Centre de Recherche en Économie et Management
Center for Research in Economics and Management

University of Caen

University of Rennes 1

Organizational Innovation and its Link with Technological Innovation in SMEs:

Empirical Evidence for Lower Normandy – France

Working Paper

Khadidja Benallou,
Jean Bonnet,
Mohammad Movahedi

UFR de sciences économiques et de gestion,
Université de Caen Basse-Normandie, CNRS UMR 6211, France

July 2012 - WP 2012-29

Organizational Innovation and its Link with Technological Innovation in SMEs:
Empirical Evidence for Lower Normandy – France

Khadidja BENALLOU* **Mohammad MOVAHEDI**** **Jean BONNET*****

UMR CNRS 6211, UFR de Sciences Economiques et de Gestion, campus 4, 19 rue Claude Bloch, BP 5186, Université de Caen, France.

*khadidja.benallou@unicaen.fr, **mohammad.movahedi@unicaen.fr, ***jean.bonnet@unicaen.fr

Version: Juillet 2012

Abstract:

In the present study, we define synthetic and relevant indicators of organizational innovation and measure the link of these indicators with various types of technological innovations (product innovation, process innovation, and mixed innovations). They are constructed from sixteen variables reflecting organizational innovation with the aid of multiple correspondence analysis (MCA) method. The variables are grouped in five categories corresponding to different aspects of organizational changes, such as training & qualification, knowledge management, production management, quality, and market transaction. We then use a regression to estimate the link between organizational innovation indicators and technological innovations (product, process and their interaction). The original database exploited is part of the IDEIS[1] project and relates to a representative sample of 90 SMEs in Lower Normandy - France. Our estimated indicators interpret the Intensity of the implementation of the Organizational Changes (IOC) and the orientation of the Organizational Innovation Strategies adopted (OIS). We find a positive and significant link between IOC and technological innovation (product innovation, process innovation, and mixed innovations), particularly so for product innovation. However, we find no clear link between the choice of the OIS and technological innovation.

Keywords: Indicators of organizational innovation, product and process innovation, innovation strategy, quality of human resources, training.

JEL-code: *D23, O33, C81, C2*

[1] This project is financed by the French Government, the region of Lower Normandy, and the European Union (European Regional Development Fund). cf. https://www.unicaen.fr/mrsh/projetideis/home/

1. INTRODUCTION

In the era of the new economy, competitiveness and growth of industrial firms are partially based on their innovation strategies. In this study, we measure the organizational changes, determine the direction of these changes, and evaluate their relationships with technological innovations, namely product and process innovations, and their interaction. Organizational innovation relates to the implementation of a whole new method of organization. There may be new practices in the mode of production, in the organization of the workplace, in external relationships of the enterprise, etc. This type of innovation differs from the commercial innovations that seek to satisfy the needs of consumers by implementing new business practices introducing significant changes in the conception, placement, and pricing of the product. These organizational innovations are also different from technological innovations that involve, on the one hand, the introduction of a new product or service, or their improvement, and on the other hand, the implementation of a process or new ways of production or distribution, (Oslo, 2005). Though numerous studies underline the complementary nature between different types of technological innovations (Greenan, 1996; Caroli and Van Reenen, 2001; Greenan and Mairesse, 2006), few of them have focused on organizational innovations. Such innovations involve continuous training of labor (Bauernschuster, Falck, & Heblich, 2008; Zamora, 2006) to fit the new needs of the enterprise and reach the level of quality of required human resources (Tremblay and Rolland, 1996, 2000, Tremblay, 2007).

Most of the studies underline various forms of organizational change; the most recent converging towards more decentralization (Boyer, 1991), modernization of the workforce, adoption of quality process, modernization of external relationships, and the adoption of a knowledge management system. Organizational innovations differ from one company to another depending on the objectives they pursue. Given the scope of the organizational innovation, it seems difficult to reduce it to one or two variables. Indicators used by various studies do not provide suitable or precise indicators for two reasons: 1) they take into account only a single type of organizational change; 2) they are predominantly measured by qualitative and often binary variables (Greenan, 1996; Greenan and Mairesse, 2006; Caroli and Van Reenen, 2001).

Moreover, the degree of change varies from one company to another, although they all reported organizational innovations. That is the reason why we propose richer and more relevant indicators of organizational innovation constructed from sixteen variables related to the organizational changes in the Lower Normandy's SMEs (Small and Medium Enterprises). These variables display a wide range of categories of organizational changes: training and qualifications, knowledge management, production management, quality[2], and external relationships.

Our research also focuses on the relationship between organizational innovation and technological innovation. Several authors have demonstrated that the introduction of product or process innovation is often accompanied by organizational change (Henderson and Clark, 1990; Dougherty, 1992). The crucial role of organizational innovation in raising firms' innovation differs according to the product or process innovation (Mothe, Nguyen-Thi, Nguyen-Van, 2012). In addition, Le Bas and Poussing (2012) have specified that when the enterprise introduces both product and process innovation; it will be more likely to remain innovative.

[2]In our research, quality refers to obtaining certifications for products and for management systems.

In this paper, we use multiple correspondence analysis (MCA) to evaluate organizational innovation indicators, making it possible to gather and synthesize a large quantity of innovative companies' information. Analysis of covariance (ANCOVA) is a general linear model which blends Analysis of variance (ANOVA) and regression. Then, we apply two ANCOVA regression models to estimate to what extent technological innovation is associated with organizational innovation.

The main questions of this study are:

1) What are the degree and the direction of organizational changes implemented by each firm?

2) Are these degree and direction of changes associated with the introduction of product and/or of process innovation?

3) Is this association more important –intensity and frequency- among enterprises that have simultaneously introduced the two types of technological innovation?

To answer these questions, we use data from the survey database IDEIS, which includes a stratified random sample of 90 SMEs in Lower Normandy. This survey was conducted in 2009-2010, covering the period from 2006 to 2008.

In what follows, we first present a brief review of the literature from which we will draw our theoretical model, defining categories of variables of organizational change. Using the MCA method, we then extract the main factorial axes that explain a great part of the variability of the cloud of the observations. Lastly, we verify the results using a linear regression so as to better understand the determinants of organizational innovations.

2. AN EXPLORATORY LOOK ON ORGANIZATIONAL INNOVATION

In the organizational context and according to Oslo manual (2005), an organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. In this study, organizational change and organizational innovation are used as two similar concepts. Innovation, compared with change, is the ability to create value by providing something new in the domain being considered.

