Sailing through stormy waters. The case of latecomer firms in Argentina[⊕]

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(Work in progress. Please, do not quote)

I. Introduction

According to theory and received wisdom, developing countries are usually importers ohigh technology goods (Rosenberg 1976, Bell & Pavitt 1993), which are produced by the most advanced firms in the developed world. However, over the past years there has been growing evidence that shows the emergence of successful multinational companies (MNCs) from developing countries, at least in low-to-medium-tech manufacturing sectors (Dunning *et al* 1997, Chudnovsky *et al* 1999, Amsden 2001). But there is still a gap in the literature on latecomers' catch up as most of these studies are fundamentally contextualized in thriving and growing economies with mild-to-strong institutional support (e.g. Asian Tigers, BRICs). So far little attention has been paid to the case of successful latecomer firms coming out of declining and crisis-ridden economies. In this sense, Argentina set a particular context of analysis as the country has suffered a considerable decline in its industrial base and technological capability (Schvarzer 2000; Katz 2006) and, as a result, we should not expect the emergence of internationally successful latecomer firms.

The general objective of this study is, therefore, to investigate *how and why latecomer firms, facing adverse economic conditions, might be able to survive, grow, and catch up with global markets and world-class innovations.*

The empirical literature East Asian catch-up (Hobday 1995, Mathews & Cho 2000, Hobday 2003, Mathews 2006) suggests that latecomer firms followed alternative strategies to catch-up with global competitors. In addition to technological innovations (i.e. product and process), many latecomer firms also relied heavily on non-technological innovations such as inter-organizational

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links with global suppliers and customers (Mathews & Cho 2000; Mathews 2006) as well as intra-organizational and marketing innovations to upgrade from OEM, to ODM, to OBM[1] (Hobday 1995, Hobday 2006). More specifically to the case of Argentina, Papa (2011) conducted a case study on a successful latecomer firm that, given the technology gap in terms of product and process innovations, caught up with global competitors via marketing and organizational innovations, as a response to a new strategy of downstream integration (i.e. manufacturing plus service activities) in time of crisis.

Based on that empirical evidence, the specific objective of this paper to investigate *to what extent organizational and marketing innovations (complementing product and process innovations) might have enabled some latecomer firms to perform better than many others during the latest economic crisis of Argentina.*

The dataset used in this study is the 2nd Innovation Survey of Argentina (INDEC, 2003) as conducted by the National Statistics Office for the period 1998-2001, which coincides with one of the most severe economic crisis of the country. The survey contains information on more than 100 variables for a sample of 1,688 manufacturing, which is largely representative of the industrial sector in Argentina as whole.

Given some data limitations on time-variant variables, we will to use a two-steps cross-section analysis to estimate the average and quantile treatment effect of non-technological innovations on firms' performance. We follow a methodology that allows us to control for biases that usually come up with this type of cross-section comparisons. In the first step, we intend to use a multinomial Probit model to estimate the probability of achieving technological and/or non-technological innovations, given a number of determinants suggested by the relevant literature. In the second step, we use propensity score matching (PSM) techniques to analyse the differential performance of firms that achieved different type of innovations (i.e. technological; non-technological; both of them; or none of them).

This preliminary paper is organized as follows. Next section presents the conceptual framework that underpins the main ideas used in this research on catch-up, latecomer firms, and non-technological innovation, with special emphasis on organizational change studies. The third section briefly depicts the main features of the dataset in question as well as the main data limitations we have to cope with. The fourth section presents some descriptive statistics of the

[1] OEM refers to original equipment manufacture, while ODM refers to own-designs manufacture, and OBM refers to own-brand manufacture.

sample. In section five we sketch the estimation strategy and methodologies with which the dataset will be tackled. The sixth section describes a tentative model specification along with the expected results, based in the relevant literature. Finally, in the last section we discuss the main methodological challenges posed to conclude this piece of research and suggest some potential solutions.

II. Conceptual Framework

Latecomer firms

In a pioneering work on industrial innovation, Freeman & Soete (1997: pp. 265-266) assert that firms' innovation activities are historically circumscribed to world market and technological possibilities and their performance depend upon the capacity of adaptation to such rapidly changing external environment and to change it. The authors conclude that upon the base of firms' resources, history, management style and luck the range of innovation strategies to be adopted could be as followed:

(i) *Offensive strategy*. The aim is to be ahead of competitors in the introduction of new products by means of technical leadership as well as market leadership. This is commonly found in advanced firms from developed countries.

(ii) *Defensive strategy*. The purpose is not to incur the heavy risks of being the first to innovate but to profit from leaders' mistakes and from later open-up of markets by introducing minor improvement leading to product differentiation.

(iii) *Traditional and opportunistic strategies*. These strategies are followed in less developed markets either by firms that do not face any challenge to innovate with the exception of design changes (traditional strategies) or by individual entrepreneurs that identify new niche markets (opportunistic strategies).

(iv) *Dependant and imitative strategies*. The dependant firms are generally capital-intensive small firms acting as satellite, subordinate or sub-contractor companies of stronger firms by supplying specific components or a variety of services. Occasionally, they may have the change of upgrading into specialized-knowledge products/services and turning into offensive innovator as it occurred in Korea (Hobday, Rush & Bessant 2004). The imitative firm is basically concerned with following the leaders in established technologies either by licensing innovators' patents or acquiring 'know-how'. However, Freeman & Soete assume a developed country context with functioning markets and access to technology. In a developing country the

enterprising imitator may aspire to become a defensive innovator and benefit from non-innovative advantages such as captive markets, geographical locations, political privileges, lower labour costs, plant investment costs, energy supplies or materials costs. In Gerschenkronian terms, if public policies, institutions and firms' dependant or imitative strategies are oriented towards catching up, it may be possible for this group of firms to turn their backwardness into competitive advantage. This leads us to introduce the concept of 'latecomer firms'.

