Persistence of innovation in Argentinean firms: entering the innovators club

Diana Suárez[1]

Abstract

This paper examines the relationship between past and present innovations for a group of Argentinean manufacturer firms, with data from three national innovation surveys for the period 1998-2006. The objective is to study how previous innovation activities and outcomes affect present results. The relevance of this analysis is to address the issue of persistence among firms located in a developing country, for a period with deep macroeconomic changes, accepting the possibility of a change in the innovative strategy. It tends to make a contribution to the design and implementation of public policies aimed at fostering innovation as sustained competitive strategy for the firms. To test the hypothesis, a dynamic random effect probit model that relates present with past innovations and three key dimensions of the innovative process (efforts, skills and funding) was estimated. Results show that while previous innovations have a low autocorrelation, an active, sustained and balanced innovative strategy are key determinants to remain in the innovators´ club.

Introduction

This paper examines the relationship between past and present innovations for a group of Argentinean manufacturer firms, with data from three national innovation surveys for the period 1998-2006. The objective is to study how previous innovation activities affect present results, through a period which includes economic crisis, recovery and growth. Between 1998 and 2002, Argentina went through one of the deepest economic recession in its history: GDP dropped 20%, the rate of unemployment got 25% and half of the families were under the poverty line. Since the second semester of 2002, Argentina started to growth again, pulled by the increase in the domestic demand and the competitive shock of the devaluation of 200% of the currency at the beginning of 2002. In 2005, GDP levels were over the 1998 peak, unemployment rate was under the two digits and the increase and redistribution of incomes had allowed the reduction of total poverty to less than 70%.

In this context, studying persistence on innovation becomes a relevant issue from both a theoretical and a public policy point of view. From the theoretical point of view, the persistence phenomenon has to do with the mechanisms that trigger endogenous growth processes, especially with the apparent dichotomy between the Schumpeterian concepts of creative destruction and creative accumulation. In this sense, since the beginning of the time series matches the beginning of the crisis, there are good reasons to give attention to

[1] Diana Suárez – Universidad Nacional de General Sarmiento/CONICET (dsuarez@ungs.edu.ar).
This paper is part of the author´s PhD Thesis titled: "Innovative Strategies in the Manufacturer Argentinean Industry 1998-2006", adscript at the Universidad National the Quilmes, supported by the CONICET (Type II PhD. scholarship). The author wants to thank the invaluable comments from B. Jonhson, B.Å. Lunvall, G. Yoguel, F. Barletta, M. Pereira and V. Roberts.

those firms that enter to the "innovators club[2]". The recovery scenario of 2002 and the one of genuine growth from 2005 raise questions regarding the possibility of changes in the innovator trajectory between the crisis and the recovery. This might challenge the concept of persistence between 1998 and 2001 but confirm it afterwards. Moreover, given the new economic model -that breaks with the neoliberal scheme of the nineties, including a new exchange rate system and a more interventionist government-, wondering about the relevance of continuing the innovative dynamic of 1998-2001 period versus the 2002-2006 one is also worthy.

From a public policy perspective, the study of persistence is associated with the arguments against the so called "repetition rate", a concept used to refer to the number of firms that access to more than one public instrument over time. The arguments of those who criticized the repetition of beneficiaries sustain that public policies should foster firms to start innovating since once in an innovative path, the firm should be capable of continuing with a competitive strategy based on innovation. On the contrary, those in favor of the repetition rate sustain that this is the way that the state foster a process of growth based on innovation, ever since technological progress cannot be a short time project. The corollary of the former is that public policies should diversify beneficiaries; the corollary of the latter is that public authorities should diversify instruments.

Then, the main research questions that lead this paper are: how the concept of persistence applies in a context of deep macroeconomic changes? In what contexts public policies should diversify the number of beneficiary firms and in which ones should diversify instruments? What happens with the concept of persistence when entering the innovators´ club is an accepted possibility of the theoretical model?

The paper is structured as follows: after this introduction, we briefly present the theoretical framework and some similar empirical analysis aimed at testing persistence. In the second section we define the model and show the data.. Then the model is applied to a set of firms with innovative dynamic information for the reference period and the results are presented. In the fourth section, some conclusions and future research questions are discussed.

1. Theoretical Background and empirical evidence

1.1. Innovation and persistence

The concept of persistence is used to define the correlation between past and present innovations, this means, the way the innovative dynamic of the firm impacts on the

[2] For the purposes of this document, an innovator company is defined as the one that has introduced innovations. An innovative company, meanwhile, is the one that has developed innovative projects, regardless the outcome (RICyT, 2000)

possibility of obtaining results over time. This concept recognizes its basis on the theory developed by Schumpeter, basically in the idea of "creative accumulation" derived from the approach known as Schumpeter Mark II (Freeman, 1982). In this regard, while in his "Theory of economic development" (Schumpeter, 1912) the basis of capitalism was given by the process of creative destruction and the entrepreneurship entrepreneur (Schumpeter Mark I according to Freeman), a few years later, in “Capitalism socialism and Democracy” (Schumpeter, 1942), Schumpeter argues that the process of technical change is associated with the existence of large firms competing in oligopolistic markets, where the development of innovations and investments to reach them (the R&D labs) trigger accumulation processes which tend to perpetuate those creative innovators on the market.

The Langlois´(Langlois, 2002) interpretation of Schumpeter as well as the one presented by Yoguel et al. (Yoguel and Barletta, 2010) lead to another reading of the concept of persistence in the original developments of Schumpeter. For these authors, the growth in the capitalist mode of production is based on the creative destruction, regardless the type of competence that prevails in the market. In that sense, in some cases, the same oligopolies are who “destry” the market by introducing a new product; in others, new product are introduced by incumbents firms. In this scenario, persistence is the result of a process of accumulation of competences inside the firm subject to the impact of the evolutionist path-dependence.

In any case, accumulation and destruction are present in both approaches and reality confirms that both dimensions of the innovative process are present on the current capitalist dynamics. If the creative destruction could explain all introduced innovations, then large ancient firms, leaders in global markets should not exist – it is worth quoting here the automotive and chemical companies. Conversely, if the process of creative accumulation were the one that explains the current capitalist dynamics, then there should be no new firms, nor those projected today as leaders of the most dynamic markets –such as software, biotechnology and nanotechnology companies. Consequently, reality shows that both accumulation and destruction are part of the capitalist dynamic and there is no *a priori* sectorial, geographical or temporal explanation to predict the causality between past and present innovations. Additionally, the coexistence of both phenomena, the fact that persistence sometimes is verified, sometimes it is not, has trigger several theoretical and empirical developments in order to understand its determinants.

From a theoretical point of view, there are three approaches to persistence analysis: the one that centers the explanation on the evolutionist path-dependence; the one that sustains that persistence happens because the generation of virtuous circles of accumulation; and the one where the focus is on the market power reached by the innovator firm. In the three cases, the key to understand the phenomenon of persistence is the acknowledgement of learning processes and dynamic scale economies – success breeds success- and the dimensioning of its impact is found on the market. The

differences among the approaches lie in the determinants of that creative accumulation, the feedback that allows it and to what extent both of them determine the trajectory of the firm in the market.

Among the precursors of path-dependence approach is C. Antonelli (1997), who argues that the firm is crossed by path-dependence non-ergodic processes which shape its future possibilities. In this sense, the author stresses the combination of irreversibility and indivisibility, in a context of structural actions that affect the firm, limiting its options. In an oversimplified sense, in a particular space and time, past decisions generate sunk costs (irreversibility), decisions which in turn determine the scope for obtaining economies of scale (indivisibility). Both aspects involve opportunity costs of new decisions, which are weighed when the firm decides the form of competition that it will carry on. The spatial and geographical grounding also contribute to shape the characteristics of the firm, thus reinforcing the existence of path-dependence processes.

Applied to the field of innovative dynamics, Antonelli (1997) argues that the accumulation of events within the firm and its relationship with its multidimensional space determine the set of possibilities so the firm may modify the innovative trajectory, but only in a narrow range of options. In turn, these development paths are conditioned and condition the endogenous capabilities and the ability to develop innovations. In this sense, the author highlights the learning processes arising from the innovation activities and the set of incentives emanating from the particular economic situation of the company (stage of growth or recessionary phase) as a source of explanation of the phenomenon of persistence. Thus, the development of innovations in the past contributes to competence building and generates opportunity costs, increasing the odds of deciding to carry on innovative projects, which obviously affect the likelihood of, in fact, reach innovations.

Studying Schumpeterian competition, Nelson and Winter (1982) presented one of the most popular explanations of the innovative dynamics. For these authors, persistence emerges from the generation of feedbacks between past innovations, present investments and future innovations. On the basis of their theoretical developments is the definition of the firm as a set of routines, which are more or less standardized ways of "doing things". Under this definition, the firm can be understood as the result of three types of routines: standard operating procedures, strategic decision-making processes and routines associated with the search for innovations. The decision process that leads to the innovation is in fact a standard behavior, which, in the case of success, will be repeated. In this sense, it is precisely the persistence of routines which impacts on the innovative features of the firm, either by developing innovative projects, or by not engaging in them[3]. However, innovative routines do not imply successful results but simply the mechanisms from which the firm proceeds to find solutions to new problems. When they occur (innovation), the firm stands out from the competition and gets a monopoly rent, which

[3] In the same chapter of the referred book (chapter 5), Nelson and Winter also interpret innovation as the combination of existing routines which lead to new ones. (Nelson *et al.*, 1982)

improves its financial situation, generating surpluses that can be reinvested in the search for new innovations. This success also creates entry barriers that allow the firm to extend the appropriation of that extra income since they slow down the effect of competition. In other words, success breeds success but also contributes to undermine competitors´ possibilities of succeeding.

The market power approach can be found in the developments of Phillips (1971), Mansfield (1962), Geroski et al (1997), among others. Those who ascribe to this approach, argue that to the extent that a firm becomes innovative, it achieves a greater market power that allows it to get an extraordinary income. Thus, past innovations allow financing future ones. The other way around, given the nature of innovation, those firms that cannot generate sufficient surpluses to fund future innovations, face major obstacles to develop an innovative project, or higher costs given by the differential in the interest rate arising from the additional risks associated to such projects.

It is possible to extract some common elements that account for the complexity of the phenomenon from the different approaches. Despite the focus of each of the arguments on persistence describe above, all of them include the financial impact, the effect on the market power and the accumulation of skill derived from innovations. Following Malerba et al. (1997), the innovator persistence can be understood as the serial correlation between past and present innovations and the statistical demonstration of the binomial accumulation-feedback which emerges from the interaction of the firm whit the environment. Under this perspective, if accumulation and feedbacks are part of the competitive process, then in all cases presented above, persistence is defined as the result of a dynamic and heterogeneous process, conditioned by the existence of thresholds (competencies, routines and financial capability), which generates positive feedbacks to the firm (learning processes, market power, financial accumulation), but negative ones for the competition (barriers to entry, loss of market share, additional costs of technological catching-up).

