innovation expenditures (42 versus 32 per cent). At the same time, employment was reduced in a lower proportion in the former than in the latter (-4 versus -10 per cent). As shown in table 4, large innovative foreign firms had the better performance both in sales and in keeping employment. SMEs did rather bad in both groups and on both accounts.

The relationship was more precisely analyzed in the second regression

$$H2: Performance = C + B_1 size + B_2 type1 (innovative or not innovative) + B_3 nationality + u_i$$

The performance, measured as the growth in sales between 1992 and 1996, was better in innovative than in non innovative firms (see statistical annex). Besides being innovative, performance was also positively related to size and nationality of the firm.

Did innovative firms perform better than those firms only relying on technology transfer? The data in table 4 suggests a positive answer, mostly due to the better performance of large innovative firms.

This is also confirmed in the third regression

$$H3: Performance = C + B_1 size + B_2 type1 + B_3 type3 (only technology transfer or not) + B_4 nationality + u_i$$

A new variable (type3), representing those firms only relying on technology transfer, was added to H2. While size, innovative firms and nationality capital are still statistically significant, firms type3 are not (see statistical annex). Hence innovative firms performed better than only those relying on technology transfer.

Finally, within innovative firms, those which combined endogenous efforts with imported inputs did better than the self reliant ones?

As shown in table 4, the firms in the first category had the best relative performance in sales and hardly reduced the employment as compared with the self reliant ones. It seems that this was mostly due to the foreign firms performance.

To verify in a more rigorous way the different performance within the innovative group of firms the following hypothesis was tested

$$H4: Performance = C + B_1 type2 (Self Reliant or both innovative and technology transfer) + B_2 size + B_3 nationality + u_i$$

It was found that the difference in performance between self reliant and the other group of firms was not statistically significant . Only size was a relevant variable in this regression while type of firm (self reliant or innovative with technology transfer) and nationality were not (see statistical annex).

In conclusion, the econometric exercises confirmed that innovative firms have performed better than non innovative ones, though further research is required to test the causality. They also confirmed that innovative firms had a better performance than those firms only relying on technology transfer. In contrast, the apparently better performance of firms that complemented their own efforts with imported inputs vis a vis self reliant firms (or firms with only technology transfer) was not statistically significant.

4. Concluding remarks

Large firms and especially foreign owned ones have been those firms that better performed in the new market conditions, following trade liberalization and resumption of growth in the period 1992-96. More than half of the large firms made innovation expenditures as part of the reaction to the new competitive conditions. Although only a bit more than a quarter of the SMEs registered innovation efforts, the intensity of these efforts was higher than in large firms.

A minority of firms have only relied on imported intangible inputs to meet their technological requirements in the new market conditions. Most innovative firms relied on their endogenous efforts and a sizeable number of firms combined imported and domestic inputs in their innovative activities.

Instead of going bust, most surveyed firms born during the ISI process were able to survive in the new demanding context. In this survival, relying only on technology imports without allocating resources for innovation activities was the exception rather than the rule. This is not precisely the picture to be expected by the proponents of the new model.

Are then the findings of this paper a corroboration of the validity of the evolutionary approach? Only to some extent.

As expected from an evolutionary approach, endogenous innovation efforts were undertaken by firms that accumulated their capabilities over a long time period. These local efforts were complemented with imported inputs in a significant number of innovative firms. However, in house efforts were seldom complemented with agreements with local technology institutions, clearly reducing the scope of innovative activities at enterprise level.

In these conditions, the better performance of innovative firms and the sizeable amount of self reliant innovative firms in the demanding environment of the 1990s are interesting developments in an evolutionary framework. But in this framework, these self reliant firms should be encouraged through policy efforts to complement their efforts with local and foreign inputs to be able to grow or even to keep them going.

While it is certainly encouraging to find a significant group of firms that have undertaken growing innovation activities in response to the new rules of the game, four crucial facts of the Argentine situation cannot be overlooked.