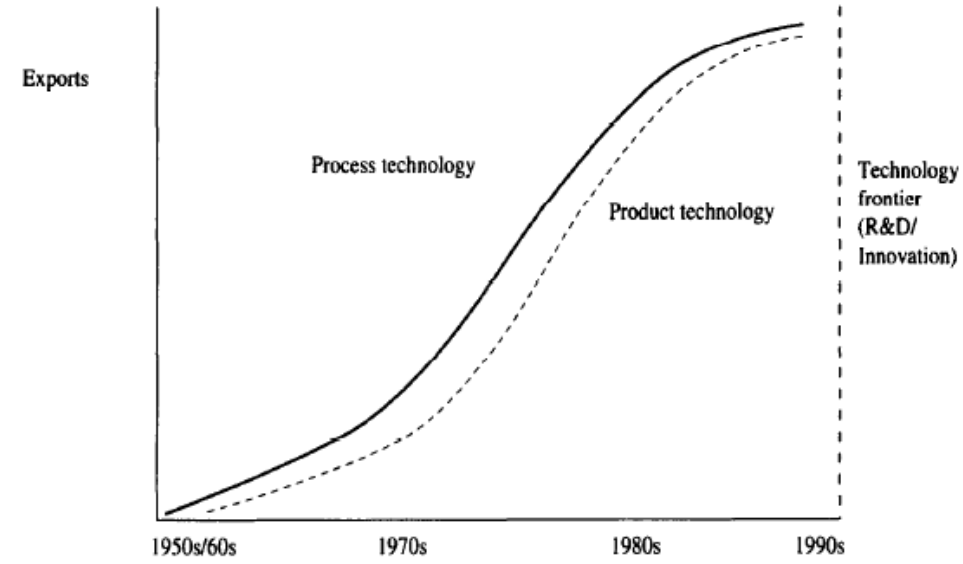
Mathews (2006: pp. 1-2) proposes extending the usage of 'latecomers' introduced by Gerschenkron (1962) to the case of firms. Referring to the advantages, the author states "latecomer firms, like latecomer countries, are able to exploit their late arrival to tap into advanced technologies, rather than having to replicate the entire previous technological trajectory. They can accelerate their uptake and learning efforts utilising various forms of collaborative processes and state agencies to assist with the process, and bypassing some of the organisational inertia that hold back their more established competitors." The author also emphasizes the opportunities of latecomer firms to link with global value chains via inter-organizational innovations (e.g. outsourcing, subcontracting, etc.)

With regards to the disadvantages, Hobday (1995: p. 1172) defines a latecomer firm as "a manufacturing company (existing or potential) which faces two sets of competitive disadvantages in attempting to compete in export markets". The first one is a technological constraint. Based in a developing country, a latecomer firm is dislocated from the most important world source of science, technology and R&D as well as engineering and technical skills. Moreover, the surrounding industrial, technological and educational (i.e. universities, technical institutions, etc.) infrastructures and networks are poorly developed or equipped. The second set of disadvantages concerns the access to international markets and sophisticated users. Once again, the author argues that a latecomer firm is dislocated from the mainstream global markets it wishes to supply which are basically located in developed countries. As a consequence, the firm must contend with supplying underdeveloped, small local markets and unsophisticated customers.

Drawing upon the experience of electronics in East Asian, Hobday (1995) examined the innovation strategies in NIEs to understand the learning mechanisms, channels of technology and links between technology and global market entry that led some latecomer firms to catch-up and even overtake traditional leaders. To interpret the main findings, the author introduces a model (Figure 1) of how latecomer firms have been linking their technological learning to export markets over time. Briefly, the dynamics of the model is as follows. Latecomer innovation is

triggered by the necessity to export because of the small size of local markets. This, in turn, pulls forward the technology (first in processes and then in products) of latecomer firms, enabling them to overcome the lack of resources and user-product links, which are typically enjoyed by leader and follower firms. Through several and sequential mechanisms prevailing in global production networks, from subcontracting & OEM (original equipment manufacture) to ODM (own-design manufacture) to OBM (own-brand manufacture), and thanks to the development of strong marketing capabilities, access to global markets finally sets the pace for catching up.

Figure 1. Latecomer Firms: Export-led catch-up in East Asia



In sum, both Hobday and Mathews agree on the fact that successful latecomer firms are likely to overcome their technological disadvantage (in terms of product and process innovations) by pursuing business strategies that supplement the former ones with non-technological innovations such as marketing and organizational (both inter- and intra-firm) change.

Particularly to the case of Argentina, Papa (2011) conducted an in-depth case study on a successful latecomer firm that, given the technology gap, caught up with global competitors via

non-technological innovations, as response to a new business strategy in times of crisis. The main empirical findings of that study show that the seamless steel pipe manufacturer *Tenaris* introduced a number of marketing and organizational changes that enabled the firm to quickly adapt to the adverse economic conditions in Argentina and. At the same time, these non-technological innovations complemented with the existing technological assets in such a way that paved the way for the firm to differentiate from global competitors in sophisticated export markets. With regards to marketing innovations, *Tenaris* got access to global markets in the early 1980s thanks to the opening up of several commercial offices abroad, which led the company to bypass intermediate sales agents and establish direct contact with its customers. For example, this enterprise was so successful that in 1997 the Japanese Corporation *NKK* formed a strategic alliance with *Tenaris* to make use of its cutting-edge commercial network, in exchange of *NKK*'s technological knowledge. With respect to organizational innovations, *Tenaris'* marketing endeavour came along with several organizational changes as the firm had been gradually enhancing the commercial network with technical & service support centers. In 2001, the new customer-oriented business strategy of the firm brought about a major organizational change that allowed the downstream integration of customised products with high-tech services to produce and deliver the so-called 'integrated solutions' (Gann & Salter 2000, Galbraith 2002, Davies 2004). In so doing, this latecomer firm was able to catch up with global competitors and become a world-leading provider of integrated solutions to the oil & gas industry.

