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Resumen

Numerosos estudios han identificado efectos positivos de persistencia de la innovación en empresas de países desarrollados. Sin embargo, esta no es la regla en las economías en desarrollo. Este artículo contribuye a la investigación en este tema, al analizar la persistencia de la innovación a corto y mediano plazo en empresas uruguayas durante el reciente período de expansión de las políticas de innovación en este país. Utilizando un panel de datos de la Encuesta Uruguaya de Innovación 2007-2018, ejecutamos estimaciones paramétricas y no paramétricas de la persistencia de la innovación de las empresas en los sectores manufacturero y de servicios. Nuestros resultados indican que la innovación en las empresas uruguayas es un proceso heterogéneo, incluso errático. Contrariamente a la mayoría de las investigaciones existentes sobre el tema, encontramos efectos de persistencia mayoritariamente negativos de resultados de innovación (tanto de productos como de procesos) a corto plazo y efectos de persistencia positivos de las actividades de I+D e innovación basadas en la adquisición de conocimientos externos (insumos de innovación) a medio plazo. Además, observamos efectos positivos del apoyo público tanto en realización de actividades de innovación como en la obtención de resultados a corto plazo, pero ningún efecto a medio plazo. A la luz de estos resultados, discutimos los retos de coordinación para las políticas de innovación en Uruguay, y la aplicabilidad de nuestros resultados a los países en desarrollo como alternativa a la interpretación extendida de la innovación como un proceso auto-eficiente.

Palabras clave persistencia innovadora; resultados de la innovación; insumos de la innovación; mix de políticas; Uruguay

Código JEL O31; O32; L25; C01

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Abstract

A large body of literature has identified positive persistence effects of innovation in firms located in developed countries. However, this is not the rule in developing economies. This article adds to this topic by analysing the short- and medium-term innovation persistence in Uruguayan firms during the recent period of expansion of the innovation policies in this country. Using a panel data set from the Uruguayan Innovation Survey 2007–2018, we run parametric and nonparametric estimations of firms' innovation persistence in manufacturing and service sectors. Our findings indicate that innovation is an uneven, even erratic, process. Contrary to most of the extant research on the topic, we find mostly negative persistence effects of outcome innovation (both product and process) in the short term and positive persistence effects of R&D and innovation activities based on external knowledge acquisition (input innovation) in the medium term. Moreover, we observe positive effects of public support on both input and outcome innovation in the short term but no effects in the medium term. We discuss timing and coordination challenges for innovation policies in Uruguay, and the applicability of our findings to developing countries as an alternative to the extended interpretation of innovation as a self-efficient process

Keywords: innovation persistence; innovation outcome; innovation input; policy mix; Uruguay

JEL Classification: O31; O32; L25; C01

1. Introduction

Research on firms' innovative persistence addresses a central issue in innovation and development studies. The literature on this topic has largely discussed whether the innovation trajectory of a particular firm is framed by a continuous systematic learning building or, conversely, by sporadic landmarks on a discontinuous, even erratic, path (Coad, 2009; Geroski, 1999; Juliao-Rossi et al., 2020).

Previous works have stressed that firms' innovation persistence—the current state's dependence on the past state—is characterised as path dependent, resulting from both initial conditions and cumulative contemporaneous events rather than as a past-dependent condition shaped only by the initial conditions (Antonelli et al., 2012). Since the development and dissemination of true state dependence estimation methods (Peters, 2009; Raymond et al., 2010), an extensive and increasingly parsimonious empirical research stream has contributed to an understanding of firms' innovation persistence. Most of the extant empirical research has conceived innovation persistence as a virtuous circle of firms' endogenous learning, which has been corroborated in developed economies by the regular observation of positive persistence effects, even in traditional sectors and during crisis periods (e.g., Antonelli et al., 2012; Antonioli and Montresor, 2021; Arroyabe and Schumann, 2022; Bartoloni, 2012; Cefis, 2003; Ganter and Hecker, 2013; Holl et al., 2022; Peters, 2009; Randy and Dzukou, 2021). On the basis on this large body of evidence, studies of developed countries have argued that innovation is a self-efficient process that reproduces itself over time and that innovation policies have long-lasting effects on the innovative behaviour of the firms (Altuzarra, 2017; Tavassoli and Karlson, 2015).

Innovation, however, is a context-dependent process, both in a historical and geographical sense (Paus et al., 2022; Vargas, 2022). Empirical research on firms' innovation persistence in developing countries and peripheral European economies, even though it is incipient, is consistently challenging the observation of innovation as a self-efficient process (Costa et al., 2020; Juliao-Rossi and Schmutzler, 2016; Long, 2021; Suárez, 2014). This alternative interpretation is based on a large body of literature on innovation and development that has stressed the unsystematic character of the innovation processes in Latin American countries (Dutrénit et al., 2011; Rapini et al., 2009; Sagasti, 2005). In this sense, recent works have argued that firms in Latin America follow a variety of innovative trajectories, and articulated innovation policies are required to impulse firms' innovation (Juliao-Rossi et al., 2020; Suárez, 2014; Vargas, 2022).

In this article, we add to this stream of research by analysing innovation persistence as a policy problem in the context of a developing country (Borrás and Edquist, 2013). We analyse innovation persistence in a broad sense, considering both innovation inputs and outcomes along the innovative trajectory of Uruguayan firms. In addition, in regard to inputs innovation, we differentiate between research and development (R&D) activities and innovation activities on the basis of external knowledge acquisition. In the same vein, we differentiate between outcomes innovation in product and process. This comprehensive approach allows us to capture the variety of innovative behaviour usually observed in Latin American firms (Berrutti and Bianchi, 2020; Vargas, 2022).

We use transition probability matrices to estimate gross persistence and panel econometric models to estimate net persistence. Hence, we analyse the trajectory of the firms, by measuring the probability of moving from a (no) innovation state to a (no) innovation one, in both manufacturing and service sectors between 2009 and 2018. However, in the short term, after achieving an innovative result or conducting an innovation activity, a firm can be unable to carry out new innovations and following a cycle of occasional innovation (Johansson and Lööf, 2010). Hence, to analyse the potential unevenness of the firms' innovative trajectory, beyond the short-term observation, we estimate both short- (3 years) and medium-term (6 years) innovation persistence effects. As far as we know, this is the first attempt to analyse time-differentiated innovation persistence effects in firms, which is particularly relevant to discuss the interpretation of innovation as a self-efficient process in the context of developing countries. In addition, we consider complementary persistent effects between different activities (R&D and external knowledge acquisition) and between different outcomes (product and process innovation).

Our results show that, instead than persistence, the effect of innovation experience on the probability of achieving new innovative outcomes is negative for most Uruguayan firms in the short term, whereas the medium-term estimations do not show significant persistent effects on outcome innovation. Short-term negative persistence effects are also observed for innovation inputs related to the acquisition of external knowledge. Conversely, we found positive medium-term persistence effects in the likelihood of conducting both R&D and innovation activities based on external knowledge acquisitions. Moreover, in the medium term, we observe that process innovation experiences create positive persistence effects on product innovation; in the meantime, complementary effects between R&D and innovation activities based on external knowledge acquisition are also registered in the short term.

These results contradict most of the empirical literature from developed countries while corroborating innovation unevenness in developing countries and the need for accurate and contextualised evidence for public policies.

In analysing our findings in light of the recent expansion of Uruguayan innovation policies, we revisit the classic distinction between explicit innovation policies, which refers to public actions oriented to affect innovation activities and outcomes, using instruments specifically designed for that; and implicit innovation policies, which refers to policy actions embedded in the prevailing national development policy that implicitly affect innovation activities and outcomes (Herrera, 1972). Following this reasoning, we use the concept of policy mix as a set of explicit and implicit policies and instruments that are more or less articulated according to the policy rationale and the specific context (Robert and Yoguel, 2022).

From a normative perspective, innovation policy instruments should be designed and implemented according to problems that the policy rationale has identified. Therefore, if, according to previous evidence, innovation as a self-efficient process should not be taken for granted in developing countries, then policy instruments to boost and sustain firms' innovation are required (Borrás and Edquist, 2013).

The accurate measuring of innovation persistence is a basic policy input, which is particularly relevant to Uruguay during the period covered by this work. In this period, the deployment of an incipient innovation policy cohabits with some chronic weaknesses of the national innovation system (Bianchi et al., 2021; Bukstein et al., 2020). One of the most salient problems is the small amount of investment in innovation activities, even considering Latin American comparisons (Aboal et al., 2015). Although national spending on R&D grew in absolute terms throughout the period considered, it does not surpass 0.53% of the gross domestic product. This growth has been driven by the public sector, while private firms' innovation investment has fallen from 35% of the national investment in 2008 to 20% in 2018[1]. The low level of private investment is one of the main policy concerns and is intrinsically related to the challenge to develop a critical mass of firms that persistently invest in innovation.

During this period, new governance for the design and implementation of explicit innovation policies was created. This process was based on a new institutional framework and followed by dramatic growth in the number of instruments oriented to promote innovative activities in private firms. Most instruments are horizontal ones, but sectoral instruments, guided by strategic goals, as well as collaborative research and innovation projects have been implemented (Aboal et al., 2015; Bianchi et al., 2021).

The creation and accumulation of instruments throughout 2007–2018 reflect a sort of experimental stage in Uruguayan innovation policy. These types of processes naturally face coordination and sustainability challenges from the mix of instruments, which can affect the incentives perceived by the firms and, in turn, their innovative behaviour. Moreover, this experimentation was guided by the programmatic rationale and only partially informed by evaluation results and only few instruments and programs include feedback mechanisms to examine experiences and discuss potential redesign (Bianchi et al., 2021; Bukstein et al., 2018).

Most of the available evidence shows positive effects of explicit innovation policy instruments oriented to promote firms' innovation in Uruguay (Aboal and Garda 2015; Berrutti and Bianchi, 2020; Bukstein et al., 2018; Gelabert et al., 2021). In particular, some policy efforts have contributed to the formation of a small core of regular innovative firms (Bukstein et al., 2018, 2020). Nevertheless, despite the number and variety of instruments implemented and the relatively stable policy supply, these works also stress that innovation policies have added only a few behavioural changes in the innovation trajectories of Uruguayan firms. In the same vein, systemic interactive effects in former no-innovative firms are seldom observed.