A second common element emerging from the theoretical developments is that of analyzing innovation as a process and not as a result. When understood as a result, innovation is defined as the successful introduction to the market of a new or significantly improved product, or the implementation – also successful - of a new or significantly improved productive, organizational or marketing process (OECD, 2005). As a process, and at the firm level, Fagerberg (2003) defines innovation as the action of combining different types of knowledge, skills, abilities and resources towards achieving improved technology, capable of generating extraordinary incomes, either through the development of new products, either by reducing costs. This combination is not passive; on the contrary, it involves making explicit efforts aimed at improving or creating skills and technological capabilities (Lall, 2001). However, and although the presented approaches acknowledge the importance of the process, all of them measure success in terms of innovations, being the feedbacks (extraordinary incomes, new competencies, productivity increase, generation of barriers to entry) a result of the success, and not vice versa.

A third common element has to do with the interdependence of factors. All the different authors sustain that the learning capacities of firms, the characteristics of past efforts, and the success of innovations are closely linked and associated dimensions. This interdependence can be understood as a simultaneous sequence of positive feedback mechanisms between the variables that determine the innovative success. These variables are articulated within a complex system in which the processes of innovation and organizational skills are strongly associated, both conceptually and methodologically (Metcalfe *et al.*, 2006; Antonelli, 2008). Thus, the acquisition of experience in one of these dimensions strongly affects the others, and vice versa. In this sense, determinants of innovation processes, usually associated with the timing of efforts, the existence of sunk costs, the overcoming of financial constraints, the accumulation of experience based on processes of learning-by-doing, the scope of dynamic scale economies and the creation and dissemination of knowledge related to business competitiveness, trigger accumulation processes that help to understand the present performance of the firm based on a specific set of past behavior

1.2. Empirical evidence

Although referring only tangentially to the issue of persistence, Nelson and Winter (1982) studied the evolution of market structures in terms of the concentration of sales – which is in fact the result of persistence. From a panel of U.S. firms in different industries, the authors conclude that there is a strong trend of increasing market share of firms with a more innovative dynamics (skills and investments), but that does not happen at the same pace or with equal intensity in all markets. Their studies present similar conclusions to those made by Mansfield in 1962, who found that concentration due to technological change becomes more pronounced but with a decreasing rate. Besides the impact of investments and capabilities, Nelson and Winter note that the firm size and the sector were determining factors, strongly correlated with the increase in the market share. In that sense, they strongly suggest the inclusion of the market structure in which the firm operates (sector) as a control variable, to the extent that they also check the hypothesis of Phillips (1971), who had already stated that the phenomenon of concentration was greater where the technological opportunities were lower.

For a set of Dutch firms and with information provided by three rounds of innovation surveys, Raymond et al. (2010) found that persistence exists among firms from high and medium-high technological intensity, where besides size, R&D investments and access to public subsidies have a positive and significant effect on the probability of reaching innovations. However, for other sectors (medium-low and low technological intensity), the hypothesis of persistence is not verified. Moreover, when the initial condition (the idiosyncratic characteristics of the firm) is not properly controlled, the authors note that there is what they called spurious persistence, related the existence of gaps in the characterization of the firm when designing the model from which hypotheses are tested. In other words, when the initial condition and other unobservable factors are not properly

accounted for, the relationship between past and present innovations may actually be a manifestation of the statistical correlation between the idiosyncratic characteristics of the firm and its innovator success. Then, authors suggest that besides structural controls (size, sector, capital origin), for any empirical testing of persistence or any dimension of the firm dynamic, the initial condition and the unobservable effects should be properly controlled.

Using panel data for German firms, Peters (2009) tries to establish causality between past and present actions, using innovative efforts as result proxies and including Raymond et al. (2010) recommendations for unobservable effects. Similar to the results obtained by these authors, while controlling for the effects of the initial condition with the developments of Wooldridge (2005), Peters corroborates persistence but also finds that size and access to subsidies are relevant variables to explain the continuity of investments. She also notes a strong correlation with other attributes of the firm: its capabilities, measured from the existence of employment with a university degree, the source of capital of the firm and the degree of exposure to international competition, measured as the intensity of exports.

Also from innovation surveys (CIS), and for the case of Luxembourgian firms, Le Bas et al. (2011) analyze the existence of persistence but differentiating among three types of innovator profiles: firms that innovated in product and process in the two periods under study, those who innovated only one of the periods and those who did not innovate at all. From this distinction, the authors test the impact of organizational innovations there where persistence is checked (the first group of firms) and there where it is not (the second and the third ones). The evidence allows arguing that organizational innovations are a key determinant not only of the persistence, but of innovations generally speaking. In that sense, they observed positive and significant impacts derived from this type of innovations, on both continuous and sporadic innovators. As in the other studies reviewed, there is also a strong association between persistence and firm´s size and the R&D sustained investments.

Another interesting study is the one performed by Clausen et at. (2011) In order to study how different dimensions of the innovative dynamic are combined inside the firm, the authors analyze a group of Norwegian enterprises to identify different innovative strategies. Based on information from three national innovation surveys (CIS), they found that firms can be classified according their specific investments on innovation, linkages and capabilities and propose a taxonomy similar to the one of Pavitt (1984) but not restricted to sector but to firms. Using a probit dynamic model, Clausen et al. corroborate persistence in the case of science based and market oriented firms, butnot in the case of firms with sporadic efforts on innovation (the ad-hoc group), nor the supplier based ones. They also confirm that the elements of the innovative process are combined differently determining different strategies. Thus these elements (efforts, linkages and capabilities) should not be studied as one single one-dimensional variable but as part of a more systemic behavior where different efforts are combined with different capabilities and both of them with different interactions with the national innovation system.

A different set of studies are those that analyze the persistence in obtaining patents. Among them, it is worth to mention those by Malerba (1997) et al. , Cefis and Orsenigo (2001) and Gerosky (1997). The advantage of these studies is that they observe trajectories in different productive sectors in different countries, allowing cross-sectoral and cross-national comparisons. In all three cases, the explanatory power of past innovations -approximated with patents- is low and focused on some productive sectors. Malerba et al. (1997), however, note that although the percentage of firms where the phenomenon of persistence is reduced, these same firms account for most of the granted patents. Cefis and Orsenigo, meanwhile, point out that there is a strong tendency to perpetuation of the status of innovator as well as the status of not innovator firm: persistence, at aggregate levels, has a low impact that also decreases in time. Finally, the results achieved by Gerosky (1997) on a series of UK firms that obtained patents in the United States, agree with those obtained by Malerba (1997), finding only a few companies where persistence holds. In all cases, as stated by the same authors, analyze the persistence from patenting involves limiting the analysis to patentable radical innovations, leaving out the possibility of achieving incremental innovations or introducing new products but not with the novelty degree required for a patent. Therefore, although the results allow conclusions regarding the importance of the sectorial belonging and the innovative dynamic, they should be read with caution when analyzing persistence.

Summing up, empirical approaches of innovation persistence can be grouped among those that explain the phenomenon from the results (output) and those which study the dynamics of efforts (inputs). The former include the analysis of trajectories of patenting and innovations. The latter are based in the study of the dynamics of innovation expenditures. In all cases there is consensus that investment on innovation activities, firm size, sectorial belonging and endogenous capabilities are explanatory factors of recurrence in innovation. Yet, the evidence is inconclusive regarding the relationship between past and present innovations. The diversity of results shows that despite the positive and significant impact of estimated coefficients, in all the analyzed panels there are innovative firms that achieved positive results year after year and innovative firms that did not. There are also firms that innovated at the beginning of the time series but did not do it again (and vice versa). Then, the phenomenon of persistence sometimes is confirmed, sometimes it is not.

1.3. Some less explored dimensions of persistence

One of the gray areas in the studies of persistence has to do with determining the lag between the dependent and the explanatory variables. In practice, the estimated lag seems to be explained more by the availability of information than by a theoretical framework of the time window considered in the analysis. At the same time, the return period of R&D or machinery expenditures are not necessarily equal to the time that takes to capitalize an innovation, allowing the reinvestment of profits, or the learning processes that develop skills to generate new innovations. In the first case, the impact should be

reflected on the innovations of the next period, in the second case, innovations should impact on profits and capabilities first and only from there, on innovations again. Evidently, an average delay is better than no delay at all and only the increased in the quantity and quality of available information will allow more complex approaches to the relationship between past actions and present results.

Another less discussed issue in the literature on persistence is the one related to the use of innovations as a proxy for success. As mentioned before, the presented analyses argue that feedbacks generated from innovator success breed profitability/capabilities enabling future innovations. However, although the correlation between innovative efforts, innovations and expertise is widely supported, international comparisons call the attention to extrapolating the innovation variable (meaning success) and development. Indeed, when looking at the share of innovator firms in the world, there is no clear correlation between this share and the level of development. Argentina, Brazil and Uruguay, for example, have a higher share of innovators that developed countries like Germany or France[4]. In this sense, it is argued that innovation is the successful introduction of a product or process to the market, but neither the implementation of a new product automatically leads to improve the performance of the firm, or its absence prevents it. On the contrary, it is precisely what happens between the input and output, -i.e.: competence building and learning processes-, which allows the understanding of the impact of the innovative dynamics.

Finally, another aspect still under discussion is the one regarding the possibility of a change in the trajectory of the firm. When analyzing the phenomenon of persistence, models neglect the possibility of entering into the "club of innovator firms" and although considered in the theoretical framework, micro-heterogeneity is not included in the empirical testing. Even worse their existence prevents the confirmation of the hypotheses. Although some of the reviewed analyses consider changes in the environment that vary over time, it is also assumed that the impact is the same for all cases[5]. This implies assuming that the incentives derived from the environment impact equally in all firms[6].

The possibility of different reactions to the same external stimulus is of particular interest in the matter of this paper given the abrupt change in the macroeconomic environment

[4] Another interpretation of the lack of correlation between the rate of innovators and the level of development has to do with the quality of the data gathered by the innovation surveys in developing countries. In this sense, questions related to innovation outputs are subject to the understanding of the respondent and his known about the international technological frontier. However, since the questionnaire follows the Oslo Manual recommendation, cross-country comparisons are possible, although the interpretation of results ought to be done with caution. This aspect is further discussed in the following sections.

[5] In practical terms, an independent variable, observed or not, which varies between periods but not between cases.

[6] Surprisingly, despite the critics that some heterodox approaches do to the “neoclassical representative agent”, empirical studies assume equal impact of the environment to all firms, this means, the same average reactions.

during the period under analysis. In this sense, two different approaches could help to understand the relationship between persistence and microheterogenity.

