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Innovation and operative real options as ways to affect organisational learning

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Abstract: This paper examines the influence of the innovation process on organisational learning. To achieve this goal, we decompose innovation into two components, innovativeness and the capacity to innovate. This paper proposes theoretically the concept of Operative Real Options (OROs) and empirically seeks to measure their influence on the relationship between innovation and organisational learning. Using empirical data gathered from 204 Chief Executive Officers (CEOs) in European firms, the findings support the hypothesis that innovation and its two components improve the learning process in the organisation. However, we do not find support for the hypothesis that OROs moderate the relation between innovation and learning.

Keywords: organisational learning; innovation; innovativeness; capacity to innovate; Operative Real Options; OROs; flexibility.

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1 Introduction

A new horizon is currently appearing in the business world due to technological changes, the development of knowledge and the evident globalisation. These issues are modifying the traditional competitive methods, giving firms a wider variety of growth options but also confronting them with constant, intense and unpredictable environmental changes. One way to succeed in an uncertain business world is through organisational learning. A study of the literature shows that few topics have enjoyed a greater consensus than organisational learning. Fiol and Lyles (1985) defined it as “the process of improving actions through better knowledge and understanding”. Learning is more of a need than an option. In organisations, learning is at the heart of company management and has become the essence of productive activity. No organisation will admit to ignoring learning, since this would be akin to allowing its demise (Lloréns-Montes *et al.*, 2005).

Over the past decade, organisational learning has been established as an important capability for achieving competitive advantage (Slater and Naver, 1998). Organisations seek combinations of resources and capabilities that facilitate and favour the organisational learning process. Inarguably, innovation is an important issue in organisations that are moving in turbulent environments. It is a strategic option for improving the organisation and making it more competitive and may even open the door to competitive advantages in both global and international markets. Applying the logic of Hurley and Hult (1998), we divide the process of innovation into two different stages: innovativeness and the capacity to innovate. Innovativeness is the notion of openness to new ideas as an aspect of a firm's culture. The purpose of the capacity to innovate is the ability of the organisation to adopt or successfully implement new ideas, processes or products.

Both the academic and professional circles provide a great deal of evidence concerning the relevance of real options. We understand real options as the company's right – not duty – to incur risk in an investment, paying a certain amount of money at a particular moment in time (Amram and Kulatilaka, 1999). Real options are directly related to strategic flexibility (Trigeorgis, 1993; Dixit and Pindyck, 1994). Companies must be flexible to handle unpredictable and discontinuous environmental changes. The growth of competition and the increased demand by consumers require that companies act rapidly to respond to market changes. The entry of new products and services in the global market is necessary because of the high number of competitors and the increasing importance of innovation.

The objective of this paper is threefold. First, this research empirically examines the influence that the process of innovation – understood as two stages, innovativeness and the capacity to innovate – will have on the organisational learning in companies.

Second, we propose theoretically the concept of Operative Real Options (OROs). Third, we attempt to empirically measure the influence of OROs on the relationship between innovation and organisational learning.

2 Conceptual framework

2.1 Organisational learning

The concept of learning has been defined in a wide range of literature (Levitt and March, 1988). It developed primarily in the field of psychology and has been understood from various perspectives. One of these, the knowledge management approach, defines organisational learning as “changes in the state of Knowledge” (Lyles, 1988). Organisational learning involves knowledge acquisition, dissemination, refinement, creation and implementation (Wang and Ahmed, 2003). It is shared or distributed among the members of the organisation and the learning outcomes are embedded in the organisations’ systems, structures and culture. Organisational learning can be internal and external. Internal learning is the generation of new knowledge in the organisation through methods such as Research and Development (R&D), training and production experience. Internal learning includes both individual learning and organisational learning as a whole, while external learning refers to the process of bringing knowledge that is outside the organisation’s boundaries into the organisation and integrating it into the organisation’s internal knowledge base.

