International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:6, No:7, 2012

Technological Innovation Persistence Organizational Innovation Matters

H. Naciba, C. Le Bas, C. Mothe, T.U. Nguyen-Thi

***Abstract*—**Organizational innovation favors technological innovation, but does it also influence technological innovation persistence? This article investigates empirically the pattern of technological innovation persistence and tests the potential impact of organizational innovation using firm-level data from three waves of the French Community Innovation Surveys. Evidence shows a positive effect of organizational innovation on technological innovation persistence, according to various measures of organizational innovation. Moreover, this impact is more significant for complex innovators (i.e., those who innovate in both products and processes). These results highlight the complexity of managing organizational practices with regard to the firm's technological innovation. They also add to comprehension of the drivers of innovation persistence, through a focus on an often forgotten dimension of innovation in a broader sense.

***Keywords*—**Organizational Innovation, Technological Innovation, Persistence

I. Introduction

ECONOMIC analyses of innovation persistence mainly focus on technological changes or drivers of technological innovation persistence. Yet firms' innovation capabilities do not depend solely on their internal technological competencies (e.g., R&D activities); rather, their ability to develop a broad set of complementary activities and organizational strategies appears crucial for increasing the performance of their innovation processes. The importance of managing various resource types, including non-technological ones, is highlighted by the resource-based view of the firm and evolutionary economic theory [38]–[35]–[47]–[46]. Firms that combine customer, technological, and organizational skills bring more innovations to the market [29].

Research is only beginning to shed light on "very complex and under-investigated topic" [29, p. 1262] of the relationships between technological and non-technological innovations. However, broadening the scope of analysis beyond the technological domain is crucial to understand firms' economic performance, because complex organizational innovation modes serve to explain this performance. Reference [4] finds that the range of innovations reflects two multi-innovation factors, 'organizational' and 'technological', which are complementary. In a meta-analysis of organizational determinants on product and process innovations [14] summarizes the impact of organizational innovation practices on technological innovation.

H. Naciba is with ESDES, University Catholique of Lyon, France

C. Le Bas is with GATE, University of Lyon 2, France

C. Mothe is with IREGE, University of Savoie, France

T.U. Nguyen-Thi is with CEPS/INSTEAD, Social Science Research Center, Luxembourg, Tel.: (352)585855632; fax: (352)585560; E-mail:thithucuyen.nguyen@ceps.lu

Reference [45] builds on the resource-based view of firms to characterize relationships among organizational process factors, product development capabilities, and performance in product development projects. Specifically, organizational process factors appear associated with the achievement of operational outcome targets for new product performance and thus customer satisfaction. Reference [2] also argues that organizational innovations serve as prerequisites and facilitators of the efficient use of technical product and process innovations, whose success depends on the degree to which the organizational structures and processes adapt to the new technologies. Organizational innovations offer an immediate source of competitive advantage, because they have significant impacts on business performance in terms of productivity, lead times, quality, and flexibility. Reference [2] thus recommends further clarification of distinct types of innovation, and especially organizational innovations.

In response to such calls for insight into the influence of organizational innovation strategies on technological innovation outcomes, we highlight the effect of non-technological innovation on firms' technological innovation persistence. Unlike previous studies of innovation persistence, we consider the specific role of organizational innovation, which clearly is important for corporate performance but has not been researched with regard to its potential impact on technological innovation persistence. To fill this gap, we begin by establishing our focal research question, based on a survey of extant literature. We then describe our data set before outlining our methodology and empirical models. Next, we discuss our results and conclude with some avenues for further research.

Innovation refers to the adoption of an idea, behavior, system, policy, program, device, process, product, or service that is new to the organization [13]. Although reference [13] considers the general concept of organizational innovation as related to all parts of the organization, most approaches divide innovation into technological and organizational versions. Reference [40] separates technological and non-technological innovation to include new marketing strategies and changes to management techniques or organizational structures in the latter category. Most literature in innovation management and economics instead concentrates on technological innovation, without clear guidelines for how firms should address the types of innovation that may lead to technological innovation [12]. The expanded definition of innovation in the Oslo Manual [36] treats organizational innovation as an innovation type, separate from the technological innovation type. Yet the question remains: How does organizational innovation affect technological innovation and thus global firm performance?

Studies of the relationships between organizational and technological innovations often highlight that technological innovation drives organizational changes within the firm [24]–[16], because firms introducing technological innovation must reorganize their production, workforce, sales, and distribution systems. Another research stream suggests an inverse relationship, such that organizational innovation enhances flexibility and creativity, which facilitates the development of technological innovations [20]–[30]. Organizational (re)structuring, if it leads to structural renewal, could facilitate other types of innovations [22]. For example, reference [44] emphasizes how external relations and networks can enhance technological innovation in pharmaceutical firms, and reference [5] shows that innovation is a function of individual efforts and organizational systems aimed at facilitating creativity, such that successful product innovation depends partly on organizational factors. Studying interrelations of different innovation strategies, reference [43] indicates that a combination of technological and non-technological innovation has a positive impact on innovation performance.