From an economic cycle point of view, the developments of Antonelli (2008) model the reactions of firms to incentives in an U-shaped paraboloid pattern, which links benefits and time. On the left there are firms with lower productivity values, in the center those which obtain the average values and to the right firms which show a level productivity higher than the average. Applied to the economic cycle, this relationship implies that during the downturn, incentives to innovate are given by the need for survival; in the stable stage, the incentives would be given by the need to differentiate the firm, escaping from the neoclassical perfect competition, and during the expansion phase, the availability of funds allows the firm to take risks, face more radical innovations and afford the costs of experimentation that companies in less favorable positions cannot. In this case, any time of the economic cycle has the potential to create incentives to innovate and persistence would be determined by the evolution of the firms´ productivity.

A more traditional interpretation of the impact of the economic cycle argues that during recession, unemployment levels help to reduce controls on registered labor, which added to the economic suffocation, creates incentives to base survival in non-registered schemes or precarious economy, which adversely affects the innovative dynamics. The stable phase, meanwhile, is a "desirable" state where the firm can maintain its profitability without assuming technological or financial risks, which impacts similarly to the previous case. Finally, the expansion phase is a time of growth pulled by an increasing demand that can both eases the downward pressure on prices and boost its growth when it exceeds supply. In this case, there would be no incentive to innovate since profits can be obtained by structural effects and persistence would be verified only in those cases where the firm´s strategy is based on innovation.

Consequently, to predict the response of the firm to the external stimulus is not possible. On the contrary, the particular phase of the cycle, the characteristics of the agents surrounding the firm and the rules governing the interactions, impact on the micro decisions but it is not possible to state *ex ante* what the particular response of the firm will be (their more or less innovative behavior). Firms may respond differently to incentives and that response will depend on its background and skills, affected in part by its sectorial belonging, but not determined by it.

From National Innovation System approach (Lundvall, 1992; Lundvall, 1998; Jensen *et al.*, 2007; Chaminade *et al.*, 2009), microheterogeity finds another explanation: the particular characteristics of the agents and the interactions between them determine how each firm will behave, given their skills and goals. From this approach, the variety is part of the system and it is in fact a key aspect that makes systems unique. In terms of micro behavior, two ideal modes of innovation can be identified: the Science, Technology and Innovation (STI) mode and the Doing, Using and Interacting (DUI) one. (Jensen *et al.*, 2007) The first one relates to the traditional, science-based, way of generating knowledge. The

second one, to the learning processes and the incorporation of knowledge generated from the productive dynamics and from the interaction with the environment. The coexistence of these modes is not necessarily harmonious; however, both modes may be at odds (eg, codified knowledge in the STI-mode vs. tacit one in the DUI-mode). So, although firms more oriented to one or the other mode can be found, there is not a clear *a priori* indication that a representative strategy exists, not an average response, not two firms behaving the same way and reaching the same results.

In terms of persistence, if the innovative strategy is the result of explicit and implicit choices about the allocation of innovative efforts then persistence would appear as the result of a persistent innovative strategy which leads to innovation and both of them to a particular trajectory of the competence building of the firm.

In short, the different approaches agree that the productive structure is the result of the adoption of different micro-strategies. Then, the strategy pursued by the firm will be determined by the accumulation of technological, organizational and productive capabilities, which also increase the firm´s ability to understand what their range of options for technological and organizational developments are. Thus, persistence will be the manifestation of a successful competitive strategy based on innovation and sustained over time.

2. Model and methodology

2.1. The hypothesis

The reviewed analyses agree on indicating a positive relationship between present innovations and three dimensions of the firm: innovative efforts, skills and financial situation. The available data confirms this and also shows a relevant impact of the firm´s size and its sectorial belonging. Regarding persistence, once these dimensions are controlled for, it appears as another relevant explanatory variable. Data allows the confirmation of the hypothesis of a significant and positive correlation between past and present innovations. If capabilities, efforts and financial viability have been properly accounted for, then this serial correlation among innovations would be showing the relationship between an "initial" innovation and the complementary ones that follow from it. Of course, if they were not properly controlled, this correlation is just another way to capture the effects of unobservable (or unmeasured) variables, that is to say, it is a spurious persistence. (Raymond *et al.*, 2010)

In what follows, the relationship between past and present innovations for a set of Argentine manufacturing firms will be tested. The relevance of this analysis is to address the issue of persistence among firms located in a developing country, for a period with deep macroeconomic changes. This involves two issues. Firstly the indicator “innovators rate" should be read carefully, to the extent that it overestimates the number of true innovator firms in developing countries. (Suárez, 2006; Anlló *et al.*, 2007; Anlló and Suárez,

2008; Lugones and Suarez, 2010).This is so because the distance to the international technological frontier, the degree of knowledge of the rest of the world and the local idiosyncrasies lead respondents to report as innovation a minor change (incremental innovation) that would be considered part of productive dynamic in a developing country, therefore not reported as innovation.

Secondly, the analyzed period includes years of recession, recovery and growth, it also includes a change from a fixed convertibility model and overvalued currency to another lead by exports via a depreciated exchange rate. The relative lower cost of labor, the boom in the price of agricultural commodities (Argentina's main export product) and the increased in the domestic demand, also represent large changes in exogenous incentives. Consequently, to assume the same micro behavior throughout the period 1998-2006 is not possible; quite the opposite: given these changes, new behaviors should be expected. In the matter of innovation, this leads to the adding of a fourth dimension to the analysis: the innovative behavior of the firm and the possibility of its modification over time.

The hypothesis can be summarized as follows:

H1: there is a positive relationship between past and present innovation, which is the manifestation of the accumulation of skills and the generation of virtuous circles among performance, innovative efforts and capabilities,
H2: given the macroeconomic change and the acceptance of a change in the competitive strategy of the firm, persistence is shows up as positive relationship in firms with innovative behavior sustained over time, and negative in firms where there is a change in this dynamic.

2.2. The data

The model was applied to a panel data that comes from innovation surveys conducted in Argentina. (INDEC, 2010) A balanced panel data for the period 1998-2006 was created, containing a total of 800 manufacturing firms (ISIC 15 to 36) who have participated in the 4 innovation surveys occurred between 1998 and 2006 and declared information for the variables to be analyzed. The data were gathered by the Argentinean National Institute of Statistics and Census (INDEC) and the questionnaire used in all cases followed the Oslo (OECD, 2005) and Bogotá Manual (RICyT, 2000) recommendations , which guarantees the possibility to merge variables coming from the different exercises as well as the international comparability of the innovation indicators.

Given the request of having participated in the four surveys, all firms were established before 1998 (first year of the first innovation survey) and they all survived the worst crisis in Argentina's history. That means that the sample is biased towards the 'successful' companies, or at least, to those who managed to cope better with the recession of 1998-2001. Since the objective of this study is to analyze the types of innovative behavior over a

relatively long period of time, it is important to keep in mind that the group is composed by the firms with relatively better performance than the average of Argentinean industrial companies.

2.3. The model

To test the hypothesis, a model to measure the impact of past innovations in the probability of reaching innovations in the present, given the innovative behavior of the firm, was constructed. Since the dependent variable is a binary one (did or did not innovate at time t), a dynamic random effects probit model was chosen, which also controls the micro heterogeneity, allowing the inclusion of unobserved effects. To control for the initial condition the Wooldridge solution (2005) was used, including the average value of the explanatory variables as well as the value of the dependent variable at time zero[7], similar to the approaches made by Raymond (Raymond *et al.*), Peters (2009) and Clausen (Clausen *et al.*, 2011). The advantage of this solution is that it allows relaxing the assumption of independence between the explanatory variables and the unobserved effects. Theoretically speaking, the solution raise from the assumption that the unobserved characteristics of the firms can be approximated as a linear function of its observable behavior. In the case of persistence studies, this implies that the innovative dynamic of the firm (linkages, expenditures, qualified human resources, access to external funds, etc. taking into account altogether) is in part the result of its unobservable characteristics.

The period under review was segmented into 3 sub-periods: 1998-2001, 2002-2004 and 2005-2006, in order to separate both, the macro determinants and the possible lag between innovation efforts and results. This is based on the fact that innovation is a process that may go beyond 12 months and also due to data restrictions. From these sub-periods, continuous variables were recalculated as annual averages and those in local currency were deflated by the producer price index, base 1998. For dichotomous variables, the criterion used was that of a positive response in at least one year of each sub-period.

The different number of years included in each sub-period is likely to affect the total reported number of innovations (it is more likely that a company has innovated when the consultation is for a period of 4 years than for a period of 2). Unfortunately, the way this variable is addressed in the questionnaire (in the four consultation exercises, question relates to the period and not to the year) makes it impossible to use variables that span equal number of years.

[7] The solution proposed by Wooldridge (2005), derived from the Chamberlain model for random effects (Chamberlain, 1980, 1984, 1992) is given by the inclusion of the independent variables at each point in time, however, following what made by Peters (2009), Clausen (2011) and Raymand et al. (2010), to replace these variables by their average value minimizes the number of explanatory variables without affecting the results of the estimation.

Then, the model explains the occurrence of innovations in Argentinean manufacturing enterprises for the period 1998-2006. Past innovations where introduced differentiating whether the firm has a continuous, a sporadic or a new innovative behavior[8]. The impact of efforts, capabilities and financing resources were also included. Formally, it is written as:

$$Inno_{ti} = \beta_0 + \beta_1 LInno_{ti} + W_{ti} + w_i + T_t + \mu_i + \in_{ti} \quad (1.a)$$

$$Inno_{ti} = \beta_0 + \beta_1 LInno\_cont_{ti} + \beta_2 LInno\_new_{ti} + \beta_3 LInno\_spor_{1i} + W_{ti} + w_i + T_t + \mu_i + \in_{ti} \quad (1.b)$$

$$W_{ti} = \beta_a II_{ti} + \beta_b IB_{ti} + \beta_c QHR_{ti} + \beta_d link_{t-2} + \beta_{e2} link_t + \beta_f ixpo_t + \beta_g rec\_ext_t \quad (2)$$

$$w_i = Labor_{ti} + KO_{t-1i} + MLT_i + MHT_i + HT_i \quad (3)$$

$$\mu_i = \alpha_0 + \alpha_1 Inno_{0i} + \sum_{t=0}^{T} \alpha_n W_{ti} + \varepsilon_i \quad (4)$$

Equations 1.a and 1.b imply that the innovation at time t ($Inno_{ti}$) depends on innovations in t-1 ($LInno_{ti}$), a set of observable attributes that vary between companies and over time (W_{ti}), a set of attributes time-invariant but also observable (w_i) and a set of idiosyncratic characteristics, unobservable and time-invariant (μ_i).

For the observable characteristics(W_{ti}), given the availability of information, variables that control the three dimensions outlined above were included: efforts, skills and financial resources. Table 1 summarizes the treatment applied to each variable.