These results suggest that the policy incentives for innovation are not aligned between explicit and implicit innovation policies. Evidence from prior works suggests that the Uruguayan policy mix offers ambiguous incentives for firms' innovation. Explicit

[1] Updated information on public and private investment in R&D for Uruguay and Latin America, can be consulted at Portal Prisma (https://prisma.org.uy/eportal/web/anii-prisma) and RICYT (http://www.ricyt.org/category/indicadores/) respectively.

innovation policies which offer relatively small grants, cohabit with implicit ones that provide strong incentives for firms' investment (Aboal et al., 2015; Llambí et al., 2018). The main investment instruments—that is, the law of investment promotion and the free-zone regime—offer generous tax exceptions and tax credit mechanisms. Firms that benefited from the free-zone regime do not require innovation or technological counterparts to receive the tax benefit, whereas, under the law of innovation promotion, investment in R&D and innovation are only marginal activities (Bértola, 2018).

In a low innovative context such as the Uruguayan economy, the expansion and partial discoordination of policies may create uneven innovation incentives for firms. In this context, the basic assumption of the persistence studies that focus on the permanence of the firm's innovation strategies cannot be taken for granted (Suárez, 2014); conversely, heterogeneous innovation strategies between firms and changes along the firms' trajectories are expected.

2 Determinants of Firms' Innovation Persistence and Policy Implications

Even though analysing the determinants of firms' innovative persistence is not our objective of this work, understanding and discussing the potential determinants of innovation trajectories in the national context is critical to providing valuable evidence for public policies.

2.1 Innovation Persistence: External Determinants

Previous studies have mostly focused on microeconomic determinants of innovation persistence. From the classic Schumpeterian view, market structure and competition intensity in particular have received great attention. Nevertheless, recent evidence has drawn attention to the importance of macroeconomic factors (e.g., Antonioli and Montresor, 2021). Suárez (2014) corroborated the fact that innovation persistence in Argentinean firms was affected by macroeconomic conditions, finding stronger persistence effects in more stable periods. Due data restrictions, we are not able to capture the macroeconomic effects. Moreover, despite the growth fluctuations, the period considered in this work is relatively stable compared with the dramatic changes analysed by Suárez for Argentina. During one of the time ranges covered in this article—2007 to 2015—the Uruguayan economy grew at historically high rates, mainly because of favourable external conditions without a structural transformation of the economy (Bértola and Lara, 2017). After that, from 2016 to 2018, Uruguay experienced a growth slowdown that is typically associated with the end of the commodity boom prices.

Meso-level factors related to the innovation system in which a firm is embedded play a crucial role in determining its innovative behaviour (Dopfer, 2012). Among the systemic aspects that affect innovation persistence, the extant research has stressed the importance of knowledge externalities that emerge from firms' interactions with other firms, institutions, or regional knowledge (Holl et al., 2022).

The systemic linkages that allow knowledge exchange and the formation of a critical mass of innovative agents are usually not present in Latin American countries (Dutrénit et al., 2011; Rapini et al., 2009). Similarly, in Uruguay, only a small proportion of firms engage in innovative activity and innovative networks are strongly supported by public and intermediate-level organisations (Berrutti and Bianchi, 2020; Galaso and Rodríguez Miranda, 2021). Moreover, foreign investments—much of them benefited by industrial policies (tax credit)—do not mobilise new innovative investment but, conversely, have hindered local knowledge exchanges (Bello-Pintado et al., 2022).

Within this systemic landscape, a sort of Mathew effect (Antonelli and Crespi, 2013; Pereira and Suárez, 2018) is observed in Uruguay. Firms with better capabilities are able to obtain public support for innovation, following a learning path that allows them repeated access to new public support (Berrutti and Bianchi, 2020). In addition, public support from explicit innovation policies has shown investment additionality effects for supported firms, allowing short-term (between 2 and 3 years) innovation persistence in these firms (Bukstein et al., 2020). In the same vein, Gelabert et al. (2021) recently found additionality effects in regular innovators acting in the sectors where many firms receive public support. This seems to reflect the effect of the explicit innovation policies on the system's functioning; however, it seems to be restricted to a set of core innovative firms that require sustained public support.

From a microeconomic perspective, firms' innovation dynamics are driven by the search for profits associated with market positions. These profits may finance future innovation activities, which in turn contribute to maintaining market power. This explanation of innovative persistence is known as the success-breeds-success mechanism (Duguet and Monjon, 2004; Flaig and Stadler, 1994), and it is mostly related to outcome innovation persistence (Peters, 2009). It is expected that product innovation persistence, rather than process innovation, will be associated with market position advantages given that new product development is the main strategy to renew one's market position (Antonelli et al., 2012). This mechanism seems to be particularly relevant to Uruguay, where the financial system is scarcely developed and the main financial source for innovation activities are the firms' profits (Bianchi and Snoeck, 2009).

This way of Schumpeterian competition, based on R&D and product innovation, is rarely observed in developing economies. Recent works from Latin American countries have shown positive but uneven effects of competition pressure on firms' innovation behaviour (Benavente and Zuniga, 2021). Ponce and Roldán (2015) found positive effects of competition intensity on the probability of achieving innovative results in the Uruguayan economy. However, for firms that engaged in innovative activities, the effort dedicated to such activities is greater in more concentrated markets. Moreover, de Elejalde et al. (2022) found negative effects of competition on both innovation inputs and outcomes. These results are consistent with the prevailing type of innovation in Uruguay, where firms' strategies are mostly oriented to enhance competitiveness through process innovation or incremental product innovation but rarely to create new markets (Cassoni and Ramada-Sarasola, 2015).

2.2 Internal Firms' Persistence Mechanisms, Complementarity and Time Spanning

Internal determinants of innovation persistence identified in the literature lie at the base of the prevailing interpretation of the self-reinforcing mechanism that creates a trajectory of regular innovation persistence. In this sense, internal knowledge accumulation is recognised as a driver of dynamic economies of scale, which allows firms to adopt new ideas that improve products and processes (Duguet and Monjon, 2002; Georski et al., 1997). Knowledge accumulation increases the probability of using such knowledge in future periods but also makes such use more efficient (Georski et al., 1997; Juliao-Rossi et al., 2020). Therefore, according to this argument, by innovating, firms are involved in a continuous learning process and are able to generate new ideas that contribute to future innovative activities (Le Bas and Scellato, 2014).

The literature has stressed that a critical determinant of innovation persistence is the sunk costs incurred by firms that have innovated in the past (Sutton, 1991). This view has been mostly associated with the costs of R&D activities oriented to product innovation in high-tech firms (Hwang et al., 2021) rather than with the innovation activities based on the acquisition of external knowledge (Ayllón and Radicic, 2019; Tavassoli and Karlsson, 2015). However, both types of activities require an initial unrecoverable investment that endures so that it can be used in subsequent periods (Le Bas and Scellato, 2014). This investment refers to both valuable tangible resources—for example, R&D laboratories, machinery, a qualified workforce—and organisational routines that, once undertaken, have an extremely high cost for stopping because of increasing returns. Hence, sunk costs affect the market structure, operating as both barriers to entry into and exit from innovation activities (Antonelli et al., 2012).

Both knowledge accumulation and sunk-cost mechanisms usually complement one other and external factors along the firm's trajectory. Moreover, there may be interactions between innovation inputs and outcomes. For example, an innovative investment in product (process) innovation may necessitate further innovative activities (acquiring external knowledge or developing R&D activities), which may drive the firm to a new process (product) because of the sunk costs of the initial investment (Bartoloni and Baussola, 2018; Martínez-Ros and Labeaga, 2009). Moreover, innovations that recover initial costs may create enough profits to invest in such activities in future periods, thus being a type of success-breeds-success complementary persistence between inputs and outcomes innovation.

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Table 1. Empirical literature on firms' innovation persistence