2.2 Innovation

It is difficult to find an industry that is not engaged in continuous or periodic innovation and reorientation due to the dynamic nature of most markets. Innovation can be defined as the adoption of an idea or behaviour that is new to the organisation and as “a critical mechanism through which firms secure a place in the competitive world of the future” (Van den Ven, 1986). This definition is sufficiently general to apply to the generation, acceptance and implementation of new ideas, processes, products or services. Thus, innovation can be either incremental or radical. Incremental innovation involves refining, improving and exploiting an existing technical trajectory. In contrast, a radical innovation disrupts an existing technological trajectory (Koberg *et al.*, 2003).

Innovations are delineated into three domains: organisational, products and services and process. This study analyses innovation mainly from the process and the products and services perspectives.

Zaltman *et al.* (1973) suggested that the two different stages of the innovation process are initiation and implementation. A critical part of the initiation stage is the openness to innovation, which is determined by whether the members of an organisation are willing to consider adopting or are resistant to innovation. Hurley and Hult (1998) introduced two innovation constructs: innovativeness and the capacity to innovate.

Innovativeness is a measure of the organisation’s orientation towards innovation. Van de Ven (1986) referred to this as the management of the firm’s attention in order to recognise the need for new ideas and action in the organisation. Innovativeness reflects a firm’s tendency to engage and support new ideas, novelty, experimentation and creative processes that may result in new products, services or technological processes.

The capacity to innovate is the ability of the organisation to adopt or successfully implement new ideas, processes or products. The innovativeness of the firm's culture acts in concert with the various structural properties of the company to affect the innovative capacity of the organisation.

2.3 *Real options*

In the field of finance, Myers (1977) was the first to suggest the term and practice of real options when referring to the use of financial options in evaluation techniques to determine the value of investment projects. The concept of a real option, in which the option is a real asset, is derived from a theory developed in finance to account for the value of financial option contracts (Black and Scholes, 1973). In the academic field, both the term and practice were rapidly accepted. Thus, the development of real options has been studied both in research reviews (McDonald and Siegel, 1984; Pindyck, 1991; Dixit and Pindyck, 1994; Trigeorgis, 1993) and in practitioners' manuals (Copeland and Weston, 1982; Trigeorgis, 1996). In the corporate world, real options are not fully accepted because of the complexity of the mathematical calculations and the fact that this relatively new concept runs contrary to the traditional business practices. Hence, real options is a conceptual approach to strategic investment that takes into account the value of preserving the right to make future choices under uncertain conditions. Furthermore, real options are created to fill the gaps left by the traditional methods for evaluating investments, the Net Present Value (NPV) and Discounted Cash Flow (DCF), which continue to be the most commonly used techniques used by Chief Executive Officers (CEOs) (Bierman, 1993; Bruners *et al.*, 1988). Due to the complexity and difficulty of the calculations, not all CEOs apply theoretically specific methods to evaluate their investments. However, CEOs are conscious of the existence and importance of strategic flexibility; they do use real options in an intuitive or qualitative way (McGrath and Nerkar, 2004). Managers can account for managerial flexibility by using decision trees (Hamilton, 2000), qualitative scoring models or better-informed managerial intuition (Fichman, 2004).

Applying useful criteria which provide flexibility to users (Trigeorgis, 1996), we can consider different types of real options. Organisations have the possibility of deferring investment for some months to benefit from the resolution of uncertainty during this period (Paddock *et al.*, 1988; Demers, 1991), of staging investment, viewing each stage as an option on the value of the subsequent stages and, thus, valuing it as a compound option (Majd and Pindyck, 1987; Trigeorgis, 1993), of interrupting production by temporarily shutting down the productive process when the obtained outcome is insufficient to cover the operative costs (for example, the maintenance cost) and restarting production when the situation has been solved (Trigeorgis and Mason, 1987). Organisations can even permanently abandon the project if the market conditions severely decline (Trigeorgis, 1993; Myers and Majd, 1990). Once the investment from the initial project has been made, firms will be able to invest new capital and launch new products in new markets if the situation is favourable, while they are not being forced to invest in the opposite case (Trigeorgis, 1996).