First, table 2 clearly shows that 60 per cent of the surveyed firms (and 69 per cent of the SMEs) did not register any endogenous innovative effort or relied on imported technological inputs to do their business activities under the new rules of the game. This is partly a reflection of the absence of several high tech branches in the Argentine economy.

Second, R&D and innovation expenditures on sales in the enterprise sector (tables 1 and 3) are quite low for a country rich in skills and with a GDP per capita of around US\$ 8000. Even in medium tech branches like pharmaceuticals, autoparts and machinery the intensity of innovation is low as compared with other countries.

Third, no information is available on innovation efforts at enterprise level since 1996. It is likely that these efforts may have been reduced in a context where some policy initiatives like a tax credit for R &D launched in 1997 were clearly insufficient to counteract the effects of the current recession in the Argentine economy.

Finally, besides the actual low size of the innovation outlays, it is important to bear in mind that the private sector efforts are generally of a short-term nature, do not include systematic scientific and technological research activities, are not linked up with public science and technology institutions and are not carried out in networks with active participation of suppliers, users and clients. In short, they are far from having the scale required in order to tackle the challenges involved in the development of a successful National Innovation System (NIS).

In sum, the evidence available on R&D and innovation efforts in Argentina clearly suggests a lack of technological deepening and a weak NSI. But at the same time, the data examined in this paper indicates a high potential for inducing more and more widespread innovation efforts through appropriate public policies.

Even if *laissez faire* was the preferred approach by the economic authorities, the lack of technological deepening and the problems faced by public research institutions to adapt their services to the new rules of the game created a demand for active technology policies.

By introducing a tax credit for R&D and trying to link up the financial incentives more effectively with the prevailing technological modernization process, and by launching the Technological Advisers Program, the government tried to give better attention to the requirements of the SMEs and to begin to reverse the reluctance of enterprises to make more significant investments in technological innovation (Chudnovsky, 1999).

In this way Argentina started to close the wide institutional gap with other countries, among other things, by adopting some horizontal policies widely used abroad.

It is fairly obvious that the government should broaden the scope of its technology policies by adopting many new ones (such as venture capital; world or regional product mandates for the TNCs operating in the country; technology based enterprise incubators), as well as investing additional resources in enlarging the breadth of those created in the late 1990s.

In any case, to be able to push for sound innovation policies further research is clearly required. To collect and analyze information on innovation activities since 1996 in the manufacturing sector and generally on other productive sectors is a must. Attention

should also be paid to the challenges faced by both self reliant and other innovative firms to keep up and develop in this peculiar policy framework.

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TABLE 1
INTERNATIONAL COMPARISON OF EXPENDITURE ON RESEARCH AND DEVELOPMENT

Country	Gross domestic expenditure on I&D (total)		Government and others		Business enterprise		Share of Gov. and others on total	Share of business ent. on total
	(U\$ million)	%GDP	(U\$ million)	%GDP	(U\$ million)	%GDP	expenditure (%)	expenditure (%)
USA	182217	2.32	46101	0.59	136116	1.73	25	75
Japan	75636	2.77	22478	0.82	53157	1.95	30	70
Korea	15132	2.68	3976	0.70	11157	1.98	26	74
Germany	37283	2.28	12754	0.78	24529	1.50	34	66
France	28392	2.31	10927	0.89	17465	1.42	38	62
Spain	5471	0.89	2768	0.45	2703	0.44	51	49
Ireland	867	1.40	256	0.41	611	0.99	30	70
Finland	2150	2.30	791	0.85	1359	1.45	37	63
Sweden	5939	3.60	1524	0.92	4415	2.68	26	74
Brazil	5484	0.76	2989	0.41	2495	0.35	55	46
Chile	495	0.64	480	0.62	15	0.02	97	3
Argentina	1263	0.42	892	0.30	371	0.12	71	29
Mexico	886	0.31	702	0.25	184	0.06	79	21

Government and others: government institutions, universities and non profit organizations.