To align the innovation efforts two indicators were included: the intensity (II) and the balance (IB) of the innovation expenditure, measured in constant prices 1998, as annual averages for each period. Then natural logarithm was applied in order to homogenize scales. The innovative intensity ratio is the coefficient between expenditures on innovation activities and sales. The underlying assumption is that the higher the expenditure, the greater the firm's commitment to the search for technological and organizational improvements; an assumption widely confirmed in the literature and empirically tested in various papers with the same data but different models and panels (Chudnovsky *et al.*, 2004; Lugones *et al.*, 2007; López and Arza, 2008).

Since the relation between results and efforts will be tested, another assumption has to be made. One widespread consistency test narrows innovation only to those firms that allocate resources to innovation (innovative firms). However, since the timing between efforts and results cannot be anticipated, for the purpose of this paper, a firm could be an

[8] A similar approached is used by Raymond et al. (2010) although they introduced these multiplicative variables in order to differentiate high-tech from low-tech firms.

innovator (positive results) without being innovative (positive expenditures). The assumption behind this state is that either the expenses were incurred during a not surveyed period, or it was made with expenditures associated with the ordinary operations of the firm[9].

Table 1: detail of the used variables

Label	Detail	Calculation	Value
$Inno_{ti}$	Product, process, organization or commercialization innovator	At least one innovation in the subperiod.	0;1
$Cont_{ti}$	Continuous innovative firm	Innovative in t, t-1 y t-2	0;1
New_{ti}	New innovative firm	Innovative in t y t-1	0;1
$Spor_{ti}$	Sporadic innovative firm	Innovative in t, t-1 o t-2 or 2 non-consecutive subperiods	0;1
W_{ti}	Observable time variant characteristics of the firm		
II_{ti}	Innovative inntensity	Innovation expenditure to sales. Annual average of the subperiod. In Ln.	0; ∞
IB_{ti}	Innovative balance	Average of the distribution of the total innovation expenditure of the subperiod. In Ln.	0; ∞
QHR_{ti}	Qualified human resources	Total number of professionals. Annual average of the subperiod. In Ln.	0; ∞
$LinkLink_{t}$	Linkages	At least one linkage in the subperiod. Variable available for t and t-2.	0;1
$Ixpo_{ti}$	Export intensity	Total exports to sales. Annual average of the subperiod. In Ln.	0; ∞
Rec_ext_{ti}	Access to external sourcer of funding	At least one external source of funding in the subperiod.	0;1
$Labour_{ti}$	Size	Total employment of the firm at the end of each subperiod. In Ln.	0; ∞
w_i	Observable time variant characteristics of the firm		
KO	Capital origin	A firm that has more than 1% of their shares owned by foreign capital in t-1	0;1
Sec	Sector technological intensity	OECD classification in t-1: high-tech, médium-high-tech, médium.low-tech and low tech. One dummy for each category.	0;1
μ	Unobservable time-invariant characteristics of the firm		
$Inno_{0i}$	Initial condition	Innovator in t-2	0;1
$\sum_{t=0}^{T} \alpha_n W_{ti}$	Average of observable characteristics		
$\in y\ \varepsilon$	Statistic error		
	Subindexes		
i	Firm		1-800
t	*Subperiod*	t = *2005-2006* $t-1$ = *2002-2004* $t-2$ = *1998-2001*	3

[9] There is a high correlation between innovative and innovator firms: all innovative firms had at least one positive result during the period under analysis.

The distribution of the innovation expenditure is another indicator proved to have impact on the innovative dynamic. (Lugones *et al.*, 2007; Yoguel *et al.*, 2011). The argument supporting this relationship indicates that the generation and application of new knowledge (or a new combination of an existing one), and its introduction to the market in the form of innovations, is the result of deliberate efforts, more or less planned, in the pursuit of technological and organizational improvements. These efforts must combine the incorporation of knowledge developed outside the firm (exogenous knowledge) with the endogenous creation of new one, in order to absorb and transform them into an innovative product or process. Even in cases where innovation happens purely and exclusively through the acquisition of embodied technology (capital goods), the impact is greater when the firm also invests in activities to select, adapt and improve it (e.g., engineering and industrial design). For the calculation of the indicator the formula developed by Lugones, Suarez and Le Clech (2007) was applied (Table 2), and then the indicator was transformed into its natural logarithm.

The general notation of the index is: $IB_i = \dfrac{n - \sum_{i=1}^{n} \dfrac{\left| \left(g_j / AI \right) - \alpha_j \right|}{\left(g_j / AI \right) + \alpha_j}}{n}$ con $0 < IB_i \leq 1$

Table 2: Innovation Expenditure Categories

Category (j)	Description	Weight (α)
A	Research and Development (internal and external)	0,25
B	Engineering and industrial design + training	0,25
C	Capital goods + Hardware	0,25
D	Technology transfer (TT) + Consulting + Software	0,25

Source: Lugones, Suárez y Le Clech (2007).

Where *i* is the identifier of the firm, *j* is the identifier of each category of expenditure summarized in Table 1, *g* is the expenditures in each category (*j*), *AI* is the cumulative total expenditures (in constant prices 1998) on innovation activities, α is the weighting coefficient for each *j* (in this case 0.25 for each set of activities, so that the sum is equal to 1), *n* is the total number of categories analyzed (4 in this case). The cumulative expenditure will be used in each sub-period because it is expected that the firm will distributes the costs between the innovation activities based on funding availability and the ability to spread the cost (e.g.: after the purchase of a capital asset, efforts in engineering and training to optimize their use should be allocated and probably the latter will be lower than the former but not less important in terms of the pursued innovation).

The authors assign equal weights to each category (0.25) in order to analyze the values obtained by different groups of firms. This analysis does not aim at finding the optimal

value of the index, but to analyze their impact on firm productivity. Then similar weights to each category are assigned and the strategies go from the perfectly balanced firm (index equal to 1) to the perfectly unbalanced one (values tending to 0). Although it cannot be zero, it can tend to it, given the weighting coefficient and the number of categories. Of course, this index is reduced to the group of innovative firms (firms that reported spending on innovation, regardless of the results achieved) given the denominator of the index. For the non-innovative firms, the IB will be set to zero in order to avoid the loss of observations.

The inclusion of the dimension of capabilities is made from professionals and links the firm has established with agents from the national system of innovation. The provision of skilled human resources (QHR_{ti}) was estimated with the absolute number of professionals in the firm, assuming that the more years of formal education, the higher the skill level of the firm. This variable was also estimated as annual average for each sub-period and then transformed into their natural logarithm[10]. Variables like this one are usually included in relative terms (for instance, to total employment). However, since the high participation of small companies in the panel and following what explained by Arocena and Sutz (1999), the absolute value of professionals and even a dummy variable to distinguish firms with this human resource from firms without them are good approximations of what happens in terms of competences and innovative dynamics.

The linkages of the firm with the national innovation system is another variable included as a proxy of capabilities, assuming that interactions with other agents increase firm´s capabilities. *Link* is a dummy variable that takes the value 1 if the firm reported interactions with other agents of the system and zero if not. The inclusion of this variable has to do with the fact that to generate new knowledge and transform it into an innovation, the firm must access to external one. Despite the disappointing empirical results (low rates of linkages/cooperation), evidence supports that interactions happen when the firm has crossed a threshold of minimum competencies. (Tether and Swann, 2003; Erbes *et al.*, 2004; Suarez, 2009; Yoguel *et al.*, 2011) For instance, a company that engages in R&D is more likely to interact with R&D laboratories than a company that does not. For the purpose of the present analyses, if the firm has established linkages, then it has crossed that minimum threshold of competences and has higher skills than a firm who has not interacted. Unfortunately, the information collected during the period 2002-2005 is not comparable with the other two exercises, so it must be excluded from the analysis. Thus, the variable is included as two time-invariant dummies, one for the period 1998-2001 ($link_{t-2}$) and one for the period 2005-2006 ($link_t$).

To approximate the availability of financial resources a variable about the access to external funding to finance innovation activities was included (public or private banks, development agencies, the value chain, etc.). *Rec_ext* is a binary variable that assumes 1 if

[10] It is widely known that measuring on absolute values bias the sample towards the small and medium enterprises. However, measures based on coefficients (in this case, professionals to total labor) bias the sample towards the larger ones. Both measures were test and results did not differ significantly.

yes and 0 if not, for each sub-period. In this case, the lack of resources has been signaled in all surveys as the most important obstacle to the realization of innovations. Thus if the firm has managed to overcome that barrier it will be in a better financial position.

Export intensity was included as a second variable related to the availability of surplus to invest in innovation. The coefficient between exports and sales, also in its natural logarithm (*ixpo*) is assumed to control for the financial situation a firm has when it can stabilize the economic cycle combining the domestic with the foreign demand. At the same time, the controlled flotation of exchange rate was an explicit public policy to foster export during the period 2002-2006. Then, it is assumed that the higher the export intensity, the higher the income level and competitiveness of the firm and with it, the higher the availability of funds.

In order to control for time-invariant effects three dummies were included, all of them with proven impact on the innovative dynamic: size, source of capital and sector, in all cases lagged one period. Sub-period 2002-2004 was used as the reference point since it is in between the turbulence of 1998-2001 and the growth of 2005-2006. Allowing these variables to change over time would absorb part of the dynamics of sales and employment, which could cause problems of collinearity and abrupt changes on indicators only via a denominator-effect.

For the sectorial distinction, the International Standard Industrial Classification Revision 3 (ISIC Rev. 3) was grouped into four categories, based on the OECD classification on technological intensity (OECD, 1997): high-tech (HT), medium-high-tech (MHT), medium-low-tech (MT) and low-tech (LT)[11].

The size control refers to the total employment of the firm at the end of each subperiod, in total number of persons in natural logarithm (Labor). A "company with participation of foreign capital" is defined as a firm that has more than 1% of their shares owned by foreign capital in t-1 (OK). This classification is based on the significant transnationalization process of many industry sectors in Argentina during the 1990's, reaching its climax at the end of last century.

One of the limitations of this model is the assumption of strict exogeneity of explanatory variables. In this case, this would imply that past innovations do not impact on the competencies, future efforts or financial situation of the firm. To avoid part of this assumption, the model is implemented in two stages. In the first, only the lagged dependent variable (lagged innovation for each strategy) and time-invariant variables were included. In the second, all the variables were tested.

[11] High-tech industries includes ISIC classification 353, 2423, 30, 32, 33; medium-high includes: 31, 34, 24 (excl. 2423), 352, 359, 29 ; medium-low-tech: 351, 25, 23, 26-28; low-tech: 36 37, 20-22, 15-19. (OECD, 1997)

In equation 1b, past innovations are differentiated according to whether firms conduct a continuous, a new or a sporadic innovative behavior, being non-innovative firms (without innovation expenditures) the referential conduct.

