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Résumé de l'article

Ce papier examine l'impact du fonctionnement en entreprise apprenante (EA) sur la performance des innovations des produits (PIP). Il vise également à explorer les effets modérateurs de la turbulence de l'environnement, de l'intensité exportatrice et du soutien public à l'innovation sur ce lien. Nous utilisons la méthode des équations structurelles avec la technique des moindres carrés partiels pour vérifier nos hypothèses sur un ensemble d'entreprises de biotechnologie en France. Les résultats sont généralement en ligne avec les prédictions théoriques et mettent en relief le rôle clé que joue l'EA pour la PIP.

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ABSTRACT

This paper examines the role played by the learning organization culture in generating product innovation performance. It also aims at assessing the moderating effects of environmental turbulence, export intensity and public innovation support on the aforementioned relationship. We use structural equations modeling with partial least squares technique to test our hypotheses on a data set from the French biotechnology industry. The results generally support theoretical predictions and emphasize the key role that learning organization has for product innovation performance.

Keywords: learning organization, product innovation performance, environmental turbulence, export intensity, public innovation support.

RÉSUMÉ

Ce papier examine l'impact du fonctionnement en entreprise apprenante (EA) sur la performance des innovations des produits (PIP). Il vise également à explorer les effets modérateurs de la turbulence de l'environnement, de l'intensité exportatrice et du soutien public à l'innovation sur ce lien. Nous utilisons la méthode des équations structurelles avec la technique des moindres carrés partiels pour vérifier nos hypothèses sur un ensemble d'entreprises de biotechnologie en France. Les résultats sont généralement en ligne avec les prédictions théoriques et mettent en relief le rôle clé que joue l'EA pour la PIP.

Mots clés : entreprise apprenante, performance des innovations des produits, turbulence de l'environnement, intensité exportatrice, soutien public à l'innovation..

RESUMEN

Esta articulo examina el impacto del funcionamiento de la empresa aparente en el rendimiento de la innovacion de productos. Su objectivo es igualmente de explorar los efectos moderadores de la turbulencia del entorno, de la instensidad exploratoria y del apoyo publico a la innovacion en este enlace. Utilizamos el metodo de las ecuaciones estructurales con la tecnica de los mínimos cuadrados parciales para comprobar nuestras suposiciones en un grupo de empresas de biotecnologia en Francia. Los resultados son generalmente de conformidad con las predicciones teóricas y destacan la función clave que desempeña el empresa aparente a la el rendimiento de la innovación de productos.

Palabras Claves: empresa aparente, rendimiento de la innovación de productos, turbulencia del entorno, instensidad exploratoria, apoyo publico a la innovacion.

The literature on management points out the critical role that organizational learning plays in improving a firm's competitive advantage (Bolivar-Ramos et al, 2012). In this regard, the resource-based view postulates that the capability to activate learning processes is the basis of the strategic performance of firms (Lopez et al, 2005). Thus, in order to survive and thrive in a turbulent environment and in front of a tough competition, several authors advocate the model of the learning organization (LO) culture (Watkins and Marsick, 1996; Ortenblad, 2004). Its aim is acquiring, creating, disseminating, and transforming new knowledge in order to improve the firm's capabilities (Yang et al, 2004). LO models are usually presented as the antecedents of organizational learning, performance and innovation. The linkages between LO, performance and innovation have been the subject of several studies (Jiménez-Jiménez and Sanz-Valle, 2011). The pattern of results shows that the LO affects positively innovation, performance (Baker and Sinkula, 2002), and performance through innovation (Calantone et al, 2002).

Innovation is seen in many areas as the most critical driver of competitive success (Evanschitzky et al, 2012). Alegre and Chiva (2008, p.315) state: "Balachandra and Friar (1997)

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consider that the successful introduction of new products is the lifeblood of most organizations". Many companies earn more than a third of their profits from products introduced since less than five years (Schilling, 2005). This author reports that Baxter, a global leader in medical equipment, has achieved 37% of its sales in 2002 with products introduced after 1999. However, the number of companies that failed to meet targeted performance of new products is alarming (Evanschitzky et al, 2012). Over 95% of new product projects earn no return on investment (Schilling, 2005). According to Cooper (2011), several projects have never been completed, and among those completed, only 25% have succeeded to commercialize such products.

Calantone et al, (2002) define innovation as successfully implementing new ideas within an organization. Therefore, innovation is closely related to organizational learning and there seems to be an agreement that a learning orientation and firm innovation are highly linked (Calantone et al, 2002). In this regard, to foster product innovation performance (PIP), some authors have called for directing firms towards a learning organization culture (Baker and Sinkula, 2002; Alegre and Chiva, 2008). The basic assumption is that learning has a key role in enabling firms to make their innovation processes faster, more flexible and more efficient (Jimènez-Jimènez and Sanz-Valle, 2011).

Despite the abundance of theoretical developments and qualitative research, supporting the existence of positive relationships between LO and PIP, empirical studies, especially those quantitative, on the subject remain scarce. Therefore, further empirical analysis is a must as suggested by Calantone et al (2002), Alegre and Chiva (2008). Management literature assumes that organizational learning finds its legitimacy mainly in a turbulent environment, especially for companies that are active on a global scale. However, research that studies the likely intermediate effects of variables such as export intensity (EI) and environmental turbulence (ET) is still scarce and rarely simultaneously taken into consideration when studying the LO-PIP link (Tsai and Huang, 2008).

This paper seeks to fill these gaps in the literature by empirically assessing the impact LO culture has on PIP in a turbulent environment and providing new insights regarding the moderating role of export intensity on this link. To obtain more reliable results, we also aim at controlling the Public Innovation Support (PIS) effect on the LO-PIP link.

To this end, we use structural equations modeling with partial least square (PLS) approach to test our research hypotheses on a data set from the French biotechnology industry. Studies show that the United States is ahead of Europe in terms of turnover and investment in R&D (France Biotech, 2009). For instance, the United States has achieved 72% of the worldwide turnover of biotechnology in 2007 against only 21% in the case of Europe. More specifically, the challenge for the French economy is important since France, still lags behind, and occupies the third place across Europe behind the UK and Germany. Hence the importance of asking our research question in this area full of economic, societal and human promises and challenges to national economies.