Similarly, [22] finds a positive relationship between organizational innovation and technological innovation. With sample of fast-moving consumer goods firms in Germany [29] studies the effect of organizational skills on firms' innovative performance. Firms implementing a combination of customer, organizational, and technological skills tend to introduce more innovations. Reference [34] finds that the effects of non-technological innovations differ depending on the phase of the innovation process. Organizational innovations significantly increase the likelihood of innovation, but not its commercial success.

These studies all acknowledge the crucial role of organizational practices on competitive advantage and firm innovation, in the sense that they provide input into the firm's innovation process and innovation capability. Therefore, we argue that firms that dedicate more resources to new organizational forms should be in a better position to use new skills and technologies efficiently.

II. Data, Variables and Descriptive Statistics

Community Innovation Surveys (CIS) follow a subject approach to studying innovation, with the firm as the statistical unit (rather than an individual innovation), and combine census and stratified sampling methods for each wave. The stratum variables are consistently activity and size, and the data collection includes both innovators and non-innovators. For statistical consistency, we draw on three successive waves of the French CIS: CIS4 (2002–2004, which we call t_0), CIS6 (2004–2006, or t_1), and CIS8 (2006–2008, or t_2), as provided by the French Institute of Statistics (INSEE) and collected by the Industrial Studies and Statistics Office (SESSI).

A. Dependent variables

We used four dependent variables. The CIS considers a firm innovative if, in a given period of time (i.e., three years prior to the survey), it introduced a new product or process. We designed dichotomous variables to measure whether the firm produced an innovation during that period, as well as to assess the type of innovation (product, process, or organization). Product innovators introduced, in the three years prior to the survey, goods or services that were 'either new or significantly improved with respect to its fundamental characteristics, technical specifications, incorporated software or other immaterial components, intended uses, or user friendliness' [36]. Process innovators implemented 'new techniques or significantly improved production technology, new and significantly improved methods of supplying services and of delivering products' [36].

From these definitions, to study the persistent innovation behavior of firms, we identified four types of innovators: pure product, pure process, single, and complex. The binary variable (Only_prod) takes a value of 1 if the firm is a pure product innovator; (Only_proc) takes the value of 1 if the firm is a pure process innovator; the (Single) variable equals 1 if the firm is a single innovator, such that it introduced either a product or a process innovation during the studied period; and the fourth dependent variable (Complex) takes a value of 1 if the firm is a complex innovator because it introduced both product and process innovations. For each type of innovator, we considered the dependent variable related to each of the three time periods (see Table 1 for definitions and descriptive statistics).

B. Organizational innovation

Our main hypothesis relates to the impact of organizational innovation on firms' technological persistence. Several measures of organizational innovation appear in previous studies examining technological innovation [43]–[2]–[33]–[34]. Generally, organizational innovations include changes in business practices (including knowledge management), in the workplace organization or the firm's external relations.

TABLE I
VARIABLES

Variables	Type	Description
		Alternative endogenous variables of innovation performance indicators all displayed for the year 2008 (present period, t)
Only_prod	B	Equals 1 for firms that are "pure product innovators": this category includes the firms that introduce a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems
Only_proc	B	Equals 1 for firms that are "pure process innovators": this category includes firms that at least one type of one of the three process innovations regarding any new or significantly improved (1) methods of manufacturing or producing goods or services (2) logistics, delivery or distribution methods for your inputs, goods or services (3) supporting activities for your processes, such as maintenance, systems or operations for purchasing, accounting, or computing
Single	B	Equals 1 for firms that have introduced a product or a process innovation
Complex	B	Equals 1 for firms that have introduced both product and process innovations
ConOrg(t-1,t)	DO	Equals 0 if firms did not introduced organizational innovation in either of the two periods; 1 if organizational innovation is introduced only in t-1; 2 if it is introduced only in t; 3 if it is continuously adopted during t-1 and t.

ISSN: 2517-9411
Vol:6, No:7, 2012

ConOrg(t-2,t-1)	DO	Equals 0 if no organizational innovation was adopted in t-2 and t-1; 1 if it is adopted only in t-2; 2 if it is adopted only in t-1; and 3 if it is continuously adopted during the two periods.
IntOrg(t)	DO	Equals 0 if none of the organizational practices are adopted in t; 1 if only one practice was adopted; 2 if two practices were adopted; and 3 if both three practices were adopted
IntOrg(t-1)	DO	Equals 0 if firms did not introduce any organizational practices in t-1; 1 if only one practice was adopted; 2 if only two practices were adopted; 3 if 3 practices were adopted and 4 if all practices were adopted.
Int_RD_{t-1}	Q	Internal R&D expenses (estimated amount of expenditures for in-house R&D that includes capital expenditures on buildings and equipment specifically dedicated to R&D) divided by the total number of employees for the year 2006.
Ext_RD_{t-1}	Q	External R&D expenses (average of three CIS variables: (1) the amount dedicated to the purchase of external R&D, (2) the acquisition of acquisition of machinery, equipment and software - that exclude expenditures on equipment for R&D- and (3) the acquisition of external knowledge) divided by the number of employees for the year 2006.
$Size_t$	DO	Ranging from 1 to 4: 1 if the firm has less than 50 employees, 2 if the firm has between 50 and 250 employees, 3 if it has between 250 and 1000 employees; 4 if it has more than 1000 employees.
$Market_t$	DO	Ranging from 1 to 4 according the situation of the geographic market where the enterprise sells its goods and products: 1 if the market is local or regional, 2 if it is national, 3 if it concerns EU member countries, 4 for all other countries.
Gp_t	B	Equals 1 if the firm is part of a group
$Dumsect_t$	DO	Score ranging from 1 to 4 to reflect the technological intensity of sectors, based on NACE Rev 1.