The four types of Innovative Conduct were defined as follows:

- Non-innovative: firms that did not make innovation efforts during the period 1998-2006.
- Sporadic innovative: enterprises which engaged in innovative efforts only in one or two non-consecutive sub-periods.
- New innovative: firms that were non-innovative between 1998 and 2001, and which made innovative efforts in the sub-periods 2002-2004 and 2005-2006 consecutively.
- Continuous innovative: firms that made innovative efforts in the three analyzed sub-periods.

Table 3 shows the distribution of the panel among the defined strategies. The non-innovative firms constitute a small group (17,5% of the panel) and this underrepresentation is explained by a high rate of mortality among them and therefore their disappearance from the statistics.

Table 3: Panel distribution by Strategy

Strategy	Number of firms	%
Non-innovative	140	17,50
Sporadic Innovative	215	26,88
New innovative	120	15,00
Continuously innovative	325	40,63
Total	800	100,00

The sporadic innovative group represents a little more than a quarter of the panel, and these are firms that present poor results of innovation, to some extent similar to those of non-innovative, but with better odds of success (given, of course, the definition of success adopted here). Sporadic efforts are related to companies that have specific problems at a certain moment that requires immediate solution, triggering innovations. It is supposed that these firms have not implemented a search for systematic technological and/or organizational improvements during the period considered and that is why its expenditure is sporadic.

The group of continuously innovative firms is composed by companies that, regardless the macro context, have sustained their efforts on innovation over time. This group represents 41% of the panel and explains part of the bias in the sample.

Finally, about one hundred companies (15% of the panel) are the new innovative group. These firms did not make efforts during the period 1998-2001, but began to invest in innovation since 2002 and to do it continuously until 2006. This group shows a change in the strategy derived from the new context and does differ from non-innovative and sporadic innovative firms, being closer to the continuous innovation type.

3. Results

3.1. Descriptive statistics

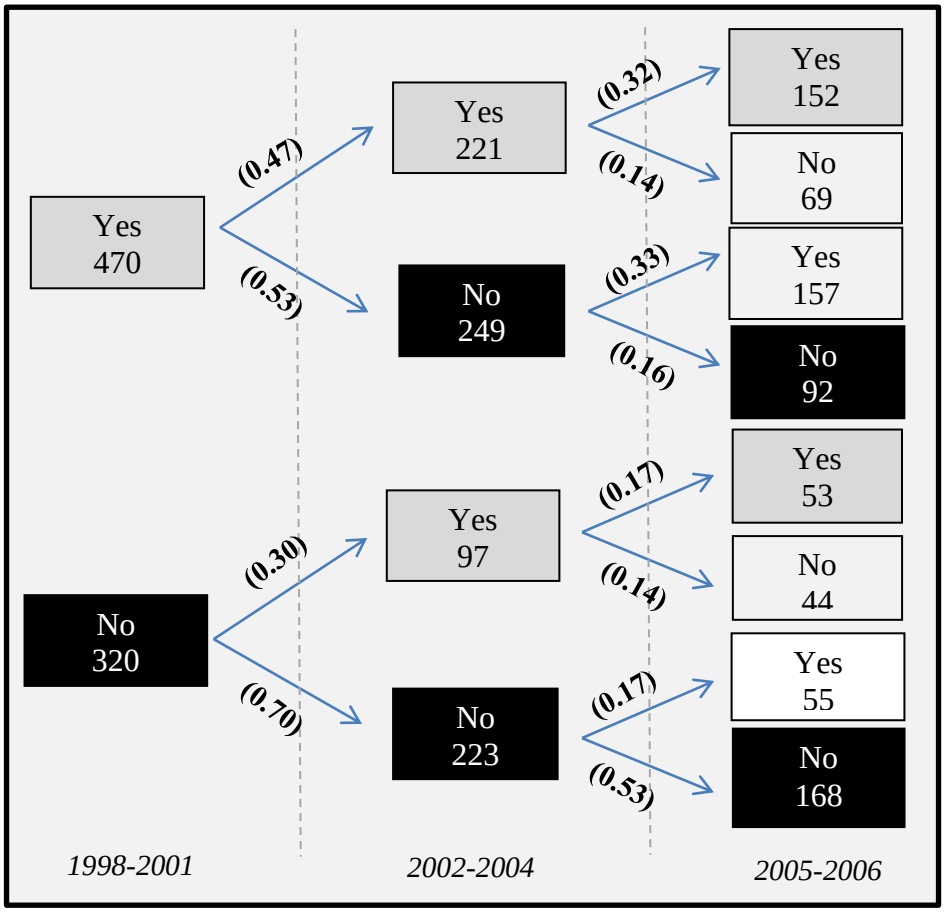
3.1.1. Transition probabilities

A simple way to get a first approach to the phenomenon of persistence is analyzing the transition probabilities. Although such schemes lack the basic controls, they are used to understand what happens with the panel and the trajectories of innovator firms. A tree diagram is presented in Figure 1, showing the transition from one moment to another of those firms that had innovated and those who had not, allowing as many branches as possible combinations. Between one time and another, the probabilities in respect to the initial condition are included. This scheme, albeit preliminary, highlights two issues. The first one, related to the innovative dynamics, the second one with the period under review.

Regarding the innovative dynamics, while between 1998 and 2001 (hereafter t-2), the probability of being an innovator was 58%, between 2002 and 2004 (hereinafter t-1), the probability of being so, subject to a positive response in the previous period was 47%. Between 2005 and 2006 (hereinafter t), the ratio falls again and if the firm was an innovator in t-1 and t-2, the probability of being it on t drops to 32%. The trajectory of the not innovator firms, however, is much more clear: while the 42% of the panel reported no innovations in t-2, this condition holds with a probability of 70% at t-1 and, subject to t-2 and t-1, of 53% at t. In this sense, persistence seems to exist in negative terms (not to be an innovator is maintained over time) but not by the positive ones (achieving an innovation in the previous period does not seem, *prima facie*, associated with innovations in the following period).

Another interesting fact is the apparent correlation between the initial condition and the final situation: regardless the result in t-1, if the firm was an innovator in t-2, the probability of sustaining this situation in t was 66%. The other way around, almost seven out of ten of non-innovators firms in t-2 remained so by the end of the period –again, regardless their situation in t-1.

Figure 1: Innovator firms – Transition probabilities - Total Panel*



* "Yes (No)" means that the firm has (has not) achieved innovations. Inside the boxes: number of firms; inside the brackets: probabilities to initial condition (1998-2001).
Source: own elaboration base don INDEC (2010).

In order to get a first approximation to the innovative strategies, figure 2 presents the same transition probabilities but distinguishing firms according to their previously defined innovative behaviors: the continuous, the sporadic and the new innovative firms. On the one hand, not only a reduced number of continuous firms did not innovate in t-2 (6% of the group), but also a smaller proportion remains in that condition over time (26%). Within this group, 40% of the firms show persistence all along the period, that is, 10 percentage points over the average value reaches for the panel. Among the sporadic group of firms, the results are quite the opposite: only 10% of the firms show persistence in all periods and more than 38% has never innovated. New innovative firms show interesting results. Within this group, more than a half of the innovators at the initial subperiod remain so over time and although almost 70% of the firms were non-innovators in t-2, only 9% remained in this situation at t.

In short, although basic control variables not included, the evolution of innovators among groups seems to differ significantly among innovative behaviors. While the continuous group show a constant increase in the number of innovators and almost the inexistence of

firms with no innovations at all and the new innovative firms follow a similar pattern but starting from 2002-2004; among the sporadic group the rate of innovators seems to follow no pattern at all and the probability of innovating is most of the times around fifty percent, being slightly higher the lack of innovation than the actual accomplish of them.

Figure 2: Innovator firms – Transition probabilities – Innovative behaviors*

<table>
<tr><th colspan="3">Continuous</th><th colspan="3">New</th><th colspan="3">Sporadic</th></tr>
<tr><th>t-2</th><th>t-1</th><th>t</th><th>t-2</th><th>t-1</th><th>t</th><th>t-2</th><th>t-1</th><th>t</th></tr>
<tr><td rowspan="4">Yes
306 firms</td><td rowspan="2">Yes - 147
(0.48)</td><td>Yes - 121
(0.40)</td><td rowspan="4">Yes
38 firms</td><td rowspan="2">Yes - 27
(0.71)</td><td>Yes - 20
(0.53)</td><td rowspan="4">Yes
113 firms</td><td rowspan="2">Yes - 47
(0.42)</td><td>Yes - 11
(0.10)</td></tr>
<tr><td>No - 26
(0.08)</td><td>No - 7
(0.18)</td><td>No - 36
(0.32)</td></tr>
<tr><td rowspan="2">No - 159
(0.52)</td><td>Yes - 133
(0.44)</td><td rowspan="2">No - 11
(0.29)</td><td>Yes - 8
(0.21)</td><td rowspan="2">No - 66
(0.48)</td><td>Yes - 16
(0.14)</td></tr>
<tr><td>No - 26
(o,08)</td><td>No - 3
(0.08)</td><td>No - 50
(0.44)</td></tr>
<tr><td rowspan="4">No
19 firms</td><td rowspan="2">Yes - 10
(0.53)</td><td>Yes - 7
(0.37)</td><td rowspan="4">No
82 firms</td><td rowspan="2">Yes - 39
(0.48)</td><td>Yes - 28
(0.34)</td><td rowspan="4">No
102 firms</td><td rowspan="2">Yes - 48
(0.47)</td><td>Yes - 18
(0.18)</td></tr>
<tr><td>No - 3
(0.16)</td><td>No - 11
(0.13)</td><td>No - 30
(0.29)</td></tr>
<tr><td rowspan="2">No - 9
(0.47)</td><td>Yes - 4
(0.21)</td><td rowspan="2">No - 43
(0.52)</td><td>Yes - 36
(0.44)</td><td rowspan="2">No - 54
(0.53)</td><td>Yes - 15
(0.15)</td></tr>
<tr><td>No - 5
(0.26)</td><td>No - 7
(0.09)</td><td>No - 39
(0.38)</td></tr>
</table>

* "Yes (No)" means that the firm has (has not) achieved innovations. Inside the boxes: number of firms; inside the brackets: probabilities to initial condition (1998-2001).
Source: own elaboration base don INDEC (2010).

3.1.2. Efforts, capabilities and financial constraints

Table 4 shows the average values for each of the variables included in the model. Values are presented in terms of their average for the whole period and the groupings distinguish between firms where persistence takes place and also according to the defined innovative behaviors. Firms where innovations occur in all sub-periods (persistence 1998-2006) outstand in all dimensions. Their innovative efforts are twice the level for the total panel (0.04 vs 0.02), the average number of professionals is 42 (23 qualified persons more than the panel); almost all firms declared linkages with agents of the national innovation system, 47% had access to external resources (17 percentage points over the panel average) and their export intensity (exports to sales) is above the media of the panel (15% vs. 13%). The differences between firms where persistence takes place at least once but not for all subperiods (1998-2004 and 2004-2006) are smaller, although both groups present higher levels for all variables.