The paper is divided into five sections. Section 2 presents the conceptual framework and hypotheses of the research. Section 3 describes the adopted research methodology. In section 4, the main results are presented. Finally, section 5 discusses the implications of the study, its limitations and makes proposals for future research.

Conceptual Background and Hypotheses

The Learning Organization Concept

The concept of the LO is rooted in managerial thinking of the seventies and eighties (Harvey and Denton, 1999). However, its first explicit appearance was in the early nineties with Peter Senge (1990) and his book "The Fifth Discipline".

An analysis of the definitions of this concept shows that the LO is one that promotes individual and collective learning in a global vision of continuous development (Watkins and Marsick, 1996). This learning takes place in a climate that is nurtured by the firm. In this way, individuals gain more efficiency and creativity yielding two phenomena. On one hand, the knowledge and skills of each individual become better and wider. On the other, the firm develops the ability to overcome challenges and transform itself permanently.

Neither can the LO be considered as a management technique, nor as an ideal organizational configuration that should be adopted (Ortenblad, 2004). It is rather a dynamic mode of organization characterized by general principles and is a management paradigm of a multidimensional nature involving a continuous co-evolution of people, teams and the organization (Yang et al, 2004). Several models of this concept have been proposed by some well-known scholars (Senge, 1990; Watkins and Marsick, 1996; Goh and Richards, 1997).

Our study is based on one of the most prevalent models in the literature (Ortenblad, 2004; Song et al, 2009). That is the model developed by Watkins and Marsick (1996): the Dimension of Learning Organization Questionnaire (DLOQ).

This choice is motivated by several reasons. First, the DLOQ covers dimensions of a LO at all levels. In fact, Redding (1997) evaluated some models of LO and stated that the DLOQ was the only model that covered all learning levels (individual, team and organizational). Second, Song et al (2009) indicate that this model includes most of the attributes of LO described in the literature since it takes into account models of Senge (1990), Pedler (1991), Garvin (1991), Goh and Richards (1997). Third, after doing a comprehensive review of literature on LO, Ortenblad (2004) suggested a typology that consists of four perspectives: organizational learning; learning at work; learning climate and learning structure. Among the twelve models evaluated by Ortenblad (2004), only that of Watkins and Marsick covers all these perspectives. Finally, Moilanen (2001) evaluated eight measurement tools of LO in terms of archetype, depth, scope and scientific validation. This author showed that the DLOQ obtained the highest score.

Watkins and Marsick (1996) defined the LO as "one that learns continuously and transforms itself. Learning is a continuous, strategically used process-integrated with and running parallel to work" (1996, p. 4). These authors identified seven dimensions that characterize firms striving to become LO. These seven dimensions and their items are presented in Appendix A.

The Product Innovation Performance

"Product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (OECD, 2005, p.156). The concept of performance means performing an action, the result arising from it or the success related to it. Understanding the relationship between innovation and performance in any type of organization has long been the subject of interest for researchers and managers (Jimènez-Jimènez and Sanz-Valle, 2011). The underlying rationale is that innovation is widely considered as a critical source of success, firm performance and its competitive advantage in an increasingly turbulent environment (Crossan and Apaydin, 2010).

The evaluation of the PIP questions the resources-results link. To this end, both academic and practitioners emphasize the importance of having a good measurement instrument of this concept. The PIP can be approached from a technical, financial, business, or global perspective (Storey and Easingwood, 1999). Although financial and business indicators are the most utilized in the literature, there is a call for more emphasis to adopt other types of indicators such as improved corporate image, the opening of new markets, customer satisfaction, etc. Several authors (Alegre and Chiva, 2008; Hsu and Fang, 2009) suggest that different aspects of the PIP are best reflected by a multidimensional measurement rather than by a unidimensional one.

To construct our measurement instrument of the PIP, we submit our extended understanding of this concept to a qualitative test with some R&D responsible. We selected three representative measurement terminology adopted by different authors to assess the PIP. The first terminology was proposed by Griffin (1997), Storey and Easingwood (1999), Hsu and Fang, (2009) and focuses on market and customer performance, financial performance, technical performance, and overall performance. The second terminology was proposed by Alegre and Chiva (2008) and consists of two dimensions: efficiency and effectiveness of new products. The third terminology is adopted by the OECD (2005). It focuses on innovation impacts related to the market demand, competition among other dimensions.

Environmental Turbulence

Environmental turbulence has been defined in many ways. Elbanna et al. (2013) indicate that it is the result of two components: hostility and uncertainty. A hostile environment is perceived as unfavorable to the mission of the company and its products. It is characterized, for example, by fierce competition, oppressive regulations and limited growth prospects. An uncertain environment is characterized by rapid change and the scarcity of information. For Gotteland and Boulé (2006), among turbulence characteristics, they cite complexity and dynamism. Complexity refers to the diversity degree of agents making up the environment and dynamism refers to the variation degree in the time of the components of the environment. Duncan (1972) had defined the turbulence of the environment as "the degree and frequency of exchange occurring over time to the firm's environment" (cited by Kim and Atuahene-Gima, 2010, p.523).

Regardless of the chosen definition, it is recognized, in the literature, that a turbulent environment induces increased difficulty of understanding and analysis. Moreover, the more dynamic, hostile, and uncertain the environment is, the more "informational sensitivity" increases. In fact, information held at a time "t" becomes less valid at a time "t +1", individuals and organizations suffering from cognitive limitations and resources to understand their environment, the quality of information cannot be fully assured (Gotteland and Boulé, 2006). This could have serious repercussions on the decisions and thus, negatively affects firm performance.

Learning Organization And Product Innovation Performance

Inkpen and Crossan (1995) see that the achieved performances are a reflection of the effectiveness and efficiency of learning processes within the firm. McKee (1992) understands product innovation as an organizational learning process and claims that directing the organization towards learning fosters innovation effectiveness and efficiency. Thus, Baker and Sinkula, (2002); Alegre and Chiva, (2008); Hsu and Fang, (2009) indicated that LO is a relevant framework for generating efficient product innovation. In what follows, we will describe the impact of DLOQ on PIP.

The underlying assumption for activating the first dimension of the DLOQ, ***continuous learning***, - which concerns learning at the individual level - is that firm learns as long as each employee is carrying a learning ability and creativity. As individual learning is supposed to improve the human capital of the firm, we can consider that a firm with a better employee quality will have higher product innovation performance because its manpower can bring skills and capabilities into full play (Hsu and Fang, 2009).