Author	Country (sector)	Data	Methodology	Interest variable	Results
Peters (2009)	Germany.	Mannheim Innov. Panel (1994-2002 manufacturing, 1996-2002 services).	Wooldridge ML estimation, RE dynamic probit.	R&D and no R&D innovation activities (inputs).	Persistence in both manufacturing and services.
Raymond et al. (2010)	Netherlands (manufacturing).	CIS panel (1994-2002).	Wooldridge ML estimation, RE dynamic probit.	Innovation, Share of innovative sales (intensity) (outcomes).	Persistence in innovation and innovation intensity only for high-tech firm
Antonelli et al. (2012)	Italy (manufacturing).	Mediocredito Centrale Bank panel (1998-2006).	Idem	Products and processes innovation (outcomes)	Persistence in innovation, greater effects for firms performing R&D.
Triguero and Córcoles (2013)	Spain (manufacturing).	ESEE panel (1990-2008).	Idem	R&D activities (inputs). Products and processes innovation (outcomes)	Persistence in R&D activities and innovation outcomes.
Ganter and Hecker (2013)	Germany (manufacturing and services).	CIS panel (2002-2008).	Wooldridge ML estimation on RE dynamic probit.	Organizational and technological innovation (outcomes).	Persistence for technological innovations.
Haned et al. (2014)	France (manufacturing).	CIS panel (2002-2008).	Idem	Products and processes innovation considering organizational innovation (outcomes).	Persistence in products only when previous organizational innovation is considered.
Suárez (2014)	Argentina (manufacturing).	INDEC (1998-2006).	Wooldridge ML estimation on RE dynamic probit.	Products and processes innovation (outcomes).	No evidence of net persistence.
Tavassoli and Karlsson (2015)	Sweden (manufacturing).	CIS panel (2002-2012).	TPM; Wooldridge ML estimation on RE dynamic probit.	Products, processes, organizational and marketing innovation (outcomes).	Persistence in products, process and organizational innovations.
Manez et al. (2015)	Spain (manufacturing).	ESEE panel (1990-2011).	Discrete-time hazard models on determinants of R&D persistence.	Indicator for survival period in which the R&D spell ends.	"Success-breeds-success", sunk costs and demand-pull are corroborated
Juliao-Rossi and Schmutzler (2016)	Colombia (manufacturing)	Colombian Innovation Survey (EDIT) panel (2003-2008)	TPM; Wooldridge ML estimation on RE dynamic probit.	Product innovations adoption and generation (outcomes).	No persistence for generation of new products. Persistence in adoption of new products.
Muinelo and Suanes (2018)	Uruguay (manufacturing).	UIS panel (2001-2009)	Idem	Products and processes innovation (outcomes)	Persistence only for products..
Costa et al. (2020)	Portugal (manufacturing and services).	CIS panel (2004-2010).	Idem	Innovative activity and intensity (continuous, sporadic, new and non-innovative)	No evidence of net persistence
Juliao-Rossi et al. (2020)	Colombia (manufacturing).	Colombian Innovation Survey (EDIT) panel (2003-2008)	ZIOP ML estimation.	Frequency of innovation in the period .	Theoretical approaches are key determinants of persistence.
Antonioli and Montresor (2021)	Italy (manufacturing)	Monitoring the Economy and the Territory (2005-2013)	Wooldridge ML estimation on RE dynamic probit	Products and processes innovation and patent filling (outcomes).	Process innovation and weak product innovation.
Ayllón and Radicic (2019)	Spain (manufacturing)	Survey of public Enterprise Foundation (2001-2014)	Wooldridge ML estimation on RE dynamic probit	Products and processes innovation (outcomes)	Persistence and complementarity in product and process innovation.
Long, 2021	Vietnam	Own Survey (2005-2013)	TPM; Wooldridge ML RE dynamic probit	introducing or upgrading new product, introducing production process	No persistence in new products and upgrading process; persistence in upgrading product
Nam and Bao Tram (2021)	Vietnam (SMEs)	Own Survey (2007-2015)	Wooldridge ML estimation on RE dynamic probit	introducing or upgrading new product, introducing production process	Persistence in product upgrading and innovation process
Holl et al., (2022)	Germany (manufacturing and services).	Mannheim Innovation Panel (2002-2016)	TPM; Wooldridge ML estimation on RE dynamic probit.	Expenditure for activities to develop and implement new products or processes	Persistence of innovation activities.
Arroyabe and Schumann (2022)	Spain	PITEC (CIS) (2005-2014)	TPM; Wooldridge ML estimation on RE dynamic probit and FE	Products and processes innovation	Evidence of net persistence in process and product.
Kaushik and Paul (2022)	India	(2006-2015)	Wooldridge ML estimation on RE GLS	R&D activity (inputs)	R&D persistence

Notes: TMP: Transition Probability Matrices; ML: Maximum Likelihood; PP: Percentage Points.

On the other hand, both sunk costs and economic success are the result of previous processes of knowledge accumulation followed by the firm, and these mechanisms can, in turn, set the conditions for further knowledge accumulation. The specific characteristics of this process as the potential complement between types of innovation along the phases of the innovative cycle are associated with characteristics of the firm and the environment. Persistence in process innovation will prevail in mature industries and established markets, whereas persistence in product innovation is expected in markets characterised by disruptive innovation (Clausen et al., 2012).

In Latin America innovation is usually based on discontinuous accumulation processes (Dantas and Bell, 2011; Juliao Rossi et al., 2020). When a firm develops a product or process innovation, it usually focuses on the development and business sustainability of this innovation rather than introducing a new one (Johansson and Lööf, 2010). In this regard, persistence innovation as a policy problem requires that one pay attention to different knowledge accumulation strategies and, in particular, to how these strategies vary along the innovation cycles of the firm

2.3 Hypotheses

After reviewing the literature on innovation persistence, we identified two main patterns (Table 1). First, because the application of the estimation methods for net persistence (Peters, 2009; Raymond et al., 2010) has been regularly applied, empirical studies of developed countries have consistently found positive persistence innovation effects in both outcomes and inputs. Despite recent discussions of the intensity of persistence effects according to the particular type of estimation method used (Arroyabe and Schumann, 2022), the findings regularly have shown positive persistence effects in developed countries. On the basis of this empirical consistency, the current literature from developed countries has stressed the self-efficient nature of the innovation process and the first impulse for the firms to initialise innovative trajectories as the main innovation policy concern (Costa et al., 2020). However, the second observed pattern is that most previous research that has focused on Latin American economies, except Muinelo and Suanes (2018), has not found evidence of innovative persistence.

Therefore, our general hypothesis is that heterogeneity will prevail over potential regular patterns for the whole sample of Uruguayan firms. Regarding outcome innovation, on the basis of previous knowledge about innovation in the Uruguayan firms, we expect positive persistence in process innovation, but not in product innovation.

H1a: There is no significant evidence of product innovation persistence for the whole sample of Uruguayan firms, both in the short and medium term.

H1b: There is significant evidence of process innovation persistence for the whole sample of Uruguayan firms, both in the short and medium term.

Considering that input innovations do not depend on external conditions, as outcome innovations do, and considering the weight of sunk costs associated with R&D activities, we expect to find positive persistence effects of input innovation related to R&D. Following the previous reasoning, and considering that the acquisition of external knowledge is the main innovative activity of the Uruguayan firms, we also expect that the innovation based on the acquisition of external knowledge presents positive persistence effects.

H2a: There is significant evidence of R&D persistence for the whole sample of Uruguayan firms, both in the short and medium term.

H2b: There is significant evidence of persistence in innovation activities based on the acquisition of external knowledge for the whole sample of Uruguayan firms, both in the short and medium term.

Even though we do not expect to find innovative persistence in innovation outcomes as a generalised effect, we expect to find that firms' innovation persistence effects are associated with specific trajectories.

By considering diachronic effects between product and process innovation, we expect complementary effects of product (process) innovation experiences on process (product) contemporaneous outcomes. We hypothesise that this effect requires a relatively long time, so we expect significant and positive effects in medium-term periods.

In a similar vein, we expect that firms that conducted R&D activities may have to acquire new external knowledge to make the most of their previous efforts, both in the short and medium term. However, the inverse relationship is not feasible given that external acquisitions of knowledge rarely require further R&D efforts. Hence, we expect to find complementary effects of R&D activities on the probability that the firm conducts innovation activities based on the acquisition of external knowledge, but not the inverse.

H3a: There are significant complementary effects between product (process) innovation and process (product) innovation persistence in the medium term.

H3b: There are significant complementary effects of R&D activities on persistence in other innovative activities based on the acquisition of external knowledge, both in the short and medium term.

3 Methodological Design and Data

First, we measure gross persistence to observe the probability of a transition from one state (innovative/no innovative) to another, even unobservable factors are at play

(Peters, 2009; Raymond et al., 2010). Second, we estimate the net effect of past innovations on present innovations, generated by a state of dependence, whereby the only observed effect is generated by previous innovation (Raymond et al., 2010). A causal relationship is then observed, which can also be seen as a path-dependence effect.

3.1 Data and Variables

The main data source we use is the Uruguayan Innovation Survey (UIS), which follows the guidelines of the Oslo Manual (Organisation for Economic Co-operation and Development, 2005). This survey has a triennial frequency, starting in 1998–2000 and with the last available wave in 2016–2018. It collects data on manufacturing and service firms' innovative activities and provides the results for both the reference year and the two previous years.

We also use data from the Annual Survey of Economic Activities (ASEA), which collects data on firms' economic performance. Such data allow us to assess both a firm's performance and the sector's characteristics. Both the UIS and ASEA survey firms of five or more employees as a sample unit and are executed by the National Institute of Statistics. Because these surveys are part of the official statistics, and response is compulsory, their response rate is assured to be high. Finally, we use data from the Central Bank of Uruguay to control for macroeconomic sectorial performance (Table 2).

Because the UIS questionnaire includes questions about public support for innovation only from the 2007–2009 wave, in this research we use an unbalanced panel for the 2007–2018 period. To check robustness, we perform estimations with both unbalanced and balanced panels (Appendix, tables A2–A4).

In accordance with our objectives, dependent variables indicate whether the firm obtained innovation results (outcomes) or conducted innovation activities (input) at time t. To test the persistence effects, the variables of interest are the lagged dependent variables in $t - k$ with $k \in [1,2]$.

The set of control variables is formed by indicators about the firms' main features and the theoretical determinants of innovation persistence discussed in the previous section (Table 2).

Table 2. Variables

Concept measured		Variable	Source
Dependent variables			
Outcome innovation: product.		*$prod_{i,t}$* =1 if firm *i* introduced a novel or improved product into the market in the period *t*, =0 otherwise.	UIS
Outcome innovation: process.		*$proc_{i,t}$* =1 if firm *i* introduced a new or substantially improved method of production in the period *t*, =0 otherwise.	UIS
Input innovation: R&D		*$R\&D_{i,t.}$* takes value 1 if the firm *i* conducts R&D in time *t* , and 0 otherwise	UIS
Input innovation: acquisition of external knowledge		*$innov\_buy_{i,t}$* takes value 1 if aiming to innovate the firm *i* acquires capital goods, information technology, or receives technology transfers in time *t* , and 0 otherwise	UIS
Control Variables			
Firms characteristics		*$Size_{it}$:* total number of employees occupied in firm *i* in *t* (log).	UIS
		Age_{it} years between *t* the firms set up in business	UIS
		Activity Sector: ISIC Code 2 digits	UIS
		$Industry_{it}$ =1 if firm *i* belongs to manufacturing sector in the period *t*; =0 otherwise.	UIS
		$kibs_{it}$ =1 if firm *i* is classified as Knowledge Intensive Based Services (KIBS) in period *t*; =0 otherwise	UIS
		$Hightech_{it}$ =1 if firm *i* is classified as high technology manufacturing in period *t*; =0 otherwise.	UIS
		Sectoral GDP growth between the first year of and the last of the three-year period according to the waves of the UIS	BCU
		Foreign capital =1 if firm *i* has foreign capital in the period *t*, =0 otherwise.	UIS
Internal determinants	Knowledge accumulation	*$Professionals\ employees_{it}$:* number of professional employees occupied in firm *i* in *t* (log).	UIS
	Sunk costs	*$R\&D_{it}$* =1 if firm *i* declares to have invested in R&D in the previous period *t-1*, =0 otherwise	UIS*
		$Innovabuy_{it}$= 1 if firm *i* declares to have invested in acquisition of external knowledge in the previous period *t-1*, =0 otherwise	UIS*
		Innovative Expenditure per employee of firm *i* in *t* (log).	UIS
	Success breed success	*Total revenue* per employee of firm *i* in *t-1* (log).	UIS
External determinants	Institutional environment	*Finance access* =1 if firm *i* declared to have financial obstacles for innovating in period *t*.	UIS
		Public Support if firm *i* declares to have received public support to innovate in the previous period *t-1*, =0 otherwise	UIS
	Market structure and exposure to competition	*Export* =1 if firm *i* is an exporting firm in the period *t*, =0 otherwise.	UIS
		Competency: Lerner Index at the sector where firm *i* operates in period *t*, at three digit SIC level.	ASEA
	Links with the NSI	*Networks* =1 if firm *i* declares to participate in a regional or international network to innovate, in the period *t*, =0 otherwise	UIS
		Cooperation: =1 if firm *i* declares to have done cooperation agreements in the period *t*, =0 otherwise.	UIS