Regarding the innovative behaviors, the continuous innovative firms presents values close to those observed for the firms with sustained persistence, except from the number of qualified employees, where the former group reaches a level significantly lower. Sporadic innovative firms have reduced values in all dimensions, being quite close to the average of

the panel. Although the new innovative firms present reduced values in most of the dimensions, they show a better endowment of skilled human resources (which also coincides with a significant increase in the relative levels between 2002-2004 and 2005-2006).

Table 4: Descriptive statistics – Average values for selected variables

	Firms	II	IB	QHR	Link	Rec_ext	ixpo
Persistence 1998-2004	221	3.09	0.34	34.00	92.31	45.25	15.08
Persistence 2004-2006	205	3.19	0.34	32.96	91.71	39.02	15.33
Persistence 1998-2006	152	3.64	0.40	42.19	97.37	47.37	17.16
Continuous	325	3.55	0.40	34.93	93.54	50.46	16.70
New	120	2.50	0.22	34.61	81.67	21.67	15.46
Sporadic	215	1.02	0.12	15.50	67.91	27.44	11.21
Total Panel	**800**	**2.09**	**0.23**	**18.78**	**74.38**	**30.38**	**12.96**

Firms: number of firms; II: innovative intensity –total expenditures on innovation activities to total sales, in percentage points. IB: balance index; QHR: total number of professionals – average per firm. Link: percentage of firms with linkages with the NIS. Rec_ext: percentage of firms with access to external resources. Ixpo: exports intensity – exports to total sales, in percentage points.
Source: own elaboration on the basis of INDEC (2010)

Looking at the evolution of these indicators is another interesting way of identifying general trends (Table 5). Regarding the effort dimension, firms with persistence on innovation, the new and the continuous innovative behavior groups reach the highest relative efforts on innovation, with an increasing tendency along time. New innovative firms outstand with 5% allocated to these activities during the subperiod 2002-2004. The balance of this expenditure is similar among all groups except from the sporadic firms, which show a strong bias (basically due to the weight of expenditures on capital woods).

In the matter of capabilities, the referred table presents the annual averages for the two indicators used to measure this dimension. Once again, all groups but the sporadic innovative firms show levels over the panel media. Once again, new innovative firms outstand with a significant increase in the total number of professionals and also an increase in the probability of interacting with the national innovation system.

Access to external resources and export intensity are the last variables included to establish the relationship between persistence and innovative dynamic. The direct relationship between persistence on innovation and access to external sources of funding is quite obvious: firms where persistence is confirmed have twice the probability of having accessed to these resources than the average for the total panel. The relationship between this variable and the defined behaviors is not so clear given the abrupt changes in probabilities over time. Regarding exports, similar conclusions can be drafted: firms with persistence over time show the higher values wile abrupt changes are observed among innovative behaviors.

Table 5: Descriptive statistics – Time evolution for selected variables

	II			IB			QHR			Link		Rec_Ext			ixpo		
	98-01	**02-04**	**05-06**	**98-01**	**02-04**	**05-06**	**98-01**	**02-04**	**05-06**	**98-01**	**05-06**	**98-01**	**02-04**	**05-06**	**98-01**	**02-04**	**05-06**
Pers. 1998-2004	2.93	4.16	2.19	0.36	0.32	0.34	32.49	30.12	39.38	84.16	60.18	30.3	13.6	18.1	12.3	17.6	15.3
Pers. 2004-2006	2.31	4.70	2.57	0.29	0.33	0.40	31.89	28.81	38.18	72.68	71.22	21.4	12.7	20.0	12.9	17.8	15.3
Pers. 1998-2006	3.05	5.23	2.65	0.38	0.39	0.42	41.66	36.69	48.21	86.84	75.00	28.9	15.8	22.4	13.9	20.3	17.3
Continuous	3.54	4.44	2.67	0.43	0.38	0.38	35.33	30.26	39.22	85.23	69.54	35.1	11.7	22.5	12.6	23.2	14.3
New	0.00	5.04	2.46	0.00	0.33	0.34	10.98	16.38	21.73	52.50	65.00	0.00	15.8	14.2	12.7	17.6	16.0
Sporadic	1.24	1.09	0.72	0.18	0.06	0.12	7.82	4.93	8.27	57.21	27.91	20.0	4.6	6.1	10.4	12.2	11.0
Total Panel	**1.77**	**2.85**	**1.65**	**0.22**	**0.22**	**0.24**	**18.35**	**16.22**	**21.78**	**62.13**	**47.13**	**19.1**	**8.4**	**12.5**	**12.3**	**17.6**	**15.3**

Firms: II: innovative intensity –total expenditures on innovation activities to total sales, in percentage points. IB: balance index; QHR: total number of professionals – average per firm. Link: percentage of firms with linkages with the NIS. Rec_ext: percentage of firms with access to external resources. Ixpo: exports intensity – exports to total sales, in percentage points.
Source: own elaboration on the basis of INDEC (2010)

3.2. Econometric estimations

Table 6 presents the estimation of the model previously defined. When only structural attributes such as size and sector of activity (Model 1 - Equation 1a) are included, persistence is confirmed but with the opposite sign than the one predicted by theory however coincident with that observed in the transition probabilities discussed before. Immediately prior innovations, measured in average values, decreases about 15% the probability of innovating in the current period. When applying the multiplicative condition differentiated by strategy (Equation 1b), these results only hold for the new innovative firms. Among those with a continuous strategy, the obtained value is not statistically significant and then persistence is not verified. Among the sporadic group, the probability of innovating increases by 13% if the firm innovated in the previous period.

The impact of unobservable effects (ρ) is positive and significant in both estimations and decreases significantly between the first and the second one. The initial condition (having innovated in 1998-2001), the size and the technological intensity have a significant impact in both models, increasing the likelihood of innovating in the present. Time controls and the intercept have an inverse relationship with innovations. The former represents the impact of the economic crisis. The later, the lower probabilities of firms not engaged in innovation efforts. Finally, capital origin coefficient has an insignificant impact, although this could be the result of the strong correlation with size.

Table 6: Random Effects Probit Model - Dep. Variable: Inno

	Model 1 – Eq. 1a			Model 1 – Eq. 1b		
	Coef.	**Std. Err.**	**Marg. Eff**	**Coef.**	**Std. Err.**	**Marg. Eff**
Structural equation						
Linno	-0.441**	0.188	-0.144			
Linno_cont				-0.183	0.283	
Linno_new				-0.382***	0.234	-0.129
Linno_spo				0.391***	0.235	0.132
MLT	0.277**	0.124	0.091	0.232**	0.109	0.078
MHT	0.428*	0.121	0.140	0.358*	0.112	0.121
HT	0.624*	0.205	0.204	0.521*	0.185	0.176
KO	-0.042	0.134	-0.014	-0.053	0.116	
Labor	0.358**	0.166	0.117	0.286***	0.154	-0.018
T-2	-0.296**	0.078	-0.097	-0.297*	0.078	-0.100
C	-1.963*	0.25		-1.702*	0.275	
Individual heterogeneity						
$Inno_0$	0.7491*	0.1646	0.245	0.590*	0.200	0.199
m_labor	-0.002	0.173	-0.001	0.010	0.159	
Ln_σ_u	-0.499	0.403		-1.268	0.904	
σ_u	0.779	0.157		0.530	0.240	
ρ	0.378*	0.095		0.220***	0.155	

***, ** and * indicate significance on a 1%, 5% and 10% level, respectively. Number of observations: 800. m_ referrers to the individual time-average of the corresponding variable. T-3 omitted due to collineality. RE Probit standar errors, marginal effects calculated with the Delta method, assuming $Inno_0$=1 and $\mu_i = 0$. Estimations based on Gauss–Hermite, quadrature approximations using twelve quadrature points. Quadrature checks, no variations over 1% .

When the rest of the explanatory variables are added -innovative efforts, skills and financial situation-, the phenomena of persistence loses significance. (Table 7) In Model 2.a, previous innovations have an insignificant impact on present ones; in Model 2.b, persistence is confirmed in the case of sporadic and continuous firms, but in this last group, with negative sign: past innovations increase by 10% the probability of achieving innovations in the present among firms with sporadic expenditure but decreases around 8% this probability among those with a continuous one. Among the new innovative firms, past innovations do not impact on the probability of present results.

Table 7: Random Effects Probit Model - Dep. Variable: Inno

	Model 2 – Eq. 1.a			Model 2 – Eq. 1.b		
	Coef.	**Std. Err.**	**Marg. Eff**	**Coef.**	**Std. Err.**	**Marg. Eff**
Structural equation						
Linno	-0.006	0.089				
Linno_cont				-0.280**	0.113	-0.087
Linno_new				0.175	0.116	
Linno_spo				0.344**	0.154	0.106
MLT	0.043	0.095		0.031	0.096	
MHT	0.038	0.093		0.049	0.093	
HT	0.061	0.162		0.038	0.164	
KO	-0.173***	0.108	-0.054	-0.164	0.108	
II	0.256	1.152		0.158	1.167	
IB	1.66*	0.351	0.520	1.466*	0.359	0.453
QHR	-0.032	0.058		-0.047	0.058	
Link.t-2	0.027	0.087		0.011	0.088	
Link.t	0.238*	0.079	0.074	0.249*	0.079	0.077
Rec_ext	0.531*	0.155	0.166	0.470*	0.156	0.145
Ixpo	0.215	0.394		0.190	0.405	
Labor	0.181	0.148		0.165	0.149	
T-2	-0.326*	0.080	-0.102	-0.285*	0.080	-0.088
C	-1.325	0.198		-1.462*	0.204	
Individual heterogeneity						
$Inno_0$	0.036	0.108		0.028	0.108	
m_II	4.504*	1.733	1.409	5.281*	1.754	1.632
m_IB	1.056**	0.501	0.330	1.798*	0.528	0.556
m_QHR	0.053	0.078		0.066	0.079	
m_Ixpo	-0.196	0.464		-0.254	0.473	
M_rec_ext	-0.492**	0.217	-0.154	-0.395***	0.218	-0.122
m_labor	-0.042	0.161		-0.016	0.162	
Ln_σ_u	-1.235	1.352		-1.050	1.292	
σ_u	0.002	0.014		0.005	0.034	
ρ	0.000	0.000		0.000	0.000	

***, ** and * indicate significance on a 1%, 5% and 10% level, respectively. Number of observations: 800. m_ referrers to the individual time-average of the corresponding variable. T-3 omitted due to collineality. RE Probit standar errors, marginal effects calculated with the Delta method, assuming $Inno_0$=1 and $\mu_i = 0$. Estimations based on Gauss–Hermite, quadrature approximations using twelve quadrature points. Quadrature checks, no variations over 1% .