Last year available for each country.

Source: OECD-STEPI-RICyT.

TABLE 2
TECHNOLOGICAL ACTIVITIES OF MANUFACTURING FIRMS IN ARGENTINA, 1996.

Type of firm	Innovative		Not Innovative		Only Technology Transfer		Total
	Number	%	Number	%	Number	%	
<i>Large Domestic</i>	118	50	101	43	15	6	234
<i>Large Foreign</i>	113	62	47	26	23	13	183
Total Large	231	55	148	35	38	9	417
<i>SMEs Domestic</i>	240	25	693	72	33	3	966
<i>SMEs Foreign</i>	45	49	40	43	7	8	92
Total SMEs	285	27	733	69	40	4	1058
Total	516	35	881	60	78	5	1475

	Self Reliant		Innovative with Technology Transfer		
	Number	%	Number	%	
<i>Large Domestic</i>	95	81	23	19	118
<i>Large Foreign</i>	-	-	113	100	113
Total Large	95		136		231
<i>SMEs Domestic</i>	208	87	32	13	240
<i>SMEs Foreign</i>	-		45	100	45
Total SMEs	208	73	77	27	285
Total	303	59	213	41	516

Total percentages may not add up 100% due to rounding.
Source: Own elaboration, based on INDEC (1998)

TABLE 3
TECHNOLOGICAL INTENSITIES BY SIZE AND NATIONALITY OF CAPITAL
(in percentages)

Innovation/sales				
Type of firm	1992	1996		
<i>Large Domestic</i>	0.58	0.52		
<i>Large Foreign</i>	0.56	0.55		
Total Large	0.57	0.54		
<i>SMEs Domestic</i>	0.96	1.33		
<i>SMEs Foreign</i>	0.67	0.90		
Total SMEs	0.88	1.20		
Total of the group	0.61	0.61		
Technology transfer /sales (innovative with technology transfer)				
	1992	1996	Innovation/sales (innovative with technology transfer)	
			1992	1996
<i>Large Domestic</i>	0.25	0.84	0.42	0.44
<i>Large Foreign</i>	0.37	0.43	0.56	0.55
Total Large	0.35	0.48	0.54	0.54
<i>SMEs Domestic</i>	0.44	1.44	0.74	0.85
<i>SMEs Foreign</i>	0.35	0.48	0.67	0.90
Total SMEs	0.38	0.81	0.69	0.88
Total of the group	0.36	0.50	0.56	0.57
Technology /sales (only tech. Transfer)				
	1992	1996	Innovation/sales (self reliant)	
			1992	1996
<i>Large Domestic</i>	2.62	2.25	0.62	0.54
<i>Large Foreign</i>	0.77	0.80	-	-
Total large	1.13	1.03	0.62	0.54
<i>SMEs Domestic</i>	1.84	1.42	1.01	1.43
<i>SMEs Foreign</i>	1.65	1.54	-	-
Total SMEs	1.78	1.47	1.01	1.43
Total of the group	1.16	1.05	0.70	0.67

Data for 1992 and 1996 available for 449 firms (out of 594).
Source: Own elaboration, based on INDEC (1998)

TABLE 4
PERCENTAGE CHANGE IN SALES AND EMPLOYMENT. 1992-1996.

