Innovation and productivity: A study of Argentine manufacturing firms´ behavior

(1992-2001)

Daniel Chudnovsky (UdeSA & CENIT)
Andrés López (CENIT & UBA)
Germán Pupato (CENIT & UdeSA)[1]

March 2004

Abstract

This paper aims to learn about the determinants and impacts of innovative inputs and outputs on Argentine manufacturing firms' productivity performance in a period characterized first by high growth rates and then by a long recession. The data show that, after increasing in the first period, firms drastically cut expenditures in acquired embodied and disembodied technologies while in-house R&D activities were maintained. This suggests that the latter are part of firms´ routines and a valuable asset to be preserved even in bad times. The econometric results indicate that having linkages with other agents (specially suppliers) as well as R&D and technology acquisition expenditures had a positive payoff in terms of enhanced probability of introducing new products and processes to the market. Furthermore, innovators attained higher productivity levels than non-innovators. However, small firms had a lower probability of engaging in innovation activities and of becoming innovators.

JEL Classification: L60, O031, O032

Keywords: innovation, research and development, technology acquisition, firm productivity

[1]. This paper is part of the final report of a project financed by the International Development Research Centre through its Research on Knowledge Systems (RoKS) program. The data was provided by the National Statistical Institute (INDEC) through a special agreement. The econometric advice of Walter Sosa Escudero from UdeSA and the research assistance of Ariana Sacroisky and Hernán Seoane are greatly acknowledged. The usual caveats apply.

Introduction

After the adoption of the Convertibility Plan and of a far-reaching program of structural reforms in the early 90s, Argentina' economy had periods of high growth in 1991-94 (interrupted by the Tequila crisis in 1995) and in 1996-98. In late 1998 the economy entered into a stagnation period that was followed by a deep fall in GDP in 2001 and 2002, when the country suffered the worst crisis of its history, as a result of a banking crisis, a default on the external debt and a huge devaluation of the peso when the Convertibility Plan was abandoned.

At the firm level, the response to the change in the rules of the game (in particular, trade and investment liberalization, which implied enhanced access to modern technologies and increased competition in the domestic market) was far from homogenous.

While many domestic firms went bust (this was specially the case among small and medium enterprises –SMEs-) or were sold to foreign investors, others totally or partially abandoned production activities to become importers of foreign goods. In turn, large firms and, most notably, transnational corporations (TNCs) affiliates, were those that performed better in the new market conditions.

Beyond the heterogeneity in their behavior and performance in the post-reform scenario, it could be expected that, on the whole, manufacturing firms (either survivors or newcomers in the industry) would increase their investments in technology modernization so as to face the challenges coming from trade liberalization.

This was in fact what happened, as revealed by the first national survey on innovation activities in manufacturing firms carried out in 1997 (INDEC, 1998). In a context of booming sales and productivity, innovation expenditures (including R&D activities, acquisition of capital goods related to innovation activities, as well as expenditures in training, consultancies, engineering and design) increased by almost 25% between 1992 and 1996.

Among firms that augmented their innovation expenditures as a reaction to the reforms, the bias in favor of technology imports over domestic innovation expenditures that had traditionally characterized the conduct of Argentine manufacturing firms in the past was, if anything, reinforced. Hence, in spite of an increase in in-house R&D and innovation expenditures, during the high-growth period inputs from abroad -mainly in the form of capital goods imports and foreign direct investment (FDI) inflows- were the main source of technological modernization for the manufacturing sector.

Besides increasing their innovation expenditures during this period, manufacturing firms were also very active introducing new product and process technologies. This comes as no surprise considering both the need to compete in a more open and deregulated economy as well as the technological lag that had been accumulated during the previous decade, in a scenario in which the Argentina's economy was closed, stagnating and highly volatile.

What happened when the growth cycle was over? In the adverse conditions that prevailed since 1998, one would have expected a severe reduction in innovation expenditures. This presumption was confirmed by the second national survey on innovation in the manufacturing sector (INDEC, 2003), which showed that in a context in which sales (as well as productivity and investment) sharply fell, innovation expenditures had a drastic reduction between 1998 and 2001. Also expectedly, there were fewer firms introducing new technologies during this period. However, surprisingly, in house R&D activities did not fall, although remained at modest levels.

A number of relevant questions arise from the Argentina's experience as described above. In this paper we aim at answering some of these questions, as follows:

a) Did firms that introduced product and/or process innovations during that period perform better than those, which kept stuck with their old technologies?

b) Was the probability of introducing a new technology in the market enhanced by making innovation expenditures and by interacting with other firms and institutions (as suggested by the received literature)?

c) Did in-house innovation activities have a different impact on the probability of becoming an innovator *vis a vis* technology acquisition? Were both sources complements and substitutes in terms of the firms' innovative processes?

d) Which kind of firms was more prone to engage in innovation activities and to launch innovations to the market (that is, which were the determinants of the innovative behavior of Argentine manufacturing firms)?

To answer the above-mentioned questions, we will rely on data from the above-mentioned innovation surveys and follow the conceptual framework and methodology employed in many available studies based on information from the European Community Innovation Surveys (CIS).

The fact that innovating is a key element in firms' performance is well established in developed countries. However, it is not always properly acknowledged in a developing country like Argentina. Moreover, in such countries, firms, policy makers and economists often believe that, even if "pays" to be an innovator, only access to foreign sources matter, not granting enough attention to the need of combining imported technologies with domestic and/or in house innovation activities.

Our results show that innovators performed better than non innovators in Argentina, and that both technology acquisition as well as R&D in house activities were crucial for becoming an innovator, which suggests that policies aimed at fostering both kinds of innovation activities should positively impact on domestic firms performance. Moreover, we found that among the determinants of the probability of becoming an innovator, size is a key factor. Hence, policies aimed at removing those barriers that could be preventing SMEs to engage in innovation activities should allow those kinds of firms to enhance their competitiveness levels.

This paper is organized as follows. The conceptual and methodological issues arising from the received literature on the subject are discussed in section 1. In section 2, after describing the basic features of the innovative behavior of Argentina's manufacturing firms in 1992-2001, econometric exercises are made with data at firm level aimed at dealing with the issues posed above. The conclusions and a research agenda are presented in the final section.

1) Innovation activities and firm performance: some conceptual and methodological issues

The availability of innovation surveys in the European Community and in other countries such as Canada in the 90s, has provided valuable information on several dimensions of the innovation process at the firm level that had been previously emphasized in the chain linked model proposed by Kline and Rosenberg (1986) as well as in the national system of innovation (NSI) literature (Edquist, 1997). The rich information available from those surveys has also fostered new ways of doing research on key issues of the received literature on technological change, such as the determinants and consequences of innovation activities, applying advanced econometric techniques.

Innovation surveys supply data, among other things, on subjects such as:

a) Innovation inputs other than R&D expenditures, such as industrial designs, training, licensing and innovation-related fixed asset investments.

b) The interactions in which firms engage during the innovation process.

c) The innovative output, estimated by the weight of new or significantly improved products and their resulting turnover at firm level.

To analyze the information from these surveys, most recent papers have followed in one way or another the conceptual framework set by Crepon, Duguet and Mairesse (1998) (or CDM approach from now on).

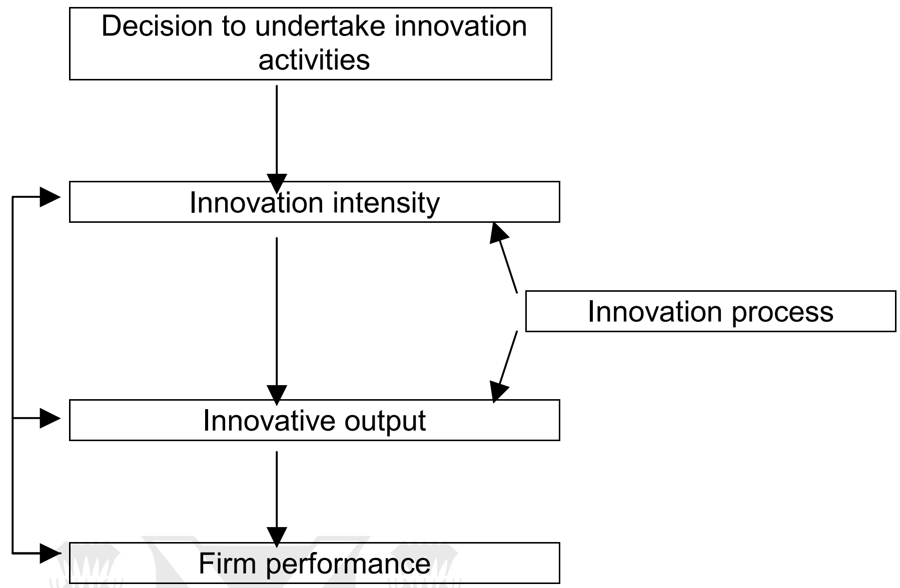
In this framework, innovation is considered as a process, which is carried out with some specific inputs (R&D activities, acquisition of embodied and disembodied technologies) and by interacting with other firms and institutions. The innovative process should lead to certain outputs such as process innovations or sales of new (for the firms or for the market, but not necessarily for the world) and/or significantly improved products. In turn, as innovation is not an end in itself, innovators (i.e. those firms which have launched new or improved products or processes) could be expected to have a better performance than non-innovators.

As shown in figure 1, in a first stage, there is a decision to allocate financial and human resources to innovation activities or not. Second, the amount of financial and human resources assigned provides a measure of the intensity of these activities at the firm level. In the third stage, there is (or there should be) an innovative output (process or product innovations) that should be related to the innovation intensity[2] and/or to some other features of the innovation process (such as interactions with different agents and institutions of the NSI). Finally, the firm's performance should be related to the innovative output[3].

[2]. Undertaking innovation activities is not the same as being an innovator, and for being an innovator is not always needed to have innovative expenditures. For instance, Crepon *et al* (1996) report that only 20% of the near 10,000 manufacturing firms in their sample that did some research in 1989 innovated between 1986 and 1990, while only 74% of all innovators performed some R&D. At least a part of these differences may arise from innovation activities that are not captured in the R&D indicator (see below).

[3]. To deal with the feedback loops from firm performance to innovation inputs and outputs, as well as with the correlation of error terms of each equation which may be reflecting non-observed variables or firm specific effects, several studies based on the CDM approach estimate all the stages simultaneously.

FIGURE 1



Source: Kemp *et al* (2003).

The received literature on this subject usually introduces a number of variables that are used as determinants of the probability of engaging in innovation activities and of the intensity of those activities. These variables are employed to control for other aspects that could influence the innovative output as well as the firms' performance beyond those relations that are of central interest for the CDM approach. Among those variables are firm's size, ownership, export activity, labor skills, sector, profitability, market power, etc. (see table A.1 in the appendix for a list of the available studies and some details about their methodology).

In turn, firms' performance is captured through a variety of indicators, including labor and total factor productivity, profits, rates of growth of sales, total assets, exports, etc. The election of the indicators generally depends not only on research objectives but also on data availability (see Kemp *et al* 2003 and Kleinknecht and Mohnen 2002 for surveys of the results of most of the papers produced on this subject).

Available studies also take explicitly into account features of the innovation process that may impact on the efficiency with which firms transform innovative inputs into innovative outputs. As innovation is an interactive process, the cooperation with other firms or universities, linkages with suppliers, knowledge about customers, etc. are key issues in this regard.

Before presenting the results of our own estimations for the Argentine case, it is useful to highlight some aspects of the innovation surveys and the studies based on them in order to know the specific advantages and limitations of the adopted methodology. It is also important to make some adaptations to fit the CDM approach to the reality of innovation activities in a developing country such as Argentina.

Regarding inputs, in most available studies the innovation intensity is measured through R&D expenditures or employees and/or by innovation expenditures as compiled in the innovation surveys. In this regard, it is important to have in mind two things:

i) Firms (specially SMEs) often make expenditures in informal innovation activities which are usually hard to estimate (since, for instance, they are a byproduct of learning by doing processes and/or firms are not able to know how many monetary or labor resources are assigned to them since no dedicated department or team exists) but that can be very relevant, specially in developing countries. Unfortunately, a large part of these activities is not captured in the available innovation surveys (hence, we will not be able to take into account the impact of these informal inputs).

ii) While it may be understandable that studies for developed countries do not take into account technology acquisition when measuring innovative inputs, this cannot be the case when analyzing firms' innovative behavior in developing countries, where external sources of technology are in general more relevant than in house innovation activities. As Argentina's innovation survey includes questions on the acquisition of embodied and disembodied technology, we will be able to include the respective flows when measuring innovative inputs. Examining if external and in house innovative expenditures are complementary or substitutes is also a key issue for this kind of studies in developing countries[4].

Regarding outputs, the firms' innovative output is often measured by the weight of new or significantly improved products on firms' turnover[5]. The main advantage of this indicator is the direct link between the innovation effort and commercial success. This procedure has also advantages over previous studies that employed patents, an indicator which has well know limitations and little use in the Argentine case, where manufacturing firms have relatively few patents[6].