Regarding the innovative dimensions, both models present similar results. The balance of efforts has a significant positive impact, with the largest marginal effect on the probability of innovating. The present level of innovative expenditure does not have a significant impact on the probability of achieving results, but it does when considered at its average value. Although this average expenditure is just a proxy of unobserved characteristics of

the firm, it is probably also an indication of the fact that innovation projects do not necessarily have a duration corresponding to the sub-periods identified here.

Regarding capabilities, current linkages have a positive and significant impact on the probability of innovating but, surprisingly, the level of professionals does not increase the likelihood of innovating. This result, although coincident with a similar study (Huergo and Moreno, 2011), contradicts the statements made by several authors and demonstrated in numerous empirical studies, both for developed countries and developing countries. (Kemp *et al.*, 2003; Chudnovsky *et al.*, 2004; Borello *et al.*, 2006; Milesi, 2006; Jensen *et al.*, 2007; Lugones *et al.*, 2007; Lugones *et al.*, 2008; Dutrenit and Puchet, 2011)

In the case of the financial dimension, only access to external resources has a positive and significant impact, increasing the odds of innovating by 14%. Surprisingly, the export intensity of the firm, on average values in the current period, does not affect the probability of innovating.

Once dimensions related to the innovative dynamic are controlled, the impact of the initial condition losses significance, as well as the unobservable effects and the structural variables (size and sector), except from the capital origin in Model 2.b, where it has a negative impact on probability.

4. Summary and conclusions

Concluding remarks

The aim of this paper was to analyze the relationship between past innovations and the probability of reaching innovations in the present for a group of Argentine manufacturing firms, that is to say, the phenomenon of persistence among firms localized in a developing country. The hypothesis was that persistence is a phenomenon explained by the accumulation of skills and the investments on innovation, which are in turn the result of explicit strategies aimed at achieving technological and organizational improvements. The objective was to shed light on the endogenous determinants of a sustained innovativion-based competitiveness and the existence of changes in the firms 'strategies so that they could enter the innovators 'club. A second objective was to understand how public policy can foster sustained innovative dynamics: if persistence is confirmed, then public policies should diversifying beneficiaries to maximaze the rate of innovatiors. If not, it should diversify instruments to accompany the firm all along the innovative trajectory.

A model that relates present with past innovations and three key dimensions of the innovative process was constructed, with information for the period 1998-2006. At the same time, firms were classified according to the frequency of their innovation expenditure, distinguishing between those with sustained efforts (continuous behavior), those whose investments on innovation were sporadic (sporadic behavior) and those which did not allocated resources to these activities between 1998 and 2001, but did it so

from 2002 up the end of the analyzed period (2006), which constitute the new innovative firms.

The relationship was tested with a dynamic random effect probit model, controlling both the unobservable effects and the initial condition of the firm, for a balanced panel of 800 manufacturing firms of different sizes and from different sectors, and for the period 1998-2006. The results show the existence of negative persistence (past innovations decrease the probability of present ones) or no persistence at all when the innovative dynamic and the idiosincratic characteristics of the firm are properly controlled for. They also show that the relationship between the innovative dynamic and its impact in terms of results (innovations) need a more complex approach than the one based on exogenous independent variables.

In that sense, and to the extent that this papers is part of a broader research project associated with the doctoral thesis of the author, conclusions are actually a set of questions that will guide the work ahead, arising from reflecting and trying to interpreting the results.

For firms with sustained innovation expenditure, past results are not significant, meaning that they do not influence the probability of innovating in the present. Alternatively, other factors such as the relative level of expenditure and the balance among innovative activities have stronger explanatory power over present innovations. Among firms where expenditure is sporadic, prior innovations increase the likelihood of achieving them in the present. This could be explained by the possibility of incremental innovations from an initial one or by the fact that the results allow the firm to accumulate positive experiences (learning-by-doing), which distinguishes it from that which has also sporadic expenditures but has failed to obtain positive results. Persistence presents the inverse sign in the case of new innovative firms, which is not significant when capabilities and innovation efforts are included. The negative impact proves the existence of a change in the innovative behavior, a change that leads these firms to enter the club of innovators and also to accept that sometimes persistence is confirmed, sometimes it is not. Of course, the evolution of this group of firms should be monitored over the subsequent periods in order to test whether these positive results are sustained over time or not.

The impact of unobservable effects (ρ) is positive and significant in the first estimations (when only structural variables are included) but decreases when other innovative dimensions are included. This would support the hypothesis that the classification according to the continuity of innovation expenditure is a good criterion to minimize the overestimation that the existence of idiosyncratic effects creates but it is just one variable that should be further complex in order to characterize different innovative dynamics.

The results obtained here agree, to some extent, with similar analyses about persistence, although none of the reviewed ones show a negative relationship between past and

present innovations. Coincidence is observed in the matter of particular cases where persistence is confirmed. For Raymond et al (2010), there is genuine persistence only for companies belonging to medium-high and high technology sectors, for Clausen et al. (2011) only when innovation strategies are based on science or market-oriented, for Le Bas at al (2011), when organizational innovations are achieved. In other words, persistence is confirmed there where the analysis is conditioned to a particular type of conduct and not merely a serial correlation. This implies that the persistence phenomenon is not automatic but requires implicit efforts aimed at generating technological and organizational changes.

To explain the divergences, descriptive statistics are quite illustrative. Among firms with a continuous innovative behavior, innovation rate is 94%, 48% and 81% on each sub-period respectively; they also show only 1.5% of non-innovator firms (5 companies). This implies that the negative relationship could be more associated with the generalized fall in the rate of innovators during the recovery period (2002-2004), given the drop in the innovative efforts during the crisis.

Among the new innovative group, past innovations are no longer significant and its impact is absorbed by the rest of the explanatory variables. In this case, while only 30% of the group declared innovations between 1998 and 2001, this ratio is 55% between 2002 and 2004 and 76% between 2005 and 2006. Thus, such is the rate of entering to the innovators´ group that the impact of past condition is not significative. Of course, other explanatory variables also play an important role since they are explicit efforts of these firms to enter the club.

Among the sporadic innovative group, persistence is confirmed according to what theory predicts: past innovations increase by 10% the probability of innovating in the present. However, for this group, the rate of innovators drops from 55% in 1998-2001 to 44% between 2002 and 2004 and to 27% between 2005 and 2006, therefore, there is a strong correlation between the firms that innovated between 1998 and 2004 and those who did so at the end of the period.

Theoretical and practical implications for future research

Looking at the results and the theoretical framework adopted in this paper, there is a need to look for explanations of the negative sign that appears over and over when testing the relationship between past and present innovations. Although one explanation may lie on a simple serial correlation associated with a statistical effect rather than a genuine state dependence, the results are clearly consistent with what was observed in the descriptive statistics and at least two complementary hypotheses could explain them.

Hypothesis 1

If innovation entails an additional risk (the technological one), along with the specific characteristics of the innovative project (time of maturation of new products/processes), then seems difficult to predict, *a priori*, how much time should pass between an innovation and its impact on an additional one. So, innovations in t-2 could impact on innovations in t but not on those from t-1. In this case, persistence exists, but the length of time when attempting to grasp it is wrong. Mairesse and Sassenou (1991) reflect in a similar way when they argue that the "problem" of innovative phenomena is how we get econometric tools that allow us to measure and characterize them.

In a broader sense, but also under the assumption of errors on how explanatory variables are approximated, these results lead to reflect about the actual capacity of econometric tools to capture a phenomenon that is always highlighted in evolutionary developments: the co-evolution of agents, variables and dimensions. Additionally to the assumptions about the distribution of errors and the exogeneity of the variables included in the model, the dynamic probit presented here, which in turn is the most used in the studies reviewed, does not capture the joint evolution of innovative dimensions. Unless factorized variables are included, which could create collinearity problems, to estimate the interactive effects between dimensions at different times is not possible. Following what stated by Dutrenit et al. (2011), variables that explain the innovative dynamics of a country (of a company, in this case), cannot be measured independently from each other. If innovation expenditure increases, then the firm is expected to advance in the complexity of their products and processes and will require more qualified labor, this in turn is supposed to affect sale levels and productivity, improving its financial position, both to reinvest profits and to access external resources.

This is nothing less but the already explained iterative innovation process defined by Kline and Rosemberg (1989): the impact of innovation on the company performance is not linear but iterative and it can start in different areas and follow different sequences. Consequently, the three dimensions analyzed here could be co-evolving, one could be pulling the others or each one of them could have their own threshold. None of these situations are considered in the model, either they are included in the ones surveyed. On the contrary, dynamic is analyzed as the evolution over time of a set of simple or complex indicators independent from each other.

Hypothesis 2

A second explanation for this evolution is the one related to the period t-1. The year 1998 represents the peak of growth of the 1990 decade wile 2002

matches the end of the recession and the lower level of the macro variables. Thus, not surprisingly, there is a high rate of innovation in 1998-2001, a decline in this rate between 2002 and 2004 and a recovery towards the end of the period under study. As a period of crisis and change, the redefinition of strategies and the adjustments to the new micro, meso and macro environment might lead firms to prioritize other dimensions over the innovative dynamics. The dominance of the so called wait and see strategies, the possibility of an economic recovery with low investments but also low competitive gains and the need of adaptation to the new conditions should, to some extent, delay, prevent to start or even discontinue innovative projects. In this sense, the gap between the rate of innovators in t-2 and t, would be supporting the hypothesis of a change in the dynamics of innovative firms, a hypothesis that is reinforced when looking at the relationship between total innovators in t versus t-1 and t-2: from the total firms that reported innovations in t, only a third had innovated in t-1 and a half in t-2. Of course, if the condition is due to a shift in the innovative strategy, then the firm should remain as incumbent at t +1. If this were not so, then the existence of a positive relationship between past and present innovations is not as clear as theory predicts.

From a theoretical point of view, when comparing this study with those made by other colleagues, firms facing decades of macroeconomic stability (in Raymand et al. Dutch companies, in Peter German and in Clausen et al. Norwegian ones) are compared with firms which went through periods of strong turbulence and changes in the rules of the games. Consequently, to expect that the innovative dynamic and innovative paths fall within the same theoretical developments or condone the use of similar empirical approaches does not seem the most accurate comparison and a more comprehensive understanding of the National Innovation System surrounding the firm is required.