* Only for the estimation of outcome innovation performance

3.2 Estimation Techniques

3.2.1 Gross Persistence

Using transition probability matrices, we estimate the probability of moving from a state i_0 to another state, i_1 , not considering the different covariables that can affect the passage. The two states are innovator (IN) and not innovator (NIN). Following Cefis (2003), and assuming a set of random variables $\{Y_1, Y_2, \ldots, Y_n\}$ that follow a Markov process, we have

$$p_{ij} = P(Y_t = j \mid Y_{t-1} = i) = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}, \qquad (1)$$

where pij is the probability of moving from state i to state j in one period. The Y variables are input and outcome innovation indicators.

The unknown parameters pij can be estimated by maximum likelihood, and $pij{=}nij/ni$, where nij is the number of observed transitions from states i to j and ni is the total number of transitions from state i (Tavassoli and Karlsson, 2015). Using this methodology, persistence is considered weak if the sum of the elements on the main diagonal ($p11$ and $p22$) is ≥1 but one of the elements is <0.5. On the other hand, there is strong persistence if the number of elements on the main diagonal is ≥1 and both elements are >0.5. Otherwise, there is no persistence (Tavassoli and Karlsson, 2015).

3.2.2 Net Persistence

Following previous contributions (e.g., Peters, 2009; Raymond et al., 2010; Tavassoli and Karlsson, 2015), we assumed that firm i would innovate in period t if the expected value to obtain this innovation $-y_{it}^*-$ is positive. In addition, y_{it}^* is supposed to depend on previous innovation realisation $y_{i,t-1}$, a set of observable characteristics of the firm X_{it}, unobservable firms' effects that do not vary across the time u_i, unobservable time effects δ_t , and other unobservable effects illustrated as an error term, ϵ_{it}. This can be modelled as follows:

$$y_{it}^* = \gamma y_{i,t-1} + \beta X_{it} + u_i + \delta_t + \epsilon_{it}, \qquad (2)$$

where y_{it}^* is a latent variable that, when observed $y_{it} = 1$, implying that the firm got innovative results in t and $y_{it} = 0$ otherwise.

The main problem with this estimation is that most firms do not start their activities with the first registered observation in the data set. This causes the initial condition, y_{i0} , to be correlated with the vector of unobservable firms' characteristics u_i, thus generating inconsistent estimations (Peters, 2009; Raymond et al., 2010). As a solution to this issue, Wooldridge (2005) proposed to model the distribution of $\{y_{i0}, y_{i1}, \ldots, y_{iT}\}$ conditional on the initial condition y_{i0} assuming the unobservable firms' characteristics can be approximated by a linear function of observable variables (Suárez, 2014). Rabe-Hesketh and Skrondal (2013) went one step further and improved Wooldridge' specifications by also controlling for the initial condition of explanatory variables. Hence, the vector u_i can be modelled as follows:

$$u_i = \alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{X}^*{}_i + \alpha_3 X^*{}_{i0} + c_i, \qquad (3)$$

with $\bar{X}^*{}_i$ as a vector of explanatory variables for each period, with no time variations. Tavassoli and Karlsson (2015) suggested using average values of the time-invariant variables included in X_{it}, with $t \in \{1, \ldots, T\}$-, $X^*{}_{i0}$ as the initial values of the variables included, and $c_i \sim N(0, \sigma^2)$ independent of the initial condition y_{i0}, $X^*{}_{i0}$ and $\bar{X}^*{}_i$. Replacing equation (3) in (2), we have

$$y^*_{it} = \gamma y_{i,t-1} + \beta X_{it} + \alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{X}^*{}_i + \alpha_3 X^*{}_{i0} + c_i + \delta_t + \epsilon_{it} \ (4)$$

Obtaining then for variable y_{it}:

$$prob(y_{it} = 1 | y_{i,0}, \ldots, y_{i,t-1}, X_{it}, X_i, c_i) = \Phi(\gamma y_{i,t-1} + \beta X_{it} + \alpha_0 + \alpha_1 y_{i0} + \alpha_2 \bar{X}^*{}_i + \delta_t), \qquad (5)$$

where Φ refers to a normal cumulative distribution function. Thus, γ indicates the effect of previous innovation on present innovation.

We performed these estimations using one and two lags covering a period of 3 and 6 years (replacing $y_{i,t-1}$ with $y_{i,t-2}$ and all lagged explanatory variables by its t - 2 correspondent), respectively.

4 Results

In regard to both gross and net persistence estimators, there is no consistent evidence of innovation persistence in the Uruguayan firms, but different persistence effects, positive and negative, are observed according to the type of innovation, the firms' characteristics analysed, and the time considered.

In regard to gross persistence, the matrices show that, in all cases except large firms that achieved process innovation, outcome innovative firms present a higher likelihood of not innovating than to innovating in subsequent periods (Table 3). Input innovative firms presented mostly positive persistence in R&D activities, except for small and medium enterprises (SME), whereas external knowledge acquisition showed negative gross persistence effects, except for large firms and manufacturing firms. These results are robust, as estimations using the balanced panel show (Table A1, Appendix).

Table 3 Transition probability matrices: product and process innovations
(Unbalanced panel)

		Product innovation		Process innovation	
		Status in *t*		**Status in *t***	
	Status in *t* − 1	NIN	IN	NIN	IN
Global	NIN	88.15	11.85	82.89	17.11
	IN	57.81	42.19	58.51	41.49
Manufacturing	NIN	85.91	14.09	82.04	17.96
	IN	56.62	43.38	54.23	45.77
Services	NIN	89.87	10.13	83.53	16.47
	IN	58.96	41.04	63.56	36.44
Large	NIN	82.86	17.14	72.77	27.23
	IN	52.58	47.42	47.33	52.67
SMEs	NIN	88.84	11.16	84.13	15.87
	IN	58.89	41.11	60.92	39.08
		R&D		External acquisition	
		Status in *t*		**Status in *t***	
	Status in *t* − 1	NIN	IN	NIN	IN
Global	NIN	91.79	8.21	80.66	19.34
	IN	49.33	50.67	52.05	47.95
Manufacturing	NIN	91.04	8.96	79.74	20.26
	IN	48.86	51.14	49.02	50.98
Services	NIN	92.37	7.63	81.38	18.62
	IN	49.74	50.26	55.03	44.97
Large	NIN	86.74	13.26	67.81	32.19
	IN	45.77	54.23	38.81	61.19
SMEs	NIN	92.48	7.52	82.06	17.94
	IN	50.07	49.93	55.02	44.98

Robustness checks: Appendix,Table A1.

Previous works that have used this method have always found positive persistence effects of innovation outcome and input in European economies, with numbers of higher magnitude than those found here (e.g., Peters, 2009; Raymond et al., 2010; Triguero and Córcoles, 2013; Tavassoli and Karlsson, 2015). This method allows us to observe the differentiated probabilities of transition according to the different samples of interest and, in particular, seems to corroborate that Uruguayan firms' innovative behaviour is different from that of European firms. Indeed, our results not only reflect the absence of innovation persistence in Uruguay but also indicate that, for some firms, innovating at a given moment of time reduces the probability of innovating in the future (Table 3).

In line with the nonparametric results, the estimations for net persistence in outcome innovations (Table 4, top panel) also show that, in the short term, the innovative experience—in both product and process—reduces the probability of obtaining innovative contemporaneous results. The same result is observed for innovation activities based on external acquisitions, although no significant persistence effects of R&D activities were found (Table 4, bottom panel). However, although outcomes innovation did not show persistence effects in the medium term, both types of input innovation showed positive effects of persistence over a longer period of time.

Table 4: Net persistence in the whole sample (marginal effects). Unbalanced panel

	Product Innovation		Process Innovation	
	(1)	(2)	(3)	(4)
$prod_{t-1}$	-0.416***	-0.425***		0.0240
	(0.101)	(0.101)		(0.0724)
$proc_{t-1}$		0.101	-0.439***	-0.438***
		(0.0791)	(0.0849)	(0.0849)
#Obs.	4,987	4,985	4,985	4,985
#firms	2,424	2,422	2,422	2,422
$prod_{t-2}$	0.00419	0.00122		0.0754
	(0.120)	(0.120)		(0.0916)
$proc_{t-2}$		0.196*	0.0387	0.0387
		(0.105)	(0.101)	(0.101)
#Obs.	2,613	2,613	2,613	2,613
#firms	1,483	1,483	1,483	1,483
	R&D		External acquisitions	
	(5)	(6)	(7)	(8)
R&D$_{t-1}$	0.0682	0.00770		0.264***
	(0.108)	(0.110)		(0.0709)
innov_buy$_{t-1}$		0.249***	-0.155**	-0.190***
		(0.0785)	(0.0700)	(0.0707)
#Obs.	4,985	4,985	4,985	4,985
#firms	2,422	2,422	2,422	2,422
R&D$_{t-2}$	0.532***	0.510***		0.199**
	(0.137)	(0.139)		(0.0990)
innov_buy$_{t-2}$		0.0873	0.334***	0.301***
		(0.107)	(0.0928)	(0.0940)
#Obs.	2,613	2,613	2,613	2,613
#firms	1,483	1,483	1,483	1,483

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Robustness checks using the balanced panel (Appendix, Table A2) mainly corroborate this finding. Even though the effect was not negative, it was not significant, showing that previous innovation does not affect present innovation in the short term. Conversely, when using the balanced panel R&D activities showed positive persistence effects in the short term (Appendix, Table A2, columns 5 and 6).

