Barriers to Innovation faced by Manufacturing Firms in Portugal: How to overcome it?

Silva, Maria and Leitão, João and Raposo, Mário

University of Beira Interior

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Maria José Silva, msilva@ubi.pt *, João Leitão jleitao@ubi.pt * and Mário Raposo* mraposo@ubi.pt
* Departamento de Gestão e Economia
Universidade da Beira Interior
Estrada do Sineiro – Covilhã
Phone: +351 275 319 625; Fax: +351 275 319 601

Abstract

This paper aims to identify the barriers to innovation that influence the innovation capability of Portuguese industrial firms. The literature review about innovation makes use of two references approaches: (i) the systemic; and (ii) the networks and inter-organizational relationships. The database is obtained through the Community Innovation Survey II (CIS II) conducted by EUROSTAT. Furthermore, from the results several public policies are proposed in order to overcome the restraining factors of the entrepreneurial innovative capability.

1. Introdution

In the context of globalisation, innovation is a key-factor for enhancing the competitiveness of firms. This paper aims to identify and analyse the determinant factors of innovation capability of Portuguese industrial firms.

Thus, it is intended with this article to develop a theoretical support for the empirical method that is going to be used, by taking into consideration two reference approaches: (i) the systemic; and (ii) the networks and inter-organizational relationships. The selection of these approaches is due to the adequacy they present for the study of the determinant factors of entrepreneurial innovative capability.

The database is the one that belongs to the Second Community Innovation Survey II (CIS II). According to the data granted by the OCT – "Observatório das Ciências e das Tecnologias" (Sciences and Technologies Observatory). This questionnaire was applied in distinct European countries, under the coordination of EUROSTAT and following the guidelines presented at Oslo Manual (OCDE, 1997, 2005). From 819 firms that answered the questionnaire, 470 carried through innovations in the product or process or these firms are involved in innovation activity, during the period of 1995-1997. In order to identify the significant restraining factors of entrepreneurial innovative capability, a logistic regression is preformed.

This study is structured as follows. In section two presents a literature review is made and the hypotheses are formulated. In section three, the research methodology based on a logistic regression is presented. In section four, the results are presented and discussed. In section five, the concluding remarks and guidelines for futures research are presented.

2. Literature Review

The innovation is not seen as something periodical that happened by accident nor something that results from the action of an individual agent. Innovation is seen as the result of an interactive and non linear process between the firm and the environment. (Kline and Rosenberg, 1986; Dosi et al., 1988; Lundvall, 1988, 1992; Nelson, 1993; Edquist, 1997; Maskell and Malmberg, 1999; Lundvall et al., 2002; Godinho, 2002; Silva, 2003; Silva et al., 2005; Leitão, 2006; Silva and Leitão, 2007). The results of this process are designated as entrepreneurial innovation capability. The term entrepreneurial innovation capability was adopted to integrate the components that result from the innovative process of a firm, namely: product innovation, process innovation, organisational innovation and marketing innovation (OECD, 2005). This paper is focused on the study of entrepreneurial innovation capability regarding the product innovation or process innovation undertaken by the firm.

This way, it is considered that the firm is innovative, when it introduces a new technological or improved product or process during the period of 1995-1997. It is defined as new product when "the product's characteristics or its use, differ significantly from those products previously produced" (CIS II, 1999:3). An improved product consists on "an existing one, whose performance was significantly widened or developed" (CIS II, 1999:3). It is defined as process innovation "the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software (OECD, 2005: 49).

In the last decades, there has been an increasing interest in studying innovation. More recently, the systemic approach about innovation and the networks and inter-organizational approach have made progress in the framework of innovation.