Prior research has tended to concentrate on the probability of introducing new organizational practices during a reference period, a procedure that fails to account for the degree of intensity of the organizational innovation or the temporal continuity of organizational change. Thus, these approaches cannot assess some key aspects of organizational innovation, such as intensity, continuity, or the impact on the dynamics of firms' innovation behavior.

Instead, we adopted new measures of organizational innovation that could (1) handle the temporal continuity of organizational innovation (ConOrg) and (2) examine the degree of intensity of organizational innovation (IntOrg). Specifically, we introduced two variables in each case to control for the continuity of implementing organizational innovation across two periods of time, such that we attain four organizational innovation variables.

To construct ConOrg, we began with data about organizational innovations implemented during the reference period for each wave and created the binary composite variable of organizational innovation (Org). The CIS04 reported three organizational practices: (1) new or significantly changed corporate strategy, (2) advanced management techniques, and (3) major changes to organizational structure. The CIS06 included data on four organizational practices: (1) new business practices for organizing work and procedures, (2) new knowledge management systems, (3) new methods of workplace organization, and (4) new methods of organizing external relations. We constructed four dummy variables for each practice. Finally, CIS08 provides information about three organizational practices: (1) new business practices for organizing work and procedures, (2) new methods of workplace organization, and (3) new methods of organizing external relations.[1] The variable Org(t) (t – 2, t – 1) equals 1 if at least one organizational practice was implemented during t (t – 2, t – 1) and 0 otherwise.

In a second step, we constructed ConOrg using Org. The variable ConOrg (t – 1, t), for example, depends on the firms' organizational innovation during t – 1 (2004–2006) and t (2006–2008). It equals 0 if firms did not introduce organizational innovation in any of the two periods, 1 if organizational innovation appears only in t – 1 (Org(t – 1) = 1 and Org(t) = 0), 2 if it has been introduced only in t (Org(t – 1) = 0 and Org(t) = 1), and 3 if it is continuously adopted throughout both periods (Org(t – 1) = 1 and Org(t) = 1).

The second variable of organizational continuity, ConOrg(t – 2, t – 1), follows similar principles: It equals 0 if no organizational innovation was adopted in t – 2 (2002–2004) or t – 1 (2004–2006), 1 if it were adopted only in t –2, 2 if it adopted only in t – 1, and 3 if it has been continuously adopted. Both indicators of organizational innovation thus are intertemporal, such that we may control for the temporal dimension of the impact of organizational innovation on the dynamics of technological innovation. Although the items pertaining to diverse organizational practices are not the same across different CIS waves, this issue does not appear to be a problem for our analysis, because we determine ConOrg on the basis of the composite organizational variable determined for each reference period.

The descriptive statistics pertaining to the relationship between organizational innovation and technological innovators' profiles show that more than 10% of pure product innovators do not introduce any organizational innovation in either t – 2 or t – 1, 11.63% introduce organizational innovations in t – 2 but not t – 1, 21.52% implement organizational innovations only in t – 1, and 56.42% do so in both periods.

In addition, we introduced two other variables to control for the degree of intensity of organizational innovation over time. Specifically, IntOrg(t) is determined on the basis of data about the three organizational practices reported in CIS08. It equals 0 if none of the organizational practices arise in t,[2] 1 if only one practice is adopted; 2 if two practices have been adopted, and 3 if all three practices are adopted during t.

Similarly, the construction of IntOrg(t – 1) uses information about four organizational practices reported in CIS06: (1) new business practices for organizing procedures, (2) new methods for organizing work responsibilities and decision making, (3) new methods for organizing external relations with other firms or public institutions, and (4) knowledge management procedures.

[1] A methodological change between the CIS06 and CIS08 reintegrated 'knowledge management' back into 'new business practices for organizing procedures' for CIS08.
[2] In this case, the firm does not introduce any organizational innovations.