Despite corroborating our general hypothesis about the existence of heterogeneous persistence effects, these results are quite disruptive. They mostly contradict our four first specific hypotheses—H1a to H2b—and, more important, they diverge from the extant empirical research, except the results found by Costa et al., (2020) who also noted negative persistence effects, in Portugal. However, these results are consistent with the main previous works on this topic from Latin America (Juliao-Rossi and Schmutzler, 2016; Suárez, 2014), which have not found significant persistence effects for Argentina and Colombia.2 In this sense, the evidence we obtained reinforces the interpretation that, in Latin America, a firm's innovation trajectory is mostly uneven and characterised by changes from innovative to not-innovative states.

The results regarding input innovation persistence in the medium term partially corroborated our hypotheses H2a and H2b: Positive innovation persistence was observed for both R&D activities and innovation activities based on the acquisition of external knowledge. We interpret this as signifying that once firms initiate innovative activities, they may dedicate efforts to pursue this activity for a period longer than 3 years. It also may reflect the critical role of public support, which may directly affect innovative inputs and their persistence, whereas innovative outcomes depend on other factors (e.g., market success, technology competition).

The differentiated effects of control variables shed some light on the heterogeneous innovative behaviour of Uruguayan firms (Appendix, Tables A5 and A6), revealing novel evidence regarding the theoretical explanations of persistence discussed in section 2 and operationalised in Table 2. Given the knowledge accumulation determinants, we observe that, unexpectedly, the number of professional employees in the workforce does not affect innovation persistence, in either the short or the medium term. Conversely, the variables associated with the sunk-cost explanations showed significant and positive effects of R&D expenditure on the probability of obtaining product innovations in the short term, but not in process innovation. In the same vein, we observed short-term positive and significant effects of investments in the acquisition of external knowledge on product and process innovation. However, the general expenditure on innovative activities per employee does not show significant effects on innovation propensity, except in the acquisition of external knowledge (negative).

Considering external determinants of firms' innovative persistence, links with the national system of innovation (NSI) and exposure to foreign competition had a significant and positive impact on the likelihood of innovating in both the short and medium term. In particular, export participation showed positive effects on product innovative outcomes and R&D activities. Moreover, we noted that foreign capital had no significant effects on the innovative behaviour and performance of Uruguayan firms (Bello-Pintado et al., 2022). However, in line with previous evidence, exposure to local competency negatively affects the probability that the firm conducts R&D activities and the development of innovative products (Ponce and Roldán, 2015).

These results indicate the relevance of systemic factors operating at the meso level, both those related to institutional environment and the market competency mechanisms, to explain the innovative trajectory in the Uruguayan firms. More important for the objectives of this research, we observed that firms that received public support for innovation showed a positive short-term persistence effect, but no effects in the medium term were observed. This result is consistent with previous measures of the time-spanning effect of public support for innovation (Bukstein et al., 2020) and with previous observations about the relative smallness of the public subsidies for innovation (Aboal et al., 2015).

Contrary to H3a, the results showed that there were no complementary persistence effects from product to process innovation in the short or medium term (Table 4). However, the effect of process innovation on the probability of achieving product innovation in the medium term was positive and significant. Considering both the results about persistence and complementarity, the innovation trajectory of the Uruguayan firms seems to be characterised by isolated innovative events rather than a continuous cumulative sequence. H3b was also partially contradicted. A complementary effect was observed from R&D activities to innovative activities based on the acquisition of external knowledge, both in the short and medium term. However, a similar effect was observed from the acquisition of external knowledge to R&D activities in the short term.

Exploring the heterogeneity of innovation, we divided the sample by size, splitting firms with at least 50 employees (large) and firms with fewer than 50 employees (SMEs; see Table 5). It is worth noticing that, because of the UIS's sampling criteria, estimates for SMEs were run for an unbalanced panel, although the results for large firms imply a balanced one.

We observe that, for SMEs, the short-term persistence effect was negative for both types of innovation outcomes. Conversely, innovation inputs showed positive persistence effects in the medium term. Large firms, in turn, did not present significant effects of persistence on outcome innovation but did exhibit mostly positive and significant effects of R&D activities in the short term. It is interesting that complementary effects from process to product innovation were observed in the medium term for SMEs. All results observed according to the size of the firm were robust when estimations were run using a balanced panel (Appendix, Table A3).

Table 5: **Net persistence for SME and large firms (marginal effects).** Unbalanced panel

	SME				Large			
	Product		Process		Product		Process	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-1}$	-0.519***	-0.517***		0.0687	-0.159	-0.167		-0.340**
	(0.119)	(0.118)		(0.0841)	(0.246)	(0.248)		(0.152)
$proc_{t-1}$		0.119	-0.615***	-0.612***		0.0405	0.222	0.228
		(0.0918)	(0.0986)	(0.0985)		(0.173)	(0.154)	(0.154)
#Obs.	4,333	4,333	4,333	4,333	652	652	652	652
#firms	2,196	2,196	2,196	2,196	226	226	226	226
$prod_{t-2}$	0.0674	0.0655		0.141	-0.307	-0.272		-0.149
	(0.131)	(0.130)		(0.102)	(0.351)	(0.352)		(0.219)
$proc_{t-2}$		0.410***	0.0495	0.0490		-0.376	0.0793	0.0831
		(0.120)	(0.113)	(0.113)		(0.279)	(0.262)	(0.261)
#Obs.	2,185	2,185	2,185	2,185	428	428	428	428
#firms	1,263	1,263	1,263	1,263	220	220	220	220

	SME				Large			
	R&D		External acquisitions		R&D		External acquisitions	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
R&D$_{t-1}$	-0.0669	-0.110		0.184**	0.648**	0.595**		0.476***
	(0.125)	(0.129)		(0.0818)	(0.258)	(0.247)		(0.185)
innov_buy$_{t-1}$		0.150	-0.248***	-0.276***		0.585***	0.246	0.246
		(0.0942)	(0.0788)	(0.0800)		(0.158)	(0.202)	(0.197)
#Obs.	4,333	4,333	4,333	4,333	652	652	652	652
#firms	2,196	2,196	2,196	2,196	226	226	226	226
R&D$_{t-2}$	0.555***	0.540***		0.190*	0.362	0.349		0.167
	(0.156)	(0.159)		(0.108)	(0.329)	(0.325)		(0.278)
innov_buy$_{t-2}$		0.0570	0.288***	0.253**		0.132	0.659**	0.653**
		(0.126)	(0.100)	(0.102)		(0.234)	(0.265)	(0.265)
#Obs.	2,185	2,185	2,185	2,185	428	428	428	428
#firms	1,263	1,263	1,263	1,263	220	220	220	220

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The results related to the activity sector are quite similar to those for the whole sample. Both manufacturing and services firms presented negative persistent effects of outcome innovation in the short term. In regard to innovation inputs, there were no significant persistence effects in the short term, although there were complementary effects between R&D activities and acquisition of external knowledge in service firms. Moreover, for service firms there were positive effects in both types of innovation inputs in the medium term (Table 6). These last results were also observed for the balanced panel, as shown in Appendix Table A6. However, negative persistence effects on outcome innovations were not observed for the balanced panel.

Persistence complementarity from process innovation to product innovation was observed in both the short and medium term for manufacturing firms, which is consistent with the idea that the manufacturing industry tends to develop new processes with the objective of enhancing competitiveness and which, according to the extant empirical evidence, may not be true for service firms (Aboal et al., 2015).

Table 6: Net persistence for manufacturing and service firms (marginal effects). Unbalanced panel

	Manufacturing				Services			
	Products		Process		Products		Process	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-1}$	-0.302**	-0.302**		0.0994	-0.457***	-0.457***		-0.0744
	(0.144)	(0.144)		(0.105)	(0.145)	(0.145)		(0.108)
$proc_{t-1}$		0.232*	-0.328**	-0.324**		0.0131	-0.620***	-0.620***
		(0.121)	(0.136)	(0.135)		(0.108)	(0.117)	(0.117)
#Obs.	2,261	2,261	2,261	2,261	2,724	2,724	2,724	2,724
#firms	1,018	1,018	1,018	1,018	1,404	1,404	1,404	1,404
$prod_{t-2}$	-0.0740	-0.0687		0.0968	0.0194	0.0182		0.0688
	(0.173)	(0.172)		(0.138)	(0.182)	(0.183)		(0.128)
$proc_{t-2}$		0.523***	0.0918	0.0913		0.0472	-0.0124	-0.0126
		(0.169)	(0.167)	(0.167)		(0.151)	(0.134)	(0.134)
#Obs.	1,263	1,263	1,263	1,263	1,350	1,350	1,350	1,350
#firms	717	717	717	717	766	766	766	766
	Manufacturing				Services			
	R&D		External acquisitions		R&D		External acquisitions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R&D$_{t-1}$	0.125	0.0665		0.169	-0.0620	-0.0943		0.199*
	(0.151)	(0.155)		(0.105)	(0.159)	(0.161)		(0.107)
innov_buy$_{t-1}$		0.224*	-0.144	-0.167		0.258**	-0.238**	-0.265***
		(0.116)	(0.109)	(0.110)		(0.110)	(0.0967)	(0.0980)
#Obs.	2,261	2,261	2,261	2,261	2,724	2,724	2,724	2,724
#firms	1,018	1,018	1,018	1,018	1,404	1,404	1,404	1,404
R&D$_{t-2}$	0.229	0.178		0.178	0.727***	0.715***		0.199
	(0.205)	(0.210)		(0.146)	(0.195)	(0.197)		(0.149)
innov_buy$_{t-2}$		0.179	0.185	0.145		0.0530	0.456***	0.433***
		(0.171)	(0.148)	(0.151)		(0.141)	(0.126)	(0.127)
#Obs.	1,263	1,263	1,263	1,263	1,350	1,350	1,350	1,350
#firms	717	717	717	717	766	766	766	766

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Finally, to explore potential biases in these results, we ran the models for different novelty degrees of innovation (new for the local and the international market) on the basis of the assumption that world market innovation may present higher persistence effects. However, nonpersistence effects remained in all the estimates, supporting previous findings.