Many studies present organizational innovations as efficient means for flexibility (Osterman, 1994), technological innovation persistence (Le Bas and Poussing, 2012), and productivity (Movahedi and Gaussens, 2012). Nevertheless, these works only take into account a few of the dimensions involved Greenan (1996a) studied the correlation between elements of the triangle formed by technological innovations, organizational changes, and changes in skills. Modernization of industrial enterprises is truly manifested in a simultaneous change affecting both production factors and their combinatorial technology. Concerning the capital factor, the change consists in the renewing of the equipment, while concerning the labour force it rather lies in adapting the level of skills to new changes. In addition, the firm must reorganize its new working methods and its new production techniques to reach better coordination. In a simultaneous study, Greenan (1996b) shows that between 1988 and 1993, following a major effort to modernize the French SMEs, the qualification structure was influenced more by organizational changes than technological ones.

Leavitt (1965) also analyzes three possible approaches to organizational change: structural, technological, and human. Consequently, the aspect of human resources is closely linked to organizational change. The new jobs brought about by a reorganization of the work require a greater degree of skills and training. According to Blosfeld (1985), an employee is highly qualified if he gets continuous training.

Furthermore, another analytical approach links organizational changes essentially to skills and knowledge. Penrose (1959) explains that the departure of an efficient employee, whose knowledge may be involved in the manufacturing process, represents a capital loss for the enterprise. Knowledge has an economic value just as any other resource capital (Nelson and Winter, 1982). In fact, knowledge management and knowledge storage have become one of the revolutionary and innovative practices of firms (Nonaka and Takeuchi, 1995; Hamel and Prahalad, 1995). Hence, the implementation of organizational change depends on the adoption of a range of new practices. We may thus deduce our first hypothesis:

H1: Organizational change reflects the implementation of a set of new practices. The magnitude of these changes can differentiate one firm from another one.

Subsequently, Caroli & Van Reenen, (2001); Tremblay (1992) and Bartoli (1986) have highlighted the close relationship between innovation strategy and characteristics of the internal and external environments of the enterprise. For the establishment of such an innovation strategy, the firm takes into consideration not only the introduction of new products and processes, but also the reorganization of work, the redefinition of skilled jobs (for the new mission or the new project) and also the implementation of a training plan. Basically, innovation strategy takes into account the quality and characteristics of human resources[3] (Tremblay, 2007). Turcotte, Leonard and Montmarquette (2003) add that companies with a strategy related to human resources or R&D are more likely to implement training activities compared to other enterprises. In addition, they observe a correlation between training and technological innovations.

According to Baldwin and Johnson (1995) innovative firms in technology are more able to increase their need for skilled employees than non-innovative ones. Baldwin, Gray and Johnson (1996) also show that, if the skills needed by companies are found on the labor market, they recruit new staff. If, however, it is difficult to find outside the firm specific knowledge (tacit knowledge), the enterprise will probably provide training for the existing staff because the specific knowledge is detained by the enterprise employees.

Finally, the enterprise is forced to choose between training current employees or recruiting a specific workforce according to Baldwin and Peters (2001). Nevertheless, this innovation strategy based on the quality of human resources is not the only one. Hall (1987) has described new organizational practices to achieve manufacturing excellence; he recommends adopting the approach of total quality and just-in-time production in order to control productive flows. Thus it follows that some new organizational practices can focus on the restructuring of the production system. This may be achieved by reducing delivery time and production time (just-in-time), and by improving the quality process. Just in time allows firms not only to reduce procurement costs but also to satisfy customers and establish stable business relationships with suppliers.

[3] That is to say distinct characteristics of labor which can be considered as advantageous but also constraining "... whether a constraint, for example if the education level of the staff is low, if job security is high, etc.. whether an advantage or a factor promoting innovation if, on the contrary, the staff is well trained, open to learning further, accepts a certain mobility within the company, etc." Tremblay (2007).

However, companies belong to different technological sectors and possess heterogeneous organizational structures; therefore their policy of change is not the same. Choosing the type of organizational change depends on the fields in which the companies must get into in order to acquire the competitive advantages at their level of product and technology process. From the above discussion we thus formalize our second hypothesis:

H2: According to their characteristics and to their needs, enterprises adopt different strategies for organizational innovation.

The present study provides a multivariate analysis taking into consideration various aspects of organizational change. Such aspects include training, employee qualifications, knowledge management, production management, quality process, and improvement of relationships with external partners.

3. METHODOLOGY AND DATABASE

Our study concerns the implementation of a set of organizational changes that may include training, knowledge management, production management, quality, and external relationships (Kannan and Tan, 2005). The variables used for this study are various and qualitative. A multiple correspondence analysis (MCA) is adapted and is easily applied to the type and large quantity of information contained in the database, allowing us to summarize the information. In fact, the contingency tables usually contain n individual statistics represented in p dimensions or variables. The MCA method helps us to synthesize the information of these large tables by projecting the p dimensions of variables on the q first optimal factorial axes ($q < p$) by losing as little information as possible (the optimal factorial axes are chosen according to eigenvalues and to their decreasing contribution to the inertia of the cloud of points) (Busca and Toutain, 2009).

The database used is the survey project IDEIS (Interdisciplinary Project for the Development of Enterprise, Innovation and Strategy) [4] which provides original information on innovation practices and training in manufacturing SMEs of Lower Normandy[5]. This project aims at developing and strengthening innovation in Lower Normandy enterprises. It resulted from a detailed investigation carried out during the period April 2009 to January 2011 based on a random and stratified sample of 90 manufacturing enterprises from a population of 803 SMEs. The sample was stratified by activity sector, size, and employment area. Firm size varies from 10 to 250 employees. The questionnaire (Gaussens and Houzet, 2009) includes all the fields of the enterprise, with a particular focus on innovation through the exploration of strategies and objectives set as milestones by business managers.

The survey was conducted face to face with managers to collect maximum reliable information. The variables used by this survey are qualitative (dichotomous and some are multi-modalities). For some, we employ the same terms; for others we have designated scores ranging from 1 to 5 (examples of the variables JAT-PRO and JAT-STOPRO which denote respectively just in time for finished goods and just in time for

[4] This interdisciplinary scientific project has been contributing since the end of 2007 to the development of the Lower Normandy region under the Project Contract between the State and the Region (CPER 2007-2013). It is included in the Operational Programme ERDF (European Regional Development Fund). It gathers Human and Social Sciences researchers grouped within the House of the Human Sciences Research (MRSH) at the University of Caen Lower-Normandy (UCBN) on topics related to firms and innovation.

[5] We only explored the variables being part of our study.

inventory of components of production; see Table 1). In our research, sixteen variables corresponding to organizational changes are analysed by the MCA method.

