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Inside Innovation Persistence: New Evidence from Italian Micro-data

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Inside Innovation Persistence: New Evidence from Italian Micro-data[1]

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Abstract

This paper contributes the analysis of the persistence of innovation activities, as measured by different innovation indicators and explores its path dependent characteristics. The empirical analysis of firm level innovative activities for a sample of 451 Italian manufacturing companies observed during the years 1998-2006 confirms the presence of significant persistence in innovation. However, the levels of persistence as captured by the inter-temporal elasticity between the innovation indicators show significant variations according to the typology of innovation considered. The higher level of persistence is found for R&D investments, witnessing the actual presence of significant entry and exit barriers. Furthermore, we obtain a relatively higher persistence for product innovation than process innovation.

KEY-WORDS: INNOVATION; PERSISTENCE; NON-ERGODIC DYNAMICS; PAST DEPENDENCE.

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1. Introduction

The assessment of the characteristics and determinants of firm-level innovation persistence along time has clear implications for both innovation policies and the understanding of long-term industry dynamics. Relatively recent important contributions on this issue (Malerba et al. 1997) have inspired a stream of empirical studies that have provided mixed results on the actual presence and significance of persistence in innovation (Geroski et al. 1997; Geroski et al. 2001; Cefis, 2003; Duguet, 2004; Roper and Hewitt-Dundas 2008; Peters, 2008). From a theoretical perspective, innovation persistence can be seen as the result of three different and yet interrelated aspects. First, innovation activities are characterized by significant entry and exit barriers, due to the relevant upfront sunk costs for the set up of research infrastructures and the required long term investments commitments needed to capitalise R&D returns (Sutton, 1991). Second, the repeated interactions between the accumulation of knowledge and the creation of routines to valorise and exploit it within the same organization eventually lead to the creation of dynamic capabilities that favour the systematic reliance upon innovation as a competitive tool (Nelson and Winter, 1982). Third, successful innovation activities have a positive impact on the conditions for follow on innovations by providing the firm with higher permanent market power, by reducing financial constraints as well as by broadening the space of available technological opportunities.
The measurement of true state persistence in innovation, i.e. the component of observed persistence actually attributable to the fact of having performed innovation activities in the past and not to other time-invariant and firm-specific unobservable factors, seems to deserve further research efforts. Most of previous empirical studies have focussed on patenting activity finding limited evidence of persistence[2]. Patents represents an important but yet partial proxy of innovation activities, they are affected by evident biases in favour of more formalised types of R&D investments and they provide very limited accountability of innovations in service sectors. Moreover, the limited availability of firm level controls in the patent based studies made it difficult to disentangle the actual determinants of observed persistence for larger innovators. Other scholars have used survey data on innovation, obtaining on average sounder evidence of persistence. In this paper we follow the latter approach and complement the previous available evidence by using an Italian dataset of about 450 companies observed along the years 1998-2006 and by discussing the different degree of persistence across diverse typologies of innovations. The appreciation of significant differentials in innovation persistence for product innovation, process innovation, R&D investment can provide hints on the expected hysteretic propagation along time of the positive effects exerted by policies supporting these different types of innovations.
The identification of specific patterns of persistence has also broader implications for the comparative assessment of different growth models (Cefis, 2003). In particular, the identification of true state dependent persistence in innovative activities would provide significant empirical support for the role of technological change as a source of increasing returns shaping to the growth dynamics of firms and industries (Klepper, 1996).

The paper is organised as follows. In section two we summaries the results from previous empirical studies of firm-level innovation persistence and discuss the theoretical

[2] On average the papers using patents finds little persistence in general, but strong persistence among 'great' innovators that account for a large proportion of patents requested.

foundations of our research hypotheses. Section three provides the description of the dataset and a detailed discussion of the analysis of persistence based on transition probability matrixes. In section four we present our econometric analysis for the estimation of true state persistence and discuss the main evidence obtained. Section five concludes and highlight implications of results.

2. Previous studies on the persistence of innovation and research hypotheses

2.1 Empirical studies on firm level innovation persistence

The empirical analysis about the persistence of innovation activities is quite a recent undertaking in the economic literature. In the special issue of the International Journal of Industrial Organization dedicated to the economics of path dependence, Malerba, Orsenigo and Petretto (1997) pave the way to this new area of investigation.
The majority of currently available evidence can be grouped into a subset of studies that build upon the analysis of large samples of patents and a subset of studies that make use of data from innovation surveys repeated along time.

Patent based studies

Malerba et al. (1997) tested the evidence provided by the OTAF-SPRU data base for five European countries: Germany, France, UK, Italy and Sweden for the period 1969-1986 for 33 technological categories. The econometric evidence confirms that the innovative activity is persistent. The rest of the paper however does not investigate the determinants and the features of the persistency but rather analysis its effects. It shows in fact that the persistence of the innovative activity plays an important role in explaining the concentration of technological activity, that is the share of patents delivered to the firms, the stability of the ranking of innovators and their innovative intensity.
Geroski, Van Reenen and Walters (1997) study the innovative history of UK firms in the period 1969-1988 using the patent records and the introduction of 'major' innovations. The empirical analysis is based upon the estimate of a proportional hazard function and consists in the empirical investigation of the innovative spells. Their results are simply summarized as it follows: "success only follows really major success, and then for only a limited period of time". A minority of firms is persistently innovative.
The somehow weak persistence of patenting activity is confirmed by Cefis and Orsenigo (2001) who apply a transition probability matrix to analyze the persistence of innovative activity in the years 1978-1993 for samples of some 1400 manufacturing firms in each country, respectively in Germany, Italy, Japan, US and France. The results show that innovative activities are characterized by a weak persistency. More specifically both low-innovators and great-innovators tend to remain in their classes. Much of the persistence in innovation activities however seems to be determined by the 'economic' persistency of the firms themselves. This study provides original evidence about inter-sectoral differences that confirm the importance of technology-specific factors. A subsequent study by Cefis (2003) focuses on 577 UK patenting firms in the period 1978-1991. Also in this case the transition probability matrix shows little persistence in general and it is characterized by a strong threshold effect. Only great innovators, in other words, have a stronger probability to keep innovating.