In contrast, measuring innovative output in terms of sales of new products has three main disadvantages: i) sectors have diverse product life cycles, which should be adequately controlled for a proper estimation of the innovative output; ii) the variable is based on the respondent's own judgment (what is considered to be an innovation for a small firm might not qualify as such for a large firm); iii) the influence of process and organizational innovations as innovative outputs (when they do not necessarily lead to new or improved products) is not measured.

Furthermore, in innovation surveys the innovative output may consist not only of "true" innovations but also of products or processes that can be new for the firm but not for the industry (imitations). This is very important since in the case of developing countries most new products or processes are in fact imitations even when introduced via licensing agreements or foreign direct investment.

When interpreting the obtained results, it is essential to have in mind these limitations of the data on which our analysis is based. In this paper we will be able to control for sectoral characteristics as described below. However, organizational innovations are not directly reflected in the output indicators used in the analysis.

[4]. The study by Hu *et al* (2003a) on China takes explicitly into account these specific features of the innovative process in a developing country.

[5]. Binary variables indicating whether products and/or process innovations have been accomplished are usually used when this indicator is not available.

[6]. According to INDEC (2003), 98 firms registered 317 patents in 1998-2001. About only 10% of the innovators have obtained patents.

2) Innovation inputs and outputs in Argentine manufacturing firms

a) Descriptive statistics

Basic data

Two datasets are used in the descriptive statistics and the econometric exercises. The first is based on matched information for a panel of 718 firms from the 1992-1996 and 1998-2001 innovation surveys[7], both designed in accordance with the methodologies suggested by the Oslo and Bogotá Manuals[8]. This information will be complemented with a second dataset, containing information only from the second innovation survey for 1243 firms in 1998-01. The use of this second dataset is explained by the fact that it contains data not available in the first survey, but still very important for our research purposes (for instance, information on sales of innovative products and on linkages within the NSI). Hence, even if in the case of the second dataset we will not be able to use panel data techniques, the information available in it will provide a more comprehensive analysis of the issues under study.

It is important to take into account that the majority (69%) of the enterprises surveyed in both periods were founded before 1975 and survived the liberalization process in the early 90s, while only 7% of them were created during this decade. Hence, the majority of these firms were born during the import substitution industrialization (ISI) process. However, more than 50% of the enterprises founded before 1975 changed ownership. These changes occurred mostly in the 90s and generally involved the acquisition of indigenous firms by TNCs.

Furthermore, small and domestic firms account for the majority of the panel of 718 firms. Although large firms conform the smallest group, they have increased their participation during the second period (table 1). Since our database focuses on the evolution of a given group of firms over time, the former trend reflects the fact that manufacturing firms' sales in 98-01 were, on average, larger than in 92-96 (see table 3). Likewise, as table 1 also shows, the fact that foreign owned firms have increased their participation in 98-01 is the consequence of the acquisition of domestic firms by foreign investors.

In this paper, a firm is considered to be an innovator if it reported having introduced new or radically modified products or processes (or both) during the periods under analysis. While most firms (80%) reported to be innovators in 1992-96, the number of them decreased notably during 98-01, though they still account for 59% of the firms (table 1). While these figures may appear surprisingly high at a first glance, is important to take into account that the Community Innovation Survey has reported that 50% of European manufacturing firms have introduced a product or process innovation during 1990-1992 (Archibugi and Sirilli 2000), a considerably shorter period than those covered by the Argentine surveys. Furthermore, as stated in the introduction, it cannot be ignored that, since the implementation of a program of structural reforms in the early 90s, the Argentine industry was radically transformed and firms were induced to adopt new strategies (to innovate, among them) to be able to survive.

As shown in Table 1, most of the innovative firms are both process and product innovators. However, the relative weight of this group in our sample decreased substantially between 1992-96 and 98-01 (from 494 to 290 firms respectively). Some of these firms became either only product or only process innovators in 1998-01. However, the increase in these two subgroups

[7]. These firms account for 29% of sales, 27% of employment and 24% of exports of the manufacturing sector in 1992-1996. For the 1998-2001 period, the figures are 27, 20 and 19% respectively.
[8]. OECD (1997) and RICYT (2001), respectively.

was not enough to offset the reduction in the overall number of innovators during the recession period *vis a vis* the previous one (from 576 to 425 firms).

Table 1 also shows that the group of innovators (and specially firms which are both process and product innovators) has a larger presence of large and foreign firms than the whole sample. Furthermore, when these figures are compared between the two periods, it can be observed that these trends were reinforced throughout the 90s.

TABLE 1: Distribution of firms according to size and nationality, %

	1992-1996				**1998-2001**			
	Large	Medium	Small	Total	Large	Medium	Small	Total
All surveyed firms	**718 firms**				**718 firms**			
Domestic	3.6	13.0	72.3	**88.9**	3.8	11.4	65.0	**80.2**
Foreign	2.4	3.5	5.3	**11.1**	4.5	6.8	8.5	**19.8**
Total firms	**6.0**	**16.4**	**77.6**	**100**	**8.2**	**18.2**	**73.5**	**100**
Innovators	**576 firms**				**425 firms**			
Domestic	4.2	14.8	68.1	**87.0**	4.5	14.6	55.3	**74.4**
Foreign	3.0	4.0	6.1	**13.0**	7.1	9.9	8.7	**25.6**
Total Innovators	**7.1**	**18.8**	**74.1**	**100**	**11.5**	**24.5**	**64.0**	**100**
Process and Product Innovators	**494 firms**				**290 firms**			
Domestic	4.7	16.6	65.8	**87.0**	6.2	13.8	51.7	**71.7**
Foreign	3.2	4.0	5.7	**13.0**	8.3	11.0	9.0	**28.3**
Total Innovators	**7.9**	**20.6**	**71.5**	**100**	**14.5**	**24.8**	**60.7**	**100**
Only Product innovators	**48 firms**				**63 firms**			
Domestic	0	0	85.4	**85.4**	1.6	12.7	73.0	**87.3**
Foreign	2.1	4.2	8.3	**14.6**	3.2	4.8	4.8	**12.7**
Total non innovators	**2.1**	**4.2**	**93.8**	**100**	**4.8**	**17.5**	**77.8**	**100**
Only Process innovators	**34 firms**				**72 firms**			
Domestic	2.9	8.8	76.5	**88.2**	0	19.4	54.2	**73.6**
Foreign	0	2.9	8.8	**11.8**	5.6	9.7	11.1	**26.4**
Total non innovators	**2.9**	**11.8**	**85.3**	**100**	**5.6**	**29.2**	**65.3**	**100**

Note: Firms are classified as small, medium or large if their total sales average in 1998-2001 is less than 25 millions of pesos, between 25 and 100 millions or more than 100 millions, respectively. A firm is considered to be foreign if its share of foreign capital is al least 10% of total capital.

In table 2, it can be appreciated that food and beverages, rubber and plastics, chemicals and machinery and equipment account for almost half of the matched firms. While natural resources intensive sectors account for almost one third of the firms, R&D intensive is the least numerous group. However, expectedly, the weight of the latter and that of scale intensive sectors increases when only the group of innovators is considered[9].

[9]. The classification of sectors into R&D, scale, labor and natural resources intensive was developed by Pavitt (1984) and later adapted by Guerrieri and Milana (1989) and Guerrieri (1992).

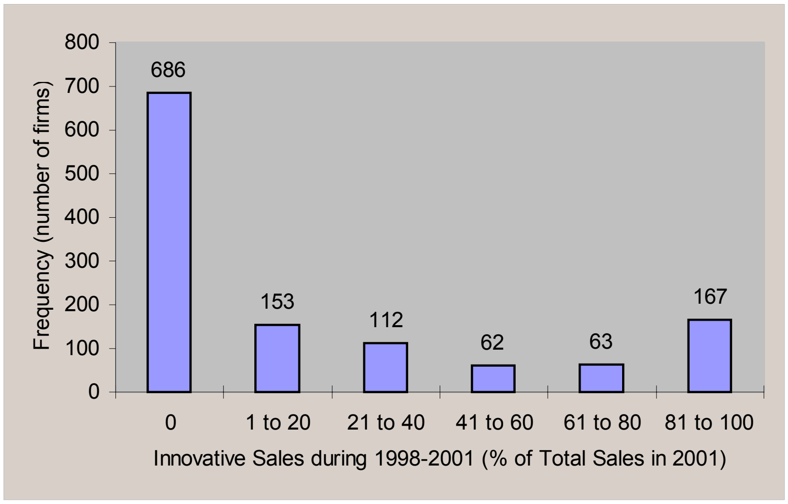
TABLE 2: Distribution of firms according to sectors

	Sector (CLANAE[10] classification)	All Survey Firms		Innovators (1992 - 1996)		Innovators (1998 - 2001)	
		Firms	**%**	**Firms**	**%**	**Firms**	**%**
Scale intensive	Rubber and Plastics	46	6.4	38	6.6	32	7.5
	Common Metals	24	3.3	20	3.5	18	4.2
	Metal Products	39	5.4	30	5.2	19	4.5
	Machinery and equipment	59	8.2	53	9.2	42	9.9
	Radio and TV equipment	9	1.3	8	1.4	8	1.9
	Vehicles	31	4.3	30	5.2	22	5.2
	Other transport equipment	10	1.4	6	1	2	0.5
Scale		**218**	**30.4**	**185**	**32.1**	**143**	**33.6**
Labor intensive	Textiles	67	9.3	47	8.2	25	5.9
	Wearing	15	2.1	10	1.7	7	1.6
	Leather and Footwear	13	1.8	11	1.9	10	2.4
	Edition and printing	38	5.3	32	5.6	18	4.2
	Furniture	27	3.8	19	3.3	12	2.8
Labor		**160**	**22.3**	**119**	**20.7**	**72**	**16.9**
R&D intensive	Chemicals	75	10.4	65	11.3	55	12.9
	Electrical machinery	24	3.3	22	3.8	17	4
	Medical instruments	10	1.4	7	1.2	6	1.4
R&D		**109**	**15.2**	**94**	**16.3**	**78**	**18.4**
Natural Resources intensive	Food and beverages	144	20.1	114	19.8	83	19.5
	Tobacco	1	0.1	1	0.2	1	0.2
	Wood	21	2.9	9	1.6	5	1.2
	Paper	21	2.9	18	3.1	13	3.1
	Petroleum	6	0.8	6	1	5	1.2
	Fabricated and non ferrous minerals	38	5.3	30	5.2	25	5.9
Natural Resources		**231**	**32.2**	**178**	**30.9**	**132**	**31.1**
Total		**718**	**100**	**576**	**100**	**425**	**100**

Whereas no information on the intensity of the innovative output is provided in the first innovation survey, this valuable data is available in the second survey. Figure 2 presents a diagram of the distribution of the surveyed firms according to the intensity of their innovative sales.

[10] National Classification of activities.

FIGURE 2: Distribution of innovative sales during 1998-2001



Out of 1243 firms, 557 (i.e. 45% of the total number of firms) reported a positive level of innovation output during 1998-2001[11]. This group of firms has an average of 52.2% of innovative sales in total turnover in 2001, but the dispersion of firms around this value is large. For example, there is a group of 167 highly innovative firms (which amounts to 30% of total innovators), with an innovative output during 1998-2001 that amounts to more than 80% of their total turnover in 2001. On the other hand, 153 innovators (27% of this group) have low output intensities, which range from 1% to 20% of total sales in 2001. Finally, 686 firms (55% of the firms surveyed) declare a null share of innovative sales during the period under analysis (hence, they are non innovators).

Firms' performance

Considering the evolution of labor productivity (measured by sales per employee), it is clear that between 1992 and 1998 surveyed firms experienced a period of high growth (37%), while the opposite occurred during 1998-2001 (-11.5%). Notably, growth rates were markedly higher for innovators (45.7% during 92-98) and their decline was slightly less severe (-10.8% during 98-01) when compared to the whole sample (table 3).

[11]. It is important to remark that this percentage of innovators is not strictly comparable to the 59% figure mentioned for the dataset of 718 firms. The reason is that the former considers product innovators (to calculate the importance of innovative sales) while the latter also includes process innovators. A comparable figure can be obtained from table 1, where the number of product innovators is 353 (adding both product and process and only product), which is equivalent to 49% of the 718 firms considered.