Thus IntOrg(t – 1) equals 0 if firms never introduce organizational practices in t – 1, 1 if they adopt one practice, 2 if they introduce two practices, 3 if three practices have been adopted, and 4 if all practices are adopted.[3]

C. Estimation method

Our goal is to test for the probability of being an innovator in period t_2, as a function of the intensity of past innovation behavior in the two previous periods. We thus needed to estimate not only past innovation behavior but also the different types of innovations that firms have adopted and the extent to which they are more persistent with organizational innovations. However, in panel data sets, investigating the impact of observed and unobserved individual characteristics and their relation with initial conditions can be problematic [23]. Empirical literature on persistent innovation resolves this issue by using dynamic panel models. Previous studies of the persistence of innovation generally use binary discrete choice modeling, out of consideration of the nature of the data sets and variables. Reference [39] investigates the persistence effects of innovation activities using several binary dependent variables that express the innovation behavior of firms as a function of past innovation and other explanatory variables, indicating variation across individuals and time. She then uses a second set of explanatory variables that are time constant and implements a probit model with the Wooldridge estimation method to control for unobserved heterogeneity. Reference [42] uses a panel of CIS-derived Dutch manufacturing firms to study the persistence of innovation with a maximum likelihood dynamic tobit model that accounts for individual effects and initial conditions. Reference[1] uses a dynamic probit random effect model to evaluate the persistence of innovation among a set of Italian manufacturing firms. In this paper, we retained a dynamic probit random model.

III. Results

We estimate dynamic probit random models, using the approach recommended by [48], to account for unobserved heterogeneity and overcome initial condition problems [39]. With this procedure, we can examine the factors that explain the dynamics of different profiles of technological innovators, taking into account different dynamic specifications of organizational innovation.

First, to gain a better understanding of the role of organizational innovation, we estimated a set of models that each included one measure of organizational innovation and four profiles of technological innovators: pure product, pure process, single, and complex. Model 1 provides the standard model and includes the two measures of temporal continuity of organizational innovation, ConOrg(t – 1, t). In Table 2 we present the results when ConOrg(t – 1, t) is a dynamic specification of the organizational continuity between the lagged period (t – 1) and the current one (t).

Thus we determine that the persistence parameters for single and complex technological innovators are positive and significant, but we find no evidence of persistence for simple product or process innovators.[4] Being a single or a complex innovator in the previous time period positively correlates with the probability of being a single or complex innovator in the future.

The value of the estimated coefficient also indicates the strength of the persistence dynamic, that is, the degree of influence of past innovation on a current decision to innovate. A higher coefficient indicates a stronger persistence process. The results show that complex innovators are prone to be more persistent than single innovators, and the initial conditions have positive and highly significant effects, such that firms' initial innovation status is strongly correlated with unobserved heterogeneity.

As another important result, we determine that the degree of organizational continuity is significant and positively correlated with the probability of being a single or complex innovator. Firms that occasionally implement organizational innovation during the lagged or current period and those that have continuously implemented it in both periods exhibit a higher probability of being complex innovators, compared with firms that implemented no organizational practices during the two periods. This expected result, in line with [28] findings, confirms the crucial role of organizational innovation for generating complex innovation over time. Its effect is twice as strong for complex innovators as for single innovators, but it does not explain firms' likelihood to be pure product or process innovators.

TABLE II
DYNAMIC RE PROBIT ESTIMATION (MODEL 1)

	Only_Prod	*Only_Proc*	*Single*	*Complex*
Lagged Innovation				
Only_prod(t-1)	0.230			
	(0.177)			
Only_proc(t-1)		0.143		
		(0.220)		
Single(t-1)			0.421**	
			(0.198)	
Complex(t-1)				0.507**
				(0.221)
Organizational Innovation				
ConOrg(t-1,t)	0.0412	-0.0193	0.0521*	0.116***
	(0.030)	(0.035)	(0.031)	(0.031)
Explanatory variables				
Int_RD(t-1)	0.005*	0.009	0.146***	-7.47e-05
	(0.003)	(0.005)	(0.019)	(0.002)
Ext_RD(t-1)	0.022***	-0.008	0.0418***	-0.002
	(0.007)	(0.005)	(0.013)	(0.005)
Size	-0.401	0.593	0.009	0.142
	(0.297)	(0.363)	(0.297)	(0.358)
Market	0.224**	0.169	0.219**	0.216

[3] We interpret IntOrg(.) as a measure of the intensity of organizational innovation. It should depict the diversity of new practices implemented by the firm.

[4] In a first step, we also estimated simple models, assuming the absence of individual effects and exogenous initial conditions. The persistence parameters were positive and highly significant for all innovator profiles. However, in these unrealistic conditions, overestimation of the dependent variable is likely, so the significance of the persistence parameters does not mean that true persistence exists. These results are available on request.

	(0.106)	(0.129)	(0.102)	(0.142)
Gp	0.141	0.348	0.256	0.315
	(0.282)	(0.336)	(0.271)	(0.344)
Dumsect	-0.168	0.219	-0.101	-0.140
	(0.209)	(0.273)	(0.212)	(0.263)
Individual heterogeneity				
Only_prod(0)	1.225***			
	(0.233)			
Only_proc(0)		0.834***		
		(0.240)		
Single(0)			0.589***	
			(0.219)	
Complex(0)				0.419**
				(0.209)
Gpmean	0.248	-0.163	0.063	-0.370
	(0.320)	(0.367)	(0.293)	(0.371)
Dumsectmean	-0.013	-0.165	0.012	0.030
	(0.214)	(0.277)	(0.217)	(0.267)
Sizemean	0.798**	-0.759**	0.253	0.139
	(0.313)	(0.374)	(0.306)	(0.368)
Marketmean	0.0910	-0.235	-0.042	-0.017
	(0.127)	(0.145)	(0.116)	(0.158)
Intercept	-2.581***	-1.370***	-1.721***	-3.049***
	(0.389)	(0.369)	(0.296)	(0.493)
ρ	0.436	0.346	0.160	0.045
	(0.088)	(0.117)	(0.150)	(0.164)
-2lnL	1114.85	697.47	912.34	546.07
Percent correctly predicted	82.5	71.9	87.9	76.6
Observations	2360	2360	2360	2360

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Standard errors in parentheses. Random effects estimates are computed by adaptive Gausse-Hermite quadrature.