Cefis and Ciccarelli (2005) contribute the literature on the persistence of innovation by exploring the persistence of the effects of innovation rather than the persistence of innovation *per se* and its causes. This paper investigates the effects of innovative activity on profitability using a panel of 267 UK firms in the period 1988-1992. The innovativeness of firms is measured by means of patent statistics. The econometric model tests with a Bayesian approach and classical estimation methods the hypothesis that past innovations exert a short and long term positive effect upon the profits of firms. The results of the Bayesian approach confirm that the impact of innovation on profits is cumulative and long lasting. This work provides a tangential contribution to the identification of persistence of innovation, as it confirms that because past innovations have a long lasting effect on profitability, innovation at time t can be positively influenced by past innovation via the greater availability of financial resources.
The approach by Alfranca, Rama and von Tunzelmann (2002) is quite original in this context. They study the persistence of innovation in a specific sector with a focus on a well-identified group of firms. They analyze 16,698 patents granted in the United States from 1977 to 1994 to 103 global firms in the food and beverage industry. They test whether patent time series are trend stationary or difference stationary to detect how large the autoregressive parameter is and how enduring is the impact of past innovation on current ones in these companies. Their results show that the 17 years patent series are not consistent with the random walk model. The evidence confirms that global firms, both of very large and smaller size, in this industry, exhibit a stable pattern of technological accumulation in which "success breeds success".
Finally, Latham and Le Bas (2006) make an important contribution to the field with a systematic investigation of the persistence on innovation based upon the analysis of French and US patents. Their results confirm that the persistence of innovation takes place, but only and mainly in a limited time span. Latham and Le Bas test the hypothesis that size and profitability exert a major positive effect on the spell of innovation activities: the larger are the firms and the larger their profitability and the longer the time spell over which firms are able to sustain a sequence of innovations. The work coordinated by Latham and Le Bas moreover expands further the investigation with the analysis of the persistence of innovation among individual inventors, as distinct from firms. The persistence of innovation is stronger among individuals than among firms. Here their results provide strong and novel evidence about the important role of 'serial inventors': creative individuals that are characterized by high levels of 'fertility' and are able to generate a persistent flow of inventions through time[3].

Survey based studies

Peters (2008) provides strong evidence in favour of persistence of innovation activities both in terms of innovations inputs, in terms of R&D activities, and innovation outputs as measured by the number of innovation introduced by German manufacturing and service firms in the years 1994-2002. The research relies upon the Manheim Innovation Panel of the ZEW and is based upon the Community Innovation Survey (CIS). A firm is defined as an innovator when it exhibits positive innovation expenditures and has introduced a new product and a new process. The results of the empirical investigation confirm that firms

[3] The results of Latham and Le Bas provide a new and important specification to the hypothesis that the distribution of creativity be characterized by the working of the well-known Pareto Law: not only a few patents account for a large share of the value, but a few innovators are 'responsible' for a large share of the important innovations (Scherer and Harhoff, 2000).

experience high levels of persistence in undertaking innovation activities: almost half of the difference across firms in the propensity to innovate between previous innovators and non-innovators in the German manufacturing industry can be explained by the state dependence, i.e. whether the firm was already involved in innovation activities tat time t-1. The persistence of innovative activities is explained by the levels of: a) skills, support of public funding, c) financial liquidity and d) size.
A contrasting evidence if found by Raymond et al. (2006) who study the persistence of innovation in Dutch manufacturing firms using firm data from three Community Innovation Surveys (CIS), in the years 1994-2000. The number of innovations that each firm claims to have introduced in each period of observation is the unit of analysis. They test the hypothesis of persistence with a maximum likelihood dynamic panel data tobit model accounting for individual effects and handling the initial conditions problem. Their findings suggest that there is no evidence of true persistence in achieving technological product or process innovations. At each point in time however the shares of sales stemming from innovative products, introduced in the past have a –small- effect on the current shares of sales of innovative products.
Roper and Hewitt-Dundas (2008) use innovation survey data and show that in the case of 3604 plants covered by the Irish Innovative Panel in the period 1991-2002 both product and process innovations are strongly persistent. In this case the size and ownership of plants matters: large plants that are part of multinational companies are more able to sustain the innovation process through time than smaller ones locally owned. The persistence in the introduction of product innovations is associated to strategic variables, while the persistence in the introduction of process innovations is associated to market pressure.

In conclusion, the evidence of the literature is mixed. Most works identify weak elements of persistency but do not provide a convincing consensus about its determinants and, most importantly, about the specific kind of dynamic process. In particular, the works that have used patents as a reliable indicator of the innovation suggest that the persistence is weak and exhibits strong values only in the case of heavy patentees. On the contrary, empirical analyses based on survey data found stronger evidence of innovation persistence, but highlight that the selection of the indicator to measure the extent to which the introduction of innovation has a hysteretic character is not trivial and results seem to be sensitive to the indicator chosen (Duguet and Monjon, 2004).

2.2 Research hypotheses

As emphasised in the literature review there is an increasing attention devoted to the analysis of the persistent character of innovation activities, which in many cases has been found to be relevant. The observed persistence is the result of three different and yet interrelated aspects. From a static viewpoint it is clear that innovation activities are characterized by significant barriers to entry and to exit. The performance of innovation activities is affected by important upfront costs, especially if they include the creation of a research ad development laboratory, sunk costs and learning economies. The decision to innovate requires that substantial resources and dedicated routines are implemented. Substantial barriers to entry in the innovation process are based upon the long term commitments that are required to perform efficiently any innovation process. Once the decision has been taken, the opportunity costs to stop are very high because of substantial dynamic increasing returns. Major learning economies characterize the performance of innovation activities together with significant economies of density. As a result it is clear that the larger is the cumulated size of activities over which the initial costs can be distributed and longer is the stretch of time upon which learning processes are at work and the larger are the positive effects on costs. The long terms curve of average costs of new technological knowledge and technological innovations is characterized by a steep negative slope. From a dynamic viewpoint it seems clear that the persistence of innovation activities stems from the working of internal interactions between distinct and yet interrelated decision processes yielding positive feedbacks between the financial liquidity made available by previous innovations, the accumulation of competence and expertise based upon learning processes and the funding of research and development activities. The repeated interactions between the accumulation of knowledge, the creation of routines to valorise and exploit it within the same organization eventually lead to the creation of dynamic capabilities that favour the systematic reliance upon innovation as a competitive tool (Penrose, 1959; Teece and Pisano, 1994). Since the introduction of innovation and the related generation of new knowledge is shaped by cumulative forces, substantial irreversibility and positive feedbacks, we expect to find that innovation is a persistent process reinforced by external feedbacks and contingent factors that may sustain or contrast the continual reliance of firms upon innovation (Antonelli, 1997, 2008).