TABLE 3: Firms' performance

	1992		1996		1998		2001	
	Avg*	%**	Avg*	%**	Avg*	%**	Avg*	%**
All surveyed firms								
Total Labor****	100.0		93.1		91.0		79.8	
In terms of total employees								
Sales*** (thousands of pesos)	100.0		127.3		137.3		121.6	
Growth rate (%) *****	-		27.3		7.8		-11.5	
Skilled labor (%)	7.4	83	8.1	84	18.4	92	19.5	92
In terms of total sales (%)								
Exports	13.9	44	14.9	60	16.5	51	19.4	54
Imports	13.6	64	14.9	73	17.5	62	14.6	60
Investment in capital goods	7.2	77	8.5	76	7.1	69	7.2	60
Innovators								
Total Labor****	100.0		94.3		109.2		96.4	
In terms of total employees								
Sales*** (thousands of pesos)	100.0		130.4		145.7		130.0	
Growth rate (%) *****	-		30.4		11.7		-10.8	
Skilled labor (%)	7.5	87	8.3	89	20.2	96	21.4	96
In terms of total sales (%)								
Exports	13.4	49	14.8	67	16.2	64	18.0	67
Imports	13.9	71	15.4	80	16.4	76	14.6	74
Investment in capital goods	7.2	82	8.5	82	6.0	82	4.3	75
Product and Process Innovators								
Total Labor****	100.0		94.5		112.3		100.5	
In terms of total employees								
Sales*** (thousands of pesos)	100.0		128.8		154.6		138.0	
Growth rate (%) *****	-		28.8		20.1		-10.7	
Skilled labor (%)	7.6	89	8.4	90	21.1	97	22.7	97
In terms of total sales (%)								
Exports	12.5	50	14.4	68	15.6	67	18.1	70
Imports	14.1	72	13.9	81	16.3	81	14.3	78
Investment in capital goods	6.1	84	6.2	83	6.0	85	4.6	77
Only Product Innovators								
Total Labor****	100.0		103.5		201.7		151.9	
In terms of total employees								
Sales*** (thousands of pesos)	100.0		129.3		121.9		103.7	
Growth rate (%) *****	-		29.3		-5.8		-14.9	
Skilled labor (%)	8.1	77	8.7	79	17.8	92	18.0	92
In terms of total sales (%)								
Exports	12.6	52	14.2	60	9.4	51	11.1	57
Imports	13.3	67	18.0	73	15.2	65	14.9	62
Investment in capital goods	7.2	69	14.7	69	5.2	78	3.0	68
Only Process Innovators								
Total Labor****	100.0		81.5		104.3		95.0	
In terms of total employees								
Sales*** (thousands of pesos)	100.0		163.0		172.2		157.9	
Growth rate (%) *****	-		63.0		5.6		-8.3	
Skilled labor (%)	5.6	79	6.1	82	18.6	97	19.1	99
In terms of total sales (%)								
Exports	33.5	35	24.3	53	23.3	64	23.0	64
Imports	10.2	53	35.4	76	17.8	67	15.4	65
Investment in capital goods	24.3	74	34.8	85	6.4	74	3.9	74
* Calculated for firms that report a positive value of the respective variable.								
** Percentage of firms that report a positive value of the respective variable.								
*** Excluding sales of goods produced by third parties. 1992=100								
**** 1992=100								
***** Calculated with respect to the previous period								

As shown in table 3, total employment in surveyed firms shows a steadily decreasing trend throughout the 90s. However, in the case of innovators employment in 1998 was higher than in

1992. While the reduction in workforce reached 20% for all surveyed firms comparing 2001 with 1992, it amounted to only 3.6% in the case of innovators.

The weight of skilled labor in total employment increased without interruption throughout the 90s, from around 7.4% up to almost 20%, the increase being larger for innovators than for the whole sample. A similar trend is visible regarding export and import coefficients (except in 2001 regarding imports, a consequence of the already mentioned economic crisis). Whereas a higher than average proportion of innovators participate in foreign trade, their export and import intensities do not seem to differ considerably with respect to the surveyed firms' average.

Finally, the number of firms reporting investments in capital goods decreased notably in 2001: while 77% of the surveyed firms reported positive investments in 1992 only 60% did so in 2001. Although innovators have been more prone to acquire capital goods when compared to the surveyed firms' average, unexpectedly, the intensity of their investments was lower (relative to their sales) in 1998 and 2001 than for the sample as a whole.

Expenditures in innovation activities

To begin with, it is important to emphasize that, as shown in table 4, after increasing in 92-96, the number of firms engaged in innovation activities (i.e. firms with positive innovation expenditures) decreased markedly -from 59 % to 45 %- during the period 1996-2001. Furthermore, among these firms, the intensity of total expenditures on innovation activities decreased to 3% of total sales in 2001 from a maximum higher than 4%, which was reached in 1996[12]. This latter pattern is observed for both innovators and non-innovators.

On the other hand, the intensity of in-house R&D expenditures for R&D performing firms increased considerably since 1996, even during the recession period (see table 4). This trend holds for innovators and for the whole sample and it is also observed in the sample of 1243 firms (table 5). Furthermore, the share of R&D performing firms increased from 22% in 1992 to 28% in 2001. This figure is substantially higher among innovators -in particular, among product and process innovators- (table 4).

[12]. Total innovation expenditures include, in addition to R&D and technology acquisition (which are analyzed below), management, engineering and industrial design investments related to innovation activities.

TABLE 4: Innovation and R&D activities

		1992		1996		1998		2001	
		Average	**%**	**Average**	**%**	**Average**	**%**	**Average**	**%**
All surveyed firms	R&D	0.89	22	0.83	29	0.86	25	0.94	28
	Technology acquisition	4.99	28	4.22	45	4.26	33	2.82	31
	Total	3.93	46	4.08	59	3.91	45	3.04	45
Innovators	R&D	0.89	27	0.84	35	0.87	40	0.93	45
	Technology acquisition	5.03	33	4.10	53	4.29	50	2.79	50
	Total	3.93	55	4.00	69	4.00	68	3.06	70
Product & Process Innovators	R&D	0.87	29	0.80	37	0.93	49	0.95	53
	Technology acquisition	4.87	36	4.18	55	4.26	51	2.97	51
	Total	3.91	57	4.14	72	3.99	72	3.13	73
Only Product Innovators	R&D	0.89	19	0.94	29	0.80	35	1.08	40
	Technology acquisition	6.40	23	3.77	35	4.19	43	2.42	40
	Total	3.99	44	2.92	60	3.96	60	3.20	60
Only Process Innovators	R&D	1.80	12	1.93	15	0.26	13	0.35	17
	Technology acquisition	7.49	15	2.73	35	4.47	54	2.35	54
	Total	4.39	32	2.84	50	4.07	63	2.61	67

Averages measure expenditures as a percentage of total sales. Calculated for firms that report a positive value for the respective variable.
% indicates the percentage of firms that report a positive value for the respective variable.

As shown in table 4, extramural technology acquisition expenditures (which, for the sample of 718 firms, include technology transfer and investment in capital goods related to innovation activities) fell to 2.82% of total sales in 2001, after reaching an intensity of 4.26% in 1998. Furthermore, after a substantial increase in 92-96, the proportion of the total surveyed firms investing in technology acquisition decreased sharply throughout the years under consideration (from a peak of 45% in 1996 up to 31% in 2001). However, this fall was lower among innovators, since 50% of the firms belonging to this group reported positive expenditures in technology acquisition in 2001 while 53% did so in 1996.

Based on the dataset for 1243 firms, extra mural expenditures can be broken down into embodied and disembodied technology inputs[13], either imported or locally acquired as shown in table 5. As mentioned above, it is clear that expenditures in technology external to the firm decreased significantly during 1998-2001 among innovators as well as among non-innovators. This trend is particularly visible in table 5 in the case of (domestic and imported) embodied technology. Nevertheless, considering the intensity of expenditures, imported capital goods are still, by far, the most important source of technology acquisition for manufacturing firms in Argentina.

[13]. In this dataset, technology acquisition has a broader definition than in the matched dataset, due to enhanced information availability. Embodied technology now includes capital goods and hardware investments related to innovation activities. Disembodied technology consists of external R&D, software, technological licenses, training and consulting expenditures related to innovation activities. This information is only provided by the second survey, together with the percentage of those technological inflows that comes from foreign sources. The latter allows disembodied and embodied investments to be further divided into domestic and imported expenditures.

TABLE 5: Innovation and R&D activities, %

			1998		2001	
			Average*	**%****	**Average***	**%****
All surveyed firms (1243)						
In house R&D			0.84	25	0.97	27
Technology acquisition	Imported	Embodied	4.03	21	2.15	19
Technology acquisition	Imported	Disembodied	0.61	10	0.82	12
Technology acquisition	Domestic	Embodied	2.52	34	1.7	35
Technology acquisition	Domestic	Disembodied	0.94	37	0.86	43
Total Expenditures in Innovation Activities			4.52	51	3.15	54
Innovators (557 firms)						
In house R&D			0.90	46	1.02	47
Technology acquisition	Imported	Embodied	3.73	32	2.09	28
Technology acquisition	Imported	Disembodied	0.57	15	0.89	17
Technology acquisition	Domestic	Embodied	2.19	52	1.59	53
Technology acquisition	Domestic	Disembodied	1.13	57	0.97	64
Total Expenditures in Innovation Activities			4.55	77	3.35	80
Non Innovators (686 firms)						
In house R&D			0.53	7.3	0.75	9.8
Technology acquisition	Imported	Embodied	4.66	12	2.27	11
Technology acquisition	Imported	Disembodied	0.68	6.1	0.7	7.1
Technology acquisition	Domestic	Embodied	3.26	19	1.95	20
Technology acquisition	Domestic	Disembodied	0.53	21	0.65	26
Total Expenditures in Innovation Activities			4.47	31	2.78	33

* Expenditures as a percentage of total sales. Calculated for firms that report a positive value for the respective variable.
** % of firms that report a positive value for the respective variable.

Investments in imported technology are higher than in domestic ones in the case of embodied technology both in 1998 and 2001, while the opposite occurs with regard to disembodied technology. Furthermore, the share of firms that declared to have innovative expenditures from domestic sources is larger than for those that acquired technology from foreign sources (this result holds both for innovators as well as for non innovators). This suggests that even if firms invest more intensely in the acquisition of foreign technologies than in domestic ones, the latter seemingly have a higher level of diffusion.

Expectedly, more firms undertake R&D and technology acquisition activities among innovators than among non-innovators. However, there are no relevant differences in the relative intensity with which firms in both groups resort to the different sources of technology (tables 4 and 5).

Cooperation linkages

The second survey also provides information on cooperation linkages related to innovation activities undertaken by manufacturing firms during 1998-2001. Table 6 shows that manufacturing firms have, primarily, engaged in cooperation linkages with domestic sources. This fact is especially clear in the case of research and training institutions.

In general, innovators are markedly more involved in cooperation linkages than non-innovators. This is valid for every linkage type considered irrespectively of its domestic or foreign condition. Suppliers emerge as the most important source of cooperation employed by non-innovators, both among domestic and foreign linkages. Although this is also the case for foreign linkages among innovators, the latter have been primarily engaged with research and training institutions when domestic partners are considered. On the other hand, (domestic and foreign) government agencies are, by far, the least widespread source of cooperation among manufacturing firms.

TABLE 6: Cooperation linkages related to innovation activities during 1998-2001, % of firms

Al Surveyed Firms (1243)		
Type	**Domestic linkages**	**Foreign linkages**
Research and Training Institutions	41.7	9.8
Suppliers	44.5	24.7
Clients	33.8	14.6
Other Firms	38.1	13.4
Government agencies	6.4	0.8
Firms of the same group	22.4	15.0
Innovators (557 firms)		
Type	**Domestic linkages**	**Foreign linkages**
Research and Training Institutions	56.7	15.8
Suppliers	54.9	37.2
Clients	43.3	22.4
Other Firms	51.2	21.0
Government agencies	9.7	1.6
Firms of the same group	29.8	21.0
Non innovators (686 firms)		
Type	**Domestic linkages**	**Foreign linkages**
Research and Training Institutions	29.4	5.0
Suppliers	36.0	14.6
Clients	26.1	8.2
Other Firms	27.6	7.3
Government agencies	3.8	0.1
Firms of the same group	16.3	10.1

b) Econometric analysis and results

Within the framework of the CDM approach, this section analyzes the innovation activities and performance of Argentine manufacturing firms during 1992-2001. The econometric exercises are primarily based on matched information for the above-mentioned panel of 718 firms from both innovation surveys. It is relevant to remark that this dataset collects information from the subset of firms sampled in both surveys (out of a total of 1639 and 1243 firms in 92-96 in 98-01 respectively).

We consider that our estimations are not subject to sample selection (attrition) issues that would arise if the available data were not representative of the population of manufacturing firms. Since the innovation surveys in Argentina were not designed or intended to follow the behavior of firms over time, but to obtain a representative sample from the universe of manufacturing firms in the Argentine industry, the decision to include the firms in and out of the survey was made randomly.

Considering the group of firms common to both surveys allows the use of panel data techniques in the econometric exercises. Otherwise, this would have been impossible since the data on innovative output is not reported on a year-by-year basis, but only once for the period being covered by each survey. Nevertheless, it is important to point out that, in this paper, fixed effects in panel data analysis are sector specific and not firm specific, as is the usual practice in econometric studies[14]. The reason is that, in general, the independent variables in our dataset do not present enough time variation to allow their effects on the dependent variables to be estimated separately from a firm specific fixed effect[15].

We also present econometric results based on the cross section of 1243 manufacturing firms from the second survey of innovation. As stated before, the advantage of this second dataset is that, although it does not allow the use of panel data techniques, it contains information not available in the panel of 718 firms regarding the intensity of the innovative output, extramural technology acquisition (see footnote 11) and cooperation linkages.