<i>Type of firm</i>	<i>Innovative</i>			<i>Not innovative</i>		
	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>
<i>Large Domestic</i>	40	-9	49	44	-7	51
<i>Large Foreign</i>	50	2	48	43	-15	58
Total Large	46	-3	49	44	-10	54
<i>SMEs Domestic</i>	8	-5	13	7	-11	17
<i>SMEs Foreign</i>	13	-16	29	11	4	8
Total SMEs	9	-7	16	7	-9	16
Total of the group	42	-4	46	32	-10	42
	<i>Self reliant</i>			<i>Innovative with technology transfer</i>		
	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>
<i>Large Domestic</i>	44	-7	51	26	-17	42
<i>Large Foreign</i>	-	-	-	50	2	48
Total Large	44	-7	51	47	-1	48
<i>SMEs Domestic</i>	6	-6	12	15	-1	17
<i>SMEs Foreign</i>	-	-	-	13	-16	29
Total SMEs	6	-6	12	14	-2	16
Total of the group	36	-6	42	45	-2	47
	<i>Only technology transfer</i>			<i>All firms</i>		
	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>	<i>Sales</i>	<i>Employment</i>	<i>Sales/emp</i>
<i>Large Domestic</i>	18	-13	31	39	-9	48
<i>Large Foreign</i>	42	-10	52	47	-3	50
Total Large	36	-11	47	44	-6	50
<i>SMEs Domestic</i>	5	-14	19	7	-3	10
<i>SMEs Foreign</i>	27	-9	36	13	-8	21
Total SMEs	10	-14	24	8	-9	17
Total of the group	35	-12	47	38	-7	45

Source: Own elaboration, based on INDEC (1998)

TABLE 5
TECHNOLOGICAL INTENSITIES IN SELECTED INDUSTRIES
(in percentages)

<i>Industry</i>	<i>Innovation/sales (all innovative firms)</i>		<i>Number of firms</i>			
	<i>1992</i>	<i>1996</i>				
Food and beverages	0.17	0.28	103			
Autoparts	1.80	1.35	39			
Pharmaceutical products	1.13	0.98	39			
Machinery and equipment	0.99	0.93	68			
Other chemical products	0.50	0.53	49			
Textiles and footwear	0.45	0.87	39			
	<i>Technology transfers/sales ("innovative with technology transfer" firms)</i>			<i>Innovation/sales ("innovative with technology transfer" firms)</i>		
	<i>1992</i>	<i>1996</i>	<i>Number of firms</i>	<i>1992</i>	<i>1996</i>	<i>Number of firms</i>
Food and beverages	0.35	0.61	32	0.17	0.32	32
Autoparts	0.28	0.78	18	2.25	1.46	18
Pharmaceutical products	0.83	0.96	24	0.97	0.83	24
Machinery and equipment	0.56	0.30	21	1.20	0.94	21
Other chemical products	0.54	0.72	31	0.45	0.52	31
Textiles and footwear	0.06	0.70	13	0.36	1.06	13
	<i>Technology transfers/sales ("only technology transfer" firms)</i>			<i>Innovation/sales ("self reliant")</i>		
	<i>1992</i>	<i>1996</i>	<i>Number of firms</i>	<i>1992</i>	<i>1996</i>	<i>Number of firms</i>
Food and beverages	0.09	0.30	14	0.17	0.25	71
Autoparts	7.01	3.99	5	0.74	0.96	21
Pharmaceutical products	0.70	2.09	4	1.56	1.41	15
Machinery and equipment	0.95	0.64	11	0.49	0.91	47
Other chemical products	1.06	1.14	10	0.76	0.57	18
Textiles and footwear	3.82	3.84	10	0.56	0.66	26

Source: Own elaboration, based on INDEC (1998)

STATISTICAL ANNEX

The samples tested represent a subsample of the 1569 surveyed firms. After cutting endpoints, complete data was available for 1475 firms.

Dependent Variables

Two dependent Variables were estimated:

- Intensity of innovation: Innovation expenditures in 1996 divided by sales in 1996 for each firm.
- Performance: Growth in sales was calculated by subtracting the logarithm of the value of sales in 1992 from its value in 1996.