4. CONSTRUCTION OF VARIABLES

The issue of qualification of human resources in organizational innovation has become more common in research related to innovation (Caroli and Van Reenan, 2001; Janod and Saint-Martin, 2003; Greenan and Mairesse, 2006). The adaptation of workers to increase rapid technological developments requires an investment in the qualification of human capital. Hall (1987) shows that there are three categories of organizational practices necessary for achieving "industrial excellence": just in time, total quality, and involvement of men. Recent research also focuses on knowledge management (Nonaka & Tackeuchi, 1995) as a means of favouring innovation. At this level, formalisation of tacit knowledge to explicit knowledge corresponds to new organizational practices. Externalization is the process of knowledge memorization technique, it involves the conversion of tacit knowledge into explicit knowledge, i.e. when knowledge is written into formal models (documents), tacit knowledge is codified and converted into explicit knowledge. Kline, Rosenberg (1986), and Teece (1996) have reported that cooperation and the establishment of effective means of communication with external partners play a crucial role in the innovation capacity of the enterprise. We identify five categories of variables corresponding to various organizational changes (Annexes).

According to the Oslo Manual (2005), intangible investment includes more than activities in R & D and constitutes our first category of variables. The use of internal training is thus one way to make this investment. Checcaglini and Marion-Vernoux (2010) have specified, in a study conducted on about 100,000 companies in Europe, that 86% of large European companies and 75% of French companies train their own employees. The firm can reevaluate competence of its employees through training (FORM) and by recruiting employees with new skills (RCRQLIFBS) in the goal to increase the share of skilled employment (APEQ). This strategy of development and qualification of workers is based on a training plan looking for well-defined objectives (PLFORM). To respond to the needs for knowledge and know-how, the enterprise can use external training (FRMEXTRBS) or even specific training to collect strategic information (FRMSI).

In information technology services sectors, the existence of knowledge communities and the collective labor promote knowledge sharing and organizational learning (Bentahri and Benallou, 2011). We then add a second category of variables, which includes taking into account new knowledge created within formal working groups or informal working groups (NVLCNS1). These groups are also called knowledge communities (CMSAV). This willingness to build up on shared knowledge requires the coding and storing of experiments and knowledge mobilized by the personnel of the enterprise (MEMO-CON).

A third category of variables contains innovative actions in production management. This category includes new management systems of stocks of finished product (JAT-STOPRO) and those of delivery management and distribution (JAT-PRO) as well as those of the organization of production (ORG PR).

The fourth category expresses the quality approach or the acquisition of certification[6] which proves the enterprise's ability to self-correct and improve operations of its production system, in order to satisfy its customers continuously. This approach involves the certification of products (QLITEPDT) and certification system of management[7] (QLITEMNG).

The fifth category involves the introduction of means or actions to improve customer satisfaction (STFCSMTR); and the establishment of a system of information exchange which accelerates communication with suppliers (STFFRNS). Greenan and Mairesse (2006) view this category as a means of enhancing the flexibility of companies, by making use of market mechanisms.

5. INTERPRETING INDICATORS OF ORGANIZATIONAL INNOVATION

Table 1 gives us a clearer view of the interactions of different variables of organizational change. The synthesis of the exploration of our sixteen variables by the MCA method is provided in the last two columns of this Table. Remember that the principle of MCA is to find the axes resulting in linear combinations of variables so that the variance of the cloud around each axis is maximal.

The first two factorial axes summarize 70% of the information contained in the whole cloud of points. We have neglected the other axes because they provide little information thus making them difficult to comment. We interpret Axis 1 as "the intensity of implementation of organizational change" (63% of the adjusted inertia) and axis 2 as "the strategy of organizational innovation" (about 7% of the adjusted inertia). The results of the MCA tell us that the majority of variables significantly influence axis 1.

All variables contribute positively to the first factorial axis that provides the most information. Consequently, we clearly see that the cumulative characteristics of implemented organizational changes are revealed by axis 1. This means that the enterprise cannot effectively adopt one new organizational practice without adopting another. This explains the complementary nature of different types of organizational changes.

The first six variables that influence axis 1 the most are, respectively; the formalization of an annual training plan, the existence of working groups or of a knowledge community, the establishment of means of consumer satisfaction, training, implementation of an effective system of information exchange, and communication with suppliers and the organization of production. These variables are dispersed into the five categories of organizational changes, another good reason to interpret this axis by the intensity of the implementation of organizational changes. The concentration of the cloud of points on the first axis shows the considerable value of the total inertia (63%) represented by the axis (see Table 1, Annexes B and C).

---

[6] According to the French Agency for Standardization, the acquisition of certification happens by a long training program, writing procedures and manuals.

[7] Most researchers consider this certification as an indicator of Total Quality Management (TQM). TQM is a fully integrated policy management in organizations, it means a set of methods and tools the objectives of which are:

- Do better than what we already do reducing unnecessary costs and improving customer / supplier relationships,
- Increase our market share by focusing on service to the final customer.

Variables	Modalities	%	axis1	axis2
Training and Qualification				
FORM	Rather yes	27,778	**4,844**	**3,285**
	Rather no	72,222	**-4,844**	**-3,285**
PLFORM	Rather yes	48,889	**5,876**	0,435
	Rather no	51,111	**-5,876**	-0,435
FRMEXTRBS	Yes	85,556	2,958	3,146
	No	14,444	-2,958	-3,146
FRMSI	Yes	24,444	**2,297**	0,247
	No	75,556	**-2,297**	-0,247
RCRQLIFBS	Yes	54,444	**2,798**	**2,366**
	No	45,556	**-2,798**	**-2,366**
APEQ	Yes	41,111	**4,205**	0,022
	No	58,889	**-4,205**	-0,022
Knowledge Management				
MEMO-CON	Rather yes	80,000	**4,283**	**4,217**
	Rather no	20,000	**-4,283**	**-4,217**
CMSAV	Yes	43,333	**4,971**	-1,392
	No	56,667	**-4,971**	1,392
NVLCNS1	Yes	86,667	**4,543**	**3,619**
	No	13,333	**-4,543**	**-3,619**
Production management				
JAT-PRO	0	12,222	0,567	**3,865**
	1	2,222	-0,243	-0,098
	2	33,333	**-4,936**	1,649
	3	10,000	1,053	**-5,502**
	4	42,222	**3,768**	-0,766
JAT-STOPRO	0	11,111	1,527	-0,911
	1	10,000	-0,503	**-3,385**
	2	57,778	**-3,754**	**5,240**
	3	3,333	0,553	**-3,053**
	4	17,778	3,729	-1,930
ORG PR	Yes	52,222	**4,563**	**-2,783**
	No	47,778	**-4,563**	**2,783**
Quality				
QLITEPDT	Yes	47,778	**3,535**	-0,568
	No	52,222	**-3,535**	0,568
QLITEMNG	Yes	21,111	**3,522**	**-2,751**
	No	78,889	**-3,522**	**2,751**
Market transactions				
TFCSMTR	Yes	7,778	**4,914**	-1,741
	No	92,222	**-4,914**	1,741
STFFRNS	Yes	24,444	**4,634**	-0,814
	No	75,556	**-4,634**	0,814

Table 1: Indicators of organizational innovation[8]

[8] The first column shows the variables, the second column their modalities and the third column tells us the percentage of each modality. In the last two columns we have taken the first two factorial axes of correspondence analysis which give us indications on organizational innovation of the companies interviewed in 2009. Axis 1: Intensity of implementation of organizational changes (63% of total inertia). Axis 2: Organizational Innovation Strategy (7% of total inertia). In the case of a two modalities variable the sum of the coordinates' modalities is zero. A bold coordinate means that the modality contributes significantly to the inertia of the factorial axis.