Organisations may react in different ways according to the evolution of the market. If the market conditions are more favourable than expected, firms can expand the scale of production or accelerate their resource utilisation. If the conditions are less favourable, organisations can reduce their scale of operation to limit the loss of money

due to underused resources. The first case represents an option of firm expansion, whereas reducing the scale of operations involves an option to sell part of the project. Furthermore, if the prices or the market demand change, the management can alter the output mix of the facility (product flexibility). The value of this option is the flexibility of the firm to modify the mix of products offered, generating more profitable outputs. Finally, organisations can produce the same outputs using different types of inputs (process flexibility), such as a cheaper productive process (Kulatilaka and Trigeorgis, 1994).

We present here a group of real options that we call OROs, since they are related to the management's flexibility to make positive changes in the management operations in response to the market opportunities or threats following environmental changes. These options are the latent opportunities in an investment. If exercised, they increase the possibility of achieving a competitive advantage (McDougall and Pike, 2003).

3 Hypotheses

The concept of organisational learning, which continually strives to develop the organisation's people and processes, is now accepted by many researchers as a competitive necessity in today's business environment. Organisations are increasingly challenged to encourage learning. Moreover, it is widely stated that knowledge creation and continuous learning at the individual, team and organisational levels may be the only source of sustainable competitive advantage. The organisations of the future will not be able to expand into new markets and win market shares unless they have a coherent framework (technologies, people, processes and methodologies) to systematically and effectively use their past knowledge to gain a competitive advantage. Companies will have to expand their organisational learning in order to facilitate change and enable the organisation to gain a leadership position (Wang and Ahmed, 2003).

The organisations attempting to develop organisational learning as a source of competitive advantage must also develop other types of distinctive capabilities that facilitate this process. In the prevailing global business environment, organisational learning, knowledge management, strategic flexibility and innovation are increasingly viewed as the main strategic elements of sustainable competitive advantage. The classic organisational learning model focuses on the continuous transformation of a business.

3.1 Learning and innovation

Innovation has been understood as necessary for organisations that want to remain competitive in constantly changing markets. Innovation is understood as an embedded process within a knowledge context, in which the exchange of learning and technical sources is elementary. On the other hand, the organisational learning focus needs to incorporate the perspective of creative innovation as a strategic orientation to sustain competitive advantage (Wang and Ahmed, 2003).

According to Boer *et al.* (2001), there are two fundamental streams of thought in the relationship between innovation and learning. The first analyses product innovation as a natural learning process. The second emphasises the product innovation process. Learning is seen as essential for the improvement and dissemination of new knowledge

throughout the rest of the organisation (Salavou, 2004). Innovation would be one of the tools for achieving the development/improvement of learning in the organisation and this learning would, in turn, contribute to the survival and improvement of the firm. Teece (2000) justified innovation as a necessary asset for knowledge development and, therefore, an asset for organisational learning. Knowledge management – which is broadly concerned with the competences, capabilities and learning processes that comprise an organisation's learning assets – takes a keen interest in sustainable innovation (Simpson, 2002).

Hypothesis 1a *In high-technology companies, innovation is positively related to organisational learning.*

Our review of the literature shows that some authors distinguish between innovation and innovativeness, while others use the terms interchangeably (Damanpour, 1991). In this paper, innovation and innovativeness are understood as two different concepts. We define innovation as “the generation, acceptance and implementation of new ideas, processes, products or services”. Innovation is a process with two different stages. The first stage, the disposition to innovate, is currently known as innovativeness. The second stage is the capacity to innovate, which we conceptualised as the ability of the firm to implement new ideas, processes, products or services (Hurley and Hult, 1998). Innovativeness appears to embody some kind of measurement contingent on an organisation's tendency towards innovation, whereas innovative capacity seems to incorporate the adoption and/or implementation of new definitions in subjective ways (Salavou, 2004).

Nieuwenhuis (2002) argued that innovation strategies and learning processes are related. An organisation can be distinguished by four processes:

- 1 formal R&D
- 2 informal knowledge diffusion through journals and organisations
- 3 learning by doing and by using innovation in problem-solving behaviour
- 4 purchasing knowledge through machinery and tools.

In all such cases, organisations and their members must be predisposed to these changes: they must develop what is known as innovativeness. All of the changes will develop learning in the organisation. Innovativeness reflects a firm's tendency to engage in and support new ideas, novelties, experimentations and creative processes. If the members of an organisation are willing to consider adopting an innovation, organisational learning will be positively influenced.