We begin with a brief comment on the estimation procedure and the measurement of the variables of the model. Afterwards, the main findings are presented. Tables with econometric results and further details can be found in the appendix.

Estimation strategy

In order to analyze the first two stages of the CDM approach using the panel data of 718 firms, a two-tiered model is estimated[16]. In accordance with the received literature, this model allows the decision to engage in innovation activities and its intensity to be explained by different mechanisms. This seems particularly appropriate for the Argentine case since a large proportion of the surveyed firms did not undertake innovation activities (41% in 1996 and 55% in 2001, as can be deducted from table 4).

In this model, the first tier is whether or not the firm decides to invest resources in innovation activities. This is analyzed by estimating and comparing pooled and fixed effects logit estimators[17]. The dependent variable is a dummy that identifies the group of firms, which reported a positive innovation input (expenditures in either R&D, technology acquisition, management, engineering and industrial design) in each period under analysis. The second tier

[14] The sector variable used in the fixed effects regression is based on the classification of sectors presented in table 2 (21 sectors at two-digit industry level of the CLANAE, the National Classification of Economic Activities).

[15] In fact, when firm specific fixed effects were included in the estimations presented in this study, it was observed that, although in most cases the sign of the coefficients did not differ with the sector specific fixed effects estimations, statistical significance at conventional levels was not attained.

[16]. An alternative to this model is the Heckman sample selection model (see the appendix and Wooldridge, 2002, for further details). Nevertheless, its adaptation to panel data entails a substantial computational cost. Furthermore, the Heckman model presents no clear performance advantages with respect to the two tier model, at least for cross sectional data (see Leung and Yu 1996).

[17]. In general, the estimated pooled and fixed effects logit coefficients agreed on the sign and significance of the explanatory variables. Therefore, in the presentation of the econometric results below, no distinction is made between these models, except for the few cases of disagreement.

determines the intensity of this investment. This stage is estimated by standard fixed and random effects analysis using only the sub sample of firms with strictly positive expenditures in both periods[18]. The intensity of the innovation activities is measured by the natural logarithm of the yearly average of total innovation expenditures in each of the two periods under analysis (in terms of total employees in 1996 and 2001 respectively).

Regarding the third stage of the CDM approach, the dataset of 718 firms enables an analysis of the determinants of the probability of successfully introducing new (or improved) product and/or process innovations. The objective is to inquire for differences not only among innovators and non-innovators, but also among different kinds of innovators. Therefore, the innovation output indicator is a categorical variable that classifies firms as only product, only process, both product and process and non innovators for each of the two time periods covered by the dataset. For this stage, the estimated econometric model is a multinomial logit since, unlike the case of the first stage of the CDM approach; the dependent variable has more than two possible (unordered) outcomes.

Finally, the fourth stage involves the fixed and random effects estimation of the impact of the innovative output on firms' performance, measured by the natural logarithm of the total sales of own products per employee[19] in 1996 and 2001, respectively[20].

As mentioned above, panel data estimations are complemented and compared with econometric exercises for a cross section of 1243 manufacturing firms from the second survey of innovation. In this case, the first three stages described in section 1 were estimated by two standard sample selection models (see the appendix for details). The final stage involves the ordinary least squares (OLS) estimation of the impact of the innovative output on the performance of the firm.

The estimation using this second dataset involves five dependent variables. The first stage of the CDM approach requires defining a dummy variable to distinguish between firms that have and have not incurred in positive innovation expenditures in 1998-2001. Secondly, as with the panel dataset, the intensity of innovation expenditures is measured by the yearly average of innovation expenditures (relative to total employment in 2001) during the analyzed periods. In the estimation of the third stage of the CDM approach, a firm is considered to be an innovator if it has reported positive sales accounted by new or significantly improved products introduced during 1998-2001. The magnitude of this variable (measured in terms of employee in 2001) defines the intensity of the innovative output in the fourth stage of the CDM approach. Finally, the performance of the firm is measured by the sales per employee in 2001[21].

With respect to the explanatory variables used in the econometric estimations, as in the previous section, innovation inputs are classified into R&D and technology acquisition in the panel data analysis. Also, firms are divided into continuous and non-continuous R&D performers[22]. Using

---

[18]. Nevertheless, the results reported in the following paragraphs are based on the fixed effects estimation, since the Hausman test rejected the hypothesis that differences in the estimated coefficients from both models were not systematic (p-value is 0.0000)

[19]. Excluding sales of goods produced by third parties.

[20]. As with the second stage of the CDM, the reported results are based in the fixed effects estimation, since a Hausman test rejected the null hypothesis of random effects (p-value is 0.0001 in this case).

[21]. The three continuous dependent variables (innovation expenditures, innovative output and productivity) are measured in natural logarithms. The dummy variables (probability of having innovative expenditures and being an innovator) are used in the selection equations of the sample selection models applied to the first and the third stage of the CDM approach.

[22]. A firm is considered to be a continuous R&D performer in a given period of time (92-96 or 98-01) if it reports positive R&D expenditures in every year of it.

the cross sectional data of the second innovation survey allows technology acquisition investment to be further divided into embodied or disembodied and imported or domestic expenditures. These activities are captured by dummy variables equal to one if expenditures are positive during the period considered (92-96 or 98-01).

Finally, in every stage of the estimations with both datasets, we have included the usual control variables considered in the literature such as size, labor skills, physical capital, foreign ownership, exports and whether the firm is independent or belongs to an economic group. An index considering total employees and sales is used as a proxy for the size of the firm. Labor skills and physical capital are proxied by the average number of technical and professional employees and investment in capital goods respectively, in terms of total employees in each period. The dummy for foreign ownership is equal to one if non-resident investors own more than 10% of a firm's equity capital[23]. To capture the effects of export activity on the dependent variables, a dummy, equal to one if the firm exported during the period considered, is included[24].

Also, the surveyed firms were classified into four groups (labor, scale, R&D and natural resources intensive) in order to control for different availability of technological opportunities (see table 2)[25]. Finally, the information available in the cross section of 1243 firms allows controlling for differences in the firms' innovation processes (such as interactions and/or cooperation linkages with foreign or domestic government agencies, clients, suppliers, universities, competitors, etc.) using dummy variables in the first three stages of the CDM approach[26].

The decision to undertake innovation activities and the intensity of innovation

The initial step of the estimation aims at identifying the determinants of the first two stages of the CDM approach: the decision to undertake innovation activities and the intensity of these activities at the firm level. Table 7 presents a brief summary containing qualitative information on the estimation results (the complete econometric results are shown in tables A3 to A7).

[23]. The reported results are not significantly altered if this dummy takes the value one when foreign ownership is 51% or 100% of the firm's capital.
[24]. See the appendix for more details on the measurement of the variables.
[25]. As an alternative to this classification, the regressions were also estimated using the 22 industrial sectors described in table 2 as controls for technological opportunity. Although not reported in the appendix, the estimated coefficients of the variables of interest are robust to either specification.
[26]. In the estimation of the third stage of the CDM approach, the distinction between foreign and domestic linkages was avoided only because it would have consumed too many degrees of freedom in the regression and, hence, the estimations would have lost statistical significance.

TABLE 7: The decision to undertake innovation activities and the intensity of innovation - Summary of econometric estimations[27]

Panel of 718 firms* (92-01)

Explanatory Variable	Probability of positive innovation expenditures*	Intensity of innovation expenditures**
Size	+	-
Tsize	+	+
Group	0	0
Skills	+	+
Exports	+	+
FDI	0	0
TsecL	0	0
TsecESC	0	0
TsecRN	+	0
Time01	0	0
* Results from the Fixed Effects Logit estimation		
** Results from standard fixed effects estimation		

Cross section of 1243 firms (98-01)

Explanatory Variable	Probability of positive innovation expenditures	Intensity of innovation expenditures
Size	+	0
Group	0	0
Skills	+	0
Exports	+	0
FDI	+	0
sectRN	0	0
SectRD	+	0
SectESC	0	0
NSIcif		0
NSIpro		0
NSIcli		0
NSIother		+
NSIgroup		0
NSIgob		0
EXcif		0
Expro		+
Excli		-
EXgroup		+
Exother		+
EXgob		0

To begin with, the estimation with both datasets shows that the size of the firm is a relevant explanatory variable in the first stage[28]. In other words, larger firms are more prone to be engaged in innovation activities. Furthermore, this effect was reinforced during 98-01 with respect to 92-96. This could be the result, among other determinants, that innovation expenditures are, *ceteris paribus*, more difficult to undertake and to finance the smaller is the firm and that this asymmetry is reinforced in times of macroeconomic instability.

On the other hand, panel data analysis suggests that the relationship between the intensity of the innovation expenditures (second stage of the CDM approach) and size was not constant over time, being negative during 92-96 but positive in 98-01[29]. Thus, while larger size implied lower innovation expenditure per employee during 92-96, the changes in economic environment affecting all firms in the following period caused this effect to be reversed (so that larger firms were associated to higher innovation intensities). Expectedly, as shown in table 7, the panel data estimation supports the hypothesis that labor skills and exports have a positive and significant impact in both of these stages of the CDM approach. This is not the case for the dummy variable representing foreign ownership, which increases the chances of undertaking innovation activities (only in the cross sectional estimation) but does not affect the intensity of

27. + or - correspond to the sign of a (statistically significant at 10%) estimated coefficient. See the appendix for a definition of the variables included in this table. Cooperation linkages are classified into domestic (NSI) and foreign (EX).

28. Throughout this section we characterize a variable as “statistically significant” if the p-value of its associated coefficient is smaller than 10%.

29. This result is obtained by comparing the magnitudes of the estimated coefficients associated, on one hand, to size and, on the other, to the interaction between the time dummy and size variables in the fixed effect estimation (see table A5). Also, in the cross sectional data, size has an insignificant statistical impact on innovation expenditures (table A7).

expenditures for a firm which is already engaged in those activities. The dummy variable for being part of a group was not found to affect any of these stages of the CDM approach.

As mentioned above, cooperation linkages are part of the innovation process that might influence the technological behavior of industrial firms. In general, the econometric exercises using the cross section for the 98-01 period reveal that domestic relationships of cooperation do not have a significant impact on the magnitude of the innovation effort (the exceptions are linkages with other firms or consultants). On the other hand, as table 7 also shows, cooperation with different foreign sources seems to have a positive impact on that variable (linkages with foreign suppliers seem to be specially important in this regard). A surprising exception is relationships with foreign clients (negative and significant coefficient).

In general, the 98-01 dataset does not provide evidence of different technological opportunities among the four technological sectors considered, once firm size, skills and exports have been controlled for. The exception are firms operating in R&D intensive branches which are, *ceteris paribus*, the most prone to undertake innovation activities. On the other hand, although fixed effects estimation using the panel dataset for 92-01 does not allow the inclusion of technological sector variables (because they are constant over time), their interaction with the time dummy reveals that firms operating in the resource natural sector intensive sector have, *ceteris paribus*, increased the probability of initiating innovation activities during 98-01.

The innovative output

As mentioned above, the innovative output indicators in the panel of 718 firms are dummy variables that allow the estimation of the probability of introducing new products and/or processes during the years covered in the innovation surveys. As already indicated, this information is complemented using the cross section of 1243 firms that provides firm level information on the intensity of the innovative output, measured by the sales per employee in 2001 accounted by new or improved products introduced during the period 1998-2001[30]. A brief summary of the estimation results obtained from both datasets is presented in table 8 below (the complete econometric results are shown in tables A8 to A10).

[30]. Therefore, this indicator captures the intensity of process innovations only indirectly, through their effect on the development of new products.

TABLE 8: Innovative output - Summary of econometric estimations[31]

Panel of 718 firms* (92-01)

Explanatory Variable	Innovator type		
	Both product and process	Only Product	Only Process
Size	+	0	+
Group	0	0	0
Skills	0	0	0
Expo	+	+	+
FDI10	-	0	0
RDc	+	+	+
RDnc	+	+	0
TechAcq	+	+	+
Time01	-	-	-
secRD	0	0	0
secESC	+	0	0
SecRN	0	0	0

* Results from multinomial Logit estimation (Non- innovators is the comparison group)

Cross section of 1243 firms (98-01)

Explanatory Variable	Probability of positive innovation output	Intensity of innovation output
Size	+	+
FDI10	0	0
Group	0	0
Skills	0	0
expo	+	0
RDc	+	+
RDnc	+	0
TDinc	0	+
TMinc	0	+
TDdesin	0	0
TMdesin	0	0
Cif	+	0
Pro	+	0
Cli	0	0
Grouplink	0	+
Other	+	0
Gob	0	0
SectRN	0	0
SectRD	0	0
SectESC	0	+

Following the CDM approach, the main focus of this section is to determine the impact of different innovation activities on the innovative output indicators. Innovation inputs are thus classified as intramural (continuous and non continuous) R&D and external technology acquisition.