Although based in a single case study, those empirical findings constitute the main motivations of this paper so as to investigate (i) to what extent non-technological innovations might complement technological innovations in the context of developing countries such as Argentina, and (ii) whether non-technological innovation are critical for the performance of latecomer firms facing crisis time (1998-2001).

Non-Technological Innovations

The seminal work of Schumpeter (1934) on economic development distinguished five categories of innovation driving economic change. On one hand, (i) the introduction of new products and (ii) new processes might be referred as to technological innovations. On the other hand, (iii) the opening of new markets, (iv) the development of new sources of supply, and (v) the creation of new forms of organization, are somehow related to the idea of non-technological innovations. Some time later, the management of different types of resources, including organizational and

marketing capabilities, would be acknowledged again as a key driver of firm growth in the resource-based theory of the firm (Penrose 1959) as well as in the evolutionary economic theory (Nelson & Winter 1982, Teece 1988). Moreover, the strand of literature on innovation management (Kelly & Kranzburg 1978, Tidd et al 2009) highlights the idea of bringing together R&D engineers and managers to better understand the co-evolutionary process of organization, technology, and markets underpinning firms' performance.

In spite of all these theoretical contributions, the empirical research on organizational and marketing innovations only started to flourish in recent years[2], mainly because of the methodological challenges posed by their measurement through large-scale surveys (Armbruster et al 2008). Curiously, the first attempt to measure non-technological innovations at large scale did not stem from developed countries. In 2001 the Bogota Manual set the guidelines on how to carry out innovation surveys in developing countries. The authors pointed that the Oslo Manual had proposed so far a rather narrow approach towards innovation by excluding key factors such as organizational change, training, quality management, use of ICTs, etc. Under these concerns, the Oslo Manual was revised in 2005 to include a separate appendix on measurement of innovation in developing countries. In line with the Bogota Manual, the 3rd edition of the Oslo Manual (OECD, 2005, p.46), now use a broader definition of innovation as *"the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organizational or external relations".* More precisely, the Bogota Manual (2001, p30) suggested developing countries to collect data on non-technological innovations based on the following definitions:

Organizational innovation: changes in the way the firm is organized and managed; changes in the organization and management of the production process; incorporation of significantly modified organizational structures; and implementation of new or substantially modified strategic corporate orientations.

Marketing innovation: marketing of new products; new methods of product delivery; changes in packaging; new distributions channels; and new customer services.

Despite the recent improvements towards the measurement of organizational and marketing innovations and the increasing availability of micro-data from innovation surveys, empirical research at large-scale about the determinants, interactions and effects of non-technological

[2] See Schmidt & Rammer (2007), Baranano (2003) , Boer & During (2001), Evangelista & Vezzani (2010)

innovations is a topic that still remains somewhat under-explored in developing countries. Apart from the work of Alvarez, Benavente, and Crespi (2010) about the impact of economic crisis on the organizational change of Chilean firms, we are not aware of any other firm-level empirical research that deals directly with the relationship between non-technological innovations and firm performance in crisis-ridden developing countries. For the case of Argentina, Chudnovsky, Lopez, and Pupato (2006) conducted the first micro-econometric study on the determinants of innovative inputs and outputs and their impacts on firm's performance, although the authors focused exclusively on product innovations (in line with the studies for industrialized countries).

Nonetheless, there seem to be a number of reasons to believe that non-technological innovations are likely to have a higher impact on the firms' performance of developing countries than in those of developed countries, *viz:* (i) the dislocation of latecomer firms from the world sources of scientific, technical and R&D knowledge (as explained earlier) might induce them to re-address their efforts towards less-technical forms of innovation; (ii) organizational and marketing innovations tend to be less costly than product and process innovations and that is a reason why latecomer firms that face financial constraints might find them more attractive; and (iii) organizational flexibility and capacity of adaptation (Freeman & Soete, 1997) are likely to be highly-valued characteristics that a latecomer firms might wish to attain, when facing crisis-ridden environment with changing institutional settings (e.g. relative prices)

III. Data Sources and Limitations

This study is based on data stemming from the 2nd Innovation Survey of Argentina (INDEC, 2003) as conducted by the National Statistics Office for the period 1998-2001, which coincides with one of the most severe economic crisis of the country.

The innovation survey has been designed in accordance with the methodological guidelines of both the Oslo and Bogota Manuals and thus contains information on a large number of variables covering a broad range of topics, namely: (a) basic information about the surveyed firm; (b) firms' economic performance; (c) employment and organization of work processes; (d) innovation activities; (e) environmental activities; (f) funding of innovation activities; (g) sources of information for innovation activities; (h) human resources related to innovation; (i) innovations achieved; (j) hindering factors to innovation; (k) links with the national innovation system; (l) information and communication technologies (TICs); and (m) technology balance of payments.

The sample was randomly drawn from the Input-Output Matrix survey of 1997 in order to be representative of the Argentinean manufacturing sector as a whole, at the beginning of the period covered (1998). The sample size is comprised of 1,688 firms that finally answered the questionnaire, out of 2,229 firms that were asked to do so originally. Therefore, the response rate was 76%, which is relatively high in comparison with the low 25%-30% usually achieved by CIS in developed countries. In addition to that, an important feature of this survey is that, contrary to the European CIS, both innovators and non-innovators are asked to answer the full questionnaire avoiding, in this way, some selectivity problems (See Crepon et al 1998).