Independent Variables

- Size: Value of sales in 1996
- Age: Years from the date of foundation
- Type1: Dummy variable : 1. Innovative firm 0. Not innovative firm
- Type2: Dummy Variable: 1. Innovative with technology transfer firms 0. Self Reliant
- Type 3: Dummy Variable: 1. Only technology transfer firms 0. All other firms
- Nationality: Dummy variable: 1. Foreign 0. Domestic

H1

$$\text{Intensity of innovation} = C + B_1 \text{ size} + B_2 \text{ age} + B_3 \text{ nationality} + u_i$$

Dependent Variable: INTENSITY

Method: Least Squares

Sample: 1 516

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.022919	0.003374	6.792395	0.0000
SALES96	-2.93E-08	1.63E-08	-1.799122	0.0726
AGE	-0.000131	6.82E-05	-1.926551	0.0546
NATIONALITY	-0.003582	0.003493	-1.025486	0.3056
R-squared	0.021432	Mean dependent var		0.014717
Adjusted R-squared	0.015893	S.D. dependent var		0.036037
S.E. of regression	0.035750	Akaike info criterion		-3.817086
Sum squared resid	0.677362	Schwarz criterion		-3.785023
Log likelihood	1023.162	F-statistic		3.869210
Durbin-Watson stat	2.067449	Prob(F-statistic)		0.009337

H2

$$\text{Performance} = C + B_1 \text{ size} + B_2 \text{ type1} + B_3 \text{ nationality} + u_i$$

Dependent Variable: PERFORMANCE

Method: Least Squares

Sample: 1 1475

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.098153	0.016218	6.052020	0.0000
SALES96	5.98E-07	1.42E-07	4.221059	0.0000
TYPE1	0.078366	0.027189	2.882271	0.0040
NATIONALITY	0.092041	0.034343	2.680083	0.0074
R-squared	0.034191	Mean dependent var		0.161427
Adjusted R-squared	0.032192	S.D. dependent var		0.487276
S.E. of regression	0.479369	Akaike info criterion		1.370057
Sum squared resid	332.9723	Schwarz criterion		1.384596
Log likelihood	-991.3461	F-statistic		17.09899
Durbin-Watson stat	1.932728	Prob(F-statistic)		0.000000

H3

$$\text{Performance} = C + B_1 \text{ size} + B_2 \text{ type1} + B_3 \text{ type3} + B_4 \text{ nationality} + u_i$$

Dependent Variable: LNVTAS

Method: Least Squares

Sample: 1 1475

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.093765	0.016888	5.552085	0.0000
SALES96	7.81E-07	1.59E-07	4.916907	0.0000
TYPE1	0.067971	0.028226	2.408129	0.0162
TYPE3	0.004805	0.059892	0.080226	0.9361
NATIONALITY	0.085645	0.035378	2.420882	0.0156
R-squared	0.036870	Mean dependent var		0.156821
Adjusted R-squared	0.034226	S.D. dependent var		0.496347
S.E. of regression	0.487779	Akaike info criterion		1.405507
Sum squared resid	346.6622	Schwarz criterion		1.423590
Log likelihood	-1022.426	F-statistic		13.94407
Durbin-Watson stat	1.926752	Prob(F-statistic)		0.000000

H4

$$\text{Performance} = C + B_1 \text{ size} + B_2 \text{ type2} + B_3 \text{ nationality} + u_i$$

Dependent Variable: PERFORMANCE

Method: Least Squares

Sample: 1 516

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.180204	0.024994	7.210001	0.0000
SALES96	8.11E-07	1.89E-07	4.291798	0.0000
TYPE2	-0.008813	0.062148	-0.141803	0.8873
NATIONALITY	0.058077	0.066927	0.867765	0.3859
R-squared	0.046415	Mean dependent var		0.234232
Adjusted R-squared	0.040716	S.D. dependent var		0.428524
S.E. of regression	0.419709	Akaike info criterion		1.109366
Sum squared resid	88.43033	Schwarz criterion		1.142777
Log likelihood	-276.6695	F-statistic		8.144819
Durbin-Watson stat	2.124639	Prob(F-statistic)		0.000026

* The values of R^2 for the four equations are lower than expected. In this respect they do not offer a satisfactory explanation of firms variation in growth, due basically to the multiple factors affecting this variable. The regressions are still useful to analyze in more rigorous way the relationship among the variables discussed in the text.