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Research and technology organizations' mobilizers of the regional environment

Competitive strategies

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Abstract

Purpose – The purpose of this paper is to propose a contingent model that facilitates knowledge of the strategies followed by the research technology organizations (RTOs) of Valencia and the Basque Country, Spain, to adapt to the turbulence of their environment.

Design/methodology/approach – The research includes context, organizational and results variables and identifies some barriers that the RTOs encounter in collaborating with SMEs and also the best practices they follow to develop competitive advantages. The methodology used consisted of applying the proposed model to the 27 RTOs of both autonomous regions; a factor analysis was then performed to determine whether there exist groups of related (correlated) variables; finally, the authors proceeded to carry out a hierarchical cluster analysis to observe how the 27 RTOs are distributed according to their ability to adapt and respond to environmental turbulence.

Findings – The technological policy must consider the characteristics of each region to propose more efficient and equitable mechanisms that allow the RTOs to face new challenges.

Originality/value – This study proposes a theoretical model suitable for RTOs to respond to environmental changes, to the current economy globalization and to cope with new challenges. This proposal means that RTOs must manage an appropriate combination of key factors, including the development of more proactive innovation strategies, an organic organizational structure to relate better with other innovation agents and universities, which help them to work more efficiently with SMEs and to obtain a higher innovative performance.

Keywords Innovation strategies, Research technology organizations (RTOs), Turbulent environment, Challenges of the research technology organizations

Paper type Research paper

1. Introduction

The research technology organizations (RTOs) have evolved by implementing institutional reforms in order to improve their competitiveness and their contribution to innovation processes (Preissl, 2006). In Spain, the austerity policies and budget reductions, in addition to changes in traditional industries and globalization of markets, are questioning the sustainability of

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RTOs (FEDIT, 2012). For this reason, it is necessary that RTOs develop new approaches that allow them to overcome these difficulties (Marco and López, 1996; Holmström, 2006).

For this study, two regions were selected on the basis of the characteristics of their own business environments and RTO models: Valencian Community and the Basque Country. These communities are an interesting case for a comparative study in which the data of more than 80 percent of RTOs from both communities were analyzed. The two autonomous communities are facing these changes in the environment in different ways. Valencia, which through REDIT Technological Institutes network integrates 14 RTOs, is the region with the highest accumulated debt, and has seen maximum reduction in the staff of the RTOs and has been forced to close some of the RTOs. It therefore needs to reorganize the network to reduce costs (REDIT, 2011) and, therefore, make it sustainable and more competitive. Meanwhile, the Basque Country, with 19 RTOs integrated on two technology platforms, TECNALIA and IK4, is developing short-term strategies to strengthen its networks and internationalize them. (Comisión Europea, 2011). In this context, our paper sets out a question about what should RTOs do to adapt or respond to the changes in their environment? The goals of this paper, therefore, are proposing a contingent model that connects context, organizational and results variables and identifying barriers that influence unemployment and best practices of the RTOs.

This paper is divided into three parts. In the first part, an analytical framework of RTOs is developed, where a review is carried out of the academic literature that has studied this phenomenon in order to identify the variables that support the analysis and subsequent proposal of a model that explains the relation between them. In the second part, a model and research hypotheses are discussed. And in the third part, the methodology used and the results are described. Finally, the conclusions of the study are presented and discussed.

2. Analytical framework

A review of the literature on RTOs, which supports the proposal of a theoretical model to study the RTOs, is presented below.

2.1 RTOs: their role, strategy and new challenges

The RTOs were created as non-profit institutions, by means of private initiative and public support (Rush *et al.*, 1996; Santamaría *et al.*, 2002), or they were promoted by groups of related companies with common interests (Berger and Hofer, 2011; Leijten, 2007). They are intermediate institutions or interface structures, which support and strengthen the innovative activities of enterprises (Albors-Garrigós *et al.*, 2014; Aström *et al.*, 2008) through an offer of complementary technological training services on training, information, intermediation, technical advice, consultation and R + D + i services (Hervás *et al.*, 2012).

The RTO model is generally constituted by public capital and private resources derivative from strategic projects with client companies (Santamaría *et al.*, 2002).The RTOs play a very significant role in the R&D activities (Arnold *et al.*, 2010; Bienkowska *et al.*, 2010), and are considered as the main agent of territorial innovation (Albors-Garrigós, Zabaleta and Ganzarain, 2010; Mas-Verdú *et al.*, 2008; Martínez-Gómez *et al.*, 2009; Tann *et al.*, 2002).

The RTOs must have a clear strategic vision, which helps to meet the needs for innovation in the local industry (Arnold *et al.*, 1998; Leitner, 2005). This is the reason they use strategic planning as a key management tool (Rush *et al.*, 1996; Arnold *et al.*, 1998; Aström *et al.*, 2008).

The RTOs have several challenges to overcome: to strengthen their internal capacities, through the convergence of different technologies and disciplines (Leijten, 2007; Leitner, 2005), build networks to cope with reduced funding and the cost of the research (Loikkanen *et al.*, 2011), and improve their relation with universities and other innovation actors (Callejón *et al.*, 2007; Mrinalini and Nath, 2008).

2.2 Technological environment and competitiveness: strategies and organizational factors to cope with the turbulence of the environment (the contingent approach)

Organizations are constantly faced with the turbulence of the environment, which is the result of the convergence between dynamism, uncertainty and complexity (Tidd, 2001). Some authors (Emery and Trist, 1965; Silverblatt and Korgaonkar, 1987) have exposed that the internal differences in management models of the organizations can contribute to their failure and the way they face the turbulence of the environment. Other studies consider that the turbulence of the environment responds to external factors, such as demographic changes (McCann and Selsky, 1984), changes in the policies that regulate the markets and economic cycles, (Dwyer and Welsh, 1985) and technological changes (Taylor and Taylor, 2012), which generate technological turbulence and uncertainty associated with the adoption of technology (Freeman and Soete, 1999).