Moreover, the empirical assessment of the actual persistence of innovation within firms leads us to unfold the problem of the identification of the specific characters of the dynamic processes. In this respect, we claim that innovation is a highly differentiated phenomenon, that is associated with diverse strategies of firms and is specific to industry conditions (see Reichstein and Salter, 2006 and Crespi and Pianta, 2008 for extensive reviews). Hence, we expect that innovation persistence may vary, depending on the different types of innovation considered. More specifically we formulate the following hypotheses that will be tested through the empirical analysis described in the next section.

HP I: R&D based innovation activities are characterised by a major degree of persistence in particular in larger firms.

The generation of technological knowledge is an activity characterized by significant indivisibility and learning. Knowledge indivisibility and learning to learn exerts strong cumulative effects by favouring the process of knowledge exploitation (Stiglitz, 1987). Moreover, the production of new knowledge deriving from R&D efforts is affected by substantial sunk costs (Máñez et al., 2009). These peculiarities of the knowledge production process determine the emergence of both barriers to entry and exit. While it is hard for companies to enter in a strategic competition based on R&D activities, corporations that have invested in R&D are more likely to keep investing simply because the incremental costs of the internal facilities designed to introduce innovations are relatively low (Arrow, 1974).

HP II: Product innovation is more persistent than process innovation.

Product innovation consists in the introduction of new idiosyncratic product, which increase the range of choices for perspective customers. The strategic routines associated with product innovation activities are typical of monopolistic competition markets, where the continuous introduction of product innovations allows firms to enjoy substantial extraprofits. In this context we expect that product innovation shows a high degree of persistence since the introduction of new product is embedded in firms' routines related to product portfolio strategies. This hypothesis is consistent with the model elaborated by Gruber (1992) about the role of sequential product innovations in maintaining the leadership in markets characterized by vertical differentiation.

In contrast, we expect process innovation to be more sporadic, since it is associated with major investments and changes in the lay-out of production processes driven by price-cost competition in the markets where firms operate.

HP III: When all different types of innovation are jointly considered (i.e. product, process and organisational innovation), a lower degree of state dependence is expected

General innovation activities should be associated with lower barriers to entry and with lower sunk costs. In this respect, we expect to observe an overall inferior state dependence for a general innovation indicator, but strong complementarities between the diverse forms of innovation activities.

3. The empirical analysis

3.1 Data description

The analysis is based on a dataset derived from the questionnaire surveys developed originally by the investment bank Mediocredito Centrale (MCC, now Unicredit), regarding a representative sample of Italian manufacturing firms with no less than 11 employees. The original MCC database comes from three different questionnaire waves, each of them collecting contemporary and retrospective (previous three years) data from samples of more than four thousand firms. In order to obtain a balanced panel dataset for our study, we merged three waves (covering years from 1998 to 2006). We cleaned the dataset by eliminating outliers and cases of M&As, ending up with a balanced panel of 451 manufacturing firms observed three times over a 9-year period.
The obtained database collects information on different aspects of innovation activities providing evidence on the different types of innovations introduced by firms and on their R&D efforts, along with data on a set of firm-level characteristics variables. This allows us to test the relevance of innovation persistence both in terms input and output measures of innovation. In the following table 1 we report the sectoral composition of the sample. In 2002, the central year of the panel, the companies included in the sample had an average number of employees equal to 191.47, 47.51% of them reported positive R&D expenditures and about 76% of them were exporters (Table 2).

[Insert Table 1 here]

[Insert Table 2 here]

3.2 Empirical analysis

Consistently with the theoretical discussion, in our modelling framework we follow two complementary approaches. In the first part of the analysis, we investigate the presence of firm-level persistence by means of transition probability matrixes (TPM). In the second part, we explore firm-level innovation persistence by means of discrete choice panel data models based on the recent estimator proposed by Wooldridge (2005) and applied by Peters (2008). While the initial TPM approach is expected to provide only summary evidence on the persistence of firm innovative activities along time, the panel data analysis aims at identifying the actual impact of past firms' innovation performance after controlling for relevant contingent factors. In the following Table 3 we report the definition of the innovation variables that will be used in the different empirical analyses on the persistence of innovation activities.

[Insert Table 3 here]

3.3 Descriptive analysis based on Transition Probability Matrixes

In this section we provide descriptive evidence on the extent of innovation persistence, using transition probability matrixes and different innovation indicators. This allows us to investigate how the persistence in innovative behaviours is reflected by different indicators, which measures different aspects of innovation activities by firms. Following Cefis (2003) it is possible to model the sequence of innovation and non-innovation states as a stochastic process approximated by a two-state Markov chain with transition probabilities:

$$P[X_t = i \mid X_{t-1} = j] = \begin{bmatrix} p,(1-p) \\ (1-q),q \end{bmatrix}$$

The corresponding AR(1) process for the stochastic variable X_t then is the following:

$$X_t = (1-q) + \rho X_{t-1} + \upsilon_t$$

where $\rho = p + q - 1$.