Axis 2 reflects two contrary concentrations. The first represents a group of companies related to training, qualification, and management of knowledge. The other corresponds to companies that have set up a production management system in the norms of just in time, respecting the quality, and building relationships with partners. The first group of this axis describes the companies establishing changes based on a strategy of quality human resources (QRH).

The second group shows companies that have built practices not based on a QRH strategy but on innovative uses related to production, to quality, and to commercialization. This axis is a reasonable interpretation of these two types of innovation strategy adopted by companies.

Therefore, according to the different types of organizational changes implemented, the MCA method determines the position of each enterprise around the two axes. Consequently, the cloud of points on the two axes also demonstrates that each firm introduces organizational changes and adopts an appropriate strategy for innovation. An underlying question challenges us at this level: which factors are influencing the most the intensity and organizational innovation strategy of the enterprise?

6. ECONOMETRIC MODEL

The adoption of different types of innovation is simultaneous (Ettlie, 1988; Georgatzas and Shapiro, 1993). Technological change has different effects at the level of organizations. In other words, an enterprise adapts to its new technology, its work organization (Zamora, 2006), its production organization (Hall, 1987) as well as its system of knowledge management (Nonaka and Takeuchi, 1997) and its external relationships (David, 1996). The evolutionary view confirms the coevolution and the parallel rhythm of technological and organizational changes (Rosenkopf and Tushman, 1994; Van de Ven and Garud, 1994).

Thus, the relationship between organizational and technological innovations can be either way. Bresnahan, Brynjolfsson, and Hitt (2002) demonstrate the importance of technological innovation as a conductive for organizational change. While, Le Bas, Mothe, Nguyen-Thi (2012) find that organizational innovation is a determinant factor for product and process innovation as well as their persistence. But few have studied the link between the *intensity* of implementation of organizational innovation and the technological innovation. The strategy of organizational innovation and its orientation at the enterprise level are also largely unexplored (Poole and Van de Ven, 2004). Therefore, the second contribution of our work is to examine the link between our synthetic indicators of organizational innovation (IOC and OIS) and each type of technological innovation (product, process).

Beyond this strong technological and organizational innovations interdependence, some approaches link the organizational innovation to other fundamental elements, namely the size of the firm and the technological level of the sector. Many researches analysing the relationship between innovation and size have demonstrated that this relationship might appear as producing contradictory results, i.e. positive, negative, and non-significant (Baldwin and Scott, 1987; Lee and Xia, 2006). Size may be considered one of the primary determinants affecting innovation activities; because large enterprises often have more complex and diversified resources, such as skills, R&D activities, and financial resources, which contribute to organisational innovation (Damanpour, 1992).

Besides, most empirical studies have shown the existence of a positive link between innovative sectors and innovative intensity (OECD, 2005). Although some authors demonstrate that the level of the technology sector is not linked to innovation, Hall, Lotti, and Mairesse (2009) show that Italian SMEs in low-tech sectors innovate with less investment in R&D than those in high technological sectors. They suggest that these firms rather use organizational changes to adopt technological innovations. Von Tunzelmann and Acha (2005) give the example of the FPI[9] sector, in which enterprises present a variety of organizational forms with varied structures, hierarchies, sizes and technological levels.

According to these researches, it appears that the technological innovation, the size and the sectoral technological level might explain IOC & OIS. However, we propose the following model:

$$Y_{it} = a + \beta_1 X_{it} + \beta_2 LnCA_{it} + \beta_3 NTS_{it} + \varepsilon_{it} \qquad \text{(Model A)}$$

Where

Y_{it} represents the synthetic variables of the intensity of the implementation of organizational changes and strategy for organizational innovation.

X_{it} alternatively represents the variables of technological innovation (product or process or both).

$LnCA_{it}$ is the logarithm of sales used as an indicator of size.

NTS_{it} defines the level of the technological sector to which the firm belongs (low-technology, medium-low-technology and medium-high-technology).

Many innovative enterprises introduce both product and process technological innovations, such as 44% in Belgium (CIS 3), 46% in Luxembourg (CIS 4), and 37% of SMEs in France[10] (OSEO, 2006). Likewise, in Lower Normandy, our data show that 40% of SMEs are hybrid innovators over the 2006-2008 period (see contingency table in appendix).

Nevertheless, enterprises which introduce the combination of product and process innovation (hybrid innovators) increase better the probability to start exportation compared to single innovators[11] (Van Beveren and Vandenbussche, 2009) and persist better in innovation (Le Bas and Poussing, 2012). In this line, we suppose that hybrid innovators may conduct more organizational change to adapt their organisation than single innovators.

The A model assumes that the differential effect of the product (process) innovation is constant whatever the process (product) innovation status of the enterprise. Indeed, it is not safe to precisely estimate the difference between enterprises that innovate in product innovation and those which innovate in process. There may be an interaction between the dummy variables of product innovation ($ProdI_{it}$) and process innovation ($ProcI_{it}$), hence their effect on the IOC and on the OIS (Y_{it}) may not be simply additive but multiplicative as well.

In fact, we can recast the A model by adding an interaction term between product innovation and process innovation. It allows us to obtain the estimated organizational innovation differential among all four groups, i.e. non innovators, single innovators in

[9] Food Processing Industry.
[10] That is 58% for large innovative companies in France (OSEO, 2006).
[11] Single innovators are enterprises that introduce only product innovation or only process innovation.

product, single innovators in process, and hybrid innovators. Therefore, we apply the following equation (Model B):

$$Y_{it} = a + \beta_1\, ProdI_{it} + \beta_2\, ProcI_{it} + \beta_3\, (ProdI_{it} * ProcI_{it}) + \gamma_1 LnCA_{it} + \gamma_2\, NTS_{it} + \varepsilon_{it}$$

Where

$ProdI_{it}$: equal to one if the enterprise introduces a product innovation, otherwise zero.

$\mathrm{ProcI}_{\mathrm{it}}$: equal to one if the enterprise introduces a process innovation, otherwise zero.

β_1 : differential effect of doing product innovation

β_2 : differential effect of doing process innovation

β_3 : differential effect of doing product and process innovation

$ProdI_{it} * ProcI_{it}$: interaction between product and process innovations.