The approach of networks and inter-organizational relations, despite coming from several theoretical approaches, has shown a considerable convergence of ideas regarding the process of innovation. The reason why these approaches are considered is due to the fact that, overall they gather fundamental elements to the study of the factors that stimulate and limite the innovative capacity. More than contradictory perspectives, these approaches are seen as complementary in the study of the process of innovation. The Industrial Cluster approach stresses the competitive pressure of the environment on the firm (Porter, 1990, 1998; Stern *et al.*, 2000; Porter and Stern, 2001; Furman *et al.*, 2002), while the

role of cooperation amongst firms is highlighted in the Industrial Districts' approach (Becattini, 1990; Sengenberger *et al.*, 1990; Brusco, 1992; Schmitz, 1992). The Industrial Networks approach enhances the role of the agents, activities and resources (Hakansson 1987; Hakansson and Johanson, 1988, 1992; Johanson and Mattson, 1991); whereas the Resource-Based View points out, mainly, the resources and the internal capacities essential to the process of innovation (Pfeffer and Salancik, 1978; Wernerfelt, 1984, 1995; Prahalad and Hamel, 1990; Cohen and Levinthal, 1989, 1990).

Therefore the systemic perspective of innovation enriched its analysis, by considering organisational and environmental factors that influence the innovative performance and the entrepreneurial competitiveness. According to this approach, innovation is originated from a collective learning process where institutions have a determinant role. Since the innovation capability is the result of an interactive process, which embraces firms and environment, by enhancing the inherent synergies of learning that belong to the economic system and by stimulating the institutions that support innovation (Lundvall, 1985, 1988, 1992; Nelson, 1993; Cooke, Uranga and Etxebarria, 1997; and Braczyk et al., 1998; Cooke et al., 2000; Kaufmann and Tödtling, 2001). The systematic approach enhances that these institutions, when connecting several agents, may play a crucial role in the creation and diffusion of innovation (Godinho, 2003). This approach provided a better understanding about the connections established between firms and external partners, as well as it allowed the acknowledgement of several agents that are crucial for disseminating innovation within the system.

There is an extensive literature that discusses the main determinants of entrepreneurial innovative capability. This capability varies from firm to firm and it is determined by a vast and complex number of aspects both stimulating and restraining factors that seem to present a significant impact on the innovative process of firms. Through the analysis of the barriers to innovation, the restraining factors of innovation, at the firm level, are presented in Table 1.

TABLE I
FACTORS AND BARRIERS TO INNOVATION

Barriers to innovation	Factors
The high economic risk	Economic
The high cost of innovation	
The lack of financing	Internal
The organisational rigidities	
The lack of skilled personnel	
The lack of information about technology	
The lack of information on market	
The lack of customers' responsiveness	Other
The Government regulations	

Source: CIS II (1999:7).

The research question of the present paper is: What are the barriers to innovation faced by Portuguese industrial firms? For addressing this research question, we formulate hypotheses to be empirically tested through the use of a logistic regression.

The hypotheses presented below aim to identify the significant determinant factors: stimulating or restraining; on the Portuguese firms' innovative capability, regarding product innovation or process innovation.

(H_1): The high economic risk is negatively related to the firm's propensity for innovating the product or process.

(H_2): The high cost of innovation is negatively related to the firm's propensity for innovating the product or process.

(H3): The lack of financing is negatively related to the firm's propensity for innovating the product or process.

(H4): The organisational rigidities are negatively related to the firm's propensity for innovating the product or process.

(H5): The lack of skilled personnel is negatively related to the firm's propensity for innovating the product or process.

(H6): The lack of information about technology is negatively related to the firm's propensity for innovating the product or process.

(H7): The lack of information on market is negatively related to the firm's propensity for innovating the product or process.

(H8): The lack of customers' responsiveness is negatively related to the firm's propensity for innovating the product or process.

(H9): The Government regulations are negatively related to the firm's propensity for innovating the product or process.

In this sense the Portuguese reality is selected as an adequate laboratory for testing the hypotheses, aiming to provide several insights and guidelines for public and private managers, in terms of the future promotion of entrepreneurial innovative capability, at the firm level.

3. Research Methodology

After presenting the research question and proposing the hypotheses to be empirically, the next step is to identify the data and variables. Afterwards, the hypotheses and logistic regression model are presented.

A. Data: Presentation

The data used in this study were collected by the OCT. The data was collected during the second semester of 1998, through a survey that consisted in a questionnaire titled as Community Innovation Survey II. The surveyed year was 1997 and there is a great deal of indicators that concern the period: 1995 - 1997.