5 Evidence about Innovation Persistence and Policy Mix

In this article, we have elaborated on the relevance of the study of firms' innovative persistence as a critical input for innovation policies. In this regard, we stress the differences between firms' innovation behaviour in developed economies and in developing ones, which were also observed in previous studies of firms' innovative persistence.

We contribute new evidence that corroborates previous studies from Latin American countries (Juliao-Rossi and Schmutzler, 2016; Suárez, 2014), meanwhile, we propose an accurate and improved estimation of specific studies of the Uruguayan economy (Muinelo and Suanes, 2018)[2]. In doing so we present evidence that Uruguayan firms follow uneven innovation trajectories signed by highly heterogeneity among firms and along the firm trajectory (Table 7).

Our results challenge the main interpretations of innovation persistence from developed countries; however, they arose from an exhaustive application of two estimation methods that followed all the econometric procedures suggested in the literature. Moreover, the results are robust when different samples and scopes of innovation are considered. More important, they are consistent with the theoretical and empirical background of differentiated innovative behaviours in developing countries compared with developed ones (e.g., Bello-Pintado et al., 2022; Suárez, 2014; Vargas, 2022).

In light of these results, we discard the interpretation of innovation as a self-reinforcing process (e.g., Clausen et al., 2012; Peters, 2009; Raymond et al., 2010; Tavassoli and Karlsson, 2015) in the Uruguayan economy. In this country, the probability of innovating in a given period is heterogeneously affected by previous innovation results. In particular, we observed that, even though most effects of innovation persistence in the short term are negative, in the medium term innovative trajectories associated with positive persistence appear.

[2] It is worth mentioning that our results contradict Muinelo and Suanes's (2018) findings in regard to the Uruguayan economy. However, the methodology we use here differs from the methodology they used in several ways. First, they controlled individual heterogeneity by including only the initial condition of the dependent variable, excluding both the time-invariant term and the initial condition of such variables. Second, they used data from three waves of the UIS between 2004 and 2012, whereas we used data from four waves, between 2007 and 2018, a more recent period. Third, they worked with a balanced panel of 400 manufacturing firms, not considering the service sector. Fourth and last, their set of control variables differs substantially from the ones we used.

Table 7: Summary of persistence effects (unbalanced panel)

	Products innovation		Process innovation	
	Persistence	**Complementarity**	**Persistence**	**Complementarity**
Short term				
Whole sample	-	0	-	0
SMEs	-	0	-	0
Large firms	0	0	0	-
Manufacturing firms	-	+	-	0
Services firms	-	0	-	-
Medium term				
Whole sample	0	+	0	0
SMEs	0	+	0	0
Large firms	0	+	0	0
Manufacturing firms	0	+	0	0
Services firms	0	0	0	0
	R&D		**External Acquisitions**	
	Persistence	**Complementarity**	**Persistence**	**Complementarity**
Short term				
Whole sample	0	+	-	+
SMEs	0	0	-	+
Large firms	0	0	-	+
Manufacturing firms	0	+	0	0
Services firms	0	+	-	+
Medium term				
Whole sample	+	0	+	+
SMEs	+	0	+	+
Large firms	0	0	+	0
Manufacturing firms	0	0	0	0
Services firms	+	0	+	0

Note: +: significant and positive effects; -: significant and negative effects; 0: non-significant effects.

On the basis of this conclusion, we claim that public support is necessary to initiate and maintain firms' innovation trajectories. Therefore, innovation policies should focus on incumbent firms that have followed an uneven innovation trajectory, by extending tax credits and subsidies for internal and collaborative projects, as well as new firms, through entrepreneurial and technological incubator programs.

This work addresses a classic debate in Latin American innovation policies, supporting the idea that the innovation policy mix should provide regular support for firms' innovation, arguably through long- or medium-term projects that help the firm follow a virtuous learning process (Juliao-Rossi et al., 2020; Pereira and Suárez, 2018). The negative persistence effects for outcome innovations seem to corroborate the idea that neither market structure nor firms' internal capabilities are enough to sustain a relatively complex innovation process. Therefore, a policy mix articulating horizontal and vertical instruments should be designed.

One thing that has been learned from Uruguay's experiences during the past few decades is the articulation of the large industrial policies executed through tax credits with incentives for innovative behaviour. This may contribute to sustained support for relatively long periods through an extended horizontal instrument. It should be complemented with vertical instruments focused on the achievement of innovation outcomes. This requires an intensification of the policy experimentation process in two main ways: (1) conducting more, and deeper, evaluation processes, not only of instruments but also of the articulation among them and (2) developing feedback mechanisms from the firms to the policymakers. During the past 15 years, Uruguay has implemented many and varied instruments; however, its basic goal of innovation policy as igniting an innovative initiative and consistently maintaining it by a critical mass of firms is far from being achieved. This is not a Uruguayan exception but is consistent with problems identified in other Latin American countries. In this sense, the evidence we have presented in this article can contribute to countries beyond Uruguay, although, as we have argued, an adequate understanding of innovation policy problems always requires an in-depth consideration of the particularities of each context.

5.1 Limitations of this Study

This research has some limitations related to the available data set and others inherent to an econometric strategy. We applied the prevailing approach in the literature based on innovation survey data, which has the advantage of controlling the effect of the initial condition through a simple-to-use method. However, according to Juliao-Rossi et al. (2020), the coefficients generated with this method are the result not only of changes in the variable of interest between individuals (between effects) but also by variations within individuals (within effects). It is impossible to discriminate between both effects; hence, this method has limitations in identifying the origins of persistence. On the other hand, biased results have been observed for a panel with fewer than five waves (Akay, 2012; Rabe-Hesketh and Skrondal, 2013). Finally, much of the criticism resides in the limitation of the method to control the number of 0s—that is, no-innovative firms—which increases as more 0s are detected (Hua and Zang, 2012), as in cases of developing countries, where the number of non-innovators is larger than in developed ones.

Despite these limitations, and because the purpose of this research is to identify not the causes of persistence but the existence and degree of innovation persistence, such methodological criticisms do not represent a relevant obstacle here. However, a very recent work (Arroyabe and Schumann, 2022) signals that methods based on a random-effects dynamic may yield inflated innovative persistence degrees.

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Appendix

Table A1: Transition probability matrices: product and process innovations (Balanced panel).

		Product innovation		Process innovation	
		Status in t		**Status in t**	
	Status in $t-1$	NIN	IN	NIN	IN
Global	NIN	87.09	12.91	81.18	18.82
	IN	55.13	44.87	55.78	44.22
Manufacturing	NIN	85.23	14.77	79.71	20.29
	IN	51.76	48.24	51.47	48.53
Services	NIN	88.69	11.31	82.35	17.65
	IN	59.15	40.85	61.57	38.43
Large	NIN	82.77	17.23	72.87	27.13
	IN	50.82	49.18	45.97	54.03
SMEs	NIN	87.96	12.04	82.78	17.22
	IN	56.45	43.55	58.74	41.26
		R&D		External acquisition	
		Status in t		**Status in t**	
	Status in $t-1$	NIN	IN	NIN	IN
Global	NIN	90.81	9.19	78.10	21.90
	IN	46.51	53.49	49.16	50.84
Manufacturing	NIN	90.10	9.90	77.85	22.15
	IN	44.28	55.72	45.98	54.02
Services	NIN	91.42	8.58	78.30	21.70
	IN	49.59	50.41	52.75	47.25
Large	NIN	86.68	13.32	67.21	32.79
	IN	43.38	56.62	38.24	61.76
SMEs	NIN	91.67	8.33	79.96	20.04
	IN	47.45	52.55	52.66	47.34

Notes: The number of transitions in the unbalanced (U) and balanced panel (B) are: 5,081 (U) and 3,405 (B) in the global sample; 2,291(U) and 1,644 (B) in the manufacturing sample; 2,788 (U) and 1,761 (B) in the services sample; 655 (U) and 624 (B) in large firms' sample; and 4,426 (U) and 2,781 (B) in the SMEs sample.

Table A2: Net persistence in the whole sample (marginal effects). Balanced panel

	Product Innovation		Process Innovation	
	(1)	(2)	(3)	(4)
$prod_{t-1}$	0.0227	0.0217		0.00797
	(0.115)	(0.115)		(0.0773)
$proc_{t-1}$		0.122	-0.127	-0.126
		(0.0823)	(0.0967)	(0.0968)
#Obs.	3,399	3,399	3,399	3,399
#firms	1,135	1,135	1,135	1,135
$prod_{t-2}$	0.00893	0.00900		0.0570
	(0.128)	(0.128)		(0.0962)
$proc_{t-2}$		0.179	0.0797	0.0809
		(0.109)	(0.106)	(0.106)
#Obs.	2,265	2,265	2,265	2,265
#firms	1,135	1,135	1,135	1,135
	R&D		External acquisitions	
	(5)	(6)	(7)	(8)
R&D$_{t-1}$	0.367***	0.305**		0.231***
	(0.129)	(0.131)		(0.0820)
innov_buy$_{t-1}$		0.277***	0.0236	-0.190***
		(0.0834)	(0.0837)	(0.0707)
#Obs.	3,399	3,399	3,399	3,399
#firms	1,135	1,135	1,135	1,135
R&D$_{t-2}$	0.530***	0.499***		0.194*
	(0.146)	(0.148)		(0.107)
innov_buy$_{t-2}$		0.130	0.317***	0.285***
		(0.113)	(0.100)	(0.102)
#Obs.	2,265	2,265	2,265	2,265
#firms	1,135	1,135	1,135	1,135

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Net persistence according to the size of the firm (marginal effects).