Each term of the (2X2) TPM will be the conditional probability $p_{ij} = P(I_t = j \mid I_{t-1} = i)$, or the probability of moving from state j to state i. Based on estimated transition probabilities different situation are possible (Roper and Dundas, 2008), in the case of a 2-dimensional matrix :

i) Transient innovation: if the sum of the lead diagonal terms is less than 1 there is no evidence of persistence.

ii) Weak innovation persistence: if the sum of the main diagonal terms is more than 1 but some of these terms are lower than 1/n (in this case 0.5).

iii) Strong innovation persistence, if the sum of the main diagonal terms is more than 1 and all the main diagonal terms are larger than 1/n (in this case 0.5).

The balanced nature of our firm- level dataset avoids possible drawbacks of the TPM analysis. The following Table 4 reports the TPMs for the different indicators of innovative activity considering the whole sample of data. The TPMs refer to i) the more general innovation indicator that takes into account the development of new products and new processes, but also the introduction of organizational innovations; ii) and iii) the indicators related to process and product innovation; iv) the indicator associated with formal R&D investments.

[Insert Table 4 here]

The TPM can be read both diagonally and horizontally. While the analysis of the main diagonal provides us with information on the overall rate of persistence, the secondary diagonal informs us about the relative importance of barriers to entry and exit the innovation activity. Finally, from the horizontal analysis of the TPM it is possible quantify the magnitude of entry barriers (southern part) and exit barriers (northern part) to innovation. In this way it is possible to derive an overall picture on what we can label, by drawing from well established IO literature, firms barriers to mobility in the innovation process (Caves and Porter, 1979).

As already mentioned, there is evidence of strong innovation persistence, if the sum of the main diagonal terms is more than 1 and all the main diagonal terms are larger than 0.5. This always applies to our data with the exception of the case of the general innovation indicator. Such a result represents a first indication of the presence of some form of inter-temporal stability in innovation effort that has to be qualified by looking in more details at our empirical findings. First of all, the sum of the main diagonal terms allows us to rank the different innovation indicators by the overall magnitude of persistence in firms' behaviours. The indicator reflecting the choice between investing or not investing in R&D activities appears to be the one associated with the highest global inter-temporal stability (1.31). A similar pattern can be identified for firms introducing product innovation (1.25). On the other hand, the overall magnitude of persistence decreases when looking at the general innovation indicator (1.18) and at the indicator associated with the introduction of new production processes (1.16). Such a different magnitude of state dependence measured by alternative indicators clearly emerges if we look at the difference in probabilities of being innovative in period T for firm that have engaged or not in innovative activities in period T-1. While the probability of investing in R&D in period t is 31 percentage points (hereafter: PP) higher for R&D performers in period t-1 than for non-R&D performers in t-1 and the probability to introduce product innovation in t is 26 PP higher for product innovators in t-1 than for non-product innovators, the probability of introduce any form of innovation in period t is 18 PP greater for innovators at t-1 than for non-innovators in t-1. Moreover, the probability to introduce new processes in period t is "only" 16 PP higher for process innovators in t-1 than for non-process innovators at t-1. Therefore, consistently with our hypotheses and with previous empirical evidence that distinguished between the persistence in product and process innovation (Roper and Dundas, 2008), product innovation persistence appears to be remarkably stronger than that for process innovation. This evidence can be interpreted as a test of the intrinsic differences in the types of firm strategies and technical constraints that characterize different forms of knowledge generation and introduction of innovations. The creation of a R&D laboratory is characterized by major sunk costs that imply a long term commitment. The activity of a R&D laboratory requires that the generation of technological knowledge and the introduction of technological innovations become a systematic component of the firm strategy and innovation is a stable element of the routines of the firms. The differences in the stability test for product and process innovations is quite interesting. Process innovations appear to be characterized by lower levels of long term stability. This evidence can be interpreted as a consequence of the tight relationship between the introduction of process innovations and the purchase of capital goods by upstream manufacturers. Downstream firms introduce process innovations when major investments take place and the lay-out of the production process is changed. At this time the interactions with upstream producers are very strong. When the flow of investments is lower and is characterized by cumulability rather than substitution, the rate of introduction of process innovations slow down. Product innovations on the opposite become a stable component of the strategy of firms that rely on the flows of new products as a long term component of their marketing strategies. Product innovations feed the oligopolistic rivalry in product markets.

The relative importance of the different forms of barriers to mobility can be grasped from the secondary diagonal of the TPMs. While in the cases of General Innovation and Product Innovation barriers to entry appear to be lower than barriers to exit, the other two indicators do not show a significant difference in the relative magnitude of the two types of barriers. In both these latter cases the relative importance of mobility barriers depends crucially on the size of firms, with smaller firms characterised by stronger entry barriers than exit barriers and vice-versa.

The horizontal analysis provides interesting evidence about the absolute relevance of barriers to entry and barriers to exit the innovation activity. In Table 4 we see that barriers to exit the innovation process are highest in the case of General Innovation: when firms have included some form of innovation in their routines they are likely to keep innovating. At the other extreme we find the case of Process Innovations where the horizontal difference between cells yields the lowest level of 0.14: in this case it seems clear that firms rely on the introduction of process innovations occasionally. The introduction of Product Innovations ranks second in the levels of the upper horizontal persistence with a score of 0.38. Firms that have experienced the introduction of product innovations are keen to keep in relying on the introduction of new products as a stable component of their market strategies.

Barriers to entry in the innovation process are clearly very strong when R&D activities are considered. The lower horizontal score for R&D activities is in fact the largest (0.32) among the four forms of innovation activity that we have considered. A crucial difference in the probability of transition from a "negative" to a "positive" status can be recognized between the general innovation indicator and the one relative to R&D activities. In the first case the probability is rather high (0.59), which reflects the fact that it is relatively easy to undertake at least one of the different possible forms of innovation activities. Conversely, it appears to be much more difficult to activate unprecedented R&D based innovation efforts (the transition probability in this case is 0.34). Here the presence of relevant sunk costs and barriers to entry related to R&D investment seem to matter in locking-out firms from R&D activities, with 2 over 3 non-R&D performers in period t-1 still being non-R&D performers at time t.