To cope with the turbulence of the environment, the contingent theory (Burns and Stalker, 1961; Khandwalla, 1972; Terreberry, 1968) proposes a more flexible or organic organizational structure, which is characterized by a low degree of formalization, horizontal communication and decentralized decision making. Another alternative for this theory is the strategic change. The reactive companies perceive changes and uncertainty, but do not respond effectively to them; thus the development of proactive and more flexible strategies is required (Teece *et al.*, 1997), which allow re-orientation and adapting to changes of the environment (Gordon *et al.*, 2000). Following this path, an organization will succeed to the extent that it can adapt to changes of its environment and survive. An organization strengthened through this approach can take advantage of the opportunities the environment offers.

Following this approach, the RTOs adapt more quickly to changes in the environment. The proper development of their activities will depend on strategic focus and organizational design (Modrego-Rico *et al.*, 2005), in which human resources play a key role (Silva and Ramírez, 2006). Hence, RTOs should promote the capabilities of their staff (Rush *et al.*, 1996; Mrinalini and Nath, 2008) and find a balance between the key variables such as environment, organizational structure and strategy in order to achieve optimal performance (Deutsch *et al.*, 2009; Rush *et al.*, 1996).

In this context, the most appropriate strategies for the RTOs are those aimed at boosting changes in the industry, through convergence and diversification of their technological offer (Leijten, 2007; Leitner, 2005), the strategies which help to overcome market failures (Modrego-Rico *et al.*, 2009), the strategies that allow RTOs to work effectively with SMEs (Aström *et al.*, 2008; Barge-Gil *et al.*, 2011), improve their relation with other innovation actors (Mas-Verdú *et al.*, 2008) and the ones which facilitate the internationalization process of their services and contribute to their sustainability (Berger and Hofer, 2011).

2.3 Relationships of the RTOs with other innovation agents: best practices

As part of the policy of promoting innovation, the RTOs have become an essential tool to reduce market failures that occur by information asymmetries (Barge-Gil and Modrego-Rico, 2008). In certain circumstances, the RTOs stand as key players in the territorial innovation system responsible for disseminating knowledge and providing support services and connectivity between SMEs and other innovation actors (Tann *et al.*, 2002; Martínez-Gómez *et al.*, 2009).

The RTOs are of vital importance to overcome the systemic failures of innovation systems. They are in charge of complementing the work of universities and other research organizations to conduct applied research, as they are strategic partners of companies with lower internal capabilities, such as SMEs (Roessl *et al.*, 2010; Barge-Gil and Modrego-Rico, 2007). According to the specialized literature (Aström *et al.*, 2008; Arnold *et al.*, 1998; Nath and Mrinalini, 2000; Rush *et al.*, 1996), the best practices of the RTOs, which help

increase their level of knowledge and improve their capability to respond to market, consist of bonds with companies, universities and other innovation agents.

The joint work between the RTOs, universities, other research organizations and industry helps create channels that facilitate the flow of information (Mrinalini and Nath, 2008), supports local industry and enables access to greater resources and participation in R&D projects internationally.

2.4 Services of the RTOs and barriers to the transference of knowledge and technology, especially to the SMEs

The RTOs work primarily with SMEs (Aström *et al.*, 2008; Barge-Gil *et al.*, 2011; Olazaran *et al.*, 2009; Zubiaurre *et al.*, 2004). One of the main functions of the RTOs is to transfer technology and knowledge to the environment and businesses (Leijten, 2007; Mrinalini and Nath, 2008; Martínez-Gómez *et al.*, 2009; Tann *et al.*, 2002).

The process of technology transfer is essential in the dynamics of innovation of the organizations (Albors-Garrigós *et al.*, 2009), in which the RTOs help companies identify sources of knowledge required to meet technological demand (Barge-Gil and Modrego-Rico, 2008) and optimize the interface between R&D/design and manufacture (Albors-Garrigós, Zabaleta and Ganzarain, 2010).

The literature identifies some barriers related to technology transfers between SMEs and RTOs (Modrego-Rico *et al.*, 2005). The SMEs, because of their size, are less likely to absorb the knowledge of their environment and to assume the costs associated with research, to access licenses or venture capital (Barge-Gil *et al.*, 2011). Also, they do not give priority to investments in R&D; therefore, a significant number of these companies do not have contact with the RTOs (Aström *et al.*, 2008; Olazaran *et al.*, 2009; Roessl *et al.*, 2010) . Therefore, the RTOs should provide technological solutions according to the needs of the SMEs (Zubiaurre *et al.*, 2004) and help them access sources of funding for their projects (Olazaran *et al.*, 2009). By combining different disciplines, the RTOs have the ability to generate and apply knowledge in SMEs (Mrinalini and Nath, 2008) and help them improve their absorption capacity (Albors-Garrigós, Zabaleta and Ganzarain, 2010; Hervás *et al.*, 2012; Intarakumnerd, 2011).

2.5 RTOs' performance indicators

In order to propose the measures of the results of innovation from the RTOs analyzed in this study, the body of literature related with innovatiive activity of RTOs object of public support was reviewed.

The studies of Modrego-Rico *et al.* (2005) in Spain and Silva and Ramírez (2006) in Brazil, consider operational, financial, relational and organizational factors and their relation with the results to measure the impact of the RTOs. Other studies (Modrego-Rico *et al.*, 2009; Barge-Gil and Modrego-Rico, 2011) measure the impact of RTOs on the environment in comparison with other innovation participants, such as universities, public RTOs and consultants. Finally, some other studies (Leitner, 2005; Nath and Mrinalini, 2000) suggest indicators to measure intangibles: knowledge transfer and innovation in the RTOs.

From a quantitative point of view, some authors (Albors-Garrigós, Zabaleta and Ganzarain, 2010; Aström *et al.*, 2008; Leitner, 2005; Modrego-Rico *et al.*, 2005; Nath and Mrinalini, 2000) proposed volume sales per employee as an appropriate indicator for establishing the result of the RTOs. Other studies have evaluated the combination of private vs public funding (or self-funding) to measure the cooperation of the RTOs and companies in Spain (Mora-Valentin *et al.*, 2004; Modrego-Rico *et al.*, 2005), as well as public funding as a paradigm of the performance of the RTOs in the Nordic countries (Bienkowska *et al.*, 2010) (Table I).