In the next section, we present and interpret the estimation results of our models A and B.

7. ESTIMATION RESULTS

Table 2 reports the results of the regression of the A & B models for both dependent variables IOC and OIS. This table provides four columns for each dependent variable. The three first columns indicate the estimates in model A, respectively, for product innovation (A-I), for process innovation (A-II) and both i.e. technological innovation (A-III) -which is a dummy variable that takes 1 if enterprises make both product and process innovations simultaneously, 0 otherwise-. The fourth column shows estimations for the B model. Standard errors are reported into brackets.

We observe a much greater association and a significant relationship between product innovation and IOC than that between process innovation and IOC (in model A 0.519 against 0.197; in model B 0.667 against 0.179). Specifically, product innovations need more than other types of technological innovations an adaptation of working methods, a structural adjustment (such as a change of hierarchical levels), an improvement of customer and supplier relationships (or even looking for new partners for new products). These changes and others create qualification and skills needs and give birth to new jobs (in case of a radical innovation). The enterprise cannot respond to this requirement of a certain level of quality of manpower except in training or in recruiting employees with new specific skills. It is interesting to note that in SMEs the establishment of a new product requires the mobilization and reorganization of all the company’s departments.

Model B gives us the influence of product and process innovation on IOC separately, taking into account the fact that many firms introduce both innovations simultaneously. This model also allows us to obtain the estimated IOC differential among all four groups, but here we must be careful to plug in the correct combination of zeros and ones. Setting $ProdI_{it}$= 0 and $ProcI_{it}$= 0 corresponds to the non-innovators group, which is the base group, since this eliminates $ProdI_{it}$, $ProcI_{it}$, and $ProdI_{it} * ProcI_{it}$. The differential between those that introduce innovation in both product and process, relative to those that do not introduce innovation, is obtained by adding all three coefficients. Model B shows explicitly that there is a statistically significant interaction between product and process innovation.

Explicative variables	The Intensity of Implementation of Organizational Changes				The organizational innovation strategy			
	Model A			Model B	Model A			Model B
	I	II	III		I	II	III	
Product innovation (β_1)	0,519*** (0,073)	-	-	0,667*** (0,121)	0,149** (0,075)	-	-	-0.056 (0.127)
Process innovation (β_2)	-	0,197** (0,087)	-	0,179** (0,088)	-	- 0,015 (0,073)	-	0.072 (0.092)
Interaction between product innovation & process innovation(β_3)	-	-	0,410*** (0,082)	-0,274* (0,155)	-	-	-0,036 (0,078)	-0.161** (0.083)
Size (γ_1)	0,181*** (0,035)	0,200*** (0,043)	0,192*** (0,040)	0,177*** (0,034)	0,029 (0,036)	0,022 (0,036)	0,024 (0,036)	0.028 (0.036)
Sectoral technological level (γ_2): Medium high-tech	0,001 (0,090)	- 0,039 (0,111)	0,004 (0,104)	-0,011 (0,089)	0,083 (0,093)	0,096 (0,095)	0,097 (0,094)	0.076 (0.093)
Medium low-tech	0,076 (0,081)	0,009 (0,099)	-0,005 (0,092)	0,104 (0,081)	0,002 (0,083)	0,021 (0,084)	0,016 (0,085)	0.027 (0.082)
Constant (a)	-1,640*** (0,299)	-1,666*** (0,364)	-1,609*** (0,314)	-1,693*** (0,271)	-0,201 (0,282)	-0,203 (0,289)	-0,96 (0,289)	-0.210 (0.282)
Number of observations	86	86	86	86	86	86	86	86
R2 (R2 adjusted)	0,519 (0,495)	0,264 (0,228)	0,403 (0,374)	0,546 (0,511)	0,065 (0,019)	0,020 (0,029)	0,022 (0,026)	0.077 (0.007)

TABLE 2: ESTIMATIONS OF MODEL REGRESSION

Model A – I: Variable of product innovation only; II: Variable of process innovation only; III: Variable of product and process innovation simultaneously.
R2: Coefficient of determination, it is computed as a value between 0 and 1.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Standard errors into brackets.

The introduction of both technological innovations simultaneously increases IOC (in model A 0.410; in model B 0.572 = 0.667 + 0.179 - 0.274). However, this increases is not so important than that for product innovation only.

Maybe the process innovation is introduced to adapt the method to produce the new product. In that case it is partially a substitute for organizational change.

Following our intuition, all things being equal, the fact that a company makes a technological innovation increases its efforts in organizational innovations. Results in table 2 show that both product and process innovation in isolation or simultaneously have a significantly positive impact on firms' IOC.

Size influences the IOC positively and significantly. Larger and medium enterprises implement more organizational changes than smaller enterprises. The probability to have implemented a change in the organization decreases as size decreases (OECD, 1989; Greenan and Guellec, 1994).

The fact that a company belongs to a particular technological sector does not significantly influence its innovation intensity. We agree with Von Tunzelman and Acha, (2005) that sectors are not necessarily characterized by technological homogeneity and uniform organizational choice.

We then treat the OIS's estimation. We use the same typology of variables as for the IOC's estimation. We observe that the OIS is not significantly related to the size and to the sector of the firm. Neither are the coefficients regarding the type of innovation significant: having only implemented a product innovation increases the probability to follow a strategy of training, increasing qualification of the labor force or knowledge management. Having implemented both product and process innovations reduces the probability to follow a strategy for organizational innovation.

8. CONCLUSION

The contributions of this work are firstly to measure the intensity of organizational innovation through different variables of organizational change and secondly to analyse its determinants. With this aim, we used a representative sample of 90 SMEs in Lower Normandy. The difficulty in selecting variables led us to refer to a large scope of literature dealing with organizational change as well as technological innovation. It allowed us to identify the elements that represent the implementation of organizational change at the enterprise level better.

According to the large set of organizational change variables, we applied multiple correspondence analysis (MCA) to construct synthetic variables which take into account the diversity of these changes.

This method leads us to extract the variables that contribute the most to the two main factorial axes. They are gathered in two synthetic variables: implementation of the organizational change (IOC) and organizational innovation strategy (OIS).

Axis 1 results show that an enterprise cannot effectively adopt one new organizational practice without adopting at least one other. There are complementary effects that lead a firm to engage in several organizational changes simultaneously.

Axis 2 results splits two groups of firms: the first group of firms that lead a strategy based on the quality of human resources which gathers enterprises that practice two categories of organizational changes, i.e. training & qualification and knowledge management. The second group is based on improving production management system, on implementing quality system, and on enhancing external relationships.

Then, we assess the relationship between IOC or OIS and technological innovation by using two linear regressions (without and with interaction effect between product and process innovations). Size and sectoral technological level are used as control variables.