Firstly, the estimations reveal that in house R&D performers have a greater probability (*vis a vis* non R&D performers) of having a positive innovative output and that this effect becomes larger if the firm is a continuous R&D performer. This is robust result that holds both in the panel and cross sectional datasets[32]. This means that a firm performing continuous R&D activities will, *ceteris paribus*, introduce innovations more likely than a firm, which performs it discontinuously.

Technology acquisition has a positive and significant effect on the probability of becoming an innovator –this holds for the three type of innovators considered- (see table 8). However, the estimations support the hypothesis that technology acquisition has a smaller impact on the likelihood of introducing both product and process and only product innovations than R&D expenditures (particularly when R&D is performed as a continuous activity)[33]. The opposite holds with respect to only process innovations. This result reflects the fact that the main component of technology acquisition is embodied technology, which is a key source of process innovations in the manufacturing industry.

Furthermore, although performing R&D augments the chances of becoming an innovator (i.e. of having positive innovation output), it also increases the relative likelihood of both product and

[31] + or - correspond to the sign of a (statistically significant at 10%) estimated coefficient. See the appendix for a definition of the variables included in this table.
[32]. The only exception is that non continuous R&D expenditure does not appear to have a significant impact on the odds ratio of obtaining a process innovations against no innovation output.
[33]. This result is obtained by comparing the magnitude of the estimated coefficients the R&D activity and technology acquisition variables in table A8.

process and only product innovations against only process innovations[34]. Interestingly, unlike R&D activities, technology acquisition seems to be a "neutral" innovative input in this sense, since although it increases the possibility of having any type of innovation output, it does not affect significantly the relative likelihood among the different output classes considered.

Turning to the innovative output intensity, based on the available cross sectional information for 1243 firms, it can be observed in table 8 that, for innovators, R&D investment has a positive impact only if it is done in a continuous fashion. While embodied technology (acquired either domestically or abroad) expenditures have a positive and significant effect on the intensity of innovative sales, disembodied technology seems statistically insignificant.

The magnitude of the estimated coefficients provides information on the different impact of the variables under analysis. As shown in table A10, the results suggest that the impact of imported embodied technology is about three times larger than the estimated effect for continuous R&D expenditures (this means that for a continuous R&D performer, each peso per employee invested in imported embodied technology will, *ceteris paribus*, yield an innovative output three times larger than for each peso per employee invested in R&D). On the other hand, the small coefficient associated to domestic embodied technology indicates a minor economic impact of this variable. Disembodied technology inputs have no impact on the firms' innovative output.

In order to capture substitution or complementarity effects among R&D and the different kinds of extramural technology sources on the innovation output intensity, the usual practice is to include interaction terms between those variables in the econometric regressions (see, for example, Hu *et al* 2003a). Following this methodology with the cross sectional data, we have found no general evidence supporting the existence of these effects[35].

Nevertheless, the estimation results suggest that while R&D investment is a fundamental determinant of the probability of successfully introducing innovations (but a moderate factor in output intensity), extramural (in particular, embodied) technological flows significantly contribute to increase the magnitude of the innovative output, *given that the firm is an innovator*. This result could be interpreted as evidence of a kind of complementary effect between R&D and extramural technological flows that differs from the usually considered link in the received literature. However, this interpretation demands further research.

In obtaining the econometric results from the two datasets, controls for size, labor skills, exports, group and foreign ownership were included. As shown in table 8, the size of the firm has a positive effect on the probability of having an innovative output, particularly with respect to both product and process and only process innovations. Furthermore, in a similar vain to the results obtained in the second stage of the CDM approach, the cross sectional results show that size has an increasing impact on the intensity of the innovative output.

Quite unexpectedly, the econometric results from both datasets suggest that labor skills do not have statistical significance in this stage of the estimation. Export activity only impacts the probability of having an innovative output. The dummy for being part of a group impacts neither on the probability nor on the intensity of the innovative output. The negative coefficient associated to the dummy for foreign ownership in the multinomial logit estimation suggests that foreign firms are, *ceteris paribus*, less likely to introduce innovations (although this difference is statistically significant regarding both product or process innovations).

[34]. This result holds both for continuous and discontinuous R&D expenditure (see table A9).

[35]. This result generally holds when technological flows are measured either as continuous or dummy variables as well as for continuous or sporadic R&D performers.

Regarding sectors, firms operating in the scale intensive sectors appear to have a higher likelihood of introducing both products and process innovations. In turn, firms in these sectors also seem to have, *ceteris paribus*, the highest innovation intensity *vis a vis* those operating in other sectors, as revealed in the cross sectional estimations.

The results from the cross sectional data in table 8 also show that cooperation linkages have heterogeneous impact on the innovative output of manufacturing firms in Argentina. Interactions with research and training institutions, suppliers and other firms have a significant impact only on the probability of launching new products, but not on the intensity of that activity. The opposite occurs when cooperation is undertaken within firms belonging to the same group. Linkages with clients or government agencies have no impact on the innovation output.

Finally, as expected (given the hostile domestic economic environment), the panel data results for the time dummy variable show that in the 98-01 period firms were less likely to have a positive innovation output (i.e. to become innovators).

Firm performance

As shown in table 9, based on the cross sectional data, the OLS regression of sales per employee on the intensity of innovative output (both measured in 2001) yields a positive and significant effect of the latter on the former[36]. Also, the fixed effects estimation using the panel for 92-01 reveals that the dummies for the different types of innovative output have the (positive) expected sign, though high statistical significance is attained only for both product and process innovators (see table 9). The overall picture is that being an innovator (in both product and process) has a direct benefit for the manufacturing firm in Argentina: it contributed to improve its labor productivity during the period under analysis.

As expected, the negative sign associated to the time dummy indicates that manufacturing firms attained, ceteris paribus, smaller productivity levels in 98-01 than in the previous period. Also, proxies for labor skills, physical capital, export activity and size have a positive impact on productivity based on the estimations using both datasets. Being part of a group and foreign ownership are significant explanatory variables in the panel dataset, indicating that foreign firms are, *ceteris paribus*, more productive than domestic firms.

Finally, regarding sectors, the cross sectional data estimations suggest that firms operating in the resource natural sectors have, *ceteris paribus*, the highest productivity, followed by the scale and R&D intensive sectors (the complete econometric results are shown in tables A11 to A13).

[36]. In the cross sectional OLS regression on productivity (table A13), we have included the performance observed in 1998 as an additional regressor. This provides a simple way to account for (unobserved) historical factors that may cause differences among the firms' performances in 2001, which would be difficult to account for in other ways. For example, it is possible that some unobserved factors at the firm level that affected productivity in 1998 continue to do so in 2001. If some of them happen to be correlated with the intensity of the innovative output, it is unlikely to obtain unbiased estimates of the impact of the latter on productivity without including the lagged dependent variable. In fact, the positive and significant coefficient associated to the lagged productivity variable indicates that these unobserved factors are important determinants of productivity and that better performance in 1998 contributed to better performance in 2001.

TABLE 9: Firm Performance - Summary of econometric estimations[37]

Panel of 718 firms* (92-01)

Explanatory Variable	Firm productivity
Only product	0
Only process	0
Both prod & proc	+
Size	+
Skills	+
Ikprodum	+
FDI10	+
Group	+
Expo	+
Time01	-
TsecRN	0
TsecESC	0
TsecL	0
* Results from standard fixed effects estimation	

Cross section of 1243 firms (98-01)

Explanatory Variable	Firm productivity
VinntotL	+
Expo	0
Skills	+
Group	0
Size	+
FDI10	0
IKprom	+
Lprod98	+
SectRN	+
SectRD	+
SectESC	+

3) Concluding remarks

Going back to the four questions posed in the introduction, our findings, which are mostly in line with those of the received literature on the subject, show that:

a) Innovators performed better than non-innovators, both during the high growth period as well as in the recession stage.

b) Performing innovation activities (including both in house R&D as well as technology acquisition) as well as having linkages with other agents (specially suppliers) enhances the probability of becoming an innovator.

c) While R&D investment is a fundamental determinant of the probability of successfully introducing innovations, extramural (in particular, embodied) technological flows significantly contribute to increase the magnitude of the innovative output, *given that the firm is an innovator*.

d) Large firms are more prone to engage in innovation activities and to launch innovations to the market. Exporting is also positively associated with both variables, while human skills influence both the decision to innovate as well as the intensity of the innovative effort.

An important lesson from our findings is that in spite of low R&D expenditures in Argentina's manufacturing industry, firms consider that R&D activities are part of their routines and a valuable asset to be preserved even in bad times. Our results suggest that they do so for good microeconomic reasons, since R&D contributes to become and innovator and, hence, to higher productivity levels than competitors which do not innovate. Public policies geared towards R&D promotion should, thus, have positive results in terms of the overall productivity of the manufacturing sector.

It is very relevant to take into account that only continuous R&D efforts have an impact on the intensity of the firm's innovative output, while discontinuous expenditures do not. Hence,

[37] + or - correspond to the sign of a (statistically significant at 10%) estimated coefficient. See the appendix for a definition of the variables included in this table.

discontinuing in house R&D activities would have a negative influence on the results of those activities. This fact reminds us of the importance of considering that firms also learn to innovate and that this learning must be a continuous process to be effective. Hence, policies aimed at stimulating R&D activities should aim at endogeneizing those activities as part of firms' routines and not only at fostering specific projects.

The finding that the smaller the firm the lower is the probability of having innovation activities and of becoming an innovator tells us that small firms are at a disadvantage against large firms due to factors that prevent them to engage in those kinds of activities. Furthermore, we found that small firms may be even more harmed in this regard during recession periods. To remove the obstacles which may be preventing SMEs to engage in innovation activities is, thus, a key area for policy-makers.

Regarding the research agenda, to learn more about the determinants and impacts of the innovative behavior of Argentine manufacturing firms and its impact on firms' performance, the following issues are important:

i) Since the number of firms declaring to be innovators seems to be quite high, more research is needed on the scope and quality of the innovations introduced by Argentine manufacturing firms.

ii) Since many firms that declare to have been engaged in innovation activities were not innovators during the period under analysis, it would be interesting to learn why this has happened. While it could be due to the fact that innovation activities may have longer-term results (and hence those firms should become innovators in the future), it could also be the case that some firms fail in getting commercially successful innovations. It is also possible that they obtained results that are not translated into product and process innovations but that are anyway useful for other purposes.

iii) At the same time, there are several firms which declare to have introduced innovations but that have not performed any of the innovation activities included in the surveys. Beyond the above-mentioned doubt about the scope and quality of the innovation indicators reported by surveyed firms, this fact could be explained by other factors. On the one hand, they could be the result of innovation expenditures undertaken prior to 1992. It could also be the case that there are activities that are not covered in this kind of surveys that may also lead to a firm to become an innovator. On the other hand, the received literature and our econometric results show that innovation activities are not the only determinants of innovations.

iv) The obstacles to the innovation process, which seemingly affect more intensely to SMEs, should be examined, paying special attention to the role of the access to finance.

v) While we have found that some linkages within the NSI are relevant for the firms' innovative process, it would be important to learn more about the precise nature and impact of those linkages, considering specially the different role of domestic and international linkages.

vi) More research is needed on the relations between domestic innovative efforts and the acquisition of technology and, within the latter, between embodied and disembodied technology inflows, as well as between foreign and domestic ones.

vii) During the period under analysis a number of policies were introduced in order to foster innovation activities in the private sector. Learning about the impact of those policies would be relevant in order to assess and, eventually, improve them.

viii) Finally, given the fact that in our study innovators have a better employment record than non-innovators, it would be equally important to quantify the impact of the introduction of new products and processes on employment evolution. Also, it would be relevant to learn to what extent export performance can be explained by the intensity of innovation inputs and outputs.

Appendix

TABLE A.1: Studies based on the CDM approach. Source: Mairesse & Mohnen (2003).