Nonetheless, it is important to discuss also the data limitations which we are dealing with, *viz*:

Limited time variation in the available data. Although we got access to the full dataset of the 2nd innovation survey in Argentina for the recession period of 1998-2001, we were not able to collect further information from other innovation surveys covering either *ex-ante* (1992-1996) or *ex-post* (2002-2004) growth and recovery periods, respectively. Hence, the limited time variation of the available data poses some restrictions to the very definition of "catching-up" with global markets, which always entails a temporal dimension. That is the reason why we have to rely on a narrow definition of latecomer firms' catch-up, given these data limitations. Hence, we operationalize the term "catching-up" for those successful latecomer firm that saw a positive growth of domestic sales, exports, and productivity, amidst the economic crisis, and simultaneously reached two other benchmarks: (i) got access to advanced export markets -U.S and EU- and, (ii) achieved innovations that were novel to the world, during the same period of time[3].

Limited number of time-varying variables. In addition to the temporal limitation on the available data, the innovation survey in question contains a reduced number of time-varying variables. Only information on firms' performance, employment, and innovation expenditures is available for two years (i.e.: 1998 & 2001), while the rest of the variables are dummies that indicate different observed characteristics of the firm, for the period 1998-2001 as a whole. This data limitation brings about important consequences to the estimation strategy as it reduces the changes of using panel data models to control for unobserved characteristics of the firm.

Broad definition of non-technological innovations. In accordance with the Bogota Manual, the innovation survey in question also uses a rather broad output variable for non-technological innovations (achieved). Hopefully, at least for the case of organizational innovations, the survey

[3] Of course, we will not be able to establish temporal causation of any kind in this way, but for the purpose of the research it is sufficient to explore the distinctive characteristics of successful firms in time of crisis.

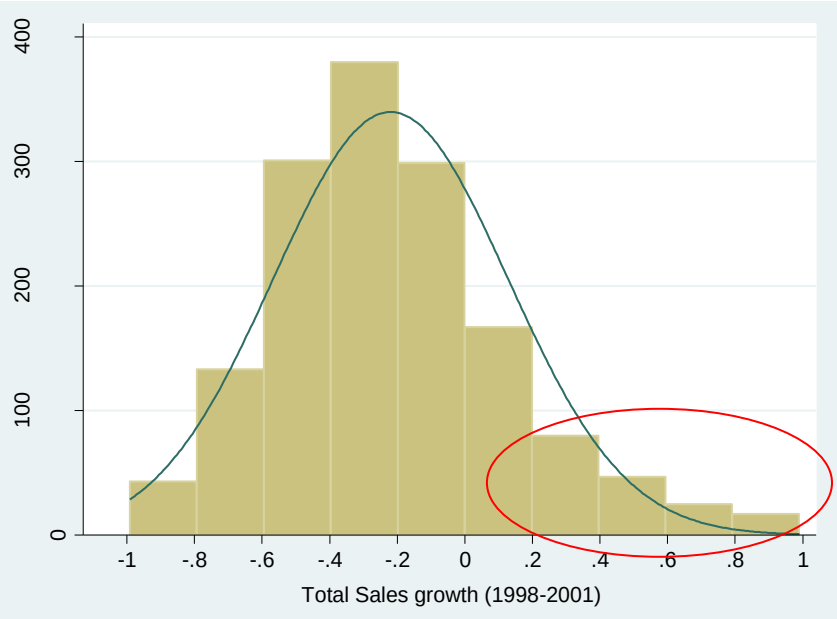
also contains a number of input variables (e.g.: teamwork, workflow control, quality management, ICTs, inter-organizational links, etc.) that might help to narrow down the scope of the definition by identifying the determinants of organizational change.

Selection bias. Although the survey's sample, as said earlier, was intended to be representative of the manufacturing industry as a whole, those (many) firms that went bankrupt and closed down their plants, during the crisis period under study, could not be surveyed. Hence, it is likely that firms included in this survey were among the best performers or, at least, the surviving ones. This concern, though, should not affect our results as we are not interested in the average firm's performance but rather in the differential performance of high-growth firms.

IV. Descriptive Statistics

The period under study (1998-2001) coincides with the one of the deepest and longest economic downturn that Argentina has experienced since the Great Depression of the 1930s. After a period of relatively high GDP growth (1991-1998), the Argentinean economy entered into a phase of long stagnation that ended up towards the end of 2001 with a deep financial, economic and social crisis, mainly due to the failure of so-called Convertibility Plan (See Schvarzer 2002). Indeed, between 1998 and 2001, the country's GDP saw a cumulative fall of nearly 20 percentage points, the unemployment rate climbed up to 20% of the economically active population, and poverty reached the alarming levels of around 50% of Argentina's population. Under these circumstances, the industrial sector was the worst hit economic activity with an average drop of 22 % (EMI, INDEC). As expected, the manufacturing firms that make up the current innovation survey also reported negative values for most of their performance indicators. During the crisis time, both total sales and employment sharply dropped by around 8% (with labour productivity remaining more or less the same), while investment levels plummeted nearly 50%. Of course, economic performance varied largely across different types of firms. For instance, large firms outperformed medium and small firms as much as foreign firms did with domestic firms, although all of them equally saw a negative performance towards the end of 2001. Figure 2 shows that most of the firms recorded a negative growth in total sales, ranging from -20% to -40%, between 1998 and 2001. Nonetheless, the circled red area indicates a bunch of nearly 300 firms (roughly 20% the sample size) that saw a positive growth in sales, in spite of the economic crisis.

Figure 2. Distribution of firms by their total sales growth, 1998-2001



Source: Own elaboration based on the Innovation Survey (INDEC, 2003)

In this paper we are particularly interested in analysing the characteristics of such a group of firms as well as the determinants of their success. Drawing on the conceptual framework presented above, we believe that the differential performance of firm might be due to the introduction of both technological and, particularly, non-technological innovations and the way the latter ones interact with the former ones. Table 1 illustrates the number (and proportion) of firms that carried out innovation activities (as an input measure) toward different orientations, namely: product, process, organizational and marketing.