Internal impact Measurable by the RTO	External impact Measurable in the RTOs effects on the environment and its clients
Benchmarking practices related to knowledge transfer to industry	Technical impact: increased competitiveness, improvements in products, processes, logistics and patents
Intellectual capital, scientific personnel, management and composition of human resources	Economic impact: sales, production costs, productivity, jobs and number of customers
Process indicators: national and international projects and percentage of own research	Impact on investment in resources: investment in R&D, machinery, software, training in human resources management
Indicators of private financing, research or guidance with industry	Impact of intangible assets: new knowledge and external sources of knowledge
RTOs results indicators: patents, scientific publications, prototypes, spin-offs created, new jobs generated, new clients	Other impacts: satisfaction of RTOs in its client companies

Table I.
RTOs' performance indicators

3. Proposed model and hypotheses

On the basis of fieldwork and the review of the analytical framework discussed in Section 2, the development and proposal of a theoretical model[1] is analyzed below.

The proposed theoretical model[2] is composed of nine variables: the technological environment and market competitiveness (V1), public and private funding (V2), innovation strategy (V3), organizational structure (V4), focus and market orientation of the SMEs (V5), relationship with other innovation agents (V6), barriers that RTOs face in transferring knowledge and technology to the SMEs (V7), the innovative performance output (V8) and turnover per employee (V9). The following table describes the items that make up each of the variables of the proposed theoretical model, as well as the academic body of references which supports them, i.e. the source of their selection. In the methodology section it is explained how these variables were constructed (Table II).

The interaction between these proposed variables represents an appropriate scene in which the RTOs can cope with the turbulence and changes that occur in the environment. Figure 1 shows the simplified model, composed of nine variables studied.

The model proposes a balance between public financing, competitive and private funds (V2), the developing of more proactive strategies (V3) and organic organizational structures (V4), which will allow the RTOs to relate better to other innovation agents (V6), work effectively with SMEs (V5), and help these companies to overcome barriers related to their absorption capacity, the perception of risk by investing in technology, the lack of a culture of innovation and lower economic capacity (V7). With the right combination of these factors, the RTOs can better adapt to changes in their environment (V1), obtaining high outputs of innovation (V8) and economic results (V9) which contribute to their sustainability.

In order to support this relation between variables, three hypotheses are formulated considering the literature review and theoretical construct that supports the proposed model.

Morgan in his seminal publication "Imágenes de la Organización" (Morgan, 1986) proposes the organization as an open system that needs careful management to meet and balance domestic needs and adapt to the circumstances of the environment as proposed by the contingent theory. In this sense it could be concluded that the RTOs, like any organization, are conditioned by their environment. To survive in turbulent and dynamic environments, organizations should develop internal capabilities that allow them to be more

	Variable	Description values from 1 to 5	References
V1	Technological environment and market competitiveness. Data provided by the RTOs, and secondary sources (sectoral studies and technological observatories)	Technology uncertainty, market competitiveness, technology life cycle (stable vs turbulent environment)	Arnold *et al.* (2010), Barge-Gil and Modrego-Rico (2008), Callejón *et al.* (2007), Deutsch *et al.* (2009), Leijten (2007), Leitner (2005), Modrego-Rico *et al.* (2005), Roessl *et al.* (2010) and Rush *et al.* (1996)
V2	Public and private financing. Self-financing of the RTO Data provided by the RTOs surveyed and complemented by reports of FEDIT, REDIT, TECNALIA and IK4	Origin and percentage of funding (public – private, competitive – non-competitive)	Arnold *et al.* (1998), Aström *et al.* (2008), Barge-Gil and Modrego-Rico (2008), Cho *et al.* (2011), Leitner (2005), Loikkanen *et al.* (2011), Preissl (2006), Rush *et al.* (1996) and Santamaría *et al.* (2002)
V3	Innovation strategy of the RTO Data provided by RTOs surveyed	Motivation for the RTOs establishment, R&D activity, risk assumption policies, research freedom, pioneering. (proactive vs reactive)	Arnold *et al.* (1998), Aström *et al.* (2008), Intarakumnerd and Chairatana (2008), Intarakumnerd (2011), Leitner (2005), Nath and Mrinalini (2000), Rush *et al.* (1996) and Santamaría *et al.* (2002)
V4	Organizational structure of the RTO Data provided by RTOs surveyed	Hierarchy levels, organization structure, staff stability, working groups, decision making, personnel selection criteria, professional careers, salary policies (mechanical vs organic structures)	Callejón *et al.* (2007), Intarakumnerd (2011), Mrinalini and Nath (2008), Modrego-Rico *et al.* (2005), Olazaran *et al.* (2009), Rush *et al.* (1996) and Silva and Ramírez (2006)
V5	Orientation and approach to the knowledge transfer and technology to SMEs Data provided by the RTOs surveyed and information contained in the RTOs activity reports	Percentage of the main firm customers size SMEs – medium companies – large companies	Aström *et al.* (2008), Barge-Gil and Modrego-Rico (2008), Barge-Gil *et al.* (2011), Callejón *et al.* (2007), Hervás *et al.* (2012), Intarakumnerd and Chairatana (2008), Intarakumnerd (2011), Mas-Verdú *et al.* (2008), Olazaran *et al.* (2009), Santamaría *et al.* (2002), Sharif and Baark (2011) and Zubiaurre *et al.* (2004)
V6	Relationship with other agents of the innovation system Data provided by the RTOs surveyed and information contained in the RTOs' activity reports	Level and frequency of collaboration with other innovation agents (Regional, Spain and Europe)	Aström *et al.* (2008), Arnold *et al.* (2010), Barge-Gil and Modrego-Rico (2007), Berger and Hofer (2011), Callejón *et al.* (2007), Mrinalini and Nath (2008), Rush *et al.* (1996) and Zubiaurre *et al.* (2004)
V7	Barriers that the RTO finds to transfer knowledge or technology to SMEs Data provided by RTOs surveyed	The main barriers that RTOs encounter to work with SMEs: financial, innovative culture and SMEs technology absorptive capacity	Albors-Garrigós, Zabaleta and Ganzarain (2010), Aström *et al.* (2008), Barge-Gil and Modrego-Rico (2011), Barge-Gil *et al.* (2011), Callejón *et al.* (2007), Hervás *et al.* (2012), Intarakumnerd, (2011), Martínez-Gómez *et al.* (2009),