The second dimension of the DLOQ is ***inquiry and dialogue***. The more this culture is initiated; the better will be the relationship between employees (Alegre and Chiva, 2008). This could lead to build trust in the firm. Trust is crucial for better collaboration between employees. In this regard, Jacob and Turcot (2000) note that the higher the level of trust is, the more the tacit knowledge is shared and it becomes an asset to solve problems and leads to innovation. Calantone et al, (2002) showed that open mindedness positively affects the capacity of innovation.

Team learning is the third dimension of the DLOQ. The team, as a collective of individuals who identify themselves as part of this entity, is considered of strategic nature for its leading role in the acquisition, sharing and development of organizational knowledge (Senge, 1990). Analyzes of successful firms, both in terms of productivity and in terms of innovation, have shown that the transition from a work whose basic unit is the individual to another whose basic unit is the team is confirmed as one of the most important issues to master by companies (Jacob and Turcot, 2000).

The next dimension of the DLOQ is ***empowerment***. It is to create a work environment where employees have more responsibility and authority to act. Watkins and Marsick (1996) emphasize that LO should ideally develop a vision around which its members must unite. A common practice eliciting members to this vision is participative decision making. This practice promotes motivation, satisfaction and commitment to work and to innovate. The feeling of belonging and unity around common goals motivates members of the company to be voluntarily more committed in terms of learning and innovation by a constant effort to check their progress against the objectives that were set by themselves (Alegre and Chiva, 2008).

Embedded systems is the next dimension of the DLOQ. It consists in establishing a set of structures, procedures and tools to capture and share information and knowledge. Sharing learned knowledge is a fundamental means by which people can mutually exchange their knowledge to achieve innovation, and finally transform it into competitive advantage of the company (Calantone et al, 2002). Intra-organizational knowledge sharing can lead to respond faster to customer needs and to lower costs (Baker and Sinkula, 2002). Wang and Wang (2012) showed that the practices regarding the sharing of explicit knowledge positively influenced quality and speed-to-market innovations. They also showed that the practices regarding the sharing of tacit knowledge were positively related to the quality of innovations produced.

The dimension of ***system connection*** reflects that the process of innovation has become more open and interactive. This dimension refers to the consideration by the firm of all its partners, such as suppliers, customers, distributors, investors, etc. (Yang et al, 2004). This results in a relevant understanding of the needs of all its stakeholders. By seeking to satisfy these latter, the firm will be naturally led to improve the performance of its products. Furthermore, knowledge stemming from cooperation with universities and research establishments, from alliances and networks might be an important factor in the successful enterprise of innovation projects. Yang et al (2004) showed that this dimension was the most critical of what they call "the knowledge performance". This latter concept measures the improvement in products and services to customers and improvements in the intellectual abilities of employees.

The seventh dimension of the DLOQ model is ***strategic leadership***. It aims at stimulating strategically generalized and permanent learning processes in service of overall firm performance (Song et al, 2009). Several authors (Garcia-Morales et al, 2012) see that transformational leadership is the most suitable for the dynamics of organizational learning. It refers to the ability of the leader to lead his subordinates to transcend their personal interests and to transform their beliefs, needs and values on behalf of a collective vision. Chen et al (2012) studied the impact of transformational leadership style on technological innovation and concluded on the existence of a direct and positive relationship. Garcia-Morales et al (2012) reported that this style of leadership positively affects the capacity and quality of innovation through organizational learning. Yang et al (2004) showed that strategic leadership has a direct positive impact on the financial performance of the firm.

The dimensions of the LO are interrelated and influence each other directly or indirectly (Watkins and Marsick, 1996). Therefore, the action on the learning process from one of these dimensions implies others (Yang et al, 2004). In this vein, several authors (Turcot and Jacob, 2000; Ortenblad, 2004) state that for an organization to be classified as a learning one, the fundamental criterion is the level of practice consistency between each other. Jacob and Turcot (2000) illustrate their remarks by the results of a meta-analysis on the effect of LO dimensions when deployed in a "systemic" way. The results of this study showed positive effects on several indicators like global performance, productivity and innovation. In conclusion, these authors point out forcefully that the implementation of some of these practices in isolation may not produce the desired effects. They suggest fewer practices to deploy, but that each level has to be affected by some practices. Calantone et al (2002) concluded that: on the one hand, the higher the level of learning orientation, the greater the degree of firm innovativeness; on the other hand, the higher the level of learning orientation, the greater the firm's performance. Alegre and Chiva (2008) showed that the more a firm tends towards the LO model, the more it is likely to achieve successful product innovations. Hence, we expect that the more a company tends towards the LO model, the more it is able to achieve high PIP. Thus, our first hypothesis is **H1**: *The higher the level of the LO, the greater the degree of PIP.*

The LO-PIP Link And Environmental Turbulence

Given that understanding the environment is critical for creating innovations, its turbulence could negatively affect the PIP (Gotteland and Boulé, 2006). Nevertheless, operating according to the principles of LO enables firms to have a certain understanding, a vision of reality that will enable them to interpret the signals from their environment and thus determine appropriate strategies (Calantone et al, 2002). Thereby, turbulence acts as a stimulant of the organizational learning process, which in turn positively affects firm's performance (Kim and Atuahene-Gima, 2010). In addition, it is suggested that in such environments, in order to crown innovation by a success, it must be connected to the organizational learning (Jimènez-Jimènez and Sanz-Valle, 2011). "Among the various forms of managerial efforts of firms facing turbulent environments, taking the initiative in learning about new market opportunities is more distinctive than others in relation to creating feature benefits for new products" (Kim and Atuahene-Gima, 2010, p. 523). These latter showed that the learning orientation-PIP link is positively moderated by environmental turbulence especially when firms are focusing on explorative learning practices. In this regard, we believe that the more the business environment is turbulent, the more the firms are brought to adopt the LO model. Consequently, the link LO-PIP will be more established. Thus, we propose the second hypothesis, **H2**: *The higher the level of environmental turbulence, the stronger the link between LO and PIP.*