The results of this study show that the implementation of organizational change is associated with technological innovation. Precisely, an enterprise that realizes any type of technological innovation (product, process or both innovations) increases its initiative in organizational innovation, all things being equal. Our analyses show that single product innovators implement more organizational changes than single process innovators and even more than hybrid innovators, although hybrid innovators a priori require more organizational changes than single process innovators.

Furthermore, we observe that the size of firms is positively correlated with the intensity of the implementation of organizational changes. The larger the company, the more likely it is to set up significant organizational changes. However, membership of a high technological sector does not influence organizational innovation. It follows that sectors are not necessarily characterized by a technological homogeneity and a uniform organizational choice. We support the idea that in some sectors firms have different organizational forms, sizes, and levels of technology.

Regarding the orientation of organizational innovation strategy, we do not find a particular relationship with technological innovation except for hybrid innovators which adopt a strategy oriented towards production management, quality and market transaction. Determinants of OIS are worth investigating further to better understand the behaviour of different SMEs at the level of organizational change.

We will complete our study with a bilateral relationship between technological and organizational innovations using a simultaneous equations model.

REFERENCE

Baldwin, J., & Peters, V. (2001). *Training as a Human Resource Strategy: The Response to Staff Shortages and Technological Change.* Research Parper, Analytical Studies Branch, Ottawa: Statistics Canada , 154.

Baldwin, J., Gray, T., & Johnson, J. (1996). *Advanced Technology Use and Training in Canadian Manufacturing.* Canadian Business Economics , 5, 51-70.

Baldwin, M., & Johnson, W. (1995). *Labor Market Discrimination against Women with Disabilities*. Industrial Relations , 34 (4), 555-577.

Baldwin, W., & Scott, J. (1987). *Market Structure and Technological Change.* London and New York : Harwood Academic Publishers .

Bartoli, H. (1986). *Au-delà des confusions. Propositions hérétiques. Flexibilité du travail et pénurie d'emploi*, Numéro spécial de la revue Économies et Sociétés , AB (14), 3-56.

Bauernschuster, Falck, & Heblich. (2008). *The Impact of continuous training on a Firm's Innovations*. *CESIFO Working Paper* .

Bentahri, B., & Benallou, K. (2011). L'apprentissage des Collectifs de Travail Structuré par les TIC dans le domaine des Services Informatiques. *Economics Working Paper Archive - CREM, 2011-19.*

Bresnahan, T., Brynjolfsson, E., & Hitt, L. (2002). Information Technology, Workplace Organization and the Demand for Skilled Labor: Firm-Level Evidence. *Quarterly Journal of Economics* , 117(1) : 339-376.

Busca, D., & Toutain, S. (2009). *Analyse factorielle simple en sociologie: Méthodes d'interprétation et études de cas*. Bruxelles: De Boeck.

Caroli, E., & Van Reenen, J. (2001). *Skill-biased Organizational Change? Evidence from a panel of British and French Establishments*. Quartely Journal of Economics , 116, 1449-1492.

Checcaglini, A., & Marion-Vernoux, I. (2010, Mars). *Les obstacles à la formation dans les PME en France et en Europe.* Education Permanente , 182, pp. 15-28.

David, A. (1996). *L'aide à la décision entre outils et organisation*. Entreprises et Histoire, 13, 9-26.

Damanpour, F. (1992). Organizational size and Innovation. *Organization Studies , 13* (3), 375-402.

Dougherty, D. (1992). A practice-centered model of organizational renewal through product innovation. Strategic Management Journal, Summer Special Issue 13 : 77–92.

Ettlie, J. (1988). *Taking Charge of Manufacturing: How Companies Are Combining Technological and Organizational Innovations to Compete Successfully*. San Francisco: Jossey-Bass.

Greenan, N. (1996a). *Progrès technique et changement organisationnel : leur impact sur l'emploi et les qualifications*. Economie et Statistique , 298, 35-44.

Greenan, N. (1996b). *Innovation technologique, changements organisationnels et évolution des compétences*. Economie et Statistique , 298, 15-33.

Greenan, N., & Guellec, D. (1994-2-3). Organisation du travail, technologie et perfomances: une étude empirique. *Economie & Prévision* (39-56).

Gaussens, O., & Houzet, P. (2009). Innovation capacity of SMEs: business models and innovation patterns, University of Caen Basse Normandie, France, Survey Support. (F. edition, Éd.)

Greenan, N., & Mairesse, J. (2006). *Mesurer les changements organisationnels : une exploration à partir de données couplées employeurs/salaries*. Revue économique 57 (6).

Hall, B. H. (1987). *The Relationship between Firm Size and Firm Growth in the U.S. Manufacturing Sector*. Journal of Industrial Economics , 35, 583-605.

Hall, B., Lotti, F., & Mairesse, J. (2009). *Innovation and productivity in SMEs: empirical evidence for Italy*. Small Business Economics , 13-33.

Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. Administrative Science Quarterly, 35, no. 1: 9–22.

Janod, V., & Saint-Martin, A. (2003). *Impact des réorganisations du travail sur les performances des entreprises manufacturières. Une analyse sur données françaises 1997-1999*. Revue Économique, 54 (3), 637-648.

Kannan, V. R., & Tan, K. C. (2005). *Just in time, total quality management, and supply chain management: understanding their linkages and impact on business performance.* The International Journal of Management Science .

Kline, S., & Rosenberg, N. (1986). *An overview of innovation*. In R. Landau, & N. Rosenberg, *The Positive Sum Strategy: Harnessing Technology for Economic Growth* (pp. 275–305). Washington, D.C.: National Academy Press.

Leavitt, H. J. (1965). *Applied organizational change in industry: structural, technical and humanistic approaches*. In J. G. March, Handbook of Organizations (pp. 1144-1170).

Le Bas, C., & Poussing, N. (2012). Are complex innovators more persistant than single innovators? An empirical analysis of innovation percistence drivers. *WP 1201* .

Lee, G., & Xia, W. (2006). Organizational size and IT innovation adoption: a meta-analysis. *Information & Management , 43* (8), 975-985.

Martin, M. , & Tanguy, C. (2008). L'innovation organisationnelle dans les petites entreprises. *9em Congrès International Francophone en Entrepreunariat et PME* .

Mothe, C., Nguyen-Thi, U., & Nguyen-Van, P. (2012). Complementarities in organizational innovation practices: Empirical evidence from Luxembourg. *JMA G2.*

Movahedi, M., & Gaussens, O. (2012). Innovation, productivity, and export: evidence from SMEs in Lower-Normandy France. *JMA G2 and, Economics Working Paper Archive – CREM, 2011-23.*

Nelson, R., & Winter, S. G. (1982). *An evolutionary theory of economic change*. Cambridge: Belknap Press of Harvard University Press.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation.* New York: Oxford University Press.