(*continued*)

Table II.
Variables of the theoretical model

	Variable	Description values from 1 to 5	References
			Mas-Verdú *et al.* (2008), Mrinalini and Nath (2008), Modrego-Rico *et al.* (2005), Nath and Mrinalini (2000), Olazaran *et al.* (2009), Roessl *et al.* (2010), Silva and Ramírez (2006), Tann *et al.* (2002) and Zubiaurre *et al.* (2004)
V8	Innovative performance (output) from the RTO's internal point of view Data provided by the RTOs surveyed and information contained in the RTOs activity reports	Obtained results by RTOs (patents, spin-offs, scientific publications, new generated jobs and new clients)	Albors-Garrigós, Segarra and Rincón-Díaz, (2010), Arnold *et al.* (1998), Aström *et al.* (2008), Barge-Gil and Modrego-Rico (2008), Callejón *et al.* (2007), Leitner (2005), Modrego-Rico *et al.* (2005, 2009), and Silva and Ramírez (2006)
V9	Turnover per employee Data provided by RTOs surveyed	Turnover per employee without public support standardized values	Albors-Garrigós, Segarra and Rincón-Díaz (2010), Arnold *et al.* (2010), Aström *et al.* (2008), Leitner (2005) and Nath and Mrinalini (2000)

Table II.

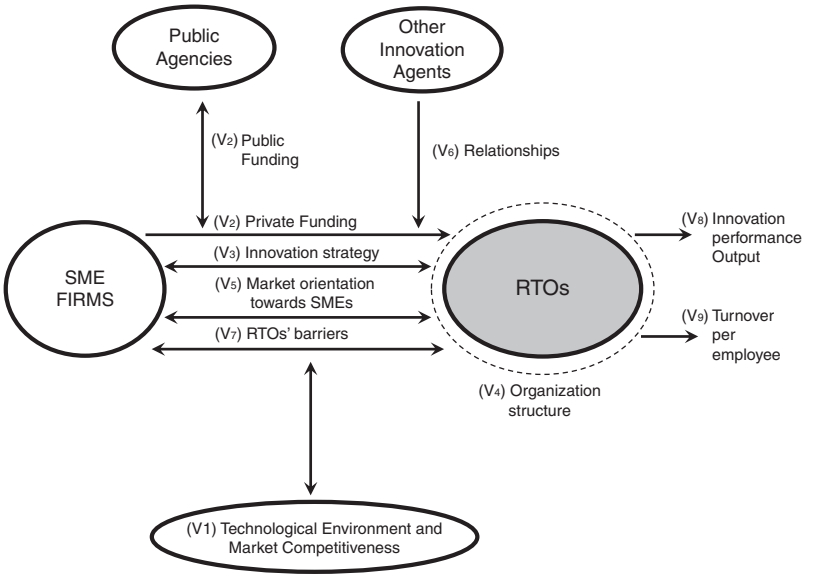

Figure 1.
Proposed model for studying research technology organizations

flexible, proactive and interact better with their environment (Deutsch *et al.*, 2009; Silverblatt and Korgaonkar, 1987; Tidd, 2001). This leads us to formulate the first hypothesis:

H1. Following the focus of the contingent theory, the ability of the RTOs to respond or adapt to changes in their environment is determined by the innovation strategy, the type of organizational structure of the RTOs, their focus on knowledge transfer to the SMEs and the level of relation which they have with other agents of innovation. Thus, according to the environment in which they operate, the RTOs are dynamic

(turbulent) or static, have an innovation strategy that is reactive or proactive, an organizational structure that is mechanical or organic, a level of interaction with other agents of innovation that is more or less active and a development that is more or less innovative.

RTOs with a higher degree of self-finance can develop better projects with SMEs (Mora-Valentin *et al.*, 2004; Bienkowska *et al.*, 2010). There are limitations to access funding sources from SMEs (Modrego-Rico *et al.*, 2005; Olazaran *et al.*, 2009; Aström *et al.*, 2008) making it difficult to implement R&D projects (Callejón *et al.*, 2007), difficulties absorbing knowledge (Molina-Morales and Mas-Verdú, 2008; Barge-Gil *et al.*, 2011) and uncertainty associated with the high costs of innovative process that represent insurmountable barriers (Silva and Ramírez, 2006).

Culturally the R + D + i is not among the priorities of the SMEs (Aström *et al.*, 2008; Olazaran *et al.*, 2009; Roessl *et al.*, 2010). The companies that collaborate with the RTOs get good technological results, but do not always translate them into the expected economic results, partly because they do not fully adapt to customers' needs (Zubiaurre *et al.*, 2004), or because of the difficulty of RTOs to communicate with their customers. (Olazaran *et al.*, 2009).

In conclusion, the success of the results in transfer of technology and knowledge of RTOs depends largely on the development of internal capabilities by the SMEs (Zubiaurre *et al.*, 2004; Barge-Gil and Modrego-Rico, 2011). In this context the following hypothesis is proposed:

H2. The source of financing, that is the percentage of private funding or the non-competitive public funding (self-funding), and the barriers that RTOs face to transfer knowledge and technology to the SMEs, influence their innovative performance. To increase self-funding and lower barriers, the performance has to be higher.

Some authors argue that there is a positive relation between the turnover of the RTOs and the results in innovation (Aström *et al.*, 2008), others emphasize the difficulty of reconciling both because of the lack of freedom of research associated with this type of contracts (Arnold *et al.*, 1998; Nath and Mrinalini, 2000), and a third current (Albors-Garrigós, Zabaleta and Ganzarain, 2010; Arnold *et al.*, 2010; Aström *et al.*, 2008; Leitner, 2005; Nath and Mrinalini, 2000) proposes the volume of sales per employee as an indicator of appropriate result to establish the impact of the RTOs in their sector.

In short, there is no consensus in the academic literature to establish a positive relation between sales figures with the outputs of innovation and intensity in R&D, as an indicator of performance of the RTOs. The proposed hypothesis based on this reason is as follows:

H3. The results of innovation of the RTOs are positively related to their financial performance indicators.