A. Sensitivity analysis and robustness checks

To check the robustness of the results, we ran further regressions with different specifications of our main explanatory variable: organizational innovation. We therefore introduce three new measures of organizational innovation: ConOrg(t – 2, t – 1), IntOrg(t), and IntOrg(t-1), with the results reported, respectively, in Tables 3, 4, and 5. The estimated coefficients and their level of significance are roughly the same as those reported in Model 1. The effects of other explanatory variables, such as R&D intensity and size, are similar across the various models, such that our estimations are robust for the control variables. Therefore, we report only the estimated coefficients related to the block of the main independent variables.

In Model 2 in Table III, in which ConOrg(t – 2, t – 1) is specified as a dynamic measure of the organizational continuity between the periods t – 2 and t – 1, the results for the persistence parameters are similar to those in Model 1. Pure product and pure process innovators do not appear persistent. On the contrary, the persistence parameters of single and complex innovators are positive and highly significant. These results confirm our previous findings from Model 1: Firms with the capacity to introduce products and/or processes in the past have a higher chance of being persistent than those that have implemented only products or only processes. The effects of organizational innovation on single and complex innovators' behaviors are positive and significant, though not as strong as in Model 1.

This finding seems to suggest that organizational innovation, once it has been continuously adopted over two recent periods of time (t – 1 and t), is more efficient for generating a higher probability of innovating than that adopted for two preceding periods (t – 2, t – 1) that are more distant in time from the reference period t. That is, there is a temporal dimension to the efficiency of the effect of organizational innovation on technological innovation.

In addition to Models 1 and 2, we estimated several other models that include our new indicators of temporal intensity of organizational innovation, IntOrg(t) and IntOrg(t – 1). We therefore explore another aspect of firms' intensity, in terms of organizational innovation practices. Recall that IntOrg(t) is a proxy for the degree of organizational intensity in period t (CIS8, 2006–2008), and it takes a value from 0 to 3, depending on the type of combinations of organizational practices reported in CIS8. Thus, we can determine whether, aside from firms' characteristics and R&D activities, the intensity of organizational practices affects the persistence parameters. Models 3–5 thus mirror Models 1 and 2, except in the indicators of organizational innovation.

TABLE III
DYNAMCIC RE PROBIT ESTIMATIONS (MODEL 2)

	Only_Prod	*Only_Proc*	*Single*	*Complex*
Lagged Innovation				
Only_Prod(t-1)	0.184			
	(0.179)			
Only_Proc(t-1)		0.151		
		(0.222)		
Single(t-1)			0.352*	
			(0.200)	
Complex(t-1)				0.381*
				(0.230)
Organizational Innovation				
ConOrg(t-2,t-1)	-0.019	0.005	0.008	0.063*
	(0.029)	(0.034)	(0.031)	(0.033)
ρ	0.466	0.341	0.214	0.143
	(0.086)	(0.119)	(0.145)	(0.104)
-2lnL	1115.55	697.60	918.06	576.45
Percent correctly predicted	82.0	71.0	86.3	78.4
Observations	2360	2360	2360	2360

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Standard errors in parentheses.

TABLE IV
DYNAMICS PROBIT ESTIMATIONS (MODEL 3)

	Only_Prod	*Only_Proc*	*Single*	*Complex*
Lagged Innovation				
Only_Prod(t-1)	0.326*			
	(0.173)			
Only_Proc(t-1)		0.151		
		(0.220)		
Single(t-1)			0.559***	
			(0.096)	
Complex(t-1)				0.311*
				(0.187)
Organizational Innovation				
IntOrg(t)	0.295***	0.0214	0.309***	0.411***
	(0.035)	(0.037)	(0.030)	(0.045)
ρ	0.372	0.343	0.001	0.073
	(0.096)	(0.118)	(0.003)	(0.130)

-2lnL	1072.03	697.00	864.65	510.34
Percent correctly predicted	84.4	71.6	89.0	84.3
Observations	2360	2360	2360	2360

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Standard errors in parentheses.

Turning to organizational innovation, the estimation results for IntOrg(t) (Model 3) in Table IV indicate that the pure product innovation variable is significant when we control for the degree of organizational intensity in the current period, all else being equal. The fact that firms implement more than two organizational practices in the current period could change the dynamics of their product innovation behavior, compared with a case in which no organizational practices are adopted.