The LO-PIP Link And Export Intensity

Many studies show that "exporters are more productive than non-exporters and these exporter performance premia tend to increase with the share of exports in total sales, there is evidence in favor of self-selection of more productive firms into export markets, but nearly no evidence in favor of the learning-by-exporting hypothesis" (ISGEP, 2008, p. 596). Recently, Love and Ganotakis (2013) have argued, given that productivity as a dependent variable is extremely heterogeneous, studying export-productivity link provides an indirect test of learning by exporting. "Since learning by exporting is about learning, a better measure of the possible effect would be one which embodies a learning outcome, such as innovation" (Love and Ganotakis, 2013, p. 3) and it is innovation, which in turn, determines firm performance. Organizational learning and functioning in a LO are important factors that may improve the performance of exporting firms (Bolivar-Ramos et al, 2012). Export activity is considered as a process of learning and knowledge accumulation during which firms exploit opportunities abroad (Alegre et al, 2012). More specifically, the studies argue that exposure to foreign markets with a wide range of cultural perspectives offers additional information not accessible to non-exporters and can enrich technological and marketing capital knowledge, which in turn constitutes the basis for innovations (Love and Ganotakis, 2013). Nevertheless, for a company to benefit in a sustainable way from learning opportunities provided by its international activities on one hand and to remain competitive in these markets on the other, it has a keen interest to work as a LO (Bolivar-Ramos et al, 2012). This will not only permit maintaining a given competitive position, but it will also serve to improve it, especially, through generation of appropriate innovations (Alegre et al, 2012). In this regard, Bolivar-Ramos et al (2012) state that companies with good absorption capacity will be better positioned to learn from international partners and to use the knowledge learned and incorporate it into their business process. Empirically, Salomon and Shaver (2005) found that learning by exporting improved product innovation. Alegre et al, (2012) showed that the LO increased export intensity via PIP. According to this latter reasoning, by making an instantaneous evaluation, it is expected that the relationship between LO and PIP will be more established for firms with high export intensity than for non-exporters or firms with low export intensity. Moreover, we argue that this latter relation will be stronger for firms with high export intensity especially in a turbulent environment. Thus, we propose to test the following hypothesis: **H3a:** *Export intensity moderates the link between LO and PIP;* **H3b:** *Export intensity moderates the link between LO and PIP in turbulent environments.*

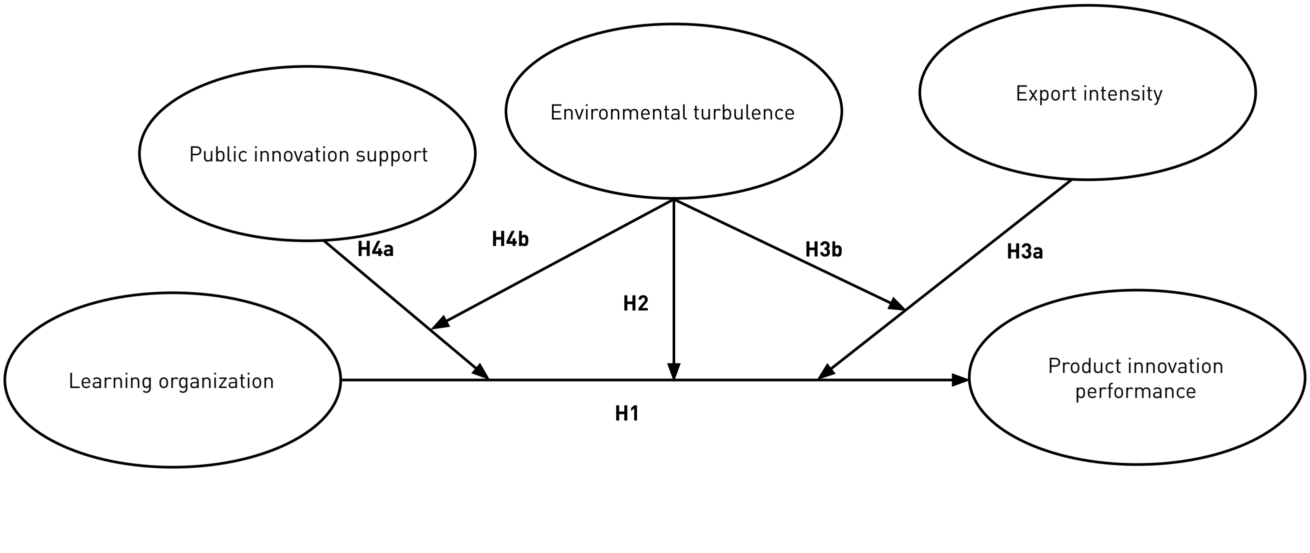
The LO-PIP Link And Public Support For Innovation

Broadly, the literature demonstrates that the effect of public innovation support (PIS) on innovation performance is potentially large (Lee and Wong, 2009). This impact can take place through different mechanisms such as the improvement of firm's knowledge, human, relational and financial capitals (Roper and Hewitt-Dundas, 2005). These mechanisms may then improve business performance and enhance the firm's ability to manage future innovative projects. The rationale for the provision of PIS is based "on the assumption that R&D conducted within firms will, directly or indirectly, stimulate innovation that leads to the production of new marketable products, processes or services" (Cunningham et al, 2013, p. 5).

Given the importance of PIS on the recipient firm, its impact may be obscured mainly if this variable is omitted from analyses relating LO to PIP.

Although little is known about the interaction effect between PIS and firm's internal factors on PIP, we can hypothesize that firms benefiting from PIS will have a stronger relation between LO and PIP. The main thrust of our study is that while LO significantly influences firm's PIP, the bundling of PIS with the firm's internal resources and capabilities (LO) provides the key to higher innovative performance. While external resources in the form of PIS will stimulate firms

CONCEPTUAL MODEL



to improve their innovative inputs in the form of R&D and innovative collaborations, the LO culture and its management practices themselves must be supportive of these inputs thus conducive to a better PIP. We think that PIS in a turbulent environment will have a stronger impact on the LO-PIP link. Based on the above discussion, we hypothesize: **H4a:** *Public innovation support moderates the link between LO and PIP*; **H4b:** *Public innovation support moderates the link between LO and PIP in turbulent environments.*

The conceptual model of this study is depicted in Figure 1.

Methodology

Measures

We used the LO measurement instrument (DLOQ) developed by Watkins and Marsick (1996). In this framework, LO is a second-order construct. Its first-order constructs are continuous learning (CL), inquiry and dialogue (ID), team learning (TL), embedded system (ES), empowerment (EM), system connection (SC) and strategic leadership (SL). Each of these first order constructs was measured by three items on a five-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The results of studies done to test the validity and reliability of the DLOQ have confirmed its applicability by providing internal consistency of each item's reliability and reliable factor structure of its dimensions (Song et al. 2009).