4. Methodological design

The fieldwork was based on a questionnaire of 50 questions covering eight areas of operation of the RTOs: organizational, environment and strategy, operational, relational and customers, finance and results areas. Initially 15 variables were identified, but only those nine variables that produce statistically significant results were selected; this means a statistically acceptable reliability. Given the limited space, the process cannot be described in detail, but is conveniently described in Rincón-Díaz (2014). Table III shows an example of valuation of the nine variables of one of the RTOs studied.

From the information on the eight areas of operation of the RTOs, the necessary information was collected to complete and sustain the nine variables that make up the

proposed theoretical model. The responses were generated on a Likert scale (1-5). In order to simplify the statistical analysis, each of the study variables was built from expressed standardized values; also, in a Likert scale of five points, using the same criteria for all the RTOs ensured that the final measures were comparable.

The questionnaire was completed through personal interviews conducted with the directors of 14 RTOs of the Valencian Community and 13 RTOs of the Basque Country. Each interview was conducted for about two hours in order to obtain reliable results; the interviewers ensured that questions were understood and completed in full. Also, secondary sources of information on the activities of the RTOs, such as annual reports, special reports and websites, were also consulted.

Subsequently, using the obtained standardized values, a correlation analysis to statistically test the hypotheses raised research was conducted.

The next step was to conduct a factorial analysis. According to Hair *et al.* (2007), the minimum sample size must be at least 50 to perform a factorial analysis, with a factorial load of 0.75. The size of the sample used in this research is 27 RTOs. However, it was considered appropriate to perform a factorial analysis with less data, considering that the sample corresponds to 81.8 percent of the population of the RTOs of the two communities studied. Finally, a hierarchical cluster analysis was carried out in order to analyze whether there are groups of RTOs according to the factors obtained. All of this was done in order to see how the RTOs of the two autonomous communities are grouped according to their ability to adapt to the dynamism of their environment.

5. Results

After standardizing each of the study variables to a five-point Likert scale for the 27 RTOs, these values were taken and a correlation analysis was carried out between the variables to test the research hypotheses. Applying the coefficient of Tau-b of Kendall for non-parametric data (−1+1), Table IV shows the bilateral correlation to an acceptable level of significance (*) 0.05.

There is a positive correlation between technological environment (V1) with the innovation strategy (V3), the organizational structure (V4), the level of relation with other innovation agents (V6) and the innovative performance (V8). A positive relation is observed between innovation strategy (V3), with the organizational structure (V4), the level of relation with other innovation agents (V6) and innovative performance (V8). Another positive correlation found corresponds to the organizational structure (V4), with the level of relation with other innovation agents (V6), and the positive correlation between the level of relation with other innovation agents (V6) and the innovative performance (V8). The results obtained show that the correlation coefficients of the funding of the RTOs (V2) and guidance to the SMEs (V5) with other variables show negative signs, or an important number of values that were difficult to contrast and difficult to reach definitive conclusions.

Finally, it can be observed that there is no significant correlation between the barriers that the RTOs face when transferring knowledge and technology to the SMEs (V7), and the innovative performance (V8). Also, there is no correlation between turnover per employee (V9) and other study variables.

Table III. Variables of RTOs assessed on Likert scale

RTO	V1	V2	V3	V4	V5	V6	V7	V8	V9
5	4.15	4.53	3.75	3.85	3.20	4.65	3.75	4.75	2.80

Note: Example of final values given to the study variables

Kendall's tau-b	V1	V2	V3	V4	V5	V6	V7	V8	V9
V1	1	*−0.326**	*0.662***	*0.483***	*−0.408***	*0.459***	0.074	*0.576***	0.173
Bilateral significance		0.018	0.000	0.000	0.003	0.001	0.609	0.000	0.210
V2		1	−0.244	−0.193	0.087	−0.069	−0.266	*−0.430***	−0.011
Bilateral significance			0.076	0.162	0.530	0.617	0.067	0.002	0.933
V3			1	*0.576***	*−0.362***	*0.574***	0.170	*0.456***	0.152
Bilateral significance				0.000	0.009	0.000	0.242	0.001	0.269
V4				1	*−0.344**	*0.551***	−0.062	0.268	0.144
Bilateral significance					0.014	0.000	0.670	0.052	0.296
V5					1	−0.211	0.078	−0.130	0.003
Bilateral significance						0.127	0.594	0.347	0.983
V6						1	0.083	*0.357***	0.237
Bilateral significance							0.566	0.009	0.083
V7							1	*0.296**	−0.071
Bilateral significance								0.041	0.625
V8								1	0.095
Bilateral significance									0.491
V9									1
Bilateral significance									

Notes: Tau-b coefficient for non-parametric data (−1+1). Correlation significant at $*p < 0.05$; $**p < 0.01$ (bilateral)

Table IV.
Correlation between variables

Under a contingent approach, these results show the RTOs which are in more turbulent environments (V1) with a high technological rotation, which follow innovation strategies (V3) more proactively and show more organic organizational structures (V3), more organic in comparison to the ones from the RTOs, which work with mature sectors and low innovative industries, and are of low technology level, which assume more reactive strategies. Differences between the type of client company (V5) and the relation with other innovative agents (V6) in both communities are also observed. The Valencian RTOs work with companies of a medium and low technological level and interact less with other agents of innovation and regional and national RTOs, whereas the Basque RTOs focus on larger companies and with a higher technological level and, in turn, it keeps them closer to universities and other agents of European innovation.

The origin and percentage of the RTOs' financing (V2) was estimated from secondary information. With these data it is possible to observe the negative correlation with innovative performance (output) (V8) in both communities. The Valencian RTOs have a higher percentage of non-competitive public funding, while in the Basque RTOs the percentage of competitive private and public funding is greater. With regard to the barriers that the RTOs have to transfer knowledge and technology to the SMEs (V7), they are important for all the RTO respondents. The Valencian RTOs give more importance to financial barriers and innovative culture of the SMEs, but consider absorption capacity of the enterprises to be less relevant. The Basque RTOs express that the financial barriers and the risk perception of businesses represent major obstacles.