Table 1. Firms that carried out innovation activities by type of orientation, 1998-2001

Innovation activities towards...	No. of firms	share out of all firms (%)	share out of innovative firms (%)
Product	960	56,9	72,6
Process	994	58,9	75,2
Organizational	941	55,7	71,2
Marketing	776	46,0	58,7
Total (innovative firms)	1322	78,3	100

Source: Argentine Innovation Survey, INDEC (2003)

We can observe that more than 78% of the firms surveyed in the sample carried out innovations activities, regardless their results. On one hand, most of the firms pursued mixed innovation strategies combining product, process and organizational innovations, which account from 55% through to nearly 60% of all firms sampled.

Table 2. Innovation output by type of firm and innovative behaviour, 1998-2001

	All firms			Large firms		Medium firms		Small firms		Foreign firms		Domestic firms	
	No. of firms	Share (%)	Achievement rate (%)	No. of firms	Share (%)	No. of firms	Share (%)	No. of firms	Share (%)	No. of firms	Share (%)	No. of firms	Share (%)
All firms	1.688	100	-	109	100	276	100	1.213	100	403	100	1.285	100
Innovations (attempt)	1.322	78	100	108	99	263	95	935	77	389	97	933	73
Innovations (achieved)	1.023	61	77	100	92	216	78	699	58	310	77	713	55
Technological innovations (only)	949	56	-	98	90	202	73	642	53	291	72	658	52
Non-technological innovations (only)	74	5	-	2	2	14	5	57	5	19	5	55	3
Product innovation	779	46	81	85	78	159	58	528	44	238	59	541	42
Process innovation	796	47	80	91	83	172	62	527	43	264	66	532	41
Organizational innovation	604	36	64	66	61	145	53	387	32	207	51	397	31
Marketing innovation	465	28	60	53	49	113	41	297	24	162	40	303	24

Source: Own elaboration based on the Innovation Survey, INDEC (2003)

On the other hand, a lower proportion of firms (46%) pursued innovation strategies towards marketing change. Table 2 shows those firms that actually attained some results out of the different innovations activities they performed, distinguishing by both firm size and ownership. Overall, some 61% of firms obtained innovation results out of their efforts, with 56% attaining technological innovations (only) and just the remaining 5% attaining non-technological innovations. Additionally, organizational and marketing innovations were achieved by 36% and 28% of surveyed firms, respectively, while product and process innovations were attained by nearly 60% of firms in both cases. Such a difference is somewhat striking and leads to think that non-technological innovations do not substitute but rather complement their technological counterparts. Even more interesting is the fact that the achievement rate (i.e.: no. of innovations achieved over no. of innovation attempts) is much higher for product and process innovations (61% and 60%, respectively) than for organizational and marketing innovation (64% and 60%, respectively). These results somehow encourage us to analyze in more details the determinants of non-technological innovations. As expected, the larger the firm size is, the higher the proportions of innovations achieved –in every category- will be (e.g. 92% for large firms, 87 for medium-size firms, and 58% for small firms). Similarly, foreign firm tend to obtain a larger share of innovations results (77%) than their domestic counterparts (55%).

Table 3. Scope of innovations (achieved), 1998-2001

Type of innovation	Total	Innovation novel to...					
	(no. of firms)	Firm	(%)	Domestic Market	(%)	International Market	(%)
Product	779	190	24	384	49	191	25
Process	796	471	59	203	26	95	12
Organizational	604	453	75	90	15	36	6
Marketing	465	213	46	161	35	85	18

Source: Argentine Innovation Survey, INDEC (2003)

Finally, Table 3 depicts the scope of the different types innovations (achieved) in term of their degree of novelty. At first glance we can see that the largest proportion of innovations attained by the surveyed firms were novel to themselves and to the domestic market, with lower percentages for world-class innovations. However, the share of product innovations novel to the international market is relatively high at 25%. The large proportion of organizational and process innovations

that were novel just to the firm helps to corroborate the idea that non-technological knowledge tend to be tacit and non-transferable. Besides, these findings also lead us to further inquiry about the interaction effects that might come up between process and organizational innovations, on one hand, and product and marketing innovations on the other hand (See Schimdt & Rammer, 2007).

V. Estimation Strategy

In this section we try to formulate an estimation strategy that allow us to answer the specific research question of this work, namely: *to what extent organizational and marketing innovations (interacting with technological innovations) might have enabled some latecomer firms to perform better than many others, during the latest economic crisis of Argentina.* For operational purposes we collapse, at this stage, product and process innovations into the category technological innovations, on one hand, and organizational and marketing innovations into the category non-technological innovations, on the other hand.

Given the data limitations on time variation, as explained in section III, we will to use a two-steps cross-section analysis to estimate the average and quantile treatment effect of non-technological innovations on firms' performance. We follow a methodology that allows us to control for biases that usually come up with this type of cross-section comparisons. In the first step, we intend to use a multinomial Probit model to estimate the probability to attain any of following mutually exclusive categories of innovations, namely: (i) technological innovations –only-; (ii) non-technological innovations –only-; (iii) both technological and non-technological innovations; and (iv) none of them. The model is conditional on a set of observables attributes or determinants suggested by the relevant literature. In the second step, we use propensity score matching (PSM) method to analyse the differential performance (i.e.: sales, exports, and productivity) of firms according to the four innovation choices above-described, paying particular attention to the case of non-technological innovations.