Another important issue has to do with the definition of the spurious persistence. Results show that there are firm´s characteristics that contribute to innovate (innovative efforts) but others contribute to do it persistently (balance). In that sense, spurious persistence would be an innovative project which does not trigger more innovations. In the second, persistence would be just another name for a virtuous innovative strategy sustained over time. In any case, the questions are, firstly, to what extend achieved innovations contribute to each type of persistence; secondly in which context (capabilities) an innovative activity contributes to innovate and when it contributes to do it persistently; and thirdly which is the correlation between those types (true and spurious) and performance.

Finally, and from a practical point of view, the analysis of the Argentinean case showed that there is no linear correlation between past and present innovations. If a firm was supported with public policies and became innovator, there are no certainties about its results in the future. Competence building, innovative efforts and linkages should be

monitored if we want to predict what will happen with its innovative trajectory. Results show that in order to evaluate instruments, looking at what strategic behavioral changes on a firm a public policy has induced is more important than counting the number of innovations it has achieved. Following Nelson and Winter (1982), this means looking at their innovative routines and performance; following Antonelli (2008), implies looking at path-dependece breakthroughs; and following Jensen et at (2007), means analyzing how the DIU and the STI mode are combined and processes of competence buildings are triggered. In short, it means the need for an evolutionary approach to the innovative strategies of the firms.

References

Anlló, G., G. Lugones and F. Peirano (2007). "La innovación en la argentina postdevaluación, antecedentes previos y tendencias a futuro". "Crisis, recuperación y nuevos dilemas. La economía argentina 2002-2007". B. e. Kosacoff, CEPAL, Santiago de Chile, 2007.

Anlló, G. and D. Suárez (2008). “Innovación: algo más que I+D. Evidencias Iberoamericanas a partir de las encuestas de innovación: construyendo las estrategias empresarias competitivas”. “El Estado de la Ciencia. Principales Indicadores de Ciencia y Tecnología Iberoamericanos/Interamericanos”, RICyT. ISSN: 0329-4838, Buenos Aires, diciembre 2008. .

Antonelli, C. (1997). "The economics of path-dependence in industrial organization." International Journal of Industrial Organization 15(6): 643-675.

Antonelli, C. (2008). Localised technological change. Towards the economics of complexity. London and New York., Ed. Routledge. .

Arocena, R. and J. Sutz (1999). Looking at National Systems of Innovation from the South. DRUID Summer Conference. 1999.

Borello, J., A. Erbes and G. Yoguel (2006). ""Sistemas locales de innovación y sistemas productivos locales"." UNGS Mimeo.

Cefis, E. and L. Orsenigo (2001). "The persistence of innovative activities: A cross-countries and cross-sectors comparative analysis." Research Policy 30(7): 1139-1158.

Clausen, T., M. Pohjola, K. Sapprasert and B. Verspagen (2011). "Innovation strategies as a source of persistent innovation." Industrial and Corporate Change.

Chamberlain, G. (1980). "Analysis of Covariance with Qualitative Data." Review of Economic Studies 47 225-238.

Chamberlain, G. (1984). Panel Data. Handbook of Econometrics. Z. Griliches and M. D. Intriligator. Amsterdam, North Holland. 2: 1247-1318.

Chamberlain, G. (1992). "Comment: Sequential Moment Restrictions in Panel Data

" Journal of Business and Economic Statistics 10: 20-26.

Chaminade, C., B. Å. Lundvall, J. Vang-Lauridsen and K. J. Joseph (2009). Innovation policies for development: towards a systemic experimentation based approach. 7th Globelics Conference. Dakar (Senegal) 6-8 October 2009.

Chudnovsky, D., A. López and G. Pupato (2004). "Innovation and productivity: A study of Argentine manufacturing frms´behavior (1992-2001)", Documento de Trabajo 70, Depto Economía, Universidad de San Andrés, mayo 2004.

Dutrenit, G. and M. Puchet (2011). Approaching the measurement of the critical mass of science, technology and innovation: How far off is Mexico? Globelics Buenos Aires 2011. Buenos Aires, Argentina. Noviembre 2011.

Erbes, A., J. Motta, S. Roitter and G. Yoguel (2004). "La construcción de competencias tecnológicas en la fase de crisis del Plan de Convertibilidad", Ponencia presentada en el Seminario RED PYMES, 9ª Reunión Anual Pymes-Mercosur: "El Rol de las Pequeñas y Medianas Empresas en un nuevo modelo de desarrollo". UNGS / FUNDES / CEPAL.

Fagerberg, J. (2003). ""Innovation: A Guite to the Literature"." Centre for Technology, Innovation and Culture, University Oslo, 2003.

Freeman, C. (1982). "Schumpeter or Schmookler?". "Unemployment and Technical Innovation. A study of Long Waves and Economic Development". C. Freeman, J. Clark and L. Soete. Londres, Pinter.

Geroski, P. A., J. Van Reenen and C. F. Walters (1997). "How persistently do firms innovate?" Research Policy 26(1): 33-48.

Huergo, E. and L. Moreno (2011). "Does history matter for the relationship between R&D, innovation, and productivity?" Industrial and Corporate Change 20(5): 1335-1368.

INDEC (2010). "Base Integrada de Desempeño Empresarial", Buenos Aires, Argentina, INDEC.

Jensen, M. B., B. Johnson, E. Lorenz and B. Å. Lundvall (2007). "Forms of knowledge and modes of innovation." Research Policy 36(5): 680-693.

Kemp, R. G. M., P. J. De Jongm, M. Folkeringa and E. F. M. Wubben (2003). Innovation and firm performance. Differences between small and medium-sized firms. SCALES-paper N200213, EIM, Business & Policy Research - SCALES, Scientific Analysis of Entrepreneurship and SMEs.

Kline, S. and N. Rosenberg (1989). "An Overview of Innovation". "The Positive Sum Strategy: Harnessing Technology for Economic Growth". R. Landau and N. e. Rosenberg, National Academies Press, Washington D.C.

Lall, S. (2001). "Competitiveness, Technology and Skills", Edward Elgar Publishing Ltd, Chettenham.

Langlois, R. N. (2002). "Schumpeter and the Obsolescence of the Entrepreneur." SSRN eLibrary.

Le Bas, C., C. Mothe and T. U. Nguyen Thi (2011). "Technological Innovation Persistence: Literature Survey and Exploration of the Role of Organizational Innovation." SSRN eLibrary.

López, A. and V. Arza (2008). Characteristics of university-industry linkages in the Argentinean industrial sector, Ponencia presentada en Globelics México 2008, México D.F., Noviembre 22-24, 2008.

Lugones, G. and D. Suarez (2010). STI indicators for policy making in developing countries: An overview of experiences and lessons learned. Conference Room Paper, Multi-Year Expert Meeting on Enterprise development policies and capacity-building in science, technology and innovation. . Ginebra 2010.

Lugones, G., D. Suarez and N. Le Clech (2007). Innovative Behaviour and its impact on firms´ performance. Ponencia presentada en Micro Evidence on innovation in developing countries, UNU-MERIT. Maastricht, Paises Bajos, Mayo -Junio , 2007.

Lugones, G., D. Suarez and P. Moldován (2008). Innovation, competitiveness and salaries: a model of combined growth at the firm level, Ponencia presentada en Globelics México 2008, México D.F., Noviembre 22-24, 2008.

Lundvall, B. Å. (1998). "Defining Industrial Dynamics and Its Research Agenda" DRUID winter seminar Middelfart.

Lundvall, B. Å. e. (1992). "National System of Innovation: Towards a Theory of Innovation and Interactive Learning", Londres, Pinter.

Mairesse, J. and M. Sassenou (1991). R&D productivity: a survey of econometric studies at the firm level, NBER Working Papers 3666, National Bureau of Economic Research, Inc.

Malerba, F., L. Orsenigo and P. Peretto (1997). "Persistence of innovative activities, sectoral patterns of innovation and international technological specialization." International Journal of Industrial Organization 15(6): 801-826.

Mansfield, E. (1962). "Entry, Gibrat's Law, Innovation, and the Growth of Firms." The American Economic Review 52(5): 1023-1051.

Metcalfe, J. S., J. Foster and R. Ramlogan (2006). "Adaptive Economic Growth." Cambridge Journal of Economics 30: 7-32.

Milesi, D. (2006). "Patrones de innovación en la industria manufacturera argentina: 1998-2001". Documento de Trabajo LITTEC. UNGS.

Nelson, R. and S. Winter (1982). "An evolutionary theory of economic change", The Belknap Press of Harvard University Press, Cambridge.

OECD (1997). "Revision of the High-Technology Sector and Product Classification". T. Hatzichronoglou, OECD Science, Technology and Industry Working Papers, 1997/2, OECD publishing:10.1787/134337307632.

OECD (2005). "Oslo Manual - 3rd edition". Guidelines for collecting and interpreting innovation data.

Pavitt, K. (1984). ""Sectoral patterns of technical change: towards a taxonomy and a theory"." Research Policy Nº 13 especially(353-369).

Peters, B. (2009). "Persistence of innovation: stylised facts and panel data evidence." The Journal of Technology Transfer 34(2): 226-243.

Phillips, A. (1971). Technology and Market Structure: A Study of the Aircraft Industry., Lexington, Mass.: D. C. Heath.

Raymond, W., P. Mohnen, F. Palm and S. S. van der Loeff (2010). "Persistence of Innovation in Dutch Manufacturing: Is It Spurious?" The Review of Economics and Statistics 92(3): 495-504.

RICyT (2000). "Manual de Bogotá: Normalización de Indicadores de Innovación Tecnológica en América Latina y el Caribe". Bogotá, Colombia., OEA/ RICYT/COLCIENCIAS/OCT.

Schumpeter, J. (1912). The theory of economic development. , Cambridge: Harvard University Press, 1934. First edition, 1912.

Schumpeter, J. (1942). Capitalism, socialism, and democracy. . New York. , Harper and Brothers, 1942.

Suarez, D. (2009). Innovative strategies and their impact on the national innovation system dynamics. Globelics Dakar 2009. Dakar, Senegal. Setiembre 2009.

Suárez, D. (2006). "National Specificities and Innovation Indicators". Globelics India 2006, Trivandrum, Kerala, India, Octubre 4-7.

Tether, B. and P. Swann (2003). ""Sourcing Science. The use by industry of the Science Base for Innovation; Evidence from the UK's Innovation Survey"." CRIC Discussion Paper Nº 64.

Wooldridge, J. M. (2005). "Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity." Journal of Applied Econometrics 20(1): 39-54.

Yoguel, G. and F. Barletta (2010). "La actualidad del pensamiento de Schumpeter." Revista de Trabajo Nueva Época - Teorías económicas y políticas públicas frente a la crisis global Año 5 - Nº 7.

Yoguel, G., V. Robert, M. Pereira and F. Barletta (2011). The effects of feedbacks on firms' productivity growth. Micro, macro, and meso determinants of productivity growth in Argentinian firms. Globelics Buenos Aires 2011. Buenos Aires, Argentina. Noviembre 2011.