The Basque RTOs have higher innovation outputs (V8) than the Valencian RTOs, in the number of patents, creation of spin-off enterprises, scientific publications and generation of new job positions. With some exceptions, some Basque RTOs, which work in more turbulent environments, have a lower ratio of outputs as they have comparatively lower values in scientific publications, new job positions and new clients. The results of innovative performance of the Valencian RTOs reveal a percentage of new customers tripling that of the Basque RTOs in the last year. This difference substantially increases the final result of this variable.

Subsequently, a factorial analysis, in order to establish whether there was grouping between variables, was performed. Initially, the measure of sampling adequacy KMO ≥ 0.5 was obtained, whose result of 0.567 is considered acceptable. In this analysis, the significance is equal to (Sig) = 0.000; therefore, it is possible to ensure that the factorial model is adequate to explain the data. When calculating the matrix of commonalities, it was observed that the variables that less explain the model are the funding (V2), which is only able to produce 56.8 percent of the variability, and the barriers that the RTOs face when transferring knowledge and technology to the SMEs (V7), which reproduces only 59.8 percent of their original variability.

Using the method of extraction of main components, three factors that explain the 75.33 percent of the total variance were obtained. To better interpret the factors obtained, a rotation was carried out using the Varimax method with Kaiser. The results obtained are shown in Table V.

The first factor is composed of the following variables: (V1) technological environment; (V3) innovation strategy; (V4) organizational structure; (V5) orientation to the SMEs; and (V6) relation with other agents of innovation. This first factor will be called "strategy" and it is related to the first research hypothesis. The second factor is composed of the following variables: (V2) financing; (V7) RTOs barriers to transfer knowledge and technology to SMEs; and (V8) innovative performance (output). This factor will be called "performance," which in turn is related to the second research hypothesis.

Finally, the third factor is composed only of the variable "Facturación" turnover per employee (V9). This factor will be called "output of result." Although, this variable it is not correlated with the innovative performance, it represents an appropriate indicator to measure the performance of an organization.

Subsequently, a hierarchical cluster analysis was performed to establish whether there are groups of RTOs according to the factors obtained. Three clusters were obtained, each one consisting of different RTOs of both autonomous regions, as shown in Table VI.

This cluster analysis helps the interpretation of the proposed model and helps to establish how the RTOs adapt or respond to cope with the turbulence of their environment. To do this, it requires the contingency between key variables of the RTOs, such as the strategy (V3), the organizational structure (V4), their relation with companies (V5),

	Component		
	1	2	3
V1 technological environment	*0.803*	0.396	0.166
V2 funding	−0.171	−0.733	0.049
V3 innovation strategy	*0.883*	0.330	0.096
V4 organizational structure	*0.894*	0.003	0.053
V5 orientation to SMEs market	*−0.679*	0.287	0.510
V6 relationship with other innovation agents	*0.748*	0.144	0.376
V7 RTO's barriers	−0.074	*0.765*	−0.089
V8 innovative performance (output)	0.391	*0.767*	0.165
V9 turnover per employee	0.226	−0.131	*0.850*

Table V.
Matrix of rotated components[a]

Notes: Extraction: main component analysis. Rotation method: Varimax standardization with Kaiser. [a]The rotation has turned into four iterations

RTOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Cluster	1	1	1	1	2	1	1	1	3	2	1	2	2	2	1	2	3	3	1	3	2	3	3	2	3	2	3

Table VI.
Cluster of belonging

the relation with other innovation agents (V6), and their innovative performance (V8), with the technological environment (V1) in which they operate. The Figure 2 shows different scenarios according to the turbulence of the environment and the capacity required from the RTOs to adapt or respond to such turbulence.

Figure 2 shows on its vertical axis the different types of technological environment (V1). This environment responds to a number of political, technological and market factors, over which the RTOs have no control in general. In the proposed model, there are three types of environment for RTOs: a highly turbulent technological environment (C), characterized by a high uncertainty, a moderately turbulent (B) technological environment, of a less uncertainty, and a more stable technological environment (A), or a little turbulent and of a low uncertainty.

On the horizontal axis of the figure, there are three levels of adaptation or response from the RTOs to the turbulence of the technological environment (1, 2, 3). Such adaptability or response capacity consists of the variables that best represent the proposed model (V3, V4, V5, V6, V8). Unlike hardly changed environment, it is possible for the RTOs to improve outcomes in these variables. The higher the value of these variables in RTOs, the greater their ability to adapt or response to the RTOs in more dynamic and turbulent environments. Following the idea presented in Figure 2, it is shown below how the RTOs are distributed in both regions according to the three clusters obtained (Figure 3).

As can be seen in Table VI the RTOs from 1 to 14 belongs to the Valencian Community and the RTOs from 15 to 27 belongs to the Basque Country. In Figure 3 it is shown that the three clusters are contingent with the proposed variables in the model: on the vertical axis is the variable V1 and the on the horizontal axis the variables V3, V4, V5, V6 and V8, which constitute the adaptability or RTOs' response capacity to the turbulence of the environment of the RTOs.