The main idea behind the propensity score matching technique, as originally proposed by Rosenbaum and Rubin (1983), is to make a comparison between the outcomes (e.g.: sales, exports) of participants (e.g.: firms) with treatment (e.g.: innovation achieved) and without treatment (e.g.: no innovation achieved). In non-experimental studies, both the treated and untreated outcome cannot be observed for the same firm at the same time. Besides, OLS estimations are likely to produce selection bias as treated and untreated firms usually tend to

differ even in the absence of treatment, due to the presence of unobservable characteristics[4]. A potential solution to this problem is to find those control firms, among the set of untreated observations, which share all the relevant pre-treatment characteristics with the treated firms, as if they were their *alter ego*. Then, average -or quantile- differences in outcomes variables between the treated and the control group can be attributed to the treatment, since each pair of firms is assumed to be very similar with regard to all other characteristics. The matching criteria[5] are based on the propensity score, which indicates the probability of being treated conditional on relevant pre-treatment characteristics. In this paper, the estimation of the propensity scores will be drawn from the results of a multinomial Probit model to account for the multiple treatments or innovations strategies being followed by firms (i.e.: technological innovations; non-technological innovations; both tech- innovations and non-tech- innovations; and none of them). At this stage, implementing matching requires that only those variables that influence simultaneously the treatment assignment and the outcome variables are included in the propensity score model.

VI. Model specification and expected results

There is a broad consensus that both reasons for and against including all of the reasonable covariates available should be based on economic theory and previous empirical findings (Caliendo & Kopeining, 2008). Hence, Table 4a illustrates the (potential) determinants of achieving different type of innovations by using a multinomial Probit model.

We would expect a positive influence of innovation efforts on the probability of achieving any type of innovation (Chudnovsky et al 2006), although varying by type of innovation expenditure. For example, innovation expenditures in management and training are likely to be more correlated to non-technological innovations. Conversely, innovation expenditures in R&D and technology transfer are more likely to be correlated to technological innovations.

Arza & Lopez (2011) have showed that firms linked with the national innovation system tend to outperform unlinked firms. Hence, we would envisage that the intensity of links with the NIS is positively correlated with the propensity of achieving any type of innovation.

[4] The key assumption underpinning the PSM technique is that an observation with similar observable covariates is likely to have similar unobservable characteristics as well.

[5] The most common alternative to select the best match between treated and untreated cases are nearest-neighbour method, caliper method, stratification, and kernel method (See Caliendo and Kopeining, 2008)

Table 4a. Propensity score model and determinants of achieving different type of innovations

Variable	Type of data	Short description
Dependant variables:		
Non-Technological innovations (only)	Dummy	Has the firm achieved either organizational or marketing innovations in the period 1998-2001?
Technological innovations (only)	Dummy	Has the firm achieved either product or process innovations in the period 1998-2001?
Non-Technological and Technological innovations	Dummy	Has the firm achieved either product or process innovations along with either organizational or marketing innovations in the period 1998-2001?
No-innovations	Dummy	Reference group
Explanatory variables:		
Innovation Efforts	Continuous (log)	Average of total expenditure in innovation activities (per employee), during 1998-2001, for each of the following categories: Internal R&D / External R&D / Acquisition of Capital Goods / Hardware / Software / Technology Transfer / Engineering & Design / Management / Training / Consulting.
Links with the NIS	Count (0-12)	What is the intensity of the national and international links the firm has established (if any) with the different institutions of the National Innovation System (NIS), during the period 1998-2001?
High-skilled labor	Ratio	Change in the share of professionals & technicians over total employment, between 1998 and 2001
Teamwork	Ratio	Change in the share of teamwork (against individual work) over total employment, between 1998 and 2001.
Workflow Control	Dummy	Does the firm have any system to control the workflow?
Quality Checkpoint	Dummy	Does the firm have any quality checkpoint?
Quality Certification (ISO)	Dummy	Has the firm achieved any quality management system certification? When (year)?
Use of ICT	Dummy	Has the firm introduced any of the following ICTs (e.g. email; intranet; extranet)?
Product life cycle	Categorical	What is the life span of the firm's main product? (short = less than 1 year; medium = 1-9 years; long= more than 9 years)
Market Share	Percentage	What's the market share of the firm's main product?
Liquidity	Dummy	Have the financial constraints of the crisis jeopardized the innovation activities of the firm?
Export profile	Percentage	Share of exports over total sales in 1998.
Size	Categorical	Small, medium and large categories vary over the number of firm's employees
Ownership	Dummy	Foreign firm = 1; domestic firm=0
Industry	Dummy	23 variables by ISIC sector classification at 2-digit level

Source: Own elaboration based on the literature review.

Caroli & Van Reenen (2001) and Alvarez *et al* (2010) suggested that skilled labour is complementary to organizational change, while Chudnovsky et al (2006) found out that a high share of professionals in total employment also have a positive impact on the probability of undertaking product and process innovations. Therefore, we prefigure that skilled labour is likely to affect the propensity of achieving technological and non-technological innovations simultaneously.

Some works indicate that the implementation of teamwork in production, workflow control and quality-management systems (OECD 2005, Damanpour & Evan 1984) as well as the adoption of ICTs (Bresnahan 1999) within the firm might be reflect changes in production and/or business routines that would ultimately lead to organizational improvements. As a result, we would expect the variables teamwork, workflow control, quality checkpoint, quality certification, and use of ICT to be positively correlated with the achievement of non-technological innovations, regardless their interaction with technological innovations.

Drawing on the CIS for German firms, Schmidt & Rammer (2007) found empirical evidence supporting the hypothesis that the shorter the product life cycle is, the higher the probability that the firm will introduce technological and/or non-technological innovations, although the coefficients are slightly higher for the former ones.

For a panel of British manufacturing firms, Blundell et al (1999) found that higher market share firms tend to commercialize more innovations because in so doing they get higher stock market values. Based on these results, we would expect the variable market share in our model to have a positive impact on the probability of achieving, particularly, product and marketing innovations.