The measurement of the PIP was developed after submitting our extended understanding of this concept to seven interviews with R&D directors. Finally, this phase generated eighteen items based on their interviewee-rated importance. These items were classified into five dimensions: Market performance (MP: 5 items), financial performance (FP: 3 items), customer performance (CP: 3 items), technical performance (TP: 4 items) and strategic performance (SP: 3 items). This scale is largely inspired from the studies of Griffin (1997), Storey and Easingwood (1999), Hsu and Fang (2009). The PIP is conceptualized as a second-order construct and these latter dimensions constitute the first order constructs. We ask respondents to state the performance of their product innovation with regard to these dimensions on a five-point Likert scale ranging from "not achieved result" to "perfectly achieved".

Environmental turbulence was measured with four items, based on Pedon and Schmidt's (2003) instrument. The items in this instrument took the form of a five-point Likert scale ranging from "not turbulent" to "extremely turbulent". Export intensity is measured by the share of exports in total sales for a particular firm and PIS is measured by the number of public aids received by a given company.

Sample

We test the proposed model by focusing on the French biotechnology industry. France accounts for nearly 10% of worldwide turnover (Ricard, 2010). This area is a suitable ground for our problem because its companies are innovative in nature and their survival is dependent on their innovation performance. Biotechnology firms qualified as "technology-based" and "science-driven" belong to high-tech sector with high potential of growth (De Luca et al, 2010). Liao et al (2010, p.3792) suggest: "Organizational learning, especially in knowledge-intensive industry, not only leads to organizational innovation, but also becomes the only sustainable competitive advantage".

French biotechnology firms are classified in the national database of biotechnology, which was created in 1999 at the initiative of the Ministry of Higher Education and Research. At the time the research was carried out, this database included 808 biotechnology manufacturing firms. In order to obtain a homogeneous sample, we defined the profile of targeted firms. Indeed, are included in this study firms with at least three years of existence. This criterion is based on OSLO manual (OECD, 2005) advocating that since innovation is a time dependent process, it is recommended to take three year period into account to evaluate innovative, scientific and technological activities. Similarly, a small staff number reduces interpersonal interactions and thus weakens the learning potential of a firm. Are then excluded very small enterprises whose workforce does not exceed ten employees. Our final target population included 798 firms. The questionnaire was addressed to R&D directors since they are responsible for all activities regarding innovation and know the overall strategies in their firm. Fieldwork was carried out from February to April 2012. The survey was conducted in two phases. Each respondent received an introductory letter explaining the purpose of the study and a questionnaire by email.

Our final sample consists of 100 companies. Several characteristics of our sample are consistent with those of biotechnology firms in France and in Europe in general (France Biotech, 2009). This provides representativeness to our sample. This sample includes young companies (51% below 10 years), rather small (77% below 50 employees) and working mainly in red biotechnology (i.e., medical biotechnology) activities.

Analytical Procedures

In order to test the proposed model, we mobilize structural equation modelling (SEM) technique. SEM enables researchers to integrate unobservable variables (latent variables) measured indirectly by indicator variables. They also facilitate establishing relationships or structural equations among these latent variables. There are two types of SEM. Covariance-based SEM (CB-SEM) and Partial Least square (PLS-SEM). PLS, which is based on the Ordinary Least Squares (OLS) algorithm, was preferred as the methodological choice because of these reasons: First, it is in accordance with our objective, which focuses on prediction and explaining the variance of key target constructs (PIP) by explanatory construct (LO). Second, it is flexible in sample size and is not rigid with non-normal distributed data. Third, it is efficient in modelling hierarchical latent variables (second order constructs) and simultaneously assessing both measurement

TABLE 1
Psychometric properties of LO scale

First order constructs										Second order construct		
Constructs	CR	AVE	1	2	3	4	5	6	7	wheight	t-value	VIF
CL	0,768	0,694	**0,833**							0,196	10,725	2.366
ES	0,825	0,613	0,597	**0,783**						0,182	7,517	2.3
SC	0,856	0,666	0,509	0,607	**0,816**					0,196	10,103	2.436
ID	0,845	0,646	0,631	0,452	0,484	**0,803**				0,174	8,898	2.029
SL	0,890	0,730	0,580	0,685	0,675	0,368	**0,854**			0,171	7,212	2.715
TL	0,849	0,653	0,534	0,554	0,586	0,570	0,561	**0,808**		0,188	11,043	2.095
EM	0,849	0,654	0,524	0,471	0,612	0,402	0,583	0,553	**0,808**	0,164	11,179	1.931

TABLE 2
Psychometric properties of PIP scale

First order constructs								Second order construct			
Constructs	CR	AVE	1	2	3	4	5	loading	t-value	AVE	CR
MP	0,887	0,612	**0,821**					0,913	48,170		
CP	0,894	0,737	0,728	**0,858**				0,880	26,513		
FP	0,912	0,777	0,785	0,606	**0,881**			0,830	19,514	0,767	0,942
SP	0,889	0,728	0,772	0,778	0,692	**0,852**		0,905	40,738		
TP	0,879	0,645	0,704	0,734	0,561	0,710	**0,803**	0,845	23,507		

and structural complex models with reflective and formative variables (Chin et al, 2008). The software used in this study is SmartPLS package version 2.0.M3.

The estimation of PLS-SEM requires two steps: the evaluation of the measurement or "outer" models and the assessing of the structural or "inner" model. The measurement model determines the relationships between the latent variables and their indicators, whereas the structural model estimates the relationships between latent variables.

Results

Psychometric Properties Of Measurement Scales

Given that LO and PIP are two-second order constructs (LO with reflective formative model; PIP with reflective reflective model), assessing the measurement models, requires two steps: evaluation of first-order model and evaluation of second-order model.

First Order Constructs

To assess the convergent validity of the reflective measures, we evaluated, average variance extracted (AVE), factor loadings, and composite reliability. In PLS analysis, the loadings are interpreted as loadings in a principal component factor analysis (Chin et al, 2008). After having dropped two items (CL1 and MP5) because of their very small and insignificant loadings, for all first order constructs of LO and PIP, factor loadings (Appendix A) not only show values above the required thresholds of 0.7 (Hair et al. 2013), but are also significant (t>1.96).