The population includes all the industrial firms with less than 20 employees. The economic activity classes belonging to the population, more specifically to the industry, are the ones that follow: from 15 until 37 and from 40 until 41. The sample was built by the INE – "Instituto Nacional de Estatística" (National Institute of Statistics), according to the methodological specifications of EUROSTAT. The INE has selected an initial sample of industrial firms, selected from the 9289 firms that are registered at the FGUE – "Ficheiro Geral de Unidades Estatísticas do INE" (Global File of INE's Statistical Units). Thus, an initial sample of 1556 industrial firms was extracted from the population. The firms that answered the questionnaire in a valid way, following the guidelines defined by EUROSTAT, came to a total of 819 firms, represented a global answer rate of 57, 3%.

Since this study is focused on the entrepreneurial innovation capability of the firms, regarding their product and/or process innovations, all 298 firms that undertook product innovation or process innovation in the period 1995-1997, were considered.

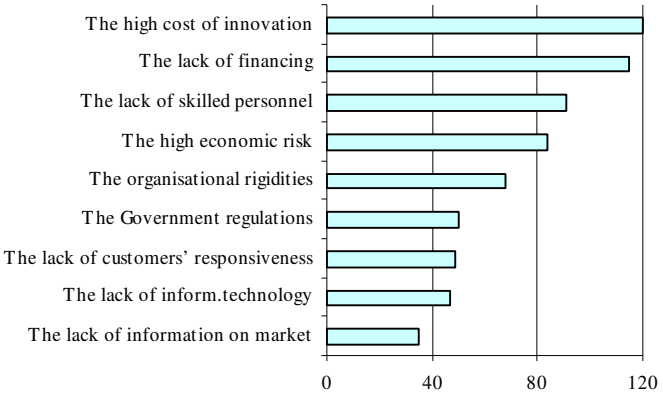
B. Data: Description and Characterization

The analysis of innovation barriers, turning to the CIS data, has been carried out by several researchers using, for this effect, data from European companies (Arundel, 1997; Silva, 2003; Gália and Legros, 2004; Tourigny and Le, 2004; Fernandez, 2005; Silva and Leitão, 2007) and Canadian companies through the adjustment of the questionnaire (Baldwin e Lin, 2002).

The firms were qualified as innovative if they introduced in the market or firm, products or processes technologically new or improved during the period of 1995-1997. As observed in Figure 1, from the sample of 819 firms, 298 answered they had innovated in the product or process.

In order to evaluate the importance of each restraining factor to innovation, it is attributed to each one of them the value equal to *1*, in case the firm answered the factor made it difficult to carry through the projects, and the value equal to *0*, else wise. The result of the distribution of the sample firms, along with the difficulties in innovating, is presented in the following Figure 1.

FIG .1. BARRIERS TO INNOVATION



In accordance with the total of the sample firms and the analysis of the Figure 1, we observe that the main barriers to innovation are economic factors namely, high cost to innovation, lack of financing and high economic risk. In what concerns the internal factors the lack of skilled personnel and organizational rigidities, should be stressed. The results obtained are similar to those of other researches carried out in Portuguese firms (CISEP, 1992). The factors associated with the lack of information on technology and the lack of information on market are less restraining to innovation.

C. Logistic Regression Model

According to what has been previously defined, the Innovation (*I*) is a binary variable, which is equal to 1, if the firm innovates; or equal to 0, if the firm does not innovate. The binary data are very common among the several types of categorical data and their modelling is part of the general linear regression models (McCullagh and Nelder, 1989). The logistic regression model the most common one (Agresti, 1996, Ferrão, 2003), regarding the way it facilitates the substantive interpretation of parameters. Thus, logit regression is an approach used in studies of manufacturing firms (Kaufmann and Tödtling, 2001; Silva, 2003, Silva *et al.* 2005, Silva and Leitão, 2007) and services firms (Tether, *et al.* 2001; Tether, 2005; and Freel, 2006).