Hypothesis 1b *In high-technology companies, innovativeness is positively related to organisational learning.*

Firms with a greater capacity to innovate will be more successful in responding to their environments and developing new capabilities that will allow them to achieve a competitive advantage and higher performance (Hurley and Hult, 1998). The capacity to innovate will require the preparation of some resources and capabilities for use, that is, new techniques to implement the new processes, develop new ideas and create new products and services. The firms endowed with such resources and capabilities can

innovate more economically and with a greater probability of success. They may also have more effective routines in place for scanning and evaluating opportunities (Fichman, 2004), which will improve the firm's organisational learning.

Hypothesis 1c In high-technology companies, the capacity to innovate is positively related to organisational learning.

If we compare organisational learning to the two different stages of innovation, we can identify which stage will have a stronger impact on organisational learning. Amabile *et al.* (1996, p.1154) stated that "being oriented towards learning indicates an appreciation for and desire to assimilate new ideas". The capacity to innovate represents an adaptive and practically-driven orientation aimed at the practical implementation of the new idea, process or service. On the other hand, both organisational learning and innovativeness represent a cognitive, knowledge-driven orientation; both are aimed at knowledge acquisition and accumulation and at the development towards a change.

Hypothesis 1d In high-technology companies, innovativeness has a stronger influence on organisational learning than the capacity to innovate.

3.2 *Organisational learning, innovation and real options*

Learning breaks frames, challenges structures and routines and casts doubt on the knowledge that holds the organisation together (Fenwick, 2003). Many researchers indicate that if companies wish to improve in the long term, innovation cannot exist alone in the organisation, but must exist in a constant relationship with the processes of innovation exploitation, which begin with the disposition to innovate and adapt to the changes that may appear before and after innovation (Crossan *et al.*, 1999).

In high-technology sectors, where the environment is turbulent and where quick and intense changes often occur, firms must have a great capacity to adapt to changes and the flexibility to modify firm resources and capabilities. Strategic flexibility in organisations is a factor that facilitates the creation of a working environment where talents are developed for the benefit of the company (Kak, 2004). Real options are an important source of strategic flexibility. They enable firms to respond more readily to changing markets and technologies by rapidly creating product variations based on combinations of new or existing inputs, modifying the combinations of the offered products or changing the level of production or the technology involved in an investment.

A flexible approach aids the organisation in innovation and the speed in meeting the demands of today's rapidly changing technology environment. Being strategically prepared to utilise real options requires preparation for and disposition to change, since these qualities develop certain capabilities, behaviours and attitudes among the members of the organisation. Hence, the capacity to adapt to new processes, new products and new ways to work will improve the processes of organisational learning in the firm.

We propose a positive correlation between innovation and organisational learning. However, this relationship will be moderated by measures of OROs as a source of strategic flexibility. The link between innovation and organisational learning will be stronger for the firms that are able to change their process (process flexibility) or outputs

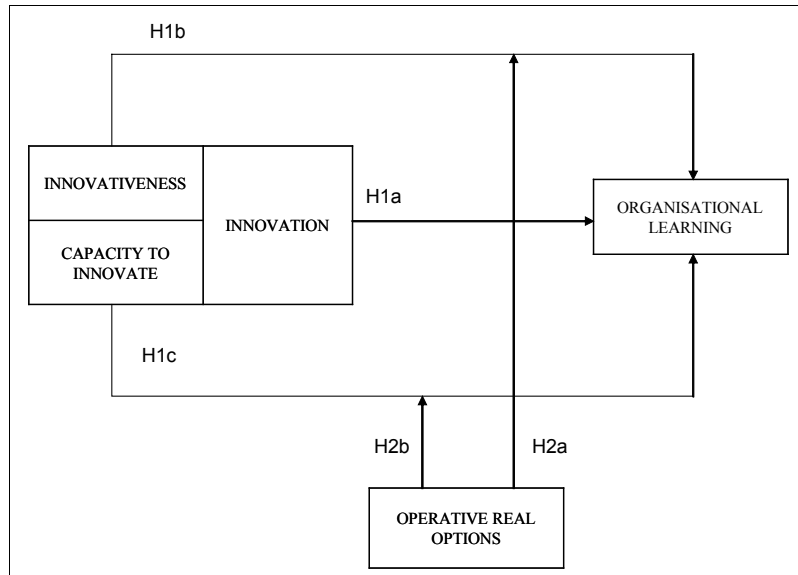
(product flexibility) quickly. As stated earlier, the capacity to innovate is the action, whereas innovativeness – or the disposition to innovate – is the state of the firm’s members. OROs, as an action, will influence the capacity to innovate more than the disposition to innovate.