As shown in table 1 and 2 respectively, for LO and PIP, the composite reliability (CR) exceeds the acceptable cut off point of 0.7 (Hair et al., 2013). For all constructs, the AVE is above the threshold of 0.5 (Hair et al., 2013).

To test discriminant validity, we use Fornell and Larcker (1981) criterion, which requests for a construct's AVE to be larger than the square of its largest correlation with any construct. All constructs satisfy this requirement (table 1 and 2). These results lend sufficient confidence that all first order constructs model fit the data well.

Second Order Constructs

For the second order of the PIP, reliability and convergent validity are well satisfied (table 2). Given that the relation between LO and its first order constructs is of formative type, criteria like reliability and convergent validity are not applicable and other quality criteria are required (Hair et al. 2013). Thus, we test for multicollinearity, as suggested by Hair et al, (2013). Multicollinearity does not play a role in the formative model as all variance inflation factors (VIF) are below the cutoff value of 5 (Table 1). Furthermore, all LO constructs have positive and significant weights.

TABLE 3
Discriminant validity of the model constructs

	LO	PIP	ET
CL	**0,812**	0,446	**0,247**
SC	**0,818**	0,409	0,142
ID	**0,702**	0,443	0,185
SL	**0,818**	0,331	0,255
TL	**0,783**	0,430	0,227
ES	**0,812**	0,391	0,292
EM	**0,730**	0,337	0,161
MP	0,452	**0,913**	0,019
FP	0,473	**0,829**	0,103
SP	0,435	**0,905**	-0,00
TP	0,394	**0,846**	0,095
CP	0,472	**0,881**	0,052
ET	0,279	0,059	**1**

In order to reduce model complexity, we averaged for each firm its environmental turbulence items in one indicator. Since the AVE for the formative model is not applicable, we used cross loadings of different constructs to test the discriminant validity of our research model (Hair et al, 2013). SmartPLS offers a table of cross loadings to test this feature. The interpretation of this table is similar to examining cross loadings in a traditional factor analysis (Hair et al, 2013). That is, indicators should load more strongly on their associated construct than on other constructs (i.e., the cross loadings).

As shown in Table 3, all indicators load more highly on their associated construct than on other constructs (loadings are higher than cross-loadings). Therefore, we conclude that the discriminant validity of our model is well fulfilled.

Test Of The Research Hypotheses

Having satisfied the requirement arising from measurement issues, the structural model was subsequently tested. The results with respect to H1 and H2 are presented in Table 4. Research hypotheses are tested by assessing the direction, strength and level of significance of path coefficients estimated by PLS, using a bootstrap resampling method with 1000 re-samples (Chin et al, 2008). We call the model without environmental turbulence "static model".

The Static Model

The coefficient on the path from LO to PIP is.51 (t = 5.63; t>1.96) suggesting that H1 is supported. The structural model explains 26% (R2) of the variance in the endogenous theoretical construct: PIP. Exceeding the cutoff level of 19%, R2 is quite good (Chin et al, 2008). The Q2 test for predictive relevance measures how well observed values are reproduced by the model and its parameter estimates (Hair et al, 2013). Since Q2 of the static model is positive (.19), we can say that it has an acceptable predictive relevance (Hair et al., 2013).

The Dynamic Model

With respect to H1, we consider the contingent effect of environmental turbulence (ET) on LO-PIP link (table 4). Given that a formative construct (LO) is involved in this model, it is recommended to use a two-stage PLS approach for estimating moderating effects (Henseler and Fassot, 2010). In the first stage (Main effects model), the effect of ET on PIP is run in order to obtain estimates for the latent variable scores. In the second stage (Interaction effects model), the interaction term LO*ET is built up as the element-wise product of the latent variable scores of LO and ET. This interaction term as well as the latent variable scores of the LO and ET are used as independent variables in a multiple linear regression on the latent variable scores of PIP. A moderator hypothesis is supported if the path coefficient from the interaction term to the dependent variable has the assumed direction and is significant irrespective of other effects (Henseler and Fassot, 2010). The assumed direction in our research model is not only very weak, but also non-significant (β=.028; t<1.96). Furthermore, the inclusion of the interaction term does not improve neither R^2 (26.8%) nor Q^2 (20.2%) of the PIP implying that H2 is not supported. As proposed by Sharma et al (1981, cited by Wilson, 2010) in such case we examine the regression coefficient of the moderator variable (ET) on the explanatory variable (LO). If this coefficient is significant, ET is an antecedent, exogenous, intervening or a suppressor variable to the relationship between LO and PIP. In our case, this coefficient is not significant. Thus, in order to make a further analysis a subgroup analysis needs to be proceeded with.

TABLE 4
PLS-MGA path modelling results

Model	Relation	Overall (H1, H2) (100)	Export intensity (H3)				Public innovation support (H4)			
			High (43)	Low (57)	Comparison test		High (54)	Low (46)	Comparison test	
					Parametric	Henseler			Parametric	Henseler
Static	LO-PIP	.510***	.655***	.368***	1.797**	2.071***	.469***	.461***	.371 ns	.364 ns
R^2		26%	43%	13.6%			23.9%	23.1%		
Q^2		19.8%	31.5%	10.3%			23.7%	22.8%		
Dynamic Interaction effects R^2 Q^2	LO-PIP	.535***	.514***	.359***	.681ns	1.170ns	.377***	.429***	.451 ns	.677 ns
	TE-PIP	-.092 ns	-.067ns	-.251***	-	-	-.191*	-.129*	-	-
	LO*T	.028 ns	.301**	-.187*	2.245***	2.924***	.322**	-.179*	2.295***	2.229***
	E-PIP	20.2%	48%	24%			27.2%	25.1%		
		20.2%	49.1%	24.3%			26.9%	24.8%		

*p<0.1 (one tailed) ; **p<0.1 (two tailed) ;***p<0.05 (two tailed) ; ns : no significant

Moderating Role Of Export Intensity

Given the dichotomous nature of the question we asked to determine the export intensity of the companies surveyed (The last three years, was the largest part of your turnover conducted nationally or internationally?), we used the technique of multi-group analysis (PLS-MGA) to test H3. "If one or both of the interacting variables is discrete, or can be made so, researchers can apply a 'multisample' approach, with the interaction effects becoming apparent as differences in parameter estimates when the same model is applied to different but related sets of data"(Henseler and Fassott, 2010, p.720). We estimated the path coefficients through PLS path modelling for each subsample. The differences between the path coefficients indicate whether export intensity acts as a moderating variable. The sample was split into two groups: high export intensity (43) vs low export intensity (57). The results (Table 4) indicate that for these two groups H1 is supported, but the LO-PIP link was stronger for the high export intensity group (β=.655; t=7.9). Similarly, the variance explained and the predictive relevance were better for this group (R^2=43%; Q^2= 31.5%).