Considering the variable answer (or dependent) *I*, let *p (I)* be the probability of the firm to innovate:

$$p(I)=Pr[I=1] \qquad (1)$$

The extension of this model to multiple explanatory variables, represented by C_n, is processed through their inclusion in the linear predictor. Since all the referred variables are nominal categorical and recoded through dummy variables, the linear predictor of the model is specified according the equation (2):

$$IN_i = \beta_0 + \beta_1 C_1 + \beta_2 C_2 + \beta_3 C_3 + \beta_4 C_4 + \beta_5 C_5 + \beta_6 C_6 + \beta_7 C_7 + \beta_8 C_8 + \beta_9 C_9 + \varepsilon_i \quad (2)$$

In the estimation process the maximum likelihood procedure is used.

4. Results: Presentation and Discussion

The results of the estimated models are presented at the following Table II.

TABLE II
LOGIT REGRESSION MODELS' RESULTS FOR BARRIERS TO INNOVATION

Barriers to innovation	Model A		Final Model		
	Parameter Estimator	Sig	Parameter Estimator	Sig	EXP (B)
The high economic risk	0,05	0,88			
The high cost of innovation	-1,13	0,00	-1,13	0,00	0,32
The lack of financing	-1,34	0,00	-1,36	0,00	0,26
The organisational rigidities	-0,22	0,53			
The lack of skilled personnel	-0,87	0,01	-0,93	0,00	0,40
The lack of information about technology	0,29	0,49			
The lack of information on market	-0,28	0,57			
The lack of customers' responsiveness	-1,27	0,01	-1,23	0,00	0,29
The Government regulations	-0,09	0,82			
Constant	1,54	0,16	1,43	0,00	4,62
Model summary					
Correct Predict (%)	72,3 %		71,9 %		
Chi-Square	123,72	0,00	122,66	0,00	
Log likelihood	493,65		494,71		
Number cases (n)	470		470		

The Model A explains the results of the systematic relations between the entrepreneurial innovative capability at the level of product and/or process innovation, and the barriers to innovation. Since some of the variables associated to the barriers are not statistically significant at a level of 5%, the hypothesis, H_1, H_4 , H_6, H_7 and H_9 were not empirically tested. Next, the estimation of the model was set forth without considering those variables, from which the final model resulted.

The estimators of the final model are presented in Table 2. According to the Wald statistics, we detect that all the estimators of the regression parameters are statistically significant up to 5%, except for the relationships established with competitors.

The predictive capacity of the model is 71,9%, which results from the comparison between the predicted and the observed values of the answer variable. The chi-square test statistics comprises 122,66 with a proof value inferior to the significance level of 0,05. The log-likelihood statistics, comprising 491,71, also corroborates the global significance of the model, when compared with the null model.

The obtained results show that most of the variables associated with barriers to innovation present a negative signal, reason for which they are considered as stimulating and restraining factors that may influence entrepreneurial innovative activities and consequently, to a decrease in the firm's propensity for innovating.

In what regards the statistical significance of each barrier to innovation, it is known that there are four statistically significant variables whose identification and analysis will take place at once.

The results of the model suggest that "high costs of innovation" have a significant effect in the firm's propensity for innovating. Aware of this data, the null hypothesis of inexistent relation between variables can be rejected, which sustains the H_2 hypothesis. Firms that consider as excessive the innovation costs present a smaller propensity for innovating. These results sustain the analysis of the barriers to innovation (Figure 1) where "high innovation costs" are presented as the main barrier to innovation. The obtained results are similar to other empirical studies (CISEP/GEPE, 1992; Martins, 1999; Tourigny and Le, 2004). The results show that firms which consider innovation costs as excessive tend not to innovate, turning this factor into a barrier to innovation.

Concerning the hypothesis that intend to test if "lack of financing sources" is associated with the propensity to innovate, the results show that this barrier is presented with a negative and significant effect, for which it can be said that firms facing scarcity of financing sources have less firm's propensity for innovating. Thus, hypothesis H_3 is confirmed. The obtained results are similar to those of other researches, where the lack of adequate financing is an important barrier to innovation (Hadjimanolis, 1999; Fernandez, 2005).