OECD. (2005). Oslo Manual: *guidelines for collecting and interpreting innovation* (Ed. Third). OECD and Eurostat.

OECD. (2005). *Main Science and Technology Indicators.*

OECD. (1998). Measuring Intangible Investment, The Challenge of Measuring and Evaluating Organisational Change in Enterprises.

Osterman, P. (1994). How Common is Workplace Transformation and who Adopts it? . *Industrial and Labor Relations Review , 47* (2), 173-184

Penrose, E. (1959). *The Theory of the Growth of the Firm*. . New York: Oxford University Press.

Poole, M., & Van de Ven, A. (2004). Handbook of organizational change and innovation. Oxford University Press.

Prahalad, C., & Hamel, G. (1990). The core competence of the corporation. Harvard Business Review, 68 (3), 79-93.

Teece, D. (1996). *Firm organization, industrial structure, and technological innovation*. Journal of Economic Behavior & Organization , 31, 193-224.

Tremblay, D.-G. (1992). *Innovation et marchés internes du travail dans le secteur bancaire ; vers un modèle multidimensionnel de l'innovation*. Technologies de l'information et société, 4 (3).

Tremblay, D.-G. (2007). *L'innovation Continue, les multiples dimensions du processus d'innovation technologique et organisationnelle*. Université du Québec à Montréal: Télé-Université.

Tremblay, D.-G. (1992). *La formation dans les entreprises : réalités et défis Possibles*. Montréal: Diffusion Édimédia.

Tremblay, D.-G., & Rolland, D. (2000). *Labour regime and industrialisation in the knowledge economy; the Japanese model and its possible hybridisation in order countries*. Labour and Management in Development Journal , 7.

Tremblay, D.-G., & Rolland, D. (1996). *Le système d'emploi japonais et sa contribution à l'innovation et à la qualification des salariés*. In D.-G. Tremblay, Innovation, technologie, qualification ; multidimension et complexité du processus d'innovation. Québec: Presses de l'université du Québec.

Turcotte, J., Léonard, A., & Montmarquette, C. (2003). *New Evidence on the Determinants of Training in Canadian Business Locations*. Statistics Canada Ottawa , 71-584-MPE .

Rosenkopf, L., & Tushman, M. L. (1998). The Coevolution of Community Networks and Technology: Lessons from the Flight Simulation Industry . Oxford University Press.

Van Beveren, I. V. (2010). Product and process innovation and firms' decision to export . Journal of Economic Policy Reform 13: 1, 3 — 24 .

Van de Ven, A., & Garud, R. (1994). *The Coevolution of Technical and Institutional Events in the Development of an Innovation.* Dans A. Baum, & J. Singh, Evolutionary Dynamics of Organizations (pp. 425-443). New York: Oxford University Press.

Van Reenen, J., & Caroli, E. (2001). Skill *biased organisational change? Evidence from British and French establishments*. Quarterly journal of economics , 171 (4), 1449-1492.

Von Tunzelmann, N., & Acha, V. (2005). *Innovation in "LowTech" Industries*. Dans J. Fagerberg, D. Mowery, & R. Nelson, The Oxford Handbook of Innovation. New York: Oxford University Press.

Zamora, P. (2006). *Changements organisationnels, technologiques et recours à la formation dans les entreprises industrielles*. Revue économique, 57 (6), 1235-1258.

ANNEXES

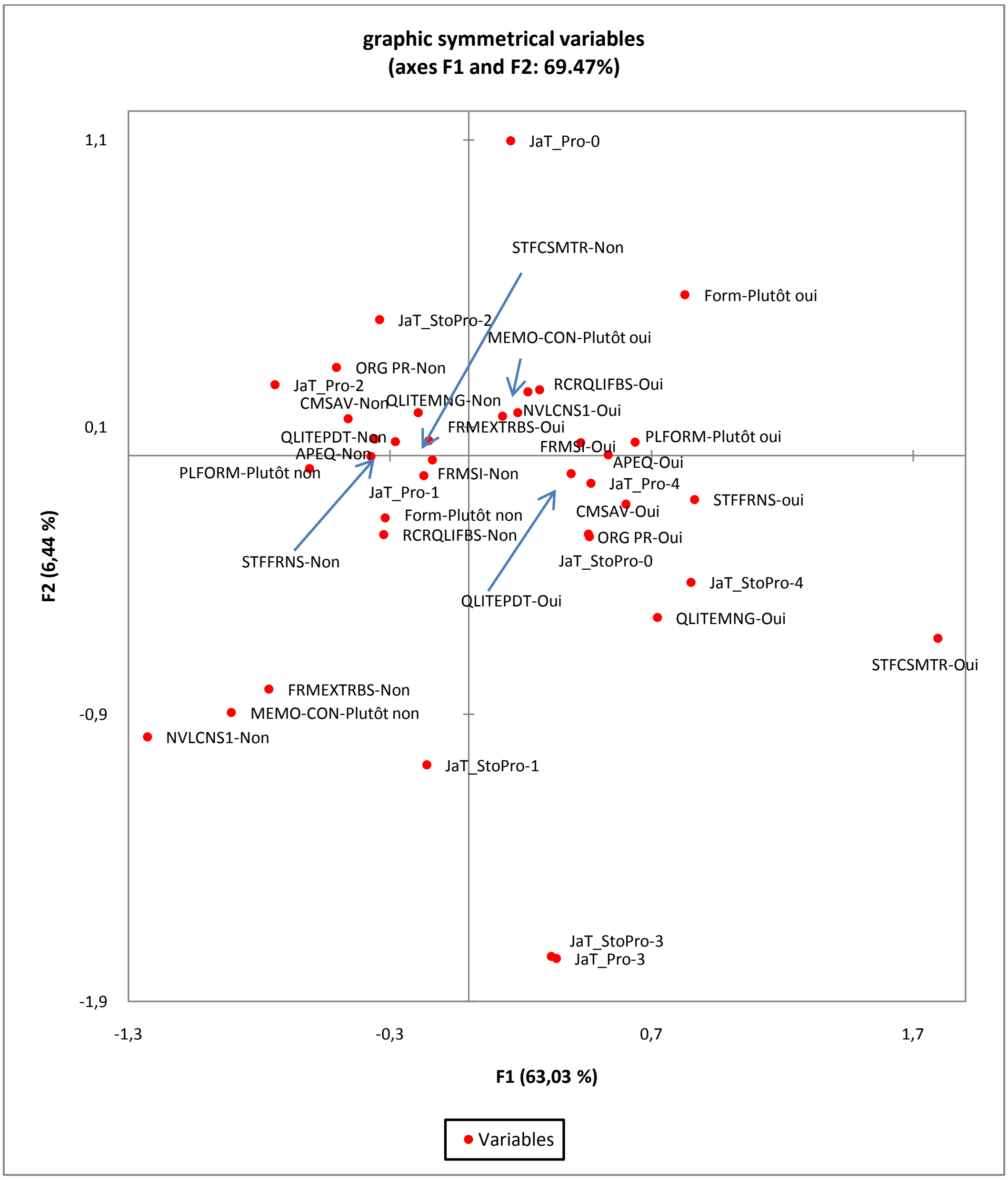
Label	**Questions**	**Answers**
ORG PR	Three years ago, did you significantly reorganiz your organization or your production workflow?	Yes No
QLITEPDT	Did you get certifications for your products?	Yes No
QLITEMN G	Did you get certifications for your management system?	Yes No
FORM	Do you offer some of your collaborators long training?	Rather yes Rather no
PLFORM	Did you formulate each year an annual training plan for the next year?	Rather yes Rather no
JAT-PRO	Three years ago, your production time and that of distribution have (are) :	0 increased for all goods 1increased for certain goods 2 remained unchanged 3 decreased for some goods 4 decreased for all goods
JAT-STOPRO	Three years ago, did your stocks of finished products have (are) :	0 increased for all goods 1increased for certain goods 2 remained unchanged 3 decreased for some goods 4 decreased for all goods
RCRQLIFB S	Do you use recruitment to meet your knowledge and know-how needs for the most qualified jobs?	Yes No
FRMEXTR BS	Do you use external training for your employees to respond to your knowledge and know-how needs?	Yes No
FRMSI	Did your business partners (or other personnel) received specific training to collect strategic information?	Yes No
CMSAV	Are there in your company permanent and regular working groups within which certain topics are discussed? (Project group, teams, quality circles, partially autonomous work groups, etc..)	Yes No
NVLCNS1	Did you develop new knowledge internally?	Yes No
MEMO-CON	Is there a memory of experience / knowledge mobilized by different people in the company to initiate or develop new solutions to avoid repeating what has been already done?	Rather yes Rather no
APEQ	Three years **ago**, did **you increase the share** of skilled jobs?	Yes No
STFCSMTR	Have you established means or actions to improve the satisfaction of your final consumers thanks to your products or services?	Yes No