We also studied the MGA under dynamic model. Results show that ET moderated positively the LO- PIP link (β=.301) for the high export intensity group. This link is negatively moderated by the ET for the other group (β =-.187). According to parametric and Henseler tests, export intensity represents a moderator variable in the static model (Δ=.287; t=2.071 and 1.797 for the Henseler test and the parametric test, respectively, p < 0.1 for both). Therefore, H3a was supported. Export intensity represents also a moderator variable in the dynamic model (Δ=.488; t=2.924 and 2.245 for the Henseler test and the parametric test, respectively; p <.05 for both). Therefore, H3b was supported.

Moderating Role Of Public Innovation Support (PIS)

PIS in the French context can take several forms such as grants, loans, R&D tax credits, subsidies. The French Association of Biotechnology (2012) reported that the research tax credit (CIR) and the "young innovative company" (JEI) are the most important forms of PIS. CIR is a tax reduction designed to promote R&D activities within French firms. JEI status consists of some tax and social security exemption for SME's that allocate at least 15% of their total costs to R&D.

In our study, firms having received at least one PIS represent 54% of the sample. Out of these firms, 48% received a research tax credit (CIR) or other fiscal or social exemption, 31% received grants, loans, repayable loans and loan guarantees, 25% received both types of PIS. We have used PLS-MGA to test H4. The sample was split into two groups: group one having received PIS (group 1; 54 firms) and group two having not received such support (group 2; 46 firms). The results (Table 4) indicate that for these two groups H1 is supported, the LO-PIP link was of very similar levels (β1=.469 vs β2=.461). MGA under dynamic model showed that ET moderated positively the LO-PIP link (β=.322) for the firms having received PIS. For the other group, this relationship is negatively moderated by the ET (β =-.179). According to the parametric and Henseler tests, PIS does not represent a moderating variable in the static model (Δ=.008; t=.364 and.371 for the Henseler test and the parametric test, respectively; p >0.1 for both). Therefore, H4a was not supported. But, PIS represents a moderator variable in the dynamic model (Δ= 0.501; t=2.229 and 2.295 for the Henseler test and the parametric test, respectively; p <.05 for both). Therefore, H4b was rejected.

Discussion

This study has shown that the DLOQ is an appropriate measure for LO in the French biotechnology sector. This is the first study validating the DLOQ in French context. This result is in line with previous studies done in a variety of contexts (Watkins and Marsick, 1996; Song et al, 2009) confirming the robustness of the DLOQ and lending further generalizability to it.

In addition, we have developed and empirically examined a measurement scale of PIP based on five dimensions: market, financial, customer, technical and strategic performance. If the stability of its structure should be tested on other samples, the proposed scale shows, at this stage of development, satisfactory psychometric qualities. Validation of the PIP scale as a multidimensional concept is in line with the work of Alegre et al, (2006). These authors showed that PIP can be modeled as a second order latent variable consisting of two dimensions: effectiveness and efficiency. It is worth mentioning that the PIP scale proposed by Alegre et al, (2006) has been validated originally in the French biotechnology sector. This gives more value to our study. Indeed, in addition to the validation of the same reasoning in the same context with similar results, our model goes deeper and is more comprehensive.

Furthermore, this research supports the viewpoint that innovation performance is dependent on the organizational learning abilities of the firm. Confirmation of H1 is consistent with theoretical developments of several authors (Baker and Sinkula, 2002; Alegre and Chiva, 2008; Hsu and Fang, 2009) arguing that adopting the LO culture is a critical factor for the development of successful product innovation. Otherwise, the LO dimensions are likely to generate a good level of PIP, when they are implemented together. Operating according to the LO principles provides the organizational framework for learning.

Learning as an organizational capability, combining tangible and non-tangible resources, is a strategic issue for firm performance. Ultimately, the survival of knowledge-intensive firms, such as biotechnology ones, is based on their organizational learning capabilities. That is to say their ability to create, improve, transform and exploit knowledge.

Environmental turbulence had no influence on the LO-PIP link in the general model (H2). This result contradicts what is stated in the literature (Kim and Atuahene-Gima, 2010). A possible explanation may be that the good level of LO had achieved the studied firms already allowed them to integrate ET to their daily business processes, to the extent that this variable is no longer a determining disability that may hinder their innovation activities and performance.

The PLS-MGA showed that this latter result should be seen under a contingency relationship. Indeed, the LO had shown its value especially for highly exporting firms. Our findings, in line with Alegre et al. (2012), show that, for highly exporting firms, the LO is more likely to improve PIP. Thus, it is strategic for internationally active firms to adopt the LO in order to generate successful product innovation. Operating as a LO had demonstrated its importance mainly for the highly exporting firms under environmental turbulence. Otherwise, environmental turbulence, as a stimulant of the organizational learning process, positively moderates the LO-PIP link especially for heavy exporters. PIP was explained as a direct function of the LO only for these latter firms. Thus, there are other explanatory factors, not taken into account here, such as R&D efforts.

We have shown that PIS had no effect on the link LO-PIP. Indeed, there were no significant differences in path coefficients of the firms having received PIS (group 1) and those having not received it (group 2). This result may be explained by the fact that firms of the second group are of larger size. Because they usually have more resources to invest in innovation, larger firms depend on PIS less than smaller firms. PIS has demonstrated its value mainly when the environment is turbulent. In fact, operating as a LO in a turbulent environment affects positively (negatively) the PIP for the group having (not) received PIS. This means that, in a turbulent environment, the effect of age is mitigated and that what makes the difference is the public innovation support. One possible explanation for the negative effect of LO * PIS on PIP for the second group is that facing hostile, complex and dynamic environments, which require more flexibility, large firms might be less willing to respond quickly and effectively. On the other hand, the combined effect of the LO with PIS was able to cope with the turbulence of the environment and to exploit it in stimulating the PIP. Hence, it is important to leverage the PIS for both small and large companies in order to improve the LO effect on PIP.