The "lack of skilled personnel" is presented as a statistically significant variable, for which the null hypothesis of inexistent relation can be rejected, therefore there is a relation and a negative signal is presented. Hence, it can be said that firms which face situations such as lack of skilled personnel, have less propensity to innovate. Therefore, the hypothesis H_5 is confirmed. The study of Hoffman et al. (1998) supports these results, when defending the thesis that lack of qualified staff can be a serious constraint to the development of the innovation process.

The results of the model show that "lack of customer's responsiveness to new products" have a significant effect in the propensity to innovate. The rejection of the null hypothesis of inexistent relation amongst variables, allows the confirmation of H_8 hypothesis. Thus, firms that perceive "lack of customer's responsiveness to new products" show fewer propensities to innovate. This result is in accordance with the interactive model of innovation, with the market-pull approach and the Porter model. These approaches demonstrate that the satisfaction of the market requires the incorporation of innovations. Therefore, if the firm believes the market is not accepting the new products, it has no incentive to innovate, and then this consciousness ends up creating a barrier to innovation.

5. Conclusions

The results show that firms which innovate are those that have more perception of the barriers to innovation. However it is observed through the logistic regression model that some of the relations established between the barriers to innovation and the entrepreneurial innovative capacity are not statistically significant.

The results reveal that the majority of the variables associated with the barriers to innovation present a negative signal. In this sense these variables are considered as factors that difficult or limit the development of innovation activities and thus make firms less prone to innovate.

In what concerns the significance of each restraining factor of innovation, four significant variables are detected. The results provide insights that high innovation costs have a negative and significant effect on the innovation propensity. The same is detected for the barrier associated with the lack of financing sources. For its turn, the lack of qualified personnel restrains the propensity of the firm for innovating and also for developing the innovation process. The lack of customers' responsiveness to new products has also a negative and significant impact on the propensity for innovating.

In this sense, several public policies oriented for promoting innovation and overcoming innovation restrains should be designed and implemented. This kind of policies is particularly important since the majority of the Portuguese firms have a micro, small or medium dimension, which face scarce resources and knowledge that restrain the entrepreneurial innovative capability. Thus, the conception and the adoption of public policies for fostering innovation and overcoming barriers to innovation should be promoted by national entities and governments.

In operational terms, the public measures should embrace financing schemes and incentives for innovation activities, in order to promote the acquisition of new entrepreneurial and innovation competences, and also the diffusion of innovation. The promotion of open innovation networks is also critical. On the one hand, they promote access to information, knowledge and supportive mechanisms for the firms. On the other hand, they promote cooperation between firms and other partners for innovation (namely, universities, research units and other kind of public or private entities).

References

[1] OECD, *OSLO Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, Paris, OECD, (1997).

[2] OECD, *OSLO Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, 3ª Ed., Paris, OECD, (2005).

[3] S. Kline, and N. Rosenberg, "An Overview of Innovation", in *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, R. Laudau, and N. Rosenberg, (Eds), National Academy Press, Washington, (1986), pp. 275-306.

[4] G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete, *Technical Change and Economic Theory*, Printer, London (1988).

[5] B. Lundvall, "Product Innovation and User-Producer Interaction", *Industrial Research,* Series Nº 31 Aalborg: Aalborg University Press, 1985.

[6] B. Lundvall, "Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation", in *Technical Change and Economic Theory*, Dosi, G.; Freeman, C.; Nelson, R.; Silverberg, G. and Soete, L. (Eds),Chapter 17, Printer, London, (1988), pp. 349-269

[7] B. Lundvall, *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Printer, London, (1992).

[8] R. Nelson, *National Systems of Innovation: A Comparative Analysis*, Oxford University Press, Oxford, (1993).

[9] C. Edquist, "Systems of Innovation Approaches - Their Emergence and Characteristics" in C. Edquist (Ed.) *Systems of Innovation: Technologies, Institutions and Organizations*, Chapter One, London, Printer, (1997), pp. 1-35,.

[10] P. Maskell and A. Malmberg, "Localised Learning and Industrial Competitiveness" *Cambridge Journal of Economics,* Oxford University Press, Vol. 23, nº2, pp. 167-185, 1999.

[11] B. Lundvall, B. Johnson, E. Andersen, E. and B. Dalum B., "National systems of production, innovation and competence building", *Research Policy*, 31, pp. 213-231, 2002.