The interpretation of these results is twofold. First, the joint implementation of organizational practices during the current period might induce a complementary effect, in terms of management and competence profitability, that enhances firms' capacity to continue to introduce new or improved products over time. Second, product innovators in general seem to achieve higher growth rates [8], which enables them to devote more resources to innovation activities and which could, in turn, create a higher capacity to innovate persistently, though this effect holds only after we control for the degree of organizational intensity.

As for the other innovator profiles, we observe that the persistence parameters are positive and significant for complex innovators and highly significant for single innovators.

With regard to the impact of organizational innovation, the organizational parameters are positive and highly significant for pure product, single, and complex innovators. The simultaneous introduction of more than one organizational practice during the three-year period t enhances firms' technological innovation capacity in that period. Finally, we present the results for the last model with IntOrg(t – 1) in Table V.

TABLE V
DYNAMIC RE PROBIT ESTIMATIONS (MODEL 4)

	Only_Prod	*Only_Proc*	*Single*	*Complex*
Lagged Innovation				
Only_prod(t-1)	0.211 (0.176)			
Only_proc(t-1)		0.150 (0.221)		
Prod_ou_proc(t-1)			0.352* (0.197)	
Prod_et_proc(t-1)				0.280 (0.211)
Organizational Innovation				
IntOrg(t-1)	0.080**	-0.013	0.101***	0.159***
	(0.033)	(0.038)	(0.033)	(0.035)
ρ	0.426 (0.089)	0.342 (0.118)	0.161 (0.147)	0.106 (0.144)
-2lnL	1112.45	697.55	914.36	567.98
Percent correctly predicted	82.2	71.9	87.9	77.8
Observations	2360	2360	2360	2360

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Standard errors in parentheses.

With these organizational innovation variables, all else being equal, single technological innovation remains persistent. In contrast, the persistence parameters for pure product and complex innovators are no longer significant. At first sight, this result might seem contradictory, but conditional on the degree of organizational intensity in the current period (IntOrg(t)), the two innovators profiles are persistent. These results may reflect the effects of lagged time returns of organizational innovation on current innovations.

Overall, the results across three models confirm that the joint implementation of organizational practices, compared with a case in which no organizational practices are adopted, has a crucial impact in terms of leading firms to innovate and enhancing their technological innovation capacity in the same period. There also could be a temporal dimension, in terms of returns on organizational strategies undertaken during the previous periods on current firms' likelihood to innovate.

IV. Conclusion

With this study, we have attempted to explore the consequences of organizational innovation on the patterns of firm technological innovation persistence. This research complements previous literature by providing detailed statistical evidence of the impact of organizational innovations, then inserting them as regressors in different empirical models. In so doing, we provide new insights into the relationship between nontechnological and technological innovation and add to comprehension of the impact of organizational innovation on technological innovation persistence. Three waves of French CIS data enabled us to examine the determinants of four profiles of technological innovators, focusing on different dynamic specifications of organizational innovation. These findings enrich the learning approach to innovation persistence. Product, process, and organization innovation exhibit strong, systematic interactions [1].

Implementing new practices or procedures, new methods of work responsibilities, and new external relations all have consequences for (or offer incentives to) the design of newly structured products or improved processes in general.

Two key results thus emerge from our empirical analysis among French manufacturing firms. First, we find persistence in innovation but also that this trend does not hold for all types of innovators. Our methodology builds on the idea that different kinds of innovators exist. We explicitly distinguish pure product, pure process, single (product *or* process), and complex (product *and* process) innovators. In line with another recent study using the Luxembourg CIS, we find that complex innovators are more persistent [28], likely due to the positive returns on past investments and the role of accumulating competencies during the previous period, which then enhance firms' capacity to innovate persistently in the future. These results also reaffirm the existence of system effects and synergies among alternative innovations. Competencies and knowledge gained during product development processes spill over to projects designed to improve innovation processes.

Conversely, innovation in processes enhances firm efficiency, which can improve capacities to introduce new goods or services [28]. Thus, firms that have combined product and process innovations in the past are more likely to be prepared, in terms of innovations opportunities, competencies, and work procedures, to introduce complex innovations in the present and future.

Second, and perhaps even more important, our estimations reveal a positive impact of organizational innovations on technological innovation persistence. This impact is neither general nor always of the same magnitude. Organizational innovation exerts a positive impact on complex innovators but almost never on pure process innovators. We have tracked the effects of two aspects of organizational innovation: relative *continuity* in the implementation of organizational innovation and the level of *intensity* in organizational innovation behavior. If the organizational innovation goes farther back, its effect is weak. That is, a specific organizational innovation exerts an effect on technological innovation in the short term, leaving almost no positive propagation effects in subsequent time periods. Instead, intensity matters more significantly and positively. The more practices are implemented by the firm, the higher the probability it remains an innovator (though this pattern does not apply to pure process innovators).