Hypothesis 2a In high-technology companies, the relation between innovativeness and organisational learning will be moderated by OROs.

Hypothesis 2b In high-technology companies, the relation between the capacity to innovate and organisational learning will be moderated by OROs.

Figure 1 synthesises our theoretical model and presents our two propositions, the variables used and the relations established between them.

Figure 1 Innovation and operative real options as ways to affect organisational learning



4 Methodology

4.1 Sample and sampling procedure

This study focuses on the following high-technology sectors within the European Union (EU): telecommunications, chemicals and vehicles sectors, as well as the services related to these sectors. The choice of these sectors is based on the interest significance of studying real options in industries with a high technological component, for which innovation and organisational learning are of vital importance. We used the Amadeus database. The questionnaire was answered by the CEOs. The questionnaire was pretested on randomly selected plants from the list. From the sample of firms selected for the study, ‘1950’, 204 responded to the survey. Stratified sampling with proportional allocation was used on the business sectors related to high technology and on the

different member states of the EU. After two rounds of follow-up reminders, 204 useful questionnaires were received, representing a 10.42% response rate. The respondent firms were from different sectors and countries of origin, including the UK (33), Spain (62), France (13), Germany (18), Italy (20), the Netherlands (21) and Sweden (37).

4.2 Measures

The questionnaire was composed of five parts that included the different aspects we aimed to measure: organisational learning, innovativeness, the capacity to innovate, OROs and general company data for control.

4.2.1 Organisational learning

Various research studies have measured learning within organisations (Hurley and Hult, 1998). We used the first two items from the scale developed by Kale *et al.* (2000), due to the fact that they are closely linked to our research, that they reflect the different trends well and that the scale's validity was verified in detail. These items have been duly adapted to the present study. Two additional items that were formulated after a theoretical overview were included. The CEOs were asked to indicate the level to which they agreed or disagreed with the following statements:

- the organisation has learnt or acquired new and important knowledge in the last seven years
- the members of the organisation have learnt or acquired some skill or critical ability in the last seven years
- the organisation has been improved and influenced by the newly acquired knowledge in the last seven years
- our company is an organisation that learns.

We used a Likert-type seven-point scale (1 = totally disagree, 7 = totally agree). We validated our scale using a Confirmatory Factor Analysis (CFA) and showed that the scale was unidimensional with a high level of reliability ($\alpha = 0.854$).

4.2.2 Innovativeness

The perceptions of support for innovation (INN) were measured using a four-item scale put forward by Koys and DeCottis (1991) and is very similar to that used by Chandler *et al.* (2000). This scale has been used in other empirical studies (Verdú-Jover *et al.*, 2005). The perception of support for innovation is a measure of the organisation's orientation towards innovation. The CEOs were asked to indicate the level to which they agreed or disagreed with the following statements:

- we are willing to try new ways of working
- we encourage improvement in our ways of working
- we discuss new ways of approaching and solving problems
- the management helps to develop new ideas.

The respondents' answers to the scales used up to this point were reflected on a Likert-type seven-point scale, where 7 corresponds to 'totally agree' and 1, to 'totally disagree'. The values between 1 and 7 are chosen when the respondent's convictions cannot be placed at either of the extremes. We developed CFA to validate our scales and showed that the scale was unidimensional and reliable ($\alpha = 0.867$).