Balanced panel

	SME				Large			
	Product		Process		Product		Process	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-1}$	-0.0192	-0.00899		0.121	-0.145	-0.157		-0.313**
	(0.137)	(0.136)		(0.0904)	(0.252)	(0.255)		(0.156)
$proc_{t-1}$		0.169*	-0.269**	-0.259**		0.0708	0.228	0.230
		(0.0982)	(0.113)	(0.113)		(0.176)	(0.156)	(0.156)
#Obs.	2,775	2,775	2,775	2,775	624	624	624	624
#firms	927	927	927	927	208	208	208	208
$prod_{t-2}$	0.0822	0.0919		0.142	-0.307	-0.272		-0.201
	(0.142)	(0.141)		(0.109)	(0.351)	(0.352)		(0.223)
$proc_{t-2}$		0.425***	0.0814	0.0850		-0.376	0.0907	0.0972
		(0.126)	(0.120)	(0.120)		(0.279)	(0.261)	(0.261)
#Obs.	1,849	1,849	1,849	1,849	428	428	416	416
#firms	927	927	927	927	220	220	208	208

	SME				Large			
	R&D		External acquisitions		R&D		External acquisitions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R&D$_{t-1}$	0.225	0.179		0.175*	0.708***	0.645**		0.477**
	(0.151)	(0.155)		(0.0951)	(0.274)	(0.256)		(0.188)
innov_buy$_{t-1}$		0.166	-0.0312	-0.0581		0.619***	0.235	0.232
		(0.103)	(0.0961)	(0.0976)		(0.160)	(0.203)	(0.199)
#Obs.	2,775	2,775	2,775	2,775	624	624	624	624
#firms	927	927	927	927	208	208	208	208
R&D$_{t-2}$	0.546***	0.514***		0.190	0.397	0.349		0.139
	(0.170)	(0.174)		(0.119)	(0.328)	(0.325)		(0.283)
innov_buy$_{t-2}$		0.120	0.260**	0.224**		0.132	0.674**	0.670**
		(0.135)	(0.111)	(0.113)		(0.234)	(0.265)	(0.265)
#Obs.	1,849	1,849	1,849	1,849	428	428	416	416
#firms	927	927	927	927	220	220	208	208

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Net persistence according activity sector (marginal effects) . Balanced Panel.

	Manufacturing				Services			
	Products		Process		Products		Process	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-1}$	0.0612	0.0653		0.156	-0.119	-0.121		-0.132
	(0.166)	(0.166)		(0.110)	(0.167)	(0.167)		(0.115)
$proc_{t-1}$		0.190	-0.0578	-0.0499		0.0495	-0.218*	-0.222*
		(0.128)	(0.153)	(0.153)		(0.116)	(0.131)	(0.131)
#Obs.	1,642	1,642	1,642	1,642	1,757	1,757	1,757	1,757
#firms	548	548	548	548	587	587	587	587
$prod_{t-2}$	-0.0724	-0.0624		0.0939	0.0491	0.0486		0.0212
	(0.183)	(0.182)		(0.145)	(0.198)	(0.198)		(0.135)
$proc_{t-2}$		0.487***	0.100	0.101		0.0264	0.0669	0.0674
		(0.176)	(0.175)	(0.175)		(0.158)	(0.142)	(0.142)
#Obs.	1,094	1,094	1,094	1,094	1,171	1,171	1,171	1,171
#firms	548	548	548	548	587	587	587	587
	Manufacturing				Services			
	R&D		External acquisitions		R&D		External acquisitions	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$R\&D_{t-1}$	0.339*	0.275		0.151	0.288	0.252		0.281**
	(0.175)	(0.178)		(0.114)	(0.195)	(0.198)		(0.121)
$innov\_buy_{t-1}$		0.288**	0.253**	0.230*		0.284**	-0.105	-0.135
		(0.126)	(0.124)	(0.126)		(0.115)	(0.117)	(0.118)
#Obs.	1,642	1,642	1,642	1,642	1,757	1,757	1,757	1,757
#firms	548	548	548	548	587	587	587	587
$R\&D_{t-2}$	0.173	0.108		0.213	0.801***	0.783***		0.135
	(0.215)	(0.221)		(0.157)	(0.208)	(0.211)		(0.162)
$innov\_buy_{t-2}$		0.108	0.192	0.143		0.0822	0.442***	0.426***
		(0.221)	(0.160)	(0.163)		(0.145)	(0.136)	(0.137)
#Obs.	1,094	1,094	1,094	1,094	1,171	1,171	1,171	1,171
#firms	548	548	548	548	587	587	587	587

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Net persistence in the whole sample: estimation of control variables for Table 4 (one-period persistence).

	Product		Process		R&D		External Acquisitions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-1}$	-0.416***	-0.425***		0.0240				
	(0.101)	(0.101)		(0.0724)				
$proc_{t-1}$		0.101	-0.439***	-0.438***				
		(0.0791)	(0.0849)	(0.0849)				
R&D$_{t-1.}$	0.241*	0.235*	0.181	0.172	0.0682	0.00770		0.264***
	(0.123)	(0.124)	(0.115)	(0.118)	(0.108)	(0.110)		(0.0709)
innov_buy$_{t-1}$	0.210***	0.164**	0.235***	0.227***		0.249***	-0.155**	-0.190***
	(0.0702)	(0.0811)	(0.0686)	(0.0724)		(0.0785)	(0.0700)	(0.0707)
Size$_{it}$	0.0834	0.0778	0.239**	0.239**	0.210	0.203	0.219**	0.208**
	(0.119)	(0.118)	(0.107)	(0.107)	(0.149)	(0.149)	(0.105)	(0.105)
$Professionals_{it}$	-0.0718	-0.0660	0.0302	0.0316	0.0768	0.0775	-0.0688	-0.0660
	(0.0922)	(0.0923)	(0.0820)	(0.0821)	(0.103)	(0.103)	(0.0809)	(0.0811)
Age_{it}	0.00702	0.00942	-0.00996	-0.00958	0.0229	0.0180	-0.0183	-0.0184
	(0.0389)	(0.0396)	(0.0344)	(0.0344)	(0.0494)	(0.0495)	(0.0349)	(0.0346)
Foreign capital$_{it}$	-0.0589	-0.0696	-0.00766	-0.00878	-0.162	-0.157	-0.105	-0.0964
	(0.0912)	(0.0923)	(0.0808)	(0.0809)	(0.113)	(0.113)	(0.0839)	(0.0833)
$Export_{it}$	0.343***	0.343***	0.0503	0.0498	0.388***	0.392***	0.0666	0.0453
	(0.0729)	(0.0744)	(0.0654)	(0.0654)	(0.0912)	(0.0912)	(0.0662)	(0.0661)
$Networks_{it}$	0.389***	0.387***	0.391***	0.391***	0.472***	0.455***	0.362***	0.349***
	(0.0800)	(0.0803)	(0.0715)	(0.0715)	(0.0921)	(0.0924)	(0.0716)	(0.0714)
$Cooperation_{it}$	0.527***	0.523***	0.391***	0.390***	0.612***	0.608***	0.405***	0.380***
	(0.0858)	(0.0861)	(0.0788)	(0.0788)	(0.100)	(0.101)	(0.0789)	(0.0789)
Public Support$_{t-1}$	0.190**	0.189**	0.108	0.107	0.279***	0.197*	0.179**	0.140
	(0.0929)	(0.0934)	(0.0859)	(0.0860)	(0.105)	(0.107)	(0.0862)	(0.0867)
Industry	0.237***	0.233***	0.178***	0.178***	0.158*	0.152*	0.177***	0.167***
	(0.0706)	(0.0723)	(0.0623)	(0.0623)	(0.0913)	(0.0914)	(0.0624)	(0.0620)
Revenue$_{t-1}$	-7.57e-06**		0.0258	0.0259	0.0317	0.0255	0.0543**	0.0522**
	(3.29e-06)		(0.0232)	(0.0232)	(0.0340)	(0.0341)	(0.0233)	(0.0232)
Innov_expenditure$_{t-1}$	0.000122	0.000113	-3.64e-05	-3.87e-05	8.73e-05	1.75e-05	7.04e-05	6.22e-05
	(0.000150)	(0.000150)	(0.000129)	(0.000129)	(0.000160)	(0.000161)	(0.000129)	(0.000128)
$Competency_{it}$	-1.275***	-1.301***	-0.222	-0.220	-1.581***	-1.578***	-0.567	-0.497
	(0.483)	(0.485)	(0.418)	(0.418)	(0.601)	(0.602)	(0.425)	(0.423)
Sectoral GDP$_{it}$	-0.0322	-0.0244	0.0160	0.0151	-0.00405	0.0185	0.366	0.360
	(0.255)	(0.256)	(0.227)	(0.227)	(0.330)	(0.332)	(0.224)	(0.223)
$Finance_{it}$	0.0149	0.00907	-0.132*	-0.132*	0.188*	0.190*	-0.176**	-0.172**
	(0.0827)	(0.0837)	(0.0744)	(0.0744)	(0.101)	(0.101)	(0.0737)	(0.0733)
prod__o	1.621***	1.638***						
	(0.118)	(0.119)						
proc__o			1.371***	1.369***				
			(0.0886)	(0.0886)				
R&D__o					1.928***	1.912***		
					(0.167)	(0.166)		
Innova_buy__o							1.432***	1.404***
							(0.0908)	(0.0898)
Size__o	-0.305***	-0.302***	-0.394***	-0.393***	-0.447***	-0.441***	-0.481***	-0.474***
	(0.0942)	(0.0944)	(0.0831)	(0.0831)	(0.128)	(0.128)	(0.0843)	(0.0837)
Professionals__o	-0.221***	-0.223***	-0.187***	-0.187***	-0.294***	-0.290***	-0.299***	-0.318***
	(0.0780)	(0.0783)	(0.0667)	(0.0667)	(0.0981)	(0.0981)	(0.0694)	(0.0693)
R&D1__o	0.373***	0.378***	0.0872	0.0846				
	(0.105)	(0.106)	(0.0947)	(0.0949)				
Revenue__o	-4.33e-06	-5.22e-06*	-1.75e-06	-1.77e-06	-8.86e-06*	-8.43e-06*	-3.24e-06	-3.18e-06
	(3.44e-06)	(2.85e-06)	(2.38e-06)	(2.38e-06)	(4.71e-06)	(4.69e-06)	(2.55e-06)	(2.53e-06)
Innov_Expe__o	-0.00128***	-0.00132***	-0.000292***	-0.000291***	-0.000302***	-0.000315***	-0.000343***	-0.000328***
	(0.000198)	(0.000200)	(7.44e-05)	(7.44e-05)	(0.000100)	(0.000101)	(6.86e-05)	(6.81e-05)
m__Size	0.304**	0.306**	0.320**	0.320**	0.391**	0.376*	0.445***	0.452***
	(0.153)	(0.152)	(0.133)	(0.133)	(0.194)	(0.195)	(0.130)	(0.130)
m__Professionals	0.339***	0.334***	0.164	0.162	0.330**	0.326**	0.409***	0.412***
	(0.125)	(0.125)	(0.108)	(0.109)	(0.146)	(0.146)	(0.108)	(0.108)
m__R&D1	0.104	0.0834	0.166	0.166				
	(0.181)	(0.181)	(0.168)	(0.168)				
m__Revenue	5.30e-06*	4.70e-06*	9.89e-07	1.01e-06	6.30e-06**	6.02e-06*	1.41e-06	1.54e-06
	(3.01e-06)	(2.64e-06)	(2.42e-06)	(2.42e-06)	(3.10e-06)	(3.15e-06)	(2.56e-06)	(2.54e-06)
m__Innov_Expend	0.00147***	0.00145***	0.000448***	0.000447***	0.00101***	0.00104***	0.000581***	0.000563***
	(0.000204)	(0.000204)	(9.46e-05)	(9.46e-05)	6.30e-06**	(0.000222)	(9.20e-05)	(9.14e-05)
#Obs.	4,987	4,985	4,985	4,985	4,985	4,985	4,985	4,985
#firms	2,424	2,422	2,422	2,422	2,422	2,422	2,422	2,422