[12] M. Godinho, "*Inovação e Mudança Tecnológica: Conceitos e Perspectivas Fundamentais*", Texto de Apoio Apresentado ao Curso de Formação Avançada do PROINOV, 2002.
[13] M. Silva, *Capacidade Inovadora Empresarial – Estudos dos Factores Impulsionadores e Limitadores nas Empresas Industriais Portuguesas,* Ph.D. Thesis in Management, University of da Beira Interior, Covilhã, (2003).
[14] M. Silva, M. Raposo, M. Ferrão, and J. Jiménez, "Relacionamentos externos no âmbito da Inovação Empresarial: Modelo Aplicado aos Avanços Inovadores", *Portuguese Journal of Management Studies*, nº 1, 5-19, 2005.
[15] J. Leitão (2006), "Open Innovation Clusters: The Case of Cova da Beira Region (Portugal)", In Conference Proceedings of ISBE 2006, Cardiff.
[16] M. Silva, and J. Leitão, "Determinant Factors of Innovation Capability of Portuguese Services Firms: A Logit Model", proceedings XVII International RESER Conference "Service Competitiveness and Cohesion - Balancing Dynamics in the Knowledge Society", 13-15th September 2007, Tampere Hall, Tampere, Finland
[17] CIS II, "Segundo Inquérito Comunitário às Actividades de Inovação", Observatório das Ciências e Tecnologias, Ministério da Ciência e da Tecnologia, Lisboa, 1999.
[18] M. Porter, *The Competitive Advantage of Nations*, Macmillan, New York, (1990).
[19] M. Porter, "Clusters and The New Economics of Competition"*, Harvard Business Review*, Nov-Dec., pp. 77-90, 1998.
[20] S. Stern, M. Porter, and J. Furman, "The Determinants of National Innovative Capacity", Working Paper 7875, National Bureau, of Economic Research, Cambridge, Massachusetts, 2000.
[21] M. Porter and S. Stern, "Innovation: Location Matters", *MIT Sloan Management Review*, Summer, 42 (4), pp. 28-36, 2001.
[22] J. Furman, M. Porter, and S. Stern, "The Determinants of National Innovative Capacity", *Research Policy*, 31, pp. 899-933, 2002.
[23] G. Becattini, "The Marshallian Industrial District as a Socio-Economic Notion", in *Industrial Districts and Inter-Firm Co-operation in Italy*, F. Pyke, G. Becattini, and W.Sengenberger (eds), International Institute for Labour Studies, Geneva, pp. 37-51, 1990.
[24] W. Sengenberger, G. Loveman. and M. Piore, *The Re-emergence of Small Enterprise - Industrial Restructuring in Industrialized Countries*, International Institute for Labour Studies, Geneva, (1990).
[25] S. Brusco, "Small Firms and the Provision of Real Services" in: *Industrial Districts and Local Economic Regeneration*, International Institute for Labour Studies, F. Pyke, and W.Sengenberger (eds), Geneva, pp. 177-196, 1992.
[26] H. Schmitz, "Industrial Districts: Model and Reality in Baden-Württemberg, Germany" in "*Industrial Districts and Local Economic Regeneration*", F. Pyke and W. Sengenberger (eds), International Institute for Labour Studies, Geneva, pp. 87-121, 1992.
[27] H. Hakansson, *Industrial Technology Development – A Network Approach*, London: Croom Helm, (1987).
[28] H. Hakansson, and J. Johanson, (1988), "Formal and Informal Cooperation Strategies in International Industrial Networks", in *Cooperation strategies in International Business*, F. Contractor and P. Lorange, (eds), Lexington Books, pp.369-379, 1988.
[29] H. Hakansson, and J. Johanson, "A Model of Industrial Networks", in *Industrial Networks – A New View of Reality*, B. Axelsson and G. Easton, (eds), Routledge, London, pp. 28-36, 1992.
[30] J. Johanson, and L. Mattsson, , "Interorganizational Relations in Industrial Systems: a Network Approach Compared with the Transactions-cost Approach", in *Markets, Hierarchies and Networks – the Coordination of Social Life*, G. Thompson, J. Frances, R. Levacic, and J. Mitchell, (eds), Sage, London, pp.256-264, 1991.
[31] J. Pfeffer, and G. Salancik, *The External Control of Organizations: A Resource Dependence Perspective*, Harper & Row, New York, (1978).
[32] B. Wernerfelt, "A Resource-Based View of the Firm", *Strategic Management Journal*, Vol. 5, Iss. 2, pp. 171-180, 1984.
[33] B. Wernerfelt, "A Resource-Based View of the Firm: Ten Years After", *Strategic Management Journal*, Vol. 16, pp. 171-174, 1995.
[34] C. Prahalad and G. Hamel, "The Core Competence of the Corporation", *Harvard Business Review*, May-June, pp. 79-91, 1990.
[35] W. Cohen and D. Levinthal, "Innovation and Learning: the Two Faces of R&D – Implications for the Analysis of R&D Investment", *Economic Journal*, 99, Set, pp. 569-596, 1989.
[36] W. Cohen and D. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, Vol. 35, March, pp.128-152, 1990.
[37] P. Cooke, M. Uranga and G. Etxebarria, "Regional Innovation Systems: Institutional and Organisational Dimensions", *Research Policy*, 26 (4-5), December, pp. 475-491, 1997.
[38] A. Kaufmann, and F. Tödtling, "Science-industry Interaction in the Process of Innovation: the Importance of Boundary-crossing Between Systems", *Research Policy*, 30, pp. 791-804, 2001.
[39]A. Arundel, "Enterprise Strategies and Barriers to Innovation" in *Innovation Measurement and Policies*, A. Arundel and R. Garrelfs (eds), European Commission, Luxembourg, EUR 17019 EN, pp 101-108, 1997.
[40] F. Gália and D. Legros, "Complementarities between obstacles to innovation: evidence from France Capacity", *Research Policy*, 33, pp. 1185-1199, 2004.
[41] D. Tourigny, and C. Le, "Impediments to innovation faced by Canadian manufacturing firms", *Economics of Innovation and New Technology*, Vol. 13, pp. 217-250, 2004.
[42] N. Fernandez, "*El Comportamiento Innovador de la Empresa Industrial. Un Modelo de Análisis a partir de la Encuesta del INE",* Tesis Doctoral, Universitat de Girona, España (2005).
[43] J. Baldwin and Z. Lin, "Impediments to Advanced Technology Adoption for Canadian Manufacturers", *Research Policy*, Vol. 31, 1–18, 2002.