4.2.3 *The capacity to innovate*

A four-item scale was developed based on the work of Miller and Friesen (1983). These items are related to processes, products and services innovation and the use of resources specially dedicated to the Capacity to Innovate (CIN). In accordance with these items, the CIN variable was developed. Something is understood as 'new' when it makes a significant change in the sector, industry or market or in an individual company. The CEOs were to indicate the extent for the last seven years to which they agreed or disagreed with the following statements:

- the percentage of new products or services has rapidly increased
- the percentage of improved new products or services has rapidly increased
- the percentage of changes in the organisation regarding production techniques or the provision of services has rapidly increased
- regarding their competitors, the organisation has become much more innovative.

A Likert-type seven-point scale (1 = totally disagree, 7 = totally agree) was used. We validated our scale using CFA and showed that the scale was unidimensional with a high level of reliability ($\alpha = 0.880$).

4.2.4 *Operative real options*

To measure the existence of ORO in organisations, it is necessary to accept that, due to the importance of strategic flexibility, the CEOs use real options in an intuitive or qualitative way (McGrath and Nerkar, 2004). We asked the CEOs to describe the existence of real options in their companies, where real options are understood as the company's right – not duty – to incur risk in an investment, paying a certain amount of money at a particular moment in time. We then investigated:

- the option of companies to increase or decrease the scale, the level of production or the technology involved in an investment when the market conditions are more or less favourable than expected (Trigeorgis and Mason, 1987; Trigeorgis, 1996)
- the option to modify the combinations of offered products (production flexibility) to face variations in the prices or demand, with the aim of selling more profitable items
- the option to alter the inputs used in the processes (process flexibility) to confront the variations in prices or demand in order to buy cheaper or to optimise inputs (Kulatilaka and Trigeorgis, 1994).

We used a Likert-type seven-point scale (1 = totally disagree, 7 = totally agree) with these three items. We validated our scale using CFA and showed that the scale was unidimensional with a high level of reliability ($\alpha = 0.840$).

4.2.5 Control variables

We controlled for firm size and country. The number of employees on a log scale was used to control for firm size. Firm size is a commonly employed control to account for the firm effects that may affect the hypothesised relationships. We controlled for country influences, using a dummy variable for each area. Three areas were defined, according to the geographical and cultural criteria relative to the firms' countries of activity. We thus group the firms, distinguishing between the North European countries (UK – 33, Sweden – 37), the Mediterranean countries (Spain – 62, Italy – 20) and the Mid-European countries (France – 13, Germany – 18 and the Netherlands – 21).

5 Analysis and results

To determine the quality of the measurement model for the sample, we evaluated its psychometric properties using CFA and LISREL 8.30 (see Table 1). The constructs display satisfactory levels of reliability ($\alpha =$ Cronbach's alpha > 0.7), compound reliabilities (compound reliability > 0.7 , ranging from 0.80 to 0.86) and shared variance coefficients (shared variance > 0.50 , ranging from 0.50 to 0.63). Table 2 shows the descriptive statistics and correlations for the variables included in this study. Multiple regression and moderated multiple regression were used to test our hypotheses. In all cases, we controlled for firm size and the geographical area within the EU. No significant differences were found. The results of these analyses are shown in Table 3.

Hypotheses 1a, 1b and 1c posit a direct positive relationship between innovation (which we decomposed into two components, innovativeness and the capacity to innovate) and organisational learning. Both innovativeness and the capacity to innovate were entered into the model separately and simultaneously as independent variables. The hypotheses are supported if both variables are positively and significantly related to organisational learning.

In Model 1, we tested the direct effect of broad innovation on organisational learning. The results indicated that the effect of innovation on organisational learning is positive and highly significant ($R^2 = 0.438$; $F = 38.729$; $p < 0.001$), which enabled us to verify Hypothesis 1. In Models 2 and 3, we decomposed the concept of innovation and measured the direct effect of its components on organisational learning. When we considered only innovativeness as the independent variable (Model 2), the determination coefficient (R^2) was 0.382 ($F = 30.785$, $p < 0.001$), with significant t -student values for the variable of innovativeness ($\beta = 0.595$, $p < 0.001$). These results provide a strong support for Hypothesis 1b. When we took the capacity to innovate and organisational learning (Model 3), the R^2 was 0.296 ($F = 20.955$, $p < 0.001$), with significant t -student values for the variable of the capacity to innovate ($\beta = 0.468$, $p < 0.001$), thus verifying Hypothesis 1c. We found that innovativeness ($\beta = 0.488$, $p < 0.001$) contributes more than the capacity to innovate ($\beta = 0.310$, $p < 0.001$) to organisational learning. This supports Hypothesis 1d, that innovativeness will have a stronger influence on organisational learning than the capacity to innovate (Model 4).