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Net persistence in the whole sample: estimation of control variables for Table 4 (two-period persistence).

	Product		Process		R&D		External Acquisitions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$prod_{t-2}$	0.00419	0.00122		0.0754				
	(0.120)	(0.120)		(0.0916)				
$proc_{t-2}$		0.196*	0.0387	0.0387				
		(0.105)	(0.101)	(0.101)				
R&D$_{t-2.}$	0.0780	0.0478	0.0548	0.0263	0.532***	0.510***		0.199**
	(0.123)	(0.124)	(0.107)	(0.112)	(0.137)	(0.139)		(0.0990)
innov_buy$_{t-2}$	0.189**	0.0782	0.138	0.116		0.0873	0.334***	0.301***
	(0.0908)	(0.109)	(0.0882)	(0.0921)		(0.107)	(0.0928)	(0.0940)
Size$_{it}$	0.0615	0.0642	0.198	0.200	0.541**	0.525**	0.135	0.139
	(0.152)	(0.153)	(0.133)	(0.133)	(0.211)	(0.211)	(0.144)	(0.144)
$Professionals_{it}$	-0.107	-0.109	0.0778	0.0742	-0.0850	-0.0843	0.0110	0.0128
	(0.117)	(0.117)	(0.100)	(0.101)	(0.136)	(0.135)	(0.111)	(0.111)
Age_{it}	0.0174	0.0155	0.0420	0.0424	0.0371	0.0363	0.00727	0.00803
	(0.0520)	(0.0521)	(0.0437)	(0.0438)	(0.0690)	(0.0688)	(0.0510)	(0.0508)
Foreign capital$_{it}$	-0.101	-0.0975	-0.0618	-0.0648	-0.297*	-0.294*	-0.0322	-0.0335
	(0.118)	(0.118)	(0.0984)	(0.0985)	(0.156)	(0.155)	(0.118)	(0.117)
$Export_{it}$	0.306***	0.304***	0.0226	0.0222	0.461***	0.459***	-0.119	-0.139
	(0.0951)	(0.0952)	(0.0799)	(0.0799)	(0.125)	(0.125)	(0.0949)	(0.0951)
$Networks_{it}$	0.376***	0.378***	0.467***	0.467***	0.574***	0.567***	0.546***	0.540***
	(0.109)	(0.109)	(0.0936)	(0.0936)	(0.131)	(0.131)	(0.106)	(0.106)
$Cooperation_{it}$	0.536***	0.536***	0.299***	0.302***	0.858***	0.854***	0.259**	0.242**
	(0.114)	(0.114)	(0.103)	(0.103)	(0.140)	(0.140)	(0.115)	(0.116)
Public Support$_{t-2}$	0.0823	0.0818	-0.0538	-0.0568	-0.0247	-0.0566	-0.0514	-0.0723
	(0.127)	(0.127)	(0.113)	(0.113)	(0.155)	(0.159)	(0.130)	(0.130)
Industry	0.297***	0.284***	0.251***	0.252***	0.284**	0.280**	0.270***	0.261***
	(0.0892)	(0.0895)	(0.0734)	(0.0735)	(0.119)	(0.119)	(0.0846)	(0.0844)
Revenue$_{t-2}$	-0.00317	-0.00182	0.0234	0.0235	0.0527	0.0496	0.0131	0.0119
	(0.0374)	(0.0374)	(0.0304)	(0.0304)	(0.0482)	(0.0483)	(0.0359)	(0.0358)
Innov_expend$_{t-2}$	-0.000183	-0.000206	8.98e-05	8.79e-05	7.43e-05	6.07e-05	-0.00213***	-0.00208***
	(0.000264)	(0.000265)	(0.000125)	(0.000123)	(0.000236)	(0.000229)	(0.000404)	(0.000404)
$Competency_{it}$	-1.566**	-1.606**	0.0369	0.0356	-1.679**	-1.652**	-0.749	-0.706
	(0.636)	(0.636)	(0.536)	(0.536)	(0.815)	(0.814)	(0.602)	(0.601)
Sectoral GDP$_{it}$	0.371	0.346	0.307	0.302	0.142	0.144	0.581**	0.566**
	(0.286)	(0.287)	(0.254)	(0.254)	(0.396)	(0.394)	(0.284)	(0.283)
$Finance_{it}$	-0.0649	-0.0740	-0.231**	-0.230**	0.148	0.148	-0.328***	-0.327***
	(0.107)	(0.107)	(0.0919)	(0.0920)	(0.133)	(0.132)	(0.105)	(0.104)
prod__0	0.562***	0.561***						
	(0.119)	(0.119)						
proc__0			0.230***	0.229**				
			(0.0893)	(0.0894)				
R&D__0					0.881***	0.871***		
					(0.173)	(0.172)		
innov_buy__0							0.276***	0.263***
							(0.0991)	(0.0988)
lSize__0	-0.193*	-0.194*	-0.275***	-0.276***	-0.355**	-0.360**	-0.450***	-0.436***
	(0.110)	(0.110)	(0.0948)	(0.0949)	(0.158)	(0.158)	(0.111)	(0.110)
lProf__0	-0.269***	-0.271***	-0.127	-0.125	-0.269**	-0.268**	-0.231**	-0.247***
	(0.0973)	(0.0975)	(0.0785)	(0.0786)	(0.125)	(0.124)	(0.0947)	(0.0947)
R&D1__0	0.235*	0.233*	0.0276	0.0215				
	(0.120)	(0.120)	(0.103)	(0.104)				
Revenue__0	-1.18e-05*	-1.20e-05*	-1.88e-06	-1.93e-06	-2.09e-05*	-2.07e-05*	-5.68e-06	-5.21e-06
	(6.16e-06)	(6.17e-06)	(2.90e-06)	(2.88e-06)	(1.12e-05)	(1.12e-05)	(5.75e-06)	(5.70e-06)
Innov_Exp__0	-0.000942***	-0.000945***	-0.000569***	-0.000568***	-0.000378	-0.000371	-0.000549	-0.000552
	(0.000154)	(0.000155)	(0.000111)	(0.000111)	(0.000237)	(0.000229)	(0.000344)	(0.000346)
m__Size	0.232	0.225	0.265	0.265	-0.0291	-0.0137	0.554***	0.539***
	(0.208)	(0.208)	(0.180)	(0.180)	(0.283)	(0.283)	(0.200)	(0.199)
m__Profs	0.413**	0.418**	0.0859	0.0884	0.512**	0.510**	0.258	0.263
	(0.171)	(0.171)	(0.143)	(0.143)	(0.205)	(0.205)	(0.163)	(0.163)
m__R&D1	0.563***	0.558***	0.545***	0.538***				
	(0.168)	(0.169)	(0.146)	(0.147)				
m__Revenue	4.78e-06	4.69e-06	2.76e-06	2.81e-06	7.27e-06*	7.34e-06*	1.38e-06	1.19e-06
	(3.19e-06)	(3.19e-06)	(2.90e-06)	(2.90e-06)	(4.09e-06)	(4.08e-06)	(3.49e-06)	(3.52e-06)
m__Innov_Exp	0.00280***	0.00281***	0.00175***	0.00175***	0.000859***	0.000851***	0.00942***	0.00924***
	(0.000346)	(0.000347)	(0.000275)	(0.000275)	(0.000269)	(0.000268)	(0.000856)	(0.000851)
#Obs.	2,613	2,613	2,613	2,613	2,613	2,613	2,613	2,613
#firms	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483

Note: The coefficients are obtained through dynamic probit estimations including the set of controls presented in table 2 and fixed year effects. Individual heterogeneity is given by initial values of the dependent variable along with the initial value and the time-average values of *Size*, *Professionals*, *R&D* (only for outcomes innovation estimations), *Revenue*, *Innov_Expenditure*. Robust standard errors in parentheses. Marginal effects are shown. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.