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## Persistence of innovation in unstable environments: Continuity and change in the firm's innovative behavior

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### ABSTRACT

The concept of persistence is generally used to define the positive relationship between past and present innovations, which is explained by feedback and accumulation processes triggered by the firm's past results. This paper states that changes in the economic or institutional conditions of the environment impact on the type of profitable innovations, and past innovations might not be suitable for the new environment. As a result, firm's innovative behavior might change, which means that the firm's set of decisions about engaging in the seek for innovations or not and, if so, the set of investments and capabilities it allocates to innovate could be modified. Empirical evidence is provided to reject the persistence hypothesis and to show that past innovations do not necessarily impact present ones. This paper examines the relationship between past and present innovations for a group of Argentinean firms during 1998–2006, which coincides with a period of macroeconomic instability. Results suggest that persistence has to be analyzed in terms of a dynamic firm's innovative behavior—regardless of its results—and how it allows the firm to accumulate competences and resources, which increases the odds of successfully responding to changes in the environment and continuing to innovate.

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### 1. Introduction

The concept of innovation persistence refers to the feedbacks, accumulation, and lock-in effects that arise from innovations and put the firm in a better position to seek new innovations, with the consequent increase in the odds of continuing to achieve these (Antonelli, 1997; Geroski et al., 1997; Nelson and Winter, 1982; Phillips, 1971). The empirical literature corroborates this, although it emphasizes that persistence is confirmed when the firm's innovative conduct is associated with explicit investments to generate technological and organizational changes (Clausen et al., 2011; Frenz and Prevezer, 2012; Le Bas et al., 2011; Peters, 2009; Raymond et al., 2010). These studies, however, implicitly condition persistence to the stability of the environments from which the empirical data was extracted (mostly European countries). This additional condition raises questions regarding the possibility of extrapolating the conclusions to unstable environments (such is the case of many middle-income countries).

Persistence literature shares the underlying idea that the environment does not change. It assumes that what the firm did in the past is useful for the things the firm has to deal with in the present. If one relaxes the assumption about the environment, a new question emerges: what if the environment changes and past innovations are no longer suitable for the new environment? This is the question that guides this article.

The hypotheses state that innovation persistence is explained by the firm's continuity on the innovative investments (the inputs) and not only by its innovation results (the outputs). The main objective is to discuss the concept of innovation persistence in unstable environments, accepting the possibility that a firm's innovative behavior might change. This means that faced to a change in the environment, firms might decide to continue, to stop or to initiate an innovation project.

The relationship between past and present innovations will be tested in a group of Argentinean firms using data from national innovation surveys in three distinct macroeconomic environments: the 1998–2001 economic crisis, the 2002–2004 recovery period, and the 2005–2006 growth phase.

Results suggest that persistence is conditioned by the performance of sustained innovative investments and the firm's ability to respond to changes in the environment. On average, the instability of the environment fostered isolated short-term innovations, which had low impact on the firms' capabilities and resources,

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which are the sources of persistence. As such, past innovations did not increase the probabilities of future ones. Conversely, among firms with long-term innovative behavior, and given the impact of path dependence and lock-in effects, past results delayed achieving the results required to compete in the present. Finally, persistence of innovation was observed among firms that changed together with the environment, in which it had the greatest impact. Therefore, there are reasons to believe that these firms sought innovations that were suitable to the new environment without the friction caused by path dependence and lock-in effects.

The remainder of this paper is as follows. Section 2 presents the theoretical framework and key empirical analysis aimed at testing persistence. It also discusses the potential and limitations of this concept when applied to unstable environments. In Section 3, methodology and data are defined. In Section 4, the model is applied and results are discussed. Finally, in Section 5, some conclusions are provided.

## 2. Theoretical background and empirical evidence

### 2.1. Innovation and persistence

The concept of persistence can be traced back to Schumpeter's (1942) creative accumulation process. This author argued that the process of technical change was associated with the existence of large firms competing in oligopolistic markets, where the development of innovations and the investments made to achieve this (R&D) triggered accumulation processes which tended to perpetuate the firm's presence in the market. Based on these ideas, although not restricted to the oligopolistic firm, three approaches to innovation persistence became the theoretical basis of recent empirical work: path dependence, virtuous cycles of accumulation, and market power dynamics.