Table 1 The validity, reliability and internal consistency of the measurement scales

Variables	Items	Validity, reliability and internal consistency		
		λ^*	R^2	AM
Organisational learning	OL1	0.79*** (22.87)	0.63	$\alpha = 0,854$ C.R. = 0,86
	OL2	0.78*** (22.13)	0.62	S.V. = 0.60
	OL3	0.80*** (23.07)	0.64	
	OL4	0.73*** (18.08)	0.53	
Innovativeness	INV1	0.78*** (22.55)	0.61	$\alpha = 0,867$ C.R. = 0.80
	INV2	0.75*** (20.37)	0.57	S.V. = 0.50
	INV3	0.80*** (24.28)	0.64	
	INV4	0.84*** (27.99)	0.70	
Capacity to innovate	CIN1	0.83*** (28.09)	0.69	
	CIN2	0.83*** (28.52)	0.69	$\alpha = 0,880$ C.R. = 0.80
	CIN3	0.78*** (22.60)	0.60	S.V. = 0.50
	CINV	0.81*** (26.10)	0.66	
Real options	ORO3	0.79*** (20.81)	0.62	$\alpha = 0,840$ C.R. = 0.84
	ORO6	0.81*** (22.06)	0.66	S.V. = 0.63
	ORO7	0.79*** (21.06)	0.63	

Notes: λ^* = Standardised structural coefficient. R^2 = Reliability. α = Cronbach's alpha.

C.R. = Compound Reliability.

S.V. = Shared Variance.

f.p. = fixed parameter.

A.M. = Adjustment Measurement.

*** $p < .001$ (two-tailed).

Table 2 The descriptive statistics and correlations among constructs

<i>N</i> = 204	Mean	Standard deviation	1	2	3	4
Organisational learning	5.4902	1.01676				
Innovativeness	5.4118	1.00684	.595(**)			
Capacity to innovate	4.9632	1.16808	.541(**)	.476(**)		
Operative real options	4.5670	1.37671	.418(**)	.334(**)	.368(**)	

Note: ** Correlation is significant at the 0.01 level (two-tailed).

Table 3 The regression results on organisational learning

<i>Independent variables</i>	<i>Organisational learning</i>					
	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
Constant	1.899*** (5.908)	2.233*** (6.831)	3.214*** (11.060)	1.770*** (5.449)	2.452*** (24.614)	
Innovation (INN)	0.710*** (11.820)					
Innovativeness (INNV)		0.595*** (10.454)		0.452*** (7.337)	0.421*** (2.897)	
Capacity to innovate (CIN)			0.468*** (8.465)	0.270*** (4.805)		
Controls						
Size	-0.211	-0.219	-0.92	-0.229	-0.258	-0.223
Country's dummies	Yes	Yes	Yes	Yes	Yes	Yes
ORO					0.31	0.521
INNV * ORO					0.25	
CIN * ORO						-0.72*
R	0.662	0.618	0.544	0.668	0.655	605
R2	0.438	0.382	0.296	0.447	0.428	366
R2 adjusted	0.426	0.370	0.282	0.433	0.411	347
F	38.729***	30.785***	20.955***	31.980***	24.614	18.959
Standard error	0.770	0.807	0.861	0.765	0.780	0.821
n	204	204	204	204	204	204

Notes: * $p < 0.05$; *** $p < 0.001$ (two-tailed).

T-students are shown in parenthesis below the variables.

To test Hypothesis 2, the moderation model, the interactions between the OROs and the components of innovation, innovativeness and the capacity to innovate, were included in the regression equation. Moderation will be supported if this model represents a statistically significant improvement over the model including only the direct effect. Models 5 and 6 present the regression model needed to test Hypotheses 2a and 2b, which state that OROs moderate the relationship between innovation components

and organisational learning. Model 5 includes the interaction terms between OROs and innovativeness, whereas Model 6 includes the multiplicative terms between OROs and the capacity to innovate. For the first case, the moderator effect of OROs on the relationship between innovativeness and organisational learning is positive, as expected, but nonsignificant. In the second case, there appears to be a negative interaction effect of OROs and the capacity to innovate on organisational learning. These results do not support Hypotheses 2a and 2b.