The analysis of the (upper) horizontal transition probabilities by size classes provided by Table 5 suggests that barriers to exit the introduction of General Innovations are strongly correlated with the size of firms. The score of the difference in fact increases systematically from 0.06 for small firms with 11-20 employees, to 0.48 with firms with 21-50 employees, to 0.64 for firms with 51-250 employees and gets the highest level of 0.78 in firms with more than 250 employees.

In the case of Product Innovations we see that volatility of both entry and exit barriers is very high in small firms. The upper horizontal score for firms with 11-20 employees is 0. Barriers to exit product innovation activities are much stronger in larger firms where the score is 0.42 for both firms with 21-50 and 51-250 employees and is highest, once more in firms with more than 250 employees where the score is 0.48. Symmetrically we find that, for all the innovation indicators considered, barriers to entry are strongly associated with the size of firms. When R&D activities are concerned the scores of the lower horizontal cells decrease clearly with size from 0.48 in firms with 11-20 employees, to 0.30 in firms with 21-50 employees, 0.26 in firms with 51-250 employees and arrive to the minimum of 0.02 in firms with more than 250 employees.

The exam of the persistence of innovation activities and the relevance of barriers to entry and to exit the different kinds of innovations distributed across the Pavitt taxonomy is also telling (Table 6). It is in fact absolutely clear that persistence and respectively barriers to entry and barriers to exit are highest in the science based industries ad lowest in supplier dominated industries.

The analysis conducted so far provides strong preliminary indications for state dependence in innovative activities, in particular those related to R&D investment and to the introduction of new products in the markets. Moreover, while the general innovation indicator allows us to appreciate the strong irreversibility associated with the different innovating behaviours, the persistence analysis conducted through the R&D indicator has highlighted the existence of relevant barriers to entry related to R&D investments that contribute substantially in determining the overall rate of state dependency observed for this indicator.

It should be clear that such findings provide only a preliminary evidence of the relevance of persistence in innovation, suggesting the presence of some form of inter-temporal stability in innovation efforts. However, they do not provide, yet, a sound indication on how much the observed persistence can be identified as true persistence driven only by previous states. The observed persistence can be clearly influenced by other factors, and the evidence provided in Table 5 and 6 offers precise hints in this direction. Results suggest in fact that innovation persistence, independently from the specific indicator used, is indeed influenced from factors such as size or the technological characteristics of industries. In particular the size of the companies turns to be positively associated with a higher persistence and a similar pattern can be identified for firms operating in science based sectors.

[Insert Table 5 here]

[Insert Table 6 here]

The econometric analysis in the next section aims specifically at controlling for those factors that can affect the observed persistence in order to isolate true state persistence effects.

4. Econometric analysis

4.1 Econometric model

In order to analyze the persistence of innovation along the analysed periods we have adopted different time varying dummy variables that equal one in period t if a company declares different typologies of innovations. We apply a dynamic discrete choice models in which such variables are regressed against their past realization and a set of appropriate controls. In order to account for sectoral innovation specificities we include in the model four sectoral dummies based on the reclassification of industries according to the Pavitt taxonomy.

As previously discussed, observed persistence may be due to true state dependence or permanent unobserved heterogeneity across the analysed companies. By a theoretical perspective, if the source of persistence is due to permanent unobserved heterogeneity, individuals show higher propensity to take a decision, but there is no effect of previous choices on current utility and past experience has no behavioural effect (Heckman, 1981).

In our specific context, we can assume that expected drivers of true state persistence include the existence of dynamic increasing return to innovation effort, the sunk R&D costs previously incurred by a company, the cumulativity of the innovation process. On the other side, the source of unobserved serially correlated characteristics that make firms more or less likely to innovate relate to risk attitude of entrepreneurs and other idiosyncratic features. By controlling for a set of observable firm specific dimensions we expect to obtain a clearer view of the actual persistence.

The baseline specification for a dynamic discrete response model is the following, where y_{it} is our innovation indicator:

$$y_{it}^{*} = \gamma y_{it-1} + \beta x_{it} + u_i + \varepsilon_{it} \qquad \text{Eq. (1)}$$

The estimation of the above model requires an important assumption on the initial observations y_{i0} and their relationship with u_i, the unobserved individual effects. In fact, if the start of the analysed process does not coincide with the start of the available observations, y_{i0} cannot be treated as exogenous and its correlation with the error term would give raise to biased estimates of the autoregressive parameter γ, that represents our measure of persistence. Two different approaches can be adopted for handling such initial condition problem: Heckman (1981) suggests to specify the distribution of y_{i0} conditional on u_i and x_i; alternatively, Wooldridge (2005) proposes to specify the distribution of u_i conditional on y_{i0} and x_i. In our empirical analysis we have applied the latter approach. In particular, we follow the methodology applied by Peters (2008) which offers a simplification of the Wooldridge method, by using the first realisation of the innovation indicators (y_{i0}) and the time-averaged covariates as predictors of the individual effect, according to the following relationship:

$$u_i = \alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{x}_i + c_i \qquad \text{Eq. (2)}$$

where

$$\bar{x}_i = T^{-1} \sum_{t=1}^{T} x_{it} \qquad \text{Eq. (3)}$$

Under the assumption that the error term c_i is distributed as $N(0,\sigma_c^2)$ and that $c_i \perp (y_{i0}, \bar{x}_i)$ we obtain that:

$$u_i \mid y_{i0}, \bar{x}_i \approx N(\alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{x}_i, \sigma_c^2] \qquad \text{Eq. (4)}$$

and the dynamic probit model can be rewritten according to the following specification:

$$P(y_{it} = 1 \mid y_{i0}, ..., y_{it-1}, x_i, \bar{x}_i, c_i) = \phi(\gamma y_{it-1} + \beta x_{it} + \alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{x}_i + c_i) \qquad \text{Eq. (5)}$$

This methodology has the advantage of being less restrictive on exogeneity assumptions with respect to the Heckman's one. The method amounts to estimating a dynamic random effect probit model in which regressors include a dummy representing the initial realisation of the dependent variable and the time average of those covariates that are expected to be correlated to the individual effect.