We also acknowledge that our approach is clearly exploratory. The three CIS surveys do not use the same questions pertaining to organizational innovation, nor has there been any standard, unanimously accepted definition of organizational innovation in academic research. Therefore, we hope ongoing studies elaborate on the concept of organizational innovation and reach a standardized definition, similar to those that already exist for product and process innovations. In addition, technological and organizational innovations significantly help explain firm performance, but we lack proper models to track the effect of different types of innovation on firm performance over time. Thus, it is necessary to expand on our analysis of innovation, beyond technological aspects, to gain a better understanding of firms' economic performance. Further research should include qualitative, longitudinal studies that can effectively tackle the continuity and intensity aspects of organizational innovation.

Finally, our study provides several new insights regarding tools to support innovation policies. The extant targets of regional and national innovation policies have been product and process innovations; we show that organizational innovation matters, perhaps even more. New routines and organizational practices by the firm not only affect its current technological innovation but also exert lasting effects on its innovation activities. Thus organizational innovation should be a more important feature in the design of new types of public support.

References

[1] C. Antonelli, F. Crespi and G. Scellato, "Inside innovation persistence: New evidence from Italian micro-data". *Structural Change and Economic Dynamics,* 2012, forthcoming.

[2] H. Armbruster, A. Bikfalvib, S. Kinkela and G. Lay, "Organizational innovation: The challenge of measuring non-technical innovation in large-scale surveys". *Technovation,* vol. 28, p. 644–657, 2008

[3] J.V. Baldridge and R.A. Burnham, "Organizational Innovation: Individual, Organizational, and Environmental Impacts", *Administrative Science Quarterly,* vol.20, p. 165-176, 1975

[4] G. Battisti and P. Stoneman, "How innovative are UK firms? Evidence from the CIS4 on synergies between technological and organizational innovations", *British Journal of Management*, vol. 34, no.1, p. 187-206, 2010

[5] S. Bharadwaj and A. Menon, "Making innovation happen in organizations: Individual creativity mechanisms, organizational creativity mechanisms or both", *Journal of Product Innovation Management,* vol. 17, no.6, p.424-434, 2000

[6] M.D. Cohen and D.A. Levinthal, "Absorptive capacity: A new perspective on learning innovation", *Administrative Science Quarterly* vol.35, no.1, p.128-152, 1990.

[7] W.M. Cohen, *Empirical Studies of Innovative Activity. Chapter 6 of Handbook of the Economics of Innovation and Technological Change*. Oxford: Blackwell, 1995.

[8] A. Colombelli, N. Haned and C. Le Bas, "On firm growth and innovation. Some new empirical perspectives using French CIS (1992-2004)", *ICER working paper*, 2010.

[9] C. Cordelier, "Innovations et performances des sociétés des services et de l'industrie manufacturière, comparaisons", W*orking paper* E 2009/06, INSEE, France. 2009.

[10] M. Crossan and M. Apaydin, "A multi-dimensional framework of organizational innovation". *Journal of Management Studies*, vol.47, no.6, p.1154-1191, 2010.

[11] R.L. Daft, "A dual-core model of organizational innovation". *Academy of Management Review*, vol.21, p.193-210, 1978.

[12] F. Damanpour, "Organizational innovation: a meta-analysis of effects of determinants and moderators". *Academy of Management Journal,* vol.34, no.3, p.550-90, 1991.

[13] F. Damanpour, "Organizational size and innovation". *Organization Studies,* vol.13, no.3, p.375-402, 1992.

[14] F. Damanpour and D. Aravind, Product and process innovations: a review of organizational and environmental determinants. In *Innovation, Science, and Institutional Change,* Ed. J. Hage and M. Meeus. Oxford: Oxford University Press, 2006.

[15] F. Damanpour and W.M. Evan, "Organizational innovation and performance: the problem of organizational lag". *Administrative Science Quarterly*, vol.29, p.392-402, 1984.

[16] D. Dougherty, "A practice-centered model of organizational renewal through product innovation". *Strategic Management Journal*, vol.23, p. 77–92, 1992.

[17] E. Duguet and S. Monjon, « Les fondements microéconomiques de la persistance de l'innovation: Une analyse économétrique ». *Revue Économique*, vol.53, no.3, p.625-636, 2002.

[18] R. Evangelista, R. and A.Vezzani, "The economic impact of technological and organizational innovations. A firm-level analysis". *Research Policy*, vol.39, p.1253–1263, 2010.

[19] P.A. Geroski, J. van Reenen and C.F. Walters, "How persistently do firms innovate?". *Research Policy*, vol.26, no.1, p.33-48, 1997.

[20] N. Greenan, D. Guellec, G. Broussaudier and L. Miotti, "Innovation organisationnelle, dynamisme technologique et performance des entreprises ». Working paper G9304/ April, INSEE, France, 1993.

[21] L. Gumusluoğlu and A. Ilsev, "Transformational leadership and organizational innovation: the roles of internal and external support for innovation". *Journal of Product Innovation Management,* vol.26, p.264–277, 2009.

[22] G. Gunday, G. Ulusoy, K. Kilic and L. Alpkan, "Effects of innovation types on firm performance". *International Journal of Production Economics*, vol.133, no.2, p.662-676, 2011.