According to the path dependence approach, the development of innovations in the past enhances a firm's capabilities and generates opportunity costs in the present, increasing the odds of the firm deciding to carry out another innovation project, which obviously affects the likelihood of actually achieving innovations. Within a particular space and time, past decisions generate sunk costs in terms of resources (irreversibility) and set the margin for obtaining scale economies (indivisibility). Both aspects involve opportunity costs for new decisions, which are weighed up when the firm makes decisions regarding new innovative processes (Antonelli, 1997, 2008).

The analysis of persistence in terms of virtuous cycles of accumulation is based on Nelson and Winter's (1982) work. For these authors, persistence emerges from the generation of feedbacks between past innovations, present investments, and future innovations. These authors argued that the decision-making process that leads to innovation is a routine (a standard behavior) which, in the case of success, will be repeated. As a consequence, the persistence of routines impacts the firm's innovative features, either by guiding the innovative projects or by blocking them. Successful firms (the ones that achieve innovations) stand out from the competition, create entry barriers and obtain quasi-monopoly rents, which improve their financial situation and generate surpluses to be reinvested in the quest for new innovations.

The market power approach can be found in the work of Phillips (1971), Mansfield (1962), and Geroski et al. (1997), among others. According to this approach, when a firm reaches an innovation, it achieves greater market power and obtains extraordinary incomes (increases its level of resources). Past innovations thus allow future ones to be financed. The other way around, given the additional uncertainty of innovation projects, those firms that cannot generate sufficient surpluses to fund future innovations face additional

financial obstacles or higher entry costs as a result of the differential interest rate arising from the risk of such projects.

In the three approaches described above, new innovations arise because past innovations have increased the firm's resources and capabilities (capabilities and opportunity costs, in the terms of the path dependence approach; extra-profits, entry barriers, and routines, in the terms of the cycles of accumulation approach; and profits, in the terms of the market power approach). In all cases, the assumption behind the expected positive association between past and present innovations is that past innovations trigger new innovation projects and this leads to new results that start the process all over again. In this way, innovation persistence is the serial correlation between past and present innovations and the statistical demonstration of the binomial accumulation feedback that emerges from the interaction between the firm and the market (Malerba et al., 1997).

To the extent that innovations have to be mediated by the market (they result from successful introductions of products, processes, or organizational practices), the firm will receive feedbacks from the market which will shape its innovative behavior. When facing a change in market conditions, path dependence will narrow the firm's range of possible responses—due to sunk and opportunity costs—resources and capabilities will limit the type of innovative projects the firm can carry out, and the routines will determine how the response is taken and applied.

However, the environment is more than market interactions (Lundvall, 1992; Nelson, 1994). It is the set of institutions affecting the selection process. In this sense, changes in the environment (such as a change in the economic model of growth or an economic recession) will impact not only on the last innovation project to have been implemented but on firm's behavior as a whole and how it faces competition. If the firm has to change its innovative trajectory to face the new environment, predicting a positive correlation between past and present innovations seems difficult. Therefore, although the three persistence approaches can explain the positive association between past and present innovations within stable contexts, they fall short when explaining this relationship within unstable ones, let alone in contexts of changes in the rules of the game or profound shifts in the main trends of demand.

### 2.2. Empirical evidence from the literature

To some extent, the recent literature on persistence can help to understand how changes in the environment could affect innovation persistence. Based on merged innovation surveys, these studies draw attention to the importance of inputs to the innovation process and how persistence is subject to specific innovative conducts. Within this literature, persistence is confirmed only in some specific types of firms.

One set of studies finds a positive relationship between past and present innovations, but this is subject to simple structural characteristics of the firm. Raymond et al. (2010) analyze persistence among Dutch firms and found that it exists among firms from sectors with high and medium-high technological intensity, which implicitly correlates persistence with high R&D expenditure, higher levels of qualified human resources, and the level of technological opportunities (the definition of high-tech sectors). For the other sectors (medium-low and low technological intensity), the hypothesis of persistence is not verified. Similarly, Peters (2009) corroborates persistence among German firms but finds that capabilities, size, and access to subsidies are relevant variables to explaining continuity of innovation. Finally, Frenz and Prevezer (2012) analyze a group of British firms and find that the variables that account for the firm's innovative behavior, together with size, sector, and age, are more important in explaining the recurrence of innovation than actual past results.

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