In summary, the present study contributes to the literature, first, by examining the links between learning organization and product innovation performance and, by using broad measures of them. Second, it provides additional evidence to previous literature that learning organization has a positive effect on product innovation performance. Third, it contributes to the literature by analyzing the likely moderating effect of export intensity and public innovation support under static and dynamic models (i.e: under environmental turbulence) on the relationship between LO and PIP. The results show that the LO-PIP link should be seen under contingent models. On one hand, this link was stronger for highly exporting firms under static and turbulent environments. On the other, it was moderated by the PIS only under environmental turbulence. Fourth, we have shown that the universality of the LO is relative. Indeed, MGA have shown that PIP produced by firms was not always strongly explained by the LO. The effect of other variables on the PIP is obviously to be explored. Finally, the present study uses a sample of French biotechnology firms, a context in which the empirical literature is especially scarce and difficult to access due to its informational sensitivity.

Beyond theoretical contributions, this work also presents some methodological contributions. First, the appropriateness of PLS in the treatment of a complex model, consisting of formative and reflective constructs, with a relatively small sample, demonstrates the flexibility of this technique and calls for a more frequent use of it in the estimation of structural equation models in management science. Second, using an innovative approach (Henseler test, 2010) to assess the moderation between two groups has demonstrated its validity, especially for non-normally-distributed data.

This work also provides managerial contributions. Since its results indicate that DLOQ is a valid and useful measure of LO characteristics, it can be used as a diagnostic tool for carrying out internal audits in firms seeking to move towards this model. The proposed product innovation measurement scale could be used by firms in setting goals or in a subsequent assessment of achievements in relation with new products. Managers have to be more aware that the generation of successful innovations is dependent, at least in part, on the ability of their firms to improve their organizational learning process and culture. Thus, they should take the seven dimensions of the DLOQ into account when setting their firms' innovation goals, especially when being internationally active under environmental turbulence.

This research presents a number of limitations, however. Because the study was carried out in the same environmental and cultural context, generalization of the results is relative. On the empirical side, a first limitation comes from the perceptual perspective of measures adopted in this research with a single respondent which could cause a bias of subjectivity. A second limitation is induced by the goodness of fit of the model with the PLS approach; even the index used to address this problem (GOF) is still controversial (Hair et al, 2013).

These limitations open perspectives for future research. First, in order to generalize the results, we can test the model based on objective measurements, especially in relation to the PIP, on larger samples and in other contexts. Then, as firms operate in a knowledge and technology intensive sector, we assumed that the generation of innovation is an inherent activity to their existence. In other traditional sectors, it would be better to test the ability of the LO to influence innovation before testing its effect in terms of performance. Finally, given that organizational learning requires time to take place, and as far as innovation affects the performance after a certain time, we believe that a longitudinal study would contribute to a better and a deeper understanding of the applicability of this research model.

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APPENDIX A

		ITEMS	OVERALL SAMPLE		
			MEAN	SD	LOADING
LEARNING ORGANIZATION	Continuous learning	People help each other learn	4,03	,717	-
		People are given time to support learning	3,67	,933	,822
		People are rewarded for learning	3,18	,999	,844
	Inquiry and dialogue	People give open and honest feedback to each other	3,57	,956	,849
		Whenever people state their view, they also ask what others think.	3,40	,953	,801
		People spend time building trust with each other	3,78	,927	,757
	Team learning	Teams/groups have the freedom to adapt their goals as needed.	3,26	1,041	,772
		Teams/groups revise their thinking as a result of group discussions or information collected.	3,83	,739	,767
		Teams/groups are confident that the organization will act on their recommendations.	3,40	,974	,878
	Embedded systems	My organization creates systems to measure gaps between current and expected performance	3,22	1,186	,745
		My organization makes its lessons learned available to all employees	3,62	1,052	,781
		My organization measures the results of the time and resources spent on training	3,27	1,221	,820
	Empowerment	My organization recognizes people for taking initiative	3,87	,928	,822
		My organization gives people control over the resources they need to accomplish their work	3,39	1,171	,743
		My organization supports employees who take calculated risks	3,51	1,049	,855
	System connection	My organization encourages people to think from a global perspective	3,72	,889	,821
		My organization works together with the outside community to meet mutual needs.	4,11	,852	,738
		My organization encourages people to get answers from across the organization when solving problems	3,99	,835	,881
	Strategic leadership	In my organization, leaders mentor and coach those they lead.	3,73	1,028	,858
		In my organization, leaders continually look for opportunities to learn.	3,69	,971	,849
		In my organization, leaders ensure that the organization's actions are consistent with its values.	4,19	,918	,855
PRODUCT INNOVATION PERFORMANCE	Financial performance	Profits attributable to new products are higher than those provided by the remaining products	3,25	1,104	,808
		New products have achieved the objectives set in terms of profit	3,30	1,005	,911
		New products have achieved the objectives set in terms of return on investment	3,22	,949	,920
	Market performance	New products sales are greater than those provided by the rest of the products	3,06	1,196	,770
		New products have achieved the objectives set in terms of sales	3,18	1,019	,890
		Compared with other products of your company, new products have achieved superior results in terms of market share	3,21	1,018	,839
		New products have achieved the objectives in terms of market share	3,12	1,018	,780
		New products have allowed the penetration of new markets	3,63	1,041	-
	Customer performance	Customers are satisfied with the performance of new products	3,85	,978	,883
		Compared with other products of your company, customer complaints regarding new products are fewer	3,69	,986	,871
		New products have improved customer loyalty	3,28	1,045	,819
	Technical performance	The quality of new products is better than the rest of the products	3,25	1,104	,772
		New products are launched in the deadlines	3,06	1,153	,878
		New products are launched within budget Development Goals	3,14	1,239	,810
		New products have reduced environmental damage, improved health and safety	3,46	1,147	,746
	Strategic performance	New products provide the company a competitive advantage	3,98	1,044	,852
		New products have reached all the goals set	3,18	1,175	,809
		New products have improved the reputation of the company	3,91	1,006	,894
Environmental turbulence		Market turbulence	4,05	,851	-
		Competition turbulence	3,97	,979	-
		Legal turbulence	3,94	1,071	-
		Technological turbulence	4,21	1,013	-