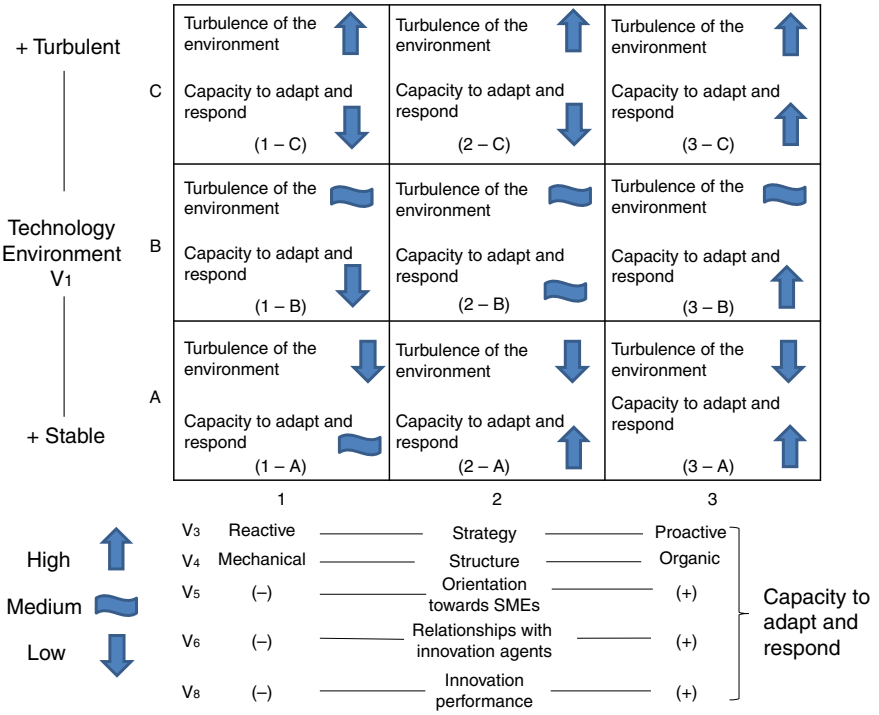

Figure 2.
Adaptability or response capacity, facing the environmental turbulence

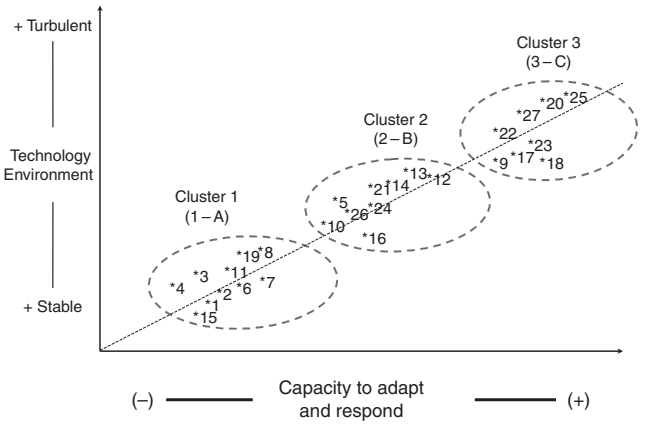

Figure 3.
Distribution of research technology organizations according to their cluster of belonging

According to the classification of the RTOs carried out in Table VI, the RTOs of the first cluster (1 – A) are in some turbulent environments and belong to traditional and mature sectors. This cluster is made up of eight RTOs of the Valencian Community and two RTOs of the Basque Country. These RTOs possess strategies of reactive innovation and organizational structure which is more mechanical. There are RTOs which generally focus their work on the SMEs, but have a low level of relation with other agents of innovation and universities. Their results of innovation are low, with the exception of the RTOs 6, 7 and 8 whose outputs of innovation are higher.

The RTOs of the second cluster (2 – B) go through a transition process that allows them to enter new sectors and innovative environments through the development of more horizontal technologies. This cluster consists of five RTOs of Valencian Community and four RTOs of the Basque Country, which have comparatively higher values in their type of innovation strategy, organizational structure, approach to SMEs, ability to relate better to other innovation agents and innovation outputs, than the RTOs of the first cluster.

The third cluster (3 – C) is made up by the highly innovative and intensive R&D RTOs working in highly turbulent environments. This cluster is composed of seven RTOs of the Basque Country and one RTO of the Valencian Community. The Basque RTOs, of this conglomerate, work in highly dynamic environments and with less mature and innovative sectors. They possess highly proactive innovation and organizational strategies that are more organic. These RTOs relate better to other innovation agents and a major percentage of their main customers are big companies. Their innovation outputs are high, although highly comparative to the Valencian RTOs, and they present lower values in the number of new client companies.

6. Conclusions

The objectives of this study were to examine the strategies employed by the RTOs of the Valencian Community and the Basque Country to adapt to their environments, identify barriers encountered and best practices carried out that suit them and be more competitive. The research examined the relation between the variables that make up the proposed theoretical model to study RTOs. The analysis shows that context variables, such as the technological environment and the competitiveness of the market, the type of funding, their innovation strategy, the level of relation with other agents of innovation and barriers found to transfer knowledge and technology to the SMEs, affect the efficiency of the RTOs, measured by their innovative performance. Following the considered hypotheses, the conclusions that can be drawn from the analyzed data are summarized below.

This paper proposes a holistic and dynamic vision which provides a global overview of the RTOs considering all the strategic aspects and the industrial policy issues that so far have been managed in a fragmented way in those investigations, and the historical review of the concerned literature to the RTOs which has not been published until now. It can be seen in some articles, as a vision of the impact of globalization on the RTOs (Berger and Hofer, 2011; Sharif and Baark, 2011).

Around the first hypothesis, the proposed model, supported empirically, shows a contingent relation between the technological environment, the innovation strategy and the organizational structure, in accordance with the proposals by Burns and Stalker (1961), Gordon *et al.* (2000), Khandwalla (1972) and Terreberry (1968). The RTOs should seek congruence between these key variables to achieve optimal performance, become more competitive and better adapt to the changes in their environment.

The Basque Country is characterized by a more dynamic and innovative industrial environment. With the exception of the RTOs 15 and 19, working with sectors of low technology, this community has a greater number of RTOs that present more organic organizational structures and follow more proactive innovation strategies that allow them to adapt better to highly turbulent environments, such as the RTOs 17, 18, 20, 23, 25 and 27, or to moderately turbulent environments, such as the RTOs 16, 21, 24 and 26. In the Valencian Community, there are more RTOs working in traditional sectors with industries of low technology level, the RTOs 1, 2, 3, 4, 6, 7, 8 and 11. These RTOs, when faced with the difficulty of environment dynamism, show more mechanical organizational structures, follow reactive innovation strategies oriented to the subsistence, follow little diversification and have high competition with similar RTOs. In this community, only the RTOs 5, 9, 10, 12, 13 and 14, which are in moderately turbulent environments, have average levels of organic structure and follow more proactive innovation strategies.