6 Discussion and conclusion

This article proposes two principles. First, it presents an empirical analysis of the influence of the innovation process on organisational learning by means of its two components, innovativeness and the capacity to innovate. Second, after introducing the concept of OROs, it measures their influence on the relation between innovation and organisational learning.

When we contrast Hypotheses 1a, 1b and 1c, the results indicate that innovation has a direct effect on organisational learning. Both innovativeness, defined as the organisation's tendency to innovate, and the capacity to innovate influence the improvement of learning in the organisation. As for Hypotheses 2a and 2b, the results of studying the moderator effect of OROs on the relation between the components of innovation and organisational learning do not support the position outlined by our hypotheses. Specifically, the results indicate that OROs, as a source of strategic flexibility, do not moderate the relationship between innovativeness and organisational learning. Furthermore, the effect of OROs on the capacity to innovate is negative. This means that for the firms in which these kinds of real options exist, the effect of innovation on organisational learning will be negative.

We feel that our results should be viewed with caution. While we have found general support for our approach to modelling OROs, innovation and organisational learning, the second proposition was not supported by the data. Although we cannot accept this hypothesis, we must attempt to understand the obtained results.

One possible explanation for our results could lie in the foundations of institutional theory. This line of research focuses, among other issues, on how structures and processes become institutionalised over time (Zucker, 1987). As we proposed in the theoretical framework, the existence of routines in the organisation, understood as "the repeated patterns of behaviour that are bound by rules and customs and that do not change very much from one interaction to another" (Cyert and March, 1963; Nelson and Winter, 1982; Levitt and March, 1988), can facilitate the process of transformation of innovation into learning, thanks to the standardisation and codification of processes (Mahajan *et al.*, 1990). However, standardisation is opposed to flexibility. OROs attempt to inject flexibility into the organisation, which opposes the process by which routines improve learning through innovation. The concept of routines can be related to the disciplinary perspectives that have analysed organisational learning over the last years, among others, the Production Management Perspective (Easterby-Smith, 1997). This perspective focuses on the idea that the production costs of any product decrease in proportion to the cumulative number of units produced (Buzzle and Bradley, 1987). This idea led to the 'learning curve', which assumes that the repetition of the process of production improves learning. OROs imply continual change in the process, the

kinds of inputs and the amount of resources. This constant variation in the processes used and the products and services offered can reduce organisational learning in innovator organisations.

Another possible explanation for the obtained results is based on organisational learning as a multidimensional construct (Akgun and Lynn, 2002). Our second proposition seeks the influence of certain real options on the relation between innovation and learning by studying this last construct from a global point of view. One dimension of learning is technological learning (Duncan and Weis, 1979; Fiol and Lyles, 1985), defined “as the acquisition and generation of explicit and tacit knowledge, which is used in improving either the development of new products, or the production of current products”. This concept is directly related to that of the proposed OROs. Future studies could analyse the influence of OROs on the relation between innovation and technological learning.

7 Limitations

This study has some limitations. First, in dealing with innovation, it does not take into account the distinction between incremental and radical innovation, but studies innovation in general. This limits the impact of each kind of innovation as a function of the organisation in which we find it, since some organisations only develop one kind of innovation. The same occurs with learning, which is also analysed from a global point of view. The generalisability of our findings is also somewhat limited. The scope of this research is only some of the high-technology companies in eight European countries. Future studies could extend this research to wider geographical and sectorial areas.

In the literature addressing organisational learning, innovation is described as the creation or discovery of a new solution, new approaches or new ideas. In contemporary environments characterised by uncertainty and instability, innovation, learning and flexibility will have greater importance. The organisations that prove to have superior abilities to manage exploration will be able to adapt better to changing circumstances. Flexibility plays an important role in directing organisational activities to achieve an optimum intellectual level in the pursuit of its goals.

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