[44] CISEP/GEPE, *"Inovação Indústria Portuguesa Observatório M.I.E."*, GEPE, Lisboa, (1992).
[45] A. Martins, "Os Determinantes da Inovação na Indústria Transformadora Portuguesa", Tese de Doutoramento em Gestão, ISCTE, Lisboa, (1999).
[46] P. McCullagh, P.and J. Nelder, *Generalised Linear Models,* 2ª Ed., Londres: Chapman & Hall, (1989).
[47] A. Agresti, An introduction to categorical data analysis*,* New York, John Wiley & Sons, (1996).
[48] M. Ferrão, *Introdução aos modelos de regressão multinível em educação,* Campinas: Komedi (2003).
[49] B. Tether, C. Hipp and I. Miles, "Standardisation and particularisation in services: evidence from Germany", *Research Policy,* nº30, 1115–1138, 2001.
[50] B. Tether, "Do Services Innovate (Differently)? Insights from the European Innobarometer Survey", *Industry and Innovation*, nº12, 153–184, 2005.
[51] M. Freel, "Patterns of Technological Innovation in Knowledge Intensive Business Services", *Industry and Innovation*, nº13, 335-356, 2006.
[52] A. Hadjimanolis, "Barriers to innovation for SMEs in a small less developed country (Cyprus)", *Technovation*, 19, pp. 561-570, 1999.
[53] K. Hoffman, M. Parejo and J. Bessant, "Small Firms, R&D, Technology and Innovation in the UK: A Literature Review", *Technovation*, 18 (1), pp. 39-55, 1998.