Study	Individual Data	Endogenous variables	Estimation method	Other comments
Crepon-Duguet-Mairesse (1998)	France 1986-1990	R&D, patent (or share of innovative sales), labor productivity	ALS	Censored data for R&D
Duguet (2002)	France 1986-1990	Radical innovation, incremental innovation, TFP growth	FIML logit for innov., 2SLS or GMM for TFP growth	Separate estimation for various technological opportunities
Galia and Legros (2003)	France 1994-1996	R&D, innovation output, training, quality, profitability	ALS	Censored data for R&D and training, dichotomous data for quality; allows for feedback effects
Janz, Loof and Peters (2003)	Germany and Sweden, 1998-2000	Innovation expenditures/employee, innov. sales/employee, and sales/employee	FIML for gen. Tobit on innov. expend., other equations by 2SLS with correction for selection bias	Censored data for innovation expenditures; feedback effect from productivity on innov. output
Van Leeuwen-Klomp (2001)	Netherlands 1994-1996	Innovation input (R&D or innov. expend.), innovation output, productivity (in levels or growth rates)	OLS, 3SLS limited system, or 3SLS full system (with or without correction for selectivity)	Productivity measured by revenue per employee or value added per employee; feedback effect from revenues on innov. output
van Leeuwen (2002)	Netherlands Panel data from CIS2 and CIS2.5	R&D, innovation output, growth in revenue/employee	FIML gen. tobit for R&D or innovation output; separate FIML for growth of revenue/employee with correction for selection bias	Dynamic model for 1994-96 or pooled model for 1994-96 and 1996-98; innov. output measured by new sales or by new and improved sales.
Benavente (2002)	Chile	R&D, patent (or share of innovative sales), labor productivity	ALS	Censored data for R&D
Loof and Heshmati (2002a)	Sweden	Innov. expend. per employee, innovative sales per employee, and value added per employee	FIML for generalized Tobit on innov. expend., other equations by 2SLS with correction for selection bias	Also estimated with only radical innovations; productivity estimated in levels and growth rates; feedback effect from productivity on innov. output
Loof and Heshmati (2002b)	Sweden	Innov. expend. per employee, innovative sales per employee, and labor productivity	FIML for gen. Tobit for innov. input, other equations by 3SLS with correction for selection bias	Labor productivity measured as innov. sales/employee or value added/employee; feedback effect from productivity on innov. output
Loof Heshmati, Apslund and Naas (2002)	Finland, Norway and Sweden 1994-1996	Innov. expend./employee, innovative sales/employee, and labor productivity	FIML for gen. Tobit for innov. input, other equations by 2SLS and 3SLS with correction for selection bias	Estimation for all innovations and for radical innovations; feedback effect from productivity on innov. output
Jefferson, Huamao, Xioajing and Xiaoyun (2002)	China Panel data 1995-1999	R&D, share of innovative sales, productivity (or profitability)	Separate estimation of each equation by OLS and IV	Square term on innovative sales
Parisi, Schiantarelli and Sembenelli (2002)	Italy, Panel data 1992-1994 and 1997-1995	Labor productivity growth, product innovation, process innovation Product and process innovations estimated by logit or conditional logit, product. growth estimated by IV		
Hu and Jefferson (2003b)	China (Beijing area) 1991-1997	R&D, output and profit Individual and SURE estimation of 2 or 3 equations with correction for selection bias		

The Heckman selection model

Two standard Heckman selection models for innovation expenditures and innovative output were estimated by the maximum likelihood procedure. The model and the assumptions needed for the estimation are:

regression equation: $y_i = X_i\beta + u_{1i}$

selection equation: $s_i = 1[Z_i\gamma + u_2 \geq 0]$

X_i and Z_i are vectors of control variables and $1[*] = 1$ if $*$ is true and 0 otherwise.
Furthermore, $u_1 \sim N(0, sigma)$, $u_2 \sim N(0,1)$ and $corr(u_1, u_2) = rho$

Each sample selection model consists of two equations. The selection equation estimates the probability of observing a strictly positive value of the dependent variables under analysis. The regression equation estimates the intensity of the latter, using the observations for which those variables are strictly positive. Therefore, the selection equation of a first sample selection model estimates the first stage of the CDM approach (i.e., the probability of having positive innovation expenditures) while its regression equation estimates the intensity of those innovation expenditures (second stage of the CDM), given that the firm has positive expenditures. In turn, the second sample selection model estimates the probability of innovating (through its selection equation) and the intensity of the innovative output (through the regression equation -third stage of the CDM approach-), given that the firm is an innovator.

Finally, as mentioned in section 2, the final stage of the CDM approach involves the ordinary least squares (OLS) estimation of the impact of the innovative output on the performance of the firm. The regression is based on the standard linear model and its usual assumptions, except that robust standard errors are calculated to avoid heteroskedasticity in the disturbance term.

Definition of variables

The definitions of the variables used in the econometric regressions are found in the following table (parenthesis refer to the names of the variables as they appear in the tables of econometric results, see below).

TABLE A.2: Definition of variables

VARIABLE	DEFINITION
Innovation expenditures (lginn)	Yearly average of total expenditure in innovation activities during 1992-1996 (98-01), per employee in 1996 (01) (measured in log)
Innovative sales (vinntotL and lvinn when measured in log)	Sales in 2001 accounted by new or improved products developed during 1998-2001, in terms of total employees in 2001 (measured in logarithm when regressed in the innovative output intensity equation)
Sginn	Dependent dummy variable in the selection equation for innovation expenditures. Equal to one if the firm reported positive innovation expenditures throughout 1998-2001
Sinn	Dependent dummy variable in the selection equation for innovative sales. Equal to one if the firm reported positive innovative sales in 2001
Productivity in 2001 (lprod)	Sales of own products per employee (log)
Productivity in 1998 (lprod98)	Sales of own products per employee in 1998 (log)

Size (insize)	According to the legal definitions currently in place in Argentina (mostly for purposes of defining whether a firm has or not the right to take advantage of some policy instruments aimed at SMEs) in order to include firms in different size segments, we have used the following formula: $I = \left(10 \ x \ \frac{Emp}{Emp^*} \ x \ 10 \ x \ \frac{Sales}{Sales^*} \right)^{1/2}$, where Emp stands for total employees and Sales for total sales Emp* = 300 employees and Sales* = $ 18 million
Foreign (FDI10)	Dummy equal to one if foreign capital share is equal or greater than 10%
Skills	Average share of technical and professional labor between 1998 and 2001
Investment in capital goods (Ikprom and Ikprodum)	Average investment in capital goods between 1998 and 2001, in terms of total employee in 2001. Ikprodum is a dummy equal to one if Ikprom is positive
Group	Dummy equal to one if the firm is part of a group
Exports (expo)	Dummy equal to one if the firm exported in the period considered
Research and development (RD)	Yearly average during 1998-2001 per employee in 2001
RDdummy	Dummy equal to one if the firm reported positive R&D expenditures during 1998-2001
RDc	Dummy equal to one if the firm reported positive R&D expenditures in every year during in the period considered
RDnc	Dummy equal to one if the firm reported non continuous R&D expenditures during the period considered
RDRDdummy	Interaction term between R&D and RDdummy
RDRDcont	Interaction term between R&D and RDc
Technology acquisition(GexMpd)	Dummy equal to one if the firm reported positive Technology acquisition expenditures during in the period considered
Domestic embodied technology (TDinc)	Yearly average during 1998-2001 per employee in 2001
Domestic disembodied technology (TDdesin)	Yearly average during 1998-2001 per employee in 2001
Imported embodied technology (TMinc)	Yearly average during 1998-2001 per employee in 2001
Imported disembodied technology (TMdesin)	Yearly average during 1998-2001 per employee in 2001
RDTMinc	Interaction term between R&D and Imported embodied technology
RDTMdesi	Interaction term between R&D and Imported disembodied technology
RDTDinc	Interaction term between R&D and Domestic embodied technology
RDTDdesi	Interaction term between R&D and Domestic disembodied technology
Clients (cli)	Dummy equal to one when firm reports cooperation linkages with clients during 1998-2001
Suppliers (pro)	Dummy equal to one when firm reports cooperation linkages with suppliers during 1998-2001
Research and training institutions (cif)	Dummy equal to one when firm reports cooperation linkages with such institutions during 1998-2001
Government agencies (gov)	Dummy equal to one when firm reports cooperation linkages with government agencies during 1998-2001
Other firms (other)	Dummy equal to one when firm reports cooperation linkages with consultants and other firms during 1998-2001

Group linkages (Grouplink)	Dummy equal to one when firm reports cooperation linkages with firms of its group during 1998-2001
SectRN	Dummy equal to one if the firm belongs to the natural resources intensive sector*
SectRD	Dummy equal to one if the firm belongs to the R&D intensive sector*
SectESC	Dummy equal to one if the firm belongs to the scale intensive sector*
SectL	Dummy equal to one if the firm belongs to the labor intensive sector*

* This classification was developed by Pavitt (1984) and later adapted by Guerrieri and Milana (1989) and Guerrieri (1992).

Tables of econometric results

TABLE A.3 - Pooled Logit model for the decision to undertake innovation activities – Maximum likelihood estimation

Group variable (i): sector2			
Number of obs	1420	Pseudo R2	0.1275
LR chi2(10)	249.77	Log likelihood	-854.47327
Prob > chi2	0.0000		

Dependent Variable: sginn						
	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Insize	0.0822047	0.0273997	3.000	0.003	0.0285023	0.135907
Tinsize	0.0986163	0.0482345	2.045	0.041	0.0040784	0.1931543
Group	0.1200962	0.1505695	0.798	0.425	-0.1750146	0.4152069
Skills	2.848353	0.5620299	5.068	0.000	1.746795	3.949911
Expo	0.7210285	0.1306675	5.518	0.000	0.4649249	0.9771321
FDI10	0.3674374	0.1905353	1.928	0.054	-0.0060049	0.7408797
TsecL	-0.5146936	0.2929241	-1.757	0.079	-1.088814	0.0594271
tsecESC	-0.3487864	0.2732857	-1.276	0.202	-0.8844164	0.1868437
tsecRN	-0.0040758	0.2795789	-0.015	0.988	-0.5520405	0.5438889
time01	0.1986004	0.300066	0.662	0.508	-0.3895181	0.7867188
_cons	-1.46639	0.1456481	-10.068	0.000	-1.751855	-1.180925

TABLE A.4 - Conditional Fixed Effects Logit model for the decision to undertake innovation activities – Maximum likelihood estimation

Number of obs	1418	Number of groups	20
Group variable (i): sector2		Obs per group:	
LR chi2(11)	184.56	min	12
Prob > chi2	0.000	avg	70.9
Log likelihood	-785.93262	max	284

Dependent variable: sginn						
	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
Insize	0.0841481	0.0295598	2.847	0.004	0.0262119	0.1420843
Tinsize	0.0966488	0.049785	1.941	0.052	-0.000928	0.1942256
Group	0.0407993	0.1545841	0.264	0.792	-0.2621799	0.3437785
Skills	2.467204	0.5963804	4.137	0.000	1.29832	3.636088
Expo	0.6445441	0.1349862	4.775	0.000	0.379976	0.9091122
FDI10	0.2660047	0.1947163	1.366	0.172	-0.1156323	0.6476417
TsecL	0.4209053	0.3966104	1.061	0.289	-0.3564368	1.198247
tsecESC	-0.2154082	0.3681751	-0.585	0.559	-0.9370181	0.5062018
tsecRN	0.8008088	0.3715744	2.155	0.031	0.0725364	1.529081
time01	-0.2343154	0.3517374	-0.666	0.505	-0.923708	0.4550772

TABLE A.5 Fixed Effects regression for innovation expenditures

Number of obs	651		
Group variable (i) : sector2		Obs per group: min	2
Number of groups	21	avg	31.0
R-sq:		max	128
Within	0.0809	F(10,620)	5.46
between	0.2011	Prob > F	0.0000
overall	0.0913	corr(u_i, Xb)	0.0683

Dependent variable: lginn						
	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnsize	-0.0521282	0.0248093	-2.101	0.036	-0.1008487	-0.0034077
tinsize	0.088789	0.0314011	2.828	0.005	0.0271236	0.1504544
Group	-0.0630213	0.13436	-0.469	0.639	-0.3268771	0.2008344
Expo	0.3361785	0.1384968	2.427	0.015	0.0641989	0.6081582
Skills	1.666183	0.5182075	3.215	0.001	0.6485288	2.683838
FDI10	-0.1067782	0.1545528	-0.691	0.490	-0.4102887	0.1967322
TsecL	-0.3290843	0.3853297	-0.854	0.393	-1.085794	0.4276252
tsecESC	-0.0829386	0.318115	-0.261	0.794	-0.7076519	0.5417748
tsecRN	0.0888337	0.3276744	0.271	0.786	-0.5546525	0.7323199
time01	0.0204473	0.2976316	0.069	0.945	-0.5640408	0.6049354
_cons	-0.667506	0.1692807	-3.943	0.000	-0.9999391	-0.335073
Sigma_u	0.58878018					
Sigma_e	1.4325701					
Rho	0.14450763	(fraction of variance due to u_i)				
F test that all u_i=0:	F(20,620) = 1.77		Prob > F = 0.0207			

TABLE A.6 - Hausman Specification Test for innovation expenditures estimation

Hausman specification test			
	Fixed Eff	Random Eff	Difference
insize	-0.0521282	-0.04448	-0.0076481
tinsize	0.088789	0.0866771	0.0021119
Group	-0.0630213	0.0425011	-0.1055225
expo	0.3361785	0.3252574	0.0109211
Skills	1.666183	2.144851	-0.4786676
FDI10	-0.1067782	-0.0763067	-0.0304715
tsecL	-0.3290843	-0.598017	0.2689326
tsecESC	-0.0829386	-0.1232531	0.0403146
tsecRN	0.0888337	-0.2771977	0.3660314
time01	0.0204473	0.1260581	-0.1056108
Test: Ho: difference in coefficients not systematic			
chi2(10)		49.93	
Prob>chi2		0.0000	

TABLE A.7 Sample selection model for innovation expenditures – Maximum likelihood estimation (Cross sectional data)

Number of obs	1243	Wald chi2(20)	96.93
Censored obs	459	Prob > chi2	0.000
Uncensored obs	784	Log likelihood	-2276.729