4.2 *Results*

Table 7 shows the results for different specifications of the persistence model regarding the 4 different indicators of innovation activities as dependent variables. We report both the simple random effect dynamic probit estimates and models estimated with the Wooldridge approach. Results in general show that, even after controlling for a number of internal and external factors, the probability of observing an innovation in period t is still positively and significantly affected by the previous realization of the considered innovation variable.
In particular, we found that the highest coefficients of the lagged dependent are those related to R&D activities and to product innovation. The model estimated for the general innovation indicator (INNOV) confirms the picture emerged from the TPM analysis highlighting a weak state dependence effect associated with this indicator. Interestingly, when we control for endogeneity and for the intensity of R&D activities (column 2) the coefficient of the lagged general innovation variable looses its significance. The statistical significance of the lagged dependent variable is restored when the R&D related variables are dropped from the model (column 3). This implies that the innovation persistence measured by the general innovation indicators is substantially associated with the group of R&D performers within the innovators' population.
The econometric results show that the initial conditions are relevant only for the variable related to R&D investment. This result confirms that R&D activities are characterised by true state persistence and past dependence. On the contrary, the initial conditions do not appear to be relevant when the other indicators are considered.

The introduction of a number of different control variables allows us to test the robustness of the relationships identified between past and current realization of the dependent variables. Moreover, the significance of the other variables is most important as it confirms the path dependent character of the non-ergodic persistence. Among the internal factors the levels of R&D intensity, as measured by the two indicators R&D expenditures per employee and the share of internal R&D over total, as well as the level of fixed capital investment significantly enhance the probability of subsequent innovation outcomes. Such result confirms the idea that investment activities is partly associated with the presence of sunk costs that might motivate the continuous undertaking of innovation activities.

The results suggest that the variable SIZE has a positive effect with the exception of the model estimated on R&D activities. However, the estimated coefficient associated to SIZE looses its significance when we control for endogeneity. A similar pattern can be observed for the variable on firms' export propensity whose coefficient is sufficiently robust only for the case of the R&D indicator. Moreover, the dummies associated to the 4 Pavitt classes are jointly significant, confirming the descriptive evidence that highlighted differentiated patterns in the persistence of innovative activities among different groups of economic sectors[4].

The empirical evidence so far explored can be further investigated with the identification of the specific typology of activity and the geographical location so as to test the important hypothesis that the persistence of innovation is also the result of the specific localization of innovating firms. Knowledge externalities play a key role in supporting the generation of new technological knowledge and the actual introduction of technological innovations. Firms rooted in an industrial and technological space that provides access to external knowledge at low costs are more likely to become persistent innovators than firms based in geographical and industrial contexts that do not provide access to local knowledge pools.

[Insert Table 7 here]

5. Conclusions

In this paper we have investigated the degree of firm level persistence in time of different typologies of innovation activities, using both transition probability matrixes and a set of dynamic probit models that account for the initial conditions. The study complements previous empirical evidence mostly based on patent based indicators. Our evidence confirms significant persistence in innovation activities. Such result turns to be robust to the introduction of a set of firm-specific controls, including size, sectoral affiliation, exporting, investments in fixed assets, intensity of R&D expenditures and after accounting for firms unobservable heterogeneity. However, the levels of persistence as captured by the inter-temporal elasticity between the innovation indicators show significant variations according to the typology of innovation considered. The higher level of persistence is found for the R&D investments, witnessing the actual presence of significant entry and exit barriers. Furthermore, we obtain a relatively higher persistence for product innovation than process innovation.

Our results have important implications for the selection of the targets and the tools of innovation policies. The provision of funding and assistance to the performance of R&D activities in fact is likely to display persistent effects in the long term. The provision of fiscal subsisdies to the adoption of process innovations instead is likely to exert its effects in the short terms and it is less likely to change the routines of receiving firms a so as to introduce innovation as a stable component of their business strategies.

[4] We have tested other regression models with additional control variables which turned-out to be not statistically significant and to not affect the significance of the coefficients associated with the past realizations of innovation activities.

References

Alfranca, O., Rama, R., von Tunzelmann, N. (2002), A patent analysis of global food and beverage firms: The persistence of innovation, *Agribusiness* 18, 349-368.

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

Antonelli, C. (2008), *Localized technological change: Towards the economics of complexity*, Routledge, London.

Arrow, K.J. (1974), *The limits of organization*, W.W.Norton, New York.

Caves R.E., Porter M.E. (1979), From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterrence to New Competition, *The Quarterly Journal of Economics* 91, 241-262.

Cefis, E. (2003), Is there persistence in innovative activities? *International Journal of Industrial Organization* 21, 489-515.

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

Cefis, E., Ciccarelli, M. (2005), Profit differentials and innovation, *Economics of Innovation and New Technology* 14, 43-61.

Crespi, F., Pianta M. (2008), Diversity in innovation and productivity in Europe, *Journal of Evolutionary Economics* 18, 529-545.

Duguet, E., Monjon, S. (2004), Is innovation persistent at the firm level? An econometric examination comparing the propensity score and regression methods, Cahiers de la Maison des Sciences Economiques, Université Panthéon-Sorbonne.

Foster, L., Haltiwanger, J. and C.J. Krizan (2002), The link between aggregate and micro productivity growth: Evidence from retail trade, NBER Working Paper.

Geroski, P.(1994), *Market structure corporate performance and innovative activity*, Oxford University Press, Oxford.

Geroski, P., Van Reenen, J., Walters, C. (1997), How persistently do firms innovate? *Research Policy*, 26, 33-48

Gruber, H. (1992), Persistence of leadership in product innovation, *Journal of Industrial Economics* 40, 359-375.

Heckman, J.J. (1981), *The incidental parameters problem and the problem of initial conditions in estimating a discrete time - discrete data stochastic process,* in C.F. Manski and D. McFadden (eds.). Structural analysis of discrete data with econometric applications, MIT Press, Cambridge.

Klepper, S., (1996), Entry, exit and innovation over the product life cycle, *American Economic Review* 86 (3), 562–582.

Latham, W.R., Le Bas, C. (eds.) (2006), *The economics of persistent innovation: An evolutionary view*, Springer, Berlin.