The first hypothesis also includes the contingent relation between technological environment of the RTOs, with their focus on the SMEs and the ability to relate to other innovation agents. There are differences between the two communities in the focus of the RTOs towards the SMEs. The most innovative RTOs according to the data obtained are more related to large and medium enterprises; it is important to remember that RTOs were created to meet the needs of the SMEs. Also, differences were identified in the ability of the RTOs to interact with other innovation agents; some RTOs that are found in mature sectors and are a little innovative have a good relation with universities and other agents in the innovation system. For these reasons, it is concluded that the first hypothesis can be partially validated. Emphasis should be placed on how important it is for the RTOs to interact through interactive networks, which is a best practice described by authors such as Aström *et al.* (2008), Arnold *et al.* (1998), Nath and Mrinalini (2000) and Rush *et al.* (1996).

Regarding the second hypothesis, considering the differences between the funding models used by the RTOs in both communities, the estimated data shows a negative correlation between the funding and the innovative performance (output). The Valencian RTOs have a higher percentage of non-competitive public funding and are less involved in competitive projects, whereas the Basque RTOs have greater self-funding capacity and obtain greater resources of competitive projects and private funding. Although there is a correlation between these two variables, the result must be interpreted with caution, as the data of the funding of RTOs were obtained mostly from secondary sources. With respect to the barriers that the RTOs face to transfer knowledge and technology to the SMEs (V7), although they are related to their innovative performance (V8), it is not possible to establish which influence is present in greater or in lesser degree in the performance of the RTOs; that is the reason it is concluded that the second hypothesis is not met. The personal interviews have shown significant differences between the environments of both communities. In this sense, the tradition of the Basque industries has facilitated the templates of the companies

and their leaders to have a higher level of human capital (Pérez and Serrano, 2013), redound it in a bigger absorption capacity and recognition of the need for R + D + i.

The economic results expressed in the ratio of turnover per employee (V9) and the innovative performance (output) (V8) of the RTOs are not correlated. Despite being a good indicator of performance, the difference in values between the RTOs with higher outputs of innovation does not allow to infer any conclusion. It is therefore concluded that the third hypothesis cannot be validated. It underlines the fact that the data about the origins of the RTOs' funding are unclear or standardized. It was observed in the fieldwork that the causes are basically the accounting divergence in the production of the RTOs balance sheets, the absence of a reliable database about funding thereof, the diversity of local, domestic and European origins, or the lack of a standardization of the concepts about the competitive, non-competitive funding, etc.

The analysis of the variables helps us to identify some of the best practices developed by the RTOs. The Valencian RTOs perform activities to meet the market and needs of their client companies, which make up mixed teams of workers from both the RTOs and companies during the development of projects and carry out activities to disseminate developed knowledge and technology. However, the level of formalization of their R+D projects is generally low, which results in a lower efficiency. For the Basque RTOs some of the best practices are made up of the knowledge of the innovation strategy of the client companies, defined by monitoring mechanisms for projects, done by planned marketing activities and visits to meet the needs of companies. Leadership and remuneration for goals are generally lacking. For all the RTO respondents, these practices have a high impact on the competitiveness of enterprises.

According to the theoretical construct, it can be concluded that under the approach of the contingent theory, the organizations can cope with the turbulence of the environment through a contingent relation between their organizational structure and their strategy. In both regions, the RTOs with more proactive strategies and more organic structures are able to better face the turbulence of the environment and to assume new challenges, as they have a more open strategy to the collaboration with other innovation agents and a higher technological level allowing them to achieve a better innovation performance. The RTOs with a more mechanical organizational structure have more trouble coping with changes in their environment, basically being conditioned to the characteristics of low technology which they work with. To be able to survive, these RTOs have to find formulas that allow them to enter new sectors through the integration of different technologies and networking with other RTOs. In short, especially applicable to those whose environment has changed substantially (traditional sectors), RTOs must adopt more organic and proactive organizational schemes, because the paradigms of these sectors (furniture, mechanical metal, ceramic, textile, footwear) have changed substantially and require strategies more oriented to adding value.

At being integrated into two technology platforms, the Basque RTOs have better conditions to reach a critical mass, internationalize and be more competitive. Only some of their RTOs present major obstacles to face the turbulence of their environment, mainly because they belong to mature sectors with low innovation. Meanwhile, the Valencian RTOs must strengthen themselves and redirect their strategy to relate better with universities, reach critical mass and generate synergies to reduce duplication in research, considering that some RTOs investigate in the same areas, for example TICs, ergonomics and electronics. Their high dependence on public funding makes them vulnerable, but does not imply that there is a lack of capacity to adapt and survive. The recent policies of reduction in these RTOs have caused a significant loss of human capital, as well as some demoralization of their workforces. On the other hand, this situation has caused a greater lack of coordination between them in contrast to what happens to the RTOs of the Basque Country[3].

The search for new forms of funding and the internationalization process, written down by some authors (Aström *et al.*, 2008; Berger and Hofer, 2011; Martínez-Gómez *et al.*, 2009), are always necessary as long as they do not move away the RTOs from their purpose of being non-profit organizations, supporting the innovative activity of companies with lower capacities. For this reason, to meet new challenges, be more competitive and respond efficiently to the changes in the environment, the RTOs need a technology policy more in line with the specific characteristics of each region. This is most evident in the RTOs of the Valencian Community, whose survival is in question. Currently two of the RTOs of the Valencian Community who participated in this study have unfortunately disappeared for not being self-sustaining.

As a contribution to the academic literature on this subject, the proposed theoretical model presents a suitable stage for the RTOs to respond to the changes in the environment and the current globalization of the economy and to cope with the new challenges. This proposal consists of the RTOs maintaining an appropriate combination of key factors, including the development of more proactive innovation strategies, a shift toward organizational structures that are more oriented to disruptive innovations which allow them to relate better with other innovation agents and universities, and which help them to work more efficiently with SMEs and obtain a higher innovative performance and a greater orientation toward innovative change.

Limitations of this paper are primarily related to the sample of the RTOs used. Therefore, the results of this research must be interpreted with caution. Although this study compares two autonomous communities with their own models of RTOs, the results are not generalized to all the Spanish RTOs; the research should be expanded and contrasted with RTOs of other autonomous communities.

Notes

1. This model is composed of nine variables that were identified by their relevance in the analytical framework.
2. The following section explains why nine variables were chosen for this paper.
3. www.europapress.es/comunitat-valenciana/ downloaded March 15, 2007.

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