Regression equation. Dependent variable: lginn						
	Coef.	Robust S. E.	z	P>|z|	[95% Conf. Interval]	
insize	0.0035936	0.0250733	0.143	0.886	-0.0455491	0.0527364
FDI10	-0.1815199	0.2177341	-0.834	0.404	-0.6082709	0.245231
Skills	0.3387625	0.2747067	1.233	0.218	-0.1996527	0.8771776
expo	-0.0876804	0.1706891	-0.514	0.607	-0.4222249	0.2468641
Group	-0.1640718	0.1845672	-0.889	0.374	-0.5258169	0.1976733
NSIcif	0.0413252	0.1330164	0.311	0.756	-0.2193822	0.3020326
NSIpro	0.1554548	0.1421442	1.094	0.274	-0.1231428	0.4340524
NSIcli	-0.0687019	0.1346727	-0.51	0.610	-0.3326556	0.1952519
NSIother	0.3792666	0.1472948	2.575	0.010	0.0905742	0.667959
NSIgroup	-0.0932808	0.1520906	-0.613	0.540	-0.3913728	0.2048113
NSIgob	0.2582738	0.1837615	1.405	0.160	-0.1018922	0.6184397
EXcif	-0.2374018	0.1685197	-1.409	0.159	-0.5676944	0.0928907
EXpro	0.8068377	0.1310243	6.158	0.000	0.5500348	1.063641
EXcli	-0.4755243	0.1506316	-3.157	0.002	-0.7707569	-0.1802917
EXgroup	0.4663792	0.1913855	2.437	0.015	0.0912705	0.841488
Exother	0.3777797	0.1532199	2.466	0.014	0.0774743	0.6780851
EXgob	0.1591472	0.7448819	0.214	0.831	-1.300795	1.619089
sectRN	0.2750582	0.2159915	1.273	0.203	-0.1482773	0.6983938
sectRD	0.3485976	0.2509481	1.389	0.165	-0.1432518	0.8404469
sectESC	0.3217328	0.2162237	1.488	0.137	-0.1020578	0.7455235
_cons	5.167847	0.2929274	17.642	0.000	4.59372	5.741974

Selection equation. Dependent variable: Sginn						
	Coef.	Robust S. E.	z	P>|z|	[95% Conf. Interval]	
insize	0.0515465	0.0224883	2.292	0.022	0.0074702	0.0956229
FDI10	0.2246159	0.1112507	2.019	0.043	0.0065684	0.4426633
Skills	0.3590679	0.1493743	2.404	0.016	0.0662997	0.6518361
expo	0.2627298	0.0799775	3.285	0.001	0.1059768	0.4194829
Group	0.1228811	0.0989634	1.242	0.214	-0.0710837	0.3168458
sectRN	0.0949795	0.0984503	0.965	0.335	-0.0979795	0.2879385
sectRD	0.2584219	0.1260409	2.05	0.040	0.0113863	0.5054575
sectESC	0.1139831	0.1002696	1.137	0.256	-0.0825417	0.3105079
_cons	-0.244056	0.0943138	-2.588	0.010	-0.4289077	-0.0592043
/athrho	-1.36516	0.1481279	-9.216	0.000	-1.655485	-1.074835
/lnsigma	0.7858968	0.0492551	15.956	0.000	0.6893586	0.882435
rho	-0.8775845	0.0340465			-0.9296065	-0.7912758
sigma	2.194374	0.108084			1.992437	2.416777
sigma	-1.925749	0.1619355			-2.243136	-1.608361
Wald test of indep. eqns. (rho = 0): chi2(1) = 84.94 Prob > chi2 = 0.000						

TABLE A.8 – Multinomial logit model for innovation output - comparison group: Non innovators

Number of obs	1420	Log likelihood	-1,186.7576
LR chi2(39)	703.77	Pseudo R2	0.2287
Prob > chi2	0.0000		

(Outcome type== "Non innovators" is the comparison group)

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
			Product and process innovators			
insize	0.2529312	0.0459237	5.508	0.000	0.1629223	0.34294
Group	0.2783033	0.2193084	1.269	0.204	-0.1515333	0.7081399
Skills	0.6724703	0.7614729	0.883	0.377	-0.8199893	2.16493
expo	0.5632695	0.1727628	3.26	0.001	0.2246607	0.9018783
FDI10	-0.4756383	0.2805585	-1.695	0.090	-1.025523	0.0742463
RDc	2.900010	0.4127916	7.025	0.000	2.090954	3.709067
RDnc	1.751997	0.3720399	4.709	0.000	1.022812	2.481182
GexMpd	1.8102700	0.2275299	7.956	0.000	1.36432	2.256220
time01	-2.5023800	0.2097031	-11.93	0.000	-2.91339	-2.091369
secRD	0.0979853	0.27902	0.351	0.725	-0.4488838	0.6448544
secESC	0.4710883	0.2156316	2.185	0.029	0.0484582	0.8937184
secRN	-0.1563913	0.2031272	-0.770	0.441	-0.5545134	0.2417307
_cons	-0.408234	0.1943688	-2.1	0.036	-0.7891899	-0.0272781
			Only Product innovators			
insize	0.0714362	0.0674424	1.059	0.290	-0.0607485	0.2036209
Group	0.3363784	0.3129216	1.075	0.282	-0.2769366	0.9496934
Skills	-0.5377893	1.105073	-0.487	0.627	-2.703693	1.628114
expo	0.5367727	0.2575458	2.084	0.037	0.0319922	1.041553
FDI10	-0.414137	0.3944033	-1.05	0.294	-1.187153	0.3588792
RDc	2.497001	0.4701563	5.311	0.000	1.575511	3.41849
RDnc	1.763306	0.4483916	3.933	0.000	0.8844747	2.642138
GexMpd	1.479012	0.3114512	4.749	0.000	0.8685792	2.089446
time01	-1.234494	0.2949402	-4.186	0.000	-1.812566	-0.6564218
secRD	0.4164595	0.3820973	1.09	0.276	-0.3324375	1.165357
secESC	0.2789959	0.3212079	0.869	0.385	-0.35056	0.9085519
secRN	-0.2655898	0.3182869	-0.834	0.404	-0.8894208	0.3582411
_cons	-1.837031	0.3051384	-6.02	0.000	-2.435091	-1.238971
			Only Process innovators			
insize	0.205364	0.0556678	3.689	0.000	0.0962571	0.3144709
Group	-0.0585674	0.3188583	-0.184	0.854	-0.6835182	0.5663834
Skills	-0.0946416	1.0579690	-0.089	0.929	-2.168222	1.978939
expo	0.5051816	0.2610771	1.935	0.053	-0.0065201	1.016883
FDI10	0.0627648	0.3641786	0.172	0.863	-0.6510122	0.7765417
RDc	1.10759	0.5142309	2.154	0.031	0.099716	2.115464
RDnc	0.6235348	0.5012794	1.244	0.214	-0.3589547	1.606024
GexMpd	2.121599	0.307816	6.892	0.000	1.518291	2.724908
time01	-1.050744	0.317782	-3.306	0.001	-1.673586	-0.4279031
secRD	-0.07646	0.4408994	-0.173	0.862	-0.9406069	0.7876869
secESC	0.4152265	0.3367366	1.233	0.218	-0.2447651	1.075218
secRN	0.1732955	0.3142335	0.551	0.581	-0.4425907	0.7891818
_cons	-2.546312	0.3232346	-7.878	0.000	-3.17984	-1.912784

TABLE A.9 – Multinomial logit model for innovation output - comparison group: Product and Process innovators

Number of obs	1420	Log likelihood	-1186.7576
LR chi2(39)	703.77	Pseudo R2	0.2287
Prob > chi2	0.000		

(Outcome type== "Product and Process innovators" is the comparison group)

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Non innovators						
insize	-0.2529312	0.0459237	-5.508	0.000	-0.34294	-0.1629223
Group	-0.2783033	0.2193084	-1.269	0.204	-0.7081399	0.1515333
Skills	-0.6724703	0.7614729	-0.883	0.377	-2.16493	0.8199893
expo	-0.5632695	0.1727628	-3.26	0.001	-0.9018783	-0.2246607
FDI10	0.4756383	0.2805585	1.695	0.090	-0.0742463	1.025523
RDc	-2.90001	0.4127916	-7.025	0.000	-3.709067	-2.090954
RDnc	-1.751997	0.3720399	-4.709	0.000	-2.481182	-1.022812
GexMpd	-1.81027	0.2275299	-7.956	0.000	-2.25622	-1.36432
time01	2.50238	0.2097031	11.933	0.000	2.091369	2.91339
secRD	-0.0979853	0.279020	-0.351	0.725	-0.6448544	0.4488838
secESC	-0.4710883	0.2156316	-2.185	0.029	-0.8937184	-0.0484582
secRN	0.1563913	0.2031272	0.770	0.441	-0.2417307	0.5545134
_cons	0.408234	0.1943688	2.100	0.036	0.0272781	0.7891899
Only Product innovators						
insize	-0.181495	0.0565089	-3.212	0.001	-0.2922503	-0.0707397
Group	0.0580751	0.2721811	0.213	0.831	-0.47539	0.5915402
Skills	-1.21026	1.014311	-1.193	0.233	-3.198272	0.7777531
expo	-0.0264969	0.2375327	-0.112	0.911	-0.4920523	0.4390586
FDI10	0.0615013	0.3405478	0.181	0.857	-0.6059601	0.7289626
RDc	-0.40301	0.2784125	-1.448	0.148	-0.9486883	0.1426684
RDnc	0.0113093	0.3315097	0.034	0.973	-0.6384378	0.6610563
GexMpd	-0.3312575	0.2956147	-1.121	0.262	-0.9106517	0.2481367
time01	1.267886	0.2880018	4.402	0.000	0.7034127	1.832359
secRD	0.3184742	0.3430439	0.928	0.353	-0.3538795	0.990828
secESC	-0.1920924	0.3002962	-0.64	0.522	-0.7806622	0.3964774
secRN	-0.1091985	0.3048687	-0.358	0.72	-0.7067301	0.4883331
_cons	-1.428797	0.2888109	-4.947	0.000	-1.994856	-0.8627379
Only Process innovators						
insize	-0.0475672	0.0398485	-1.194	0.233	-0.1256688	0.0305345
Group	-0.3368707	0.2821053	-1.194	0.232	-0.889787	0.2160456
Skills	-0.7671119	0.9851295	-0.779	0.436	-2.69793	1.163706
expo	-0.058088	0.245953	-0.236	0.813	-0.540147	0.4239711
FDI10	0.5384031	0.318713	1.689	0.091	-0.0862629	1.163069
RDc	-1.79242	0.3434675	-5.219	0.000	-2.465604	-1.119237
RDnc	-1.128462	0.39066	-2.889	0.004	-1.894141	-0.3627825
GexMpd	0.3113295	0.3016899	1.032	0.302	-0.2799717	0.9026308
time01	1.451635	0.3146302	4.614	0.000	0.8349715	2.068299
secRD	-0.1744454	0.4132098	-0.422	0.673	-0.9843217	0.635431
secESC	-0.0558618	0.321536	-0.174	0.862	-0.6860607	0.5743372
secRN	0.3296869	0.304585	1.082	0.279	-0.2672887	0.9266624
_cons	-2.138078	0.3071562	-6.961	0.000	-2.740093	-1.536063

TABLE A.10 Sample selection model for innovative sales – M L estimation (Cross sectional data)

Number of obs	1243	Wald chi2(20)	142.37
Censored obs	686	Prob > chi2	0.000
Uncensored obs	557	Log likelihood	-1578.432