Conventional wisdom suggests that financial constraints tend to reduce the probability of achievement any type of innovation, through lower investment levels in innovation activities. Nonetheless, we believe that the negative impact of financial constraints would be higher for technological innovations than for non-technological ones, given the larger amount of investments required in the first case.

Clerides et al (1998) coined the term "learning by exporting" to explain the gains in firms' productivity due to their exporting activities. Baldwin & Gu 2004 and Crespi et al 2008 inquired further on this relationship and found out that exporting, indeed, generates economies of learning that eventually enhance the innovation capabilities of firms. Based on these findings, we have

reasons to believe that export profile of firm at the beginning of the period under study (i.e.: 1998) might positively influence the probability of achieving innovations.

Finally, the usual set of control variables (i.e. size, industry, and ownership) is also included in the model.

Table 4b. Outcome variables for the estimation of average and quantile treatment effects

Variable	Type of data	Short description
Domestic sales	Ratio	Rate of change between 1998 and 2001
Exports	Ratio	Rate of change between 1998 and 2001
Labor productivity	Ratio	Rate of change between 1998 and 2001
Access to global markets	Dummy	Has the firm got access to advanced export markets in the US or the UE, other than continental markets?
World-class innovation	Dummy	Has the firm achieved any innovation that is novel to the world?

Source: Own elaboration based on the literature review.

With regard to the estimations of average treatment effect, as shown in Table 4b, we would expect the differences in outcome variables to be augmented when firms combine both technological and non-technological innovation than in any other case, given the complementarities of product and marketing innovations, on one hand, and process and organizational innovations, on the other hand (Schmidt & Rammer, 2008). It is worth to note that the variables "access to global markets" and "world-class innovation" have been added to the estimation of the treatment effects in order to comply with our definition of latecomers' catch up (Hobday 1995, Mathews 2006).

VII. Main Challenges

Perhaps, the most challenging issue of this study is to find out the most suitable methodology that allows us to address the research questions, given the data limitations above mentioned. We believe that propensity score matching techniques for multiple treatments could, in principle, provide us some insights about the importance of non-technological innovations -as a group- on firm performance. In this case, the propensity scores are drawn from a multinomial Probit model with four mutually exclusive treatments, namely: (i) non-technological innovations –only-; (ii) technological innovations –only-; (iii) both technological and non-technological innovations; and

(iv) none of them, as a reference group. However, if we want to further analyze the relationships and complementarities between technological and non-technological innovations as well as their effect on firm performance, we do need to expand these categories to product and process innovations, on one hand, and organizational and marketing innovations, on the other hand. If we continue using PSM techniques, this alternative would turn out to be computationally burdensome as we would have to construct one sample for each mutually exclusive combinatorial category of innovation, which would amount to 15 (2^4 - 1) treatments. A tentative solution to this problem would be to estimate a series of bivariate Probit models for each combination of innovation achieved to analyze their main determinants and complementarities, as it has been modelled in Schmidt & Rammer (2007). However, this methodological approach will not allow us to estimate the ultimate goal of our research, which is to assess the effect of organizational and marketing innovations on firms' performance. Besides, running OLS regressions in the second step would require further data to control for specific characteristics of the firm, which is currently not available.

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References

- Alvarez, R., Benavente, J.M. & Crespi, G. (2010). "Economic crisis and organisational change in developing countries: evidence from Chile," *International Journal of Technological Learning, Innovation and Development*, Inderscience Enterprises Ltd, vol. 3, No 1, pp 67-86.
- Amsden, A. (2001), *The Rise of "The Rest" - Challenges to the West From Late-Industrializing Economies*. NY: Oxford University Press.
- Armbruster, H., et al (2008), "Organizational innovation: The challenge of measuring nontechnical innovation in large-scale surveys", *Technovation*, Elsevier, pp. 644-657.
- Arza, V. & López, A. (2011), "Firms' linkages with public research organisations in Argentina: Drivers, perceptions and behaviours", *Technovation*, Vol 31, No 8, pp 384-400.
- Baldwin, J. & Gu, W. (2004), "Trade Liberalization: Export-market Participation, Productivity Growth, and Innovation," *Oxford Review of Economic Policy*, Oxford University Press, vol. 20, No 3, pp 372-392, Autumn.

- Baranano, A.M. (2003), "The non-technological side of technological innovation: state-of-the-art and guidelines for further empirical research", *International Journal of Entrepreneurship and Innovation Management*, No. 3, pp. 107-125.
- Bell, M. and Pavitt, K. (1993), 'Technological accumulation and industrial growth: contrasts between developed and developing countries', *Industrial and Corporate Change*, Vol. 2, No. 2, pp. 157-210.
- Blundell, R., Griffith, R. & van Reenen, J, (1999), "Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms", *Review of Economic Studies*, Wiley Blackwell, vol. 66(3), pp. 529-54, July.
- Boer, H., W.E. During (2001), "Innovation, what innovation? A comparison between product, process and organisational innovation", *International Journal of Technology Management*, No 22, pp. 83-107.
- Bresnahan, T.F. (1999). "Computerisation and Wage Dispersion: An Analytical Reinterpretation". *Economic Journal*, No109, pp. F390-F415
- Caliendo, M. and Kopeinig, S. (2008), "Some practical guidance for the implementation of propensity score matching", *Journal of Economic Surveys*, No 22, pp 31–72
- Caroli, E. & Van Reenen, J. (2001), "Skill-Biased Organizational Change? Evidence From A Panel Of British And French Establishments," *The Quarterly Journal of Economics*, MIT Press, vol. 116, No 4, pp 1449-1492, November
- Chudnovsky, D., Kosacoff, B., and Lopez, A. (1999), *Las Multinacionales Latinoamericanas: Sus Estrategias en un Mundo Globalizado*, Buenos Aires: Fondo de Cultura Económica.
- Chudnovsky, D., Lopez, A. & Pupato, G., (2006), "Innovation and productivity in developing countries: A study of Argentine manufacturing firms' behavior (1992-2001)," *Research Policy*, Elsevier, vol. 35(2), pp 266-288, March.
- Clerides, S., Lach, S. & Tybout, J. (1998) "Is Learning By Exporting Important? Micro-Dynamic Evidence From Colombia, Mexico, And Morocco," *The Quarterly Journal of Economics*, MIT Press, vol. 113, No 3, pp 903-947.
- Crepon, B., Duguet, E., Mairesse J., (1998), "Research, innovation and productivity: an econometric analysis at the firm level", *NBER*, Working Paper 6696.