[23] J.J. Heckman, "The incidental parameters problem and the problem of initial conditions in estimating a discrete time discrete data stochastic process". In *The structural analysis of discrete*. Ed. C. Manski and D. McFadden. Boston: MIT Press, 1981.

[24] R. Henderson, R. and K. Clark, "Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms". *Administrative Science Quarterly*, vol.35, p.9-30, 1990.
[25] J.R. Kimberly and M.J. Evanisko, "Organizational Innovation: the influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations". *Academy of Management Journal*, vol.24, no.4, p.689-713, 1981.
[26] A. Lam, "Organizational innovation". In *The Oxford Handbook of Innovation*, ed. Jan Fagerberg J., Mowery D.C., Nelson R.R. Oxford: Oxford University Press, 2005.
[27] W. Latham and C. Le Bas, *The Economics of Persistent Innovation*, Berlin and New York: Springer, 2006.
[28] C. Le Bas and N. Poussing, « Are complex innovators more persistent than single innovators? An empirical analysis of innovation persistence drivers". Working Paper 1201, GATE, Lyon Saint-Etienne, France, 2012.
[29] B. Lokshin, A. Van Gils and E. Bauer, „Crafting firm competencies to improve innovative performance". Working Paper, UNU-MERIT, available at: http://www.merit.unu.edu/publications/wppdf/2008/wp2008-009.pdf (accessed 12 November 2011), 2008a.
[30] B. Lokshin, R. Belderbos and M. Carree, "The productivity effects of internal and external R&D: evidence from a dynamic panel data model". *Oxford Bulletin of Economics and Statistics*, vol.70, no.3, p.399-413, 2008b.
[31] J.H. Love and S. Roper, "Location and network effects on innovation success: evidence for UK, German and Irish manufacturing plants". *Research Policy*, vol.30,no.4, p.643-661, 2001.
[32] J. Mairesse and P. Mohnen, "Using innovations surveys for econometric analysis". NBER working paper series 15857. http://www.nber.org/papers/w15857, 2010.
[33] C. Mothe and T.U. Nguyen-Thi, "The link between non technological innovations and technological innovation". *European Journal of Innovation Management,* vol.13, no.3, p.313-332, 2010.
[34] C. Mothe C. and T.U. Nguyen-Thi, "Non-technological and technological innovations: Do services differ from manufacturing? An empirical analysis of Luxembourg firms", *International Journal of Technology Management*, forthcoming.
[35] R.R. Nelson and S.G. Winter, *An Evolutionary Theory of Economic Change*. The Belknap Press of Harvard University Press: Cambridge, 1982.
[36] OECD. 2005. *Oslo Manual.* 3rd edition
[37] K. Pavitt, "Innovation Processes". In Jan Fagerberg J., . Mowery D.C., Nelson R.R., Eds, The Oxford Handbook of Innovation. Oxford Handbooks in Business and Management. p.86-114, 2005.
[38] E.T. Penrose, *The Theory of the Growth of the Firm*. New York: John Wiley, 1959.
[39] B. Peters, "Persistence Effects of Innovation Activities. In Peters, B, Ed, Innovation and firm performance". Physica Verlag, Zew Economic Studies 38, p. 151-199, 2008.
[40] R. Phillips, "Innovation and firm performance in Australian manufacturing, industry commission", Staff Research Paper, Canberra, 1997.
[41] M. Polder M, G.V. Leeuwen, P. Mohnen and W. Raymond, "Product, process and organizational innovation: drivers, complementarity and productivity effects", United Nations University - Maastricht Economic and social Research and training centre on Innovation and Technology, Maastricht, The Netherlands, 2010.
[42] W. Raymond, P. Mohnen, F.C. Palm and S. Schim Van Der Loeff, "Persistence of innovation in Dutch manufacturing: Is it spurious?" *Review of Economics and Statistics*, vol.92,no.3, p.495–504, 2010.
[43] T. Schmidt and C. Rammer, "Non-technological and technological innovation: strange bedfellows?". Working Paper 07-052, 2007, ZEW, available at: ftp://ftp.zew.de/pub/zew-docs/dp/dp07052.pdf
[44] K. Staropoli, "Cooperation in R&D through a network, an organizational gamble? An empirical analysis of Rhône Poulenc Rorer–Gencell". *Technology Analysis and Strategic Management*, vol.10, no.4, p.511-527, 1998.
[45] M.V. Tatikonda and M.M. Montoya-Weiss, "Integrating operations and marketing perspectives of product innovation: the influence of organizational process factors and capabilities on development performance". *Management Science*, vol.47, no.1, p.151–172, 2001.
[46] D.J. Teece, "Technological change and the nature of the firm". In *Technical Change and Economic Theory*. Ed. G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete. 1988. New York: Pinter Publishers.
[47] B. Wernerfelt, "A resource-based view of the firm". *Strategic Management Journal*, vol.5, no.2, p.171–180, 1984.
[48] J.M. Wooldridge, "Simple solutions to the initial conditions problem in dynamic nonlinear panel data models with unobserved heterogeneity". *Journal of Applied Econometrics*, vol.20, no.1, p.39–54, 2005.