Regression equation. Dependent variable: lvinn						
	Coef.	Robust S. E.	z	P>|z|	[95% Conf. Interval]	
insize	0.06315	0.0211872	2.981	0.003	0.0216239	0.1046761
FDI10	0.1022486	0.164837	0.62	0.535	-0.2208259	0.4253231
Group	0.0544489	0.14966	0.364	0.716	-0.2388793	0.3477772
Skills	0.2040211	0.2238811	0.911	0.362	-0.2347777	0.64282
expo	-0.0490926	0.1197073	-0.41	0.682	-0.2837146	0.1855295
RDRDdu	0.0000981	0.0002543	0.386	0.700	-0.0004003	0.0005964
RDRDcont	0.0000538	0.0000206	2.611	0.009	0.0000134	0.0000942
TDinc	0.0000651	0.0000225	2.894	0.004	0.000021	0.0001092
TMinc	0.0001798	0.0000487	3.69	0.000	0.0000843	0.0002753
TDdesinc	0.00003	0.0000319	0.94	0.347	-0.0000325	0.0000924
TMdesinc	-0.000261	0.000291	-0.897	0.370	-0.0008314	0.0003093
RDTMinc	-4.45E-08	3.70E-08	-1.203	0.229	-1.17E-07	2.80E-08
RDTMdesi	-2.98E-07	4.58E-07	-0.652	0.515	-1.20E-06	5.99E-07
RDTDinc	3.15E-08	2.30E-08	1.369	0.171	-1.36E-08	7.65E-08
RDTDdesi	8.47E-09	2.07E-08	0.41	0.682	-3.20E-08	4.90E-08
Cif	-0.049111	0.1409848	-0.348	0.728	-0.3254362	0.2272142
Pro	-0.0221785	0.144625	-0.153	0.878	-0.3056384	0.2612813
Cli	0.0167834	0.131976	0.127	0.899	-0.2418848	0.2754516
Grouplink	0.2459966	0.1481349	1.661	0.097	-0.0443424	0.5363356
Other	-0.1818099	0.1311381	-1.386	0.166	-0.4388359	0.0752161
Gob	-0.1077786	0.196863	-0.547	0.584	-0.4936231	0.2780658
sectRN	0.2239746	0.1732652	1.293	0.196	-0.115619	0.5635682
sectRD	0.1996811	0.1759607	1.135	0.256	-0.1451954	0.5445576
sectESC	0.2667418	0.1542497	1.729	0.084	-0.0355821	0.5690657
_cons	9.517279	0.2816967	33.786	0.000	8.965164	10.06939
Selection equation. Dependent variable: Sinn						
	Coef.	Robust S. E.	z	P>|z|	[95% Conf. Interval]	
insize	0.0286704	0.0155468	1.844	0.065	-0.0018007	0.0591414
FDI10	0.0073071	0.1279249	0.057	0.954	-0.2434211	0.2580352
Group	0.0549175	0.111864	0.491	0.623	-0.1643318	0.2741669
Skills	0.1188335	0.1626638	0.731	0.465	-0.1999817	0.4376487
expo	0.2624605	0.0894461	2.934	0.003	0.0871493	0.4377717
RDdummy	0.8049215	0.1247476	6.452	0.000	0.5604207	1.049422
RDcont	1.197595	0.1220893	9.809	0.000	0.9583045	1.436886
TDinc	2.04E-07	0.0000272	0.008	0.994	-0.0000531	0.0000535
TMinc	-2.10E-06	0.0000488	-0.043	0.966	-0.0000978	0.0000936
TDdesin	0.0000521	0.0000409	1.275	0.202	-0.000028	0.0001322
TMdesin	0.0007423	0.0005104	1.454	0.146	-0.0002581	0.0017427
RDTMinc	1.17E-07	1.21E-07	0.966	0.334	-1.20E-07	3.54E-07
RDTMdesi	-1.42E-06	7.25E-07	-1.956	0.050	-2.84E-06	2.64E-09
RDTDinc	1.09E-07	1.29E-07	0.847	0.397	-1.43E-07	3.62E-07
RDTDdesi	7.74E-08	7.28E-08	1.063	0.288	-6.53E-08	2.20E-07
Cif	0.2632288	0.0947068	2.779	0.005	0.077607	0.4488507
Pro	0.2524567	0.1062609	2.376	0.018	0.0441892	0.4607242
Cli	0.0677542	0.1054096	0.643	0.520	-0.1388449	0.2743533
Grouplink	0.0435833	0.1211535	0.36	0.719	-0.1938731	0.2810398
Other	0.1613565	0.097723	1.651	0.099	-0.030177	0.35289
Gob	0.1480136	0.1703106	0.869	0.385	-0.1857891	0.4818164
sectRN	-0.1820685	0.1146992	-1.587	0.112	-0.4068747	0.0427377
sectRD	-0.0288177	0.1431181	-0.201	0.840	-0.3093241	0.2516887
sectESC	0.0452842	0.1140727	0.397	0.691	-0.1782941	0.2688625
_cons	-1.110062	0.1035232	-10.723	0.000	-1.312964	-0.9071605
/athrho	0.0662551	0.1318321	0.503	0.615	-0.1921311	0.3246412
/lnsigma	0.2496409	0.0409482	6.096	0.000	0.1693838	0.329898
rho	0.0661583	0.1312551			-0.1898013	0.3136975
sigma	1.283564	0.0525597			1.184575	1.390826
lambda	0.0849184	0.1688787			-0.2460778	0.4159147

Wald test of indep. eqns. (rho = 0): chi2(1) = 0.25 Prob > chi2 = 0.6153

TABLE A.11 – Fixed effects estimation for firm productivity

Number of obs	1410		
Group variable (i) : sector2		Obs per group: min	2
Number of groups	21	avg	67.1
R-sq:		max	282
within	0.2329	F(13,1376)	32.13
between	0.7804	Prob > F	0.000
overall	0.2896	corr(u_i, Xb)	0.2282

Dependent variable: Inprod						
	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
sprod2	0.0652379	0.0816624	0.799	0.425	-0.0949583	0.2254341
sproc2	0.0734762	0.0830281	0.885	0.376	-0.0893992	0.2363515
prodproc	0.152399	0.0525626	2.899	0.004	0.0492875	0.2555104
insize	0.0637175	0.007541	8.449	0.000	0.0489244	0.0785105
Skills	1.339761	0.1947061	6.881	0.000	0.9578082	1.721.714
IKprodum	0.1401118	0.0523808	2.675	0.008	0.0373569	0.2428667
FDI10	0.1185112	0.0643181	1.843	0.066	-0.007661	0.2446834
Group	0.1836882	0.0517478	3.550	0.000	0.0821751	0.2852014
expo	0.0823087	0.0465814	1.767	0.077	-0.0090695	0.1736869
time01	-0.3069784	0.1054622	-2.911	0.004	-0.5138624	-0.1000944
tsecRN	0.1028121	0.122996	0.836	0.403	-0.1384678	0.3440921
tsecESC	0.1018587	0.124477	0.818	0.413	-.1423265	0.3460439
tsecL	-0.0995079	0.1321031	-0.753	0.451	-0.3586532	0.1596373
_cons	3.635642	0.0581162	62.558	0.000	3.521636	3.749648
sigma_u	0.26865858					
sigma_e	0.74153035					
rho	0.11603255 (fraction of variance due to u_i)					
F test that all u_i=0:	F(20,1376) = 3.83		Prob > F = 0.0000			

TABLE A.12 - Hausman Specification Test for firm productivity estimation

Hausman specification test			
	Fixed Eff	Random Eff	Difference
sprod2	0.0652379	0.0835123	-0.0182744
sproc2	0.0734762	0.0869547	-0.0134786
prodproc	0.152399	0.1633004	-0.0109014
insize	0.0637175	0.0670462	-0.0033287
Skills	1.339761	1.359555	-0.0197942
IKprodum	0.1401118	0.141547	-0.0014352
FDI10	0.1185112	0.1125491	0.0059621
Group	0.1836882	0.185832	-0.0021438
expo	0.0823087	0.0898833	-0.0075746
time01	-0.3069784	-0.2860652	-0.0209132
tsecRN	0.1028121	0.1232496	-0.0204374
tsecESC	0.1018587	0.0491753	0.0526834
tsecL	-0.0995079	-0.1436948	0.0441868
Test: Ho: difference in coefficients not systematic			
chi2(13)		39.24	
Prob>chi2		0.0002	

Table A13: OLS regression (with robust standard errors) on productivity (Cross sectional data)

Number of obs	1243
F(11, 1230)	157.83
Prob > F	0.000
R-squared	0.6955
Root MSE	0.55431

Dependent variable: lprod01						
	Coef.	Robust S. E.	t	P>|t|	[95% Conf. Interval]	
vinntotL	9.61E-08	5.81E-08	1.654	0.098	-1.79E-08	2.10E-07
expo	-0.0158646	0.0337793	-0.47	0.639	-0.082136	0.0504069
Skills	0.1813504	0.0579246	3.131	0.002	0.0677085	0.2949924
Group	0.0598044	0.0496123	1.205	0.228	-0.0375298	0.1571386
insize	0.0366537	0.0071777	5.107	0.000	0.0225717	0.0507356
FDI10	0.0508548	0.0480141	1.059	0.290	-0.0433438	0.1450534
IKprom	1.02E-06	5.22E-07	1.946	0.052	-8.25E-09	2.04E-06
lprod98	0.7612143	0.0423735	17.964	0.000	0.6780819	0.8443466
sectRN	0.253739	0.0471221	5.385	0.000	0.1612903	0.3461876
sectRD	0.1435205	0.0560119	2.562	0.011	0.0336311	0.2534099
sectESC	0.1578967	0.0463694	3.405	0.001	0.0669247	0.2488686
_cons	2.107255	0.4507382	4.675	0.000	1.222954	2.991556

References

Archibugi, D and Sirilli, G. (2000), "The Direct Measurement of Technological Innovation in Business" in Innovation and enterprise creation: Statistics and indicators. Proceedings of the conference held at Sophia Antipolis, November 2000.

Benavente, J. M. (2002), "The role of research and innovation in promoting productivity in Chile", mimeo.

Crepon, B. Duguet, E. and Kabla,I. (1996) "Schumpeterian conjectures: A moderate support from various innolvation measures" in A. Kleinknecht (ed) **Determinants of Innovation. The message from new indicators**,. Macmillan, London

Crepon B., E. Duguet and J. Mairesse (1998), "Research, innovation and productivity: an econometric analysis at the firm level", NBER Working Paper 6696.

Duguet, E. (2002), "Innovation height, spillovers and TFP growth at the firm level: Evidence from French manufacturing", mimeo, September.

Edquist (ed.) (1997), **Systems of Innovation: Technologies, Institutions and Organizations,** Pinter, London.

Galia, F. and D. Legros (2002), "Complementarities between obstacles to innovation: empirical study on a French data set", paper presented at the DRUID Summer Conference 2003 on **Industrial dynamics of the New and Old Economy – who is embracing whom?**, June.

Guerrieri, P. and C. Milana (1989), **L' industria italiana nel commercio mondiale**, Ed. Il Mulino, Bologna.

Guerrieri, P. (1992), "Technology and trade performance of the most advances countries", **Research Policy**.

Hu, A., G. Jefferson and Q. Jinchang (2003a), "R&D and technology transfer. Firm-level evidence from Chinese industry", mimeo.

Hu, A. and G. Jefferson (2003b), *"*Returns to research and development in Chinese industry: Evidence from enterprises in Beijing*",* mimeo.

INDEC (1998), **Encuesta sobre la conducta tecnológica de las empresas industriales argentinas**, Serie Estudios, No. 31, Buenos Aires.

INDEC (2003), **Segunda Encuesta Nacional de Innovación y Conducta Tecnológica de las Empresas Argentinas***,* Serie Estudios No. 38, Buenos Aires.

Janz, N., H. Lööf and B. Peters (2003), "Innovation and productivity: a cross-country comparison between Germany and Sweden", mimeo.

Jefferson, G., B. Huamano, G. Xioajing and Y. Xiaoyun (2002), "R and D Performance in Chinese Industry", mimeo.

Kemp R., M. Folkeringa, J. De Jong and E. Wubben (2003), "Innovation and firm performance", Scale. Scientific analysis of entrepreneurship and SMEs, Research Report H200207.

Kleinknecht, A. and P. Mohnen (eds.) (2002), **Innovation and firm performance. Econometric explorations of survey data**, Palgrave.

Kline, S. and N. Rosenberg (1986), "An overview of innovation", in R. Landau and N. Rosenberg (eds.), **The positive sum strategy: harnessing technology for economic growth**, Washington, D.C., National Academic Press.

Lööf, H. and Heshmati A. (2002), "Knowledge capital and performance heterogeneity: A firm-level innovation study", **International Journal of Production Economics**, 76(1), 61-85.

Lööf, H. and Heshmati A. (2002), "On the relationship between innovation and performance: A sensitivity analysis", mimeo.

Lööf H., Heshmati A., Asplund R. and Naas S. (2002), "Innovation and performance in manufacturing industries: a comparison of the Nordic countries", SSE/EFI Working Paper Series in Economics and Finance No. 457.

Leung S. F., Yu S. (1996) "On the choice between sample selection and two-part models", Journal of Econometrics 72 (1996) 197-229.

Mairesse, J. and P. Mohnen (2003), "R&D and productivity: a reexamination in light of the innovation surveys", paper presented at the **DRUID Summer Conference 2003 on Creating, Shearing and Transferring Knowledge. The role of Geography, Institutions and Organizations**.

OECD (1997). **The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological innovation data (Oslo Manual)**. Organization for Economic Co-operation and Development. 1997.

Parisi, M. L., Schiantarelli F. and Sembenelli A. (2002), "Productivity creation and absorption, and R&D: Micro evidence for Italy", mimeo.

Pavitt, K. (1984), "Sectoral patterns of technical change: towards a taxonomy and a theory", **Research Policy**, December.

RICYT (2001). **Standardization of indicators of technological innovation in Latin American and Caribbean countries (Bogotá Manual)**. Iberoamerican network of science and technology indicators (RICYT). March 2001.

Van Leeuwen, G. (2002), "Linking innovation to productivity growth using two waves of CIS", STI Working Paper 2002/8, OECD.

Van Leeuwen, G. and L. Klomp (2001), "On the contribution of innovation to multifactor productivity growth", mimeo.

Wooldridge, J. M. (2001), **Econometric analysis of cross section and panel data**, MIT Press.