- Crespi, G., Criscuolo, C. & Haskel, J. (2008), "Productivity, exporting, and the learning-by-exporting hypothesis: direct evidence from UK firms," *Canadian Journal of Economics*, Canadian Economics Association, vol. 41, No 2, pp 619-638, May.
- Damanpour, F., & Evan, W.M., (1984), „Organizational innovation and performance: the problem of ‘‘Organizational Lag’’, *Administrative Science Quarterly*, No 29, pp 392–409.
- Davies, A. (2004), ‘Moving base into high-value integrated solutions: a value stream approach’. *Industrial and Corporate Change*, Vol. 13, No. 5, pp. 727-756.
- Dunning, J., van Hoesel, R., and Narula, R. (1997), ‘Third world multinationals revisited: new developments and theoretical implications’, Discussion Papers in International Investment and Management, No. 227, University of Reading, Reading.
- Evangelista, R., & Vezzani, A. (2010), “The economic impact of technological and organizational innovations. A firm-level analysis”, *Research Policy*, Vol. 39, No 10, pp 1253-1263. Elsevier.
- Freeman, C. & Soete, L. (1997), *The Economics of Industrial Innovation*, Cambridge MA: The MIT Press.
- Galbraith, J. R. (2002), ‘Organising to deliver solutions’, *Organizational Dynamics*, Vol. 31, No. 2, pp. 194-207.
- Gann, D. & Salter, A. (2000), ‘Innovation in project-based, service-enhanced firms: the construction of complex products and systems’. *Research Policy*, Special Issue: *Innovation in Complex Products and Systems*, Vol. 29, pp. 955-972.
- Gerschenkron, A. (1962), *Economic Backwardness in Historical Perspective*, Cambridge, MA: Harvard University Press.
- Hobday, M. (1995), ‘East Asian latecomer firms: learning the technology of electronics’, *World Development*, Vol. 23, No. 7, pp. 1171-l 193.
- Hobday, M. (2003), ‘Innovation in Asian industrialization: a Gerschenkronian perspective’, *Oxford Development Studies*, Vol. 31, No. 3, pp. 293-314.
- Hobday, M. Rush, H., and Bessant, J. (2004), ‘Approaching the innovation frontier in Korea: the transition phase to leadership’, *Research Policy*, Vol. 33, No. 10, pp. 1433-1457.
- INDEC (2003), “Segunda encuesta nacional de innovación y conducta tecnológica de las empresas argentinas (1998-2001)”, *38 Estudios*, INDEC, Buenos Aires.

- Katz, J. (2006), 'Structural change and domestic technological capabilities', CEPAL Review, No. 89, ECLAC / UN, Santiago.
- Kelly, P. & Kranzburg M. (1978) "Technological Innovation: A Critical Review of Current Knowledge", *San Francisco Press*, SF.
- Mathews, J. A. & Cho, D-S (2000), *Tiger Technology: The creation. of a Semiconductor Industry in East Asia*, NY: Cambridge University Press.
- Mathews, J. A. (2006), 'Catch-up strategies and the latecomer effect in industrial development', *New Political Economy*, Vol. 11, No. 3.
- Nelson, R. & Winter, S. (1982), *An Evolutionary Theory of Economic Change*. Harvard University Press.
- OECD (2005), "*Oslo Manual*", 3rd Edition, Paris.
- Papa, J. (2011), "Catching up in capital goods and high-tech services. The (un)usual case of a latecomer firm in Argentina", Paper submitted to the *9th Globelics Conference* held in Buenos Aires, Argentina.
- Penrose, E. T. (1959), *The Theory of the Growth of the Firm*. New York: John Wiley
- RICYT / OEA / CYTED (2001), "*Bogota Manual"*, COLCIENCIAS/OCYT, Bogota.
- Rosenbaum, P.R., & Rubin, D.B. (1983), "The central role of the propensity score in observational studies for causal effects", *Biometrika*, Vol 70, No 1, pp. 41–55.
- Rosenberg, N. (1976), *Perspectives on Technology*, London: Cambridge University Press.
- Schmidt, T. & Rammer, C. (2007), "Non-technological and Technological Innovation: Strange Bedfellows?", *DRUID Discussion Paper*, No. 07-052.
- Schumpeter, J.A. (1934), *The theory of economic development : an inquiry into profits, capital, credit, interest, and the business cycle,* New York: OUP
- Schvarzer, J. (2000) *La Industria que Supimos Conseguir. Una Historia Político-Social de la Industria Argentina,* Buenos Aires: Ediciones Cooperativas.
- Schvarzer, Jorge (2002), "El fracaso histórico de la convertibilidad. La Argentina en la década de los noventa", *Realidad Económica*, No 187, Buenos Aires, abril-mayo
- Tidd, J. & Bessant, J. (2009), *Managing Innovation: Integrating Technological, Market and Organizational Change*,. Chichester: Wiley.