STFFRNS	Have you established a system for exchanging information that accelerates or makes communication with your suppliers more efficient**?** (All types of suppliers: supply, maintenance, equipment ...)?	Yes No
Product innovation	Does the company make product innovation?	Yes No
Innovation process	Does the company make innovation process?	Yes No

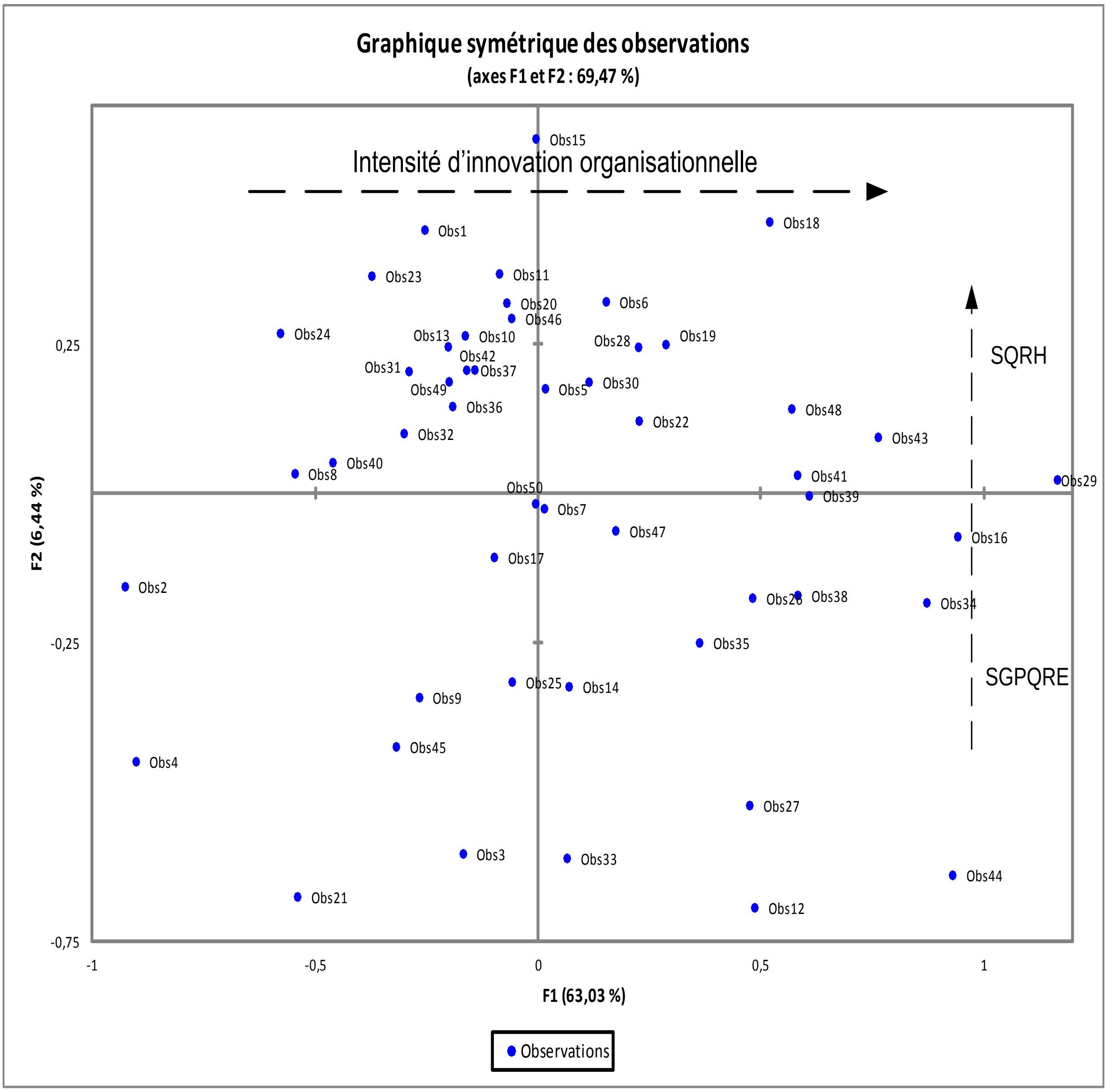
ANNEXE A: TABLE OF VARIABLES

		Process innovation		Total
		Yes	No	
Product innovation	Yes	22	10	32
	No	24	30	54
Total		46	40	86

ANNEX B : CONTINGENCY TABLE



ANNEX C: GRAPH OF VARIABLES



ANNEX D: GRAPH OF OBSERVATIONS