Malerba, F., Orsenigo, L., Petretto, P. (1997), Persistence of innovative activities sectoral patters of innovation and international technological specialization, *International Journal of Industrial Organization* 15, 801-826.

Máñez, J. A., Rochina, M. E., Sanchis, A., Sanchis, J. (2009), The role of sunk costs in the decision to invest in R&D, *Journal of Industrial Economics* 57, 712-735.

Nelson, R., Winter, S. (1982), *An Evolutionary Theory of Economic Change*. The Bellknap Press of Harvard University Press, Cambridge, MA.

Penrose, E., (1959), *The theory of the growth of the firm*, Oxford University Press, Oxford.

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

Raymond, W., Mohnen, P., Palm, F.C., Schim Van Der Loeff, S. (2006), Persistence of innovation in Dutch manufacturing: Is it spurious? CESifo Working Paper Series No. 1681.

Reichstein T., Salter A., (2006), Investigating the Sources of Process Innovation among UK Manufacturing Firms, *Industrial and Corporate Change*, 15, 653-682.

Roper, S., Hewitt-Dundas, N. (2008), Innovation persistence: Survey and case-study evidence, *Research Policy* 37, 149-162.

Scherer, F.M., Harhoff, D. (2000), Technology policy for a world of skew-distribution outcomes, *Research Policy* 29, 559–566.

Stiglitz, J.E. (1987), *Learning to learn localized learning and technological progress*, in Dasgupta, P. and Stoneman, P. (eds.), Economic policy and technological performance, Cambridge University Press, Cambridge.

Sutton, J. (1991). *Sunk costs and market structure*. Cambridge, MA.

Teece, D., Pisano, G. (1994), The dynamic capabilities of firms: An introduction, *Industrial and Corporate Change* 3, 537-555.

Wooldridge, J. (2005), Simple solutions to the initial conditions. Problem in dynamic nonlinear panel data models with unobserved heterogeneity, *Journal of Applied Econometrics* 20, 39–54.

LIST OF TABLES

Table 1 Sectoral composition of the sample

NACE Rev. 1 Sectors	Number of firms	%
FOOD PRODUCTS AND BEVERAGES	33	7.32
TEXTILES	32	7.1
WEARING APPAREL, DRESSING AND DYING OF FUR	13	2.88
LEATHER, LEATHER PRODUCTS AND FOOTWEAR	19	4.21
WOOD AND PRODUCTS OF WOOD AND CORK	11	2.44
PULP, PAPER AND PAPER PRODUCTS	16	3.55
PRINTING AND PUBLISHING	9	2
COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	2	0.44
CHEMICALS AND CHEMICAL PRODUCTS	19	4.21
RUBBER AND PLASTICS PRODUCTS	23	5.1
OTHER NON-METALLIC MINERAL PRODUCTS	29	6.43
BASIC METALS	24	5.32
FABRICATED METAL PRODUCTS, except machinery and equipment	63	13.97
MACHINERY AND EQUIPMENT, N.E.C.	84	18.63
OFFICE, ACCOUNTING AND COMPUTING MACHINERY	1	0.22
ELECTRICAL MACHINERY AND APPARATUS, NEC	17	3.77
RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	8	1.77
MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	14	3.1
MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	3	0.67
OTHER TRANSPORT EQUIPMENT	6	1.33
MANUFACTURING NEC	25	5.54
TOTAL	451	100

Table 2 Summary statistics for the sample for year 2002.

	Mean	median	st dev	5%	95%
Number of employees	191.47	46	651.43	10	5725
Number of employees in R&D	7.83	1	29.83	0	225
Age	29.45	26	17.8	5	130
Turnover (MEuro)	51.11	7.94	234.93	1.9	141.01
Fixed capital investments (Meuro)	1.86	0.21	7.91	0	7
Export	76.24%				
Positive R&D expenditures	47.51%				

Table 3 Definition of variables.

INPDT	Dummy variable that equals one if the company performs product innovation
INPCS	Dummy variable that equals one if the company performs process innovation
INRD	Dummy variable that equals one if the company declares positive R&D expenditures
INNOV	Dummy variable that equals one if the company performs either product innovation, process innovation, R&D expenditures or organisational innovations.
SIZE	Log of the number of employees
EXPORT	Dummy variable that equals one if the company exports
INV	Log of the fixed assets investments performed by the company
R&D/EMPL	Ratio of the R&D expenditures to the number of employees
SH_INT_R&D	Ratio of the cost of internally performed R&D to the total R&D expenditures

REG_R&D	Log of the total R&D expenditures in the region in which the company headquarters are located

Table 4 Transition probabilities between period T and T-1 along years 1998-2006. Full sample.

General Innovation				R&D investment		
	Yes	No			Yes	No
Yes	0.77	0.23		Yes	0.65	0.35
No	0.59	0.41		No	0.34	0.66
Product Innovation				Process Innovation		
	Yes	No			Yes	No
Yes	0.69	0.31		Yes	0.57	0.43
No	0.44	0.56		No	0.41	0.59

Table 5 Transition probabilities between period T and T-1 along years 1998-2006 by size classes

		General Innovation			R&D investment		
		Yes	No			Yes	No
Firm size	Yes	0.53	0.47		Yes	0.48	0.52
11-20 employees	No	0.55	0.45		No	0.26	0.74
		Yes	No			Yes	No
Firm size	Yes	0.74	0.26		Yes	0.58	0.42
21-50 employees	No	0.55	0.45		No	0.35	0.65
		Yes	No			Yes	No
Firm size	Yes	0.82	0.18		Yes	0.71	0.29
51-250 employees	No	0.67	0.33		No	0.37	0.63
		Yes	No			Yes	No
Firm size	Yes	0.89	0.11		Yes	0.69	0.31
>250 employees	No	0.92	0.08		No	0.49	0.51

		Product Innovation			Process Innovation		
		Yes	No			Yes	No
Firm size	Yes	0.50	0.50		Yes	0.28	0.72
11-20 employees	No	0.33	0.67		No	0.34	0.66
		Yes	No			Yes	No
Firm size	Yes	0.71	0.29		Yes	0.49	0.51
21-50 employees	No	0.41	0.59		No	0.37	0.63
		Yes	No			Yes	No
Firm size	Yes	0.71	0.29		Yes	0.63	0.37
51-250 employees	No	0.51	0.49		No	0.49	0.51
		Yes	No			Yes	No
Firm size	Yes	0.74	0.26		Yes	0.76	0.24
>250 employees	No	0.62	0.38		No	0.53	0.47

Table 6 Transition probabilities between period T and T-1 along years 1998-2006 by Pavitt Classes

General Innovation				R&D investment			
		Yes	No			Yes	No
Pavitt class Supplier dominated	Yes	0.69	0.31		Yes	0.59	0.41
	No	0.60	0.40		No	0.31	0.69
		Yes	No			Yes	No
Pavitt class Scale intensive	Yes	0.75	0.25		Yes	0.60	0.40
	No	0.50	0.50		No	0.28	0.72
		Yes	No			Yes	No
Pavitt class Specialised suppliers	Yes	0.82	0.18		Yes	0.68	0.32
	No	0.60	0.40		No	0.45	0.55
		Yes	No			Yes	No
Pavitt class Science Based	Yes	0.92	0.08		Yes	0.74	0.26
	No	0.90	0.10		No	0.37	0.63
	Product Innovation				**Process Innovation**		
		Yes	No			Yes	No
Pavitt class Supplier dominated	Yes	0.65	0.35		Yes	0.52	0.48
	No	0.38	0.62		No	0.43	0.57
		Yes	No			Yes	No
Pavitt class Scale intensive	Yes	0.70	0.30		Yes	0.56	0.44
	No	0.36	0.64		No	0.40	0.60
		Yes	No			Yes	No
Pavitt class Specialised suppliers	Yes	0.70	0.30		Yes	0.62	0.38
	No	0.58	0.42		No	0.37	0.63
		Yes	No			Yes	No
Pavitt class Science Based	Yes	0.78	0.22		Yes	0.69	0.31
	No	0.74	0.26		No	0.57	0.43

Table 7 Dynamic probit model with random effects on innovation persistence. Models 2,3,5,7 and 9 are estimated using the Wooldridge (2005) method.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable	INNOV	INNOV	INNOV	INPDT	INPDT	INPCS	INPCS	INRD	INRD
INNOV (-1)	0.21**	0.19	0.25**						
	(0.105)	(0.130)	(0.124)						
INPDT (-1)				0.41***	0.42***				
				(0.096)	(0.122)				
INPCS (-1)						0.29***	0.22**		
						(0.089)	(0.109)		
INRD (-1)								0.54***	0.24*
								(0.096)	(0.131)
SIZE	0.20***	0.11	0.06	0.11***	0.17	0.15***	0.10	0.03	-0.15
	(0.046)	(0.137)	(0.129)	(0.039)	(0.134)	(0.038)	(0.121)	(0.038)	(0.122)
EXPORT	0.22**	-0.12	-0.04	0.44***	0.00	0.15	-0.02	0.56***	0.50**
	(0.108)	(0.211)	(0.205)	(0.106)	(0.203)	(0.102)	(0.197)	(0.107)	(0.201)
LOG INV.	0.02***	0.02**	0.03***	-0.00	-0.00	0.01*	0.01	0.03***	0.03***
	(0.009)	(0.010)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)
R&D/EMP.	0.62***	0.65***		0.32**	0.17	0.08	0.10		
	(0.222)	(0.249)		(0.134)	(0.172)	(0.099)	(0.139)		
SH. INT. R&D	0.68***	0.52***		0.71***	0.73***	0.46***	0.35**		
	(0.146)	(0.176)		(0.120)	(0.151)	(0.113)	(0.144)		
INNOV (0)		-0.10	0.00						
		(0.127)	(0.121)						
INPDT (0)					-0.12				
					(0.126)				
INPCS (0)							0.06		
							(0.108)		
INRD (0)									0.45***
									(0.134)
AVG. SIZE		0.07	0.11		-0.09		-0.01		0.18
		(0.150)	(0.142)		(0.144)		(0.131)		(0.133)
AVG.R&D/EMP.		-0.17			0.40		-0.12		
		(0.281)			(0.283)		(0.215)		
AVG. EXPORT		0.43*	0.50**		0.59**		0.18		0.04
		(0.250)	(0.242)		(0.245)		(0.236)		(0.243)
AVG.INT.R&D		0.47*			-0.02		0.33		
		(0.269)			(0.250)		(0.232)		
AVG INV.		0.00	0.01		0.01		0.03*		0.00
		(0.020)	(0.019)		(0.019)		(0.018)		(0.019)
PAVITT 2	-0.01	-0.01	-0.02	0.06	0.08	-0.03	-0.06	-0.03	-0.06
	(0.128)	(0.130)	(0.126)	(0.123)	(0.124)	(0.119)	(0.121)	(0.122)	(0.124)
PAVITT 3	0.12	0.05	0.17	0.15	0.13	-0.13	-0.18*	0.22**	0.16
	(0.117)	(0.122)	(0.113)	(0.108)	(0.112)	(0.103)	(0.108)	(0.107)	(0.110)
PAVITT 4	0.58**	0.54*	0.70**	0.46**	0.44*	0.11	0.05	0.49**	0.43*
	(0.292)	(0.297)	(0.283)	(0.230)	(0.235)	(0.203)	(0.209)	(0.222)	(0.225)
Constant	-1.02***	-1.07***	-0.97***	-1.18***	-1.27***	-1.12***	-1.21***	-1.15***	-1.20***
	(0.180)	(0.194)	(0.184)	(0.163)	(0.176)	(0.155)	(0.168)	(0.158)	(0.173)
Wald Chi-sq.	140.13	146.20	103.19	165.51	171.41	87.15	94.35	141.58	154.34
Obs.	902	902	902	902	902	902	902	902	902
N. of Firms	451	451	451	451	451	451	451	451	451

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10