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Attitudes to innovation in peripheral economic regions

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ABSTRACT

The objective of this study is to shed light on the identification of the internal and external factors that affect the attitudes towards innovation of companies located in regions situated on the periphery of economic centres. The main research questions are as follows: (1) What are the internal factors that predispose companies to seek access to innovation? (2) To what extent do external factors such as location and technological opportunities condition or stimulate favourable attitudes towards innovation? To test the hypotheses put forward to answer these questions, we formulate and estimate econometric specifications, taking a sample of more than 2000 companies situated in Andalusia (one of the less-favoured regions in Spain). Our results show that the cost of innovation and the level of indebtedness of a company have a statistically significant and negative effect on attitudes to innovation, whereas the technical qualifications of the employees, the propensity to export, and the company size (measured by the number of employees) have a significant and positive effect on a company's attitude towards innovation. Furthermore, technological opportunities and location exert positive effects on attitudes towards innovation.

1. Introduction

Regional studies on innovation have usually concentrated on the phases of invention, innovation, and diffusion, using conventional indicators of resources, results or technology transfer. However, there is a prior stage of special relevance in less-developed regions, which is the predisposition of companies to participate in any of these prior substantive phases, described simply as *attitude towards innovation*. It is well known that, in general, there is little innovatory tradition in peripheral regions. These zones face problems in transforming their R&D effort into economic activity. They have relatively weak economic activity and a lack of entrepreneurship (Rodríguez-Pose, 1999). One of the principal obstacles for local and regional governments with competence in R&D and innovation is the inertia of the local businessmen, or their unreceptive attitude to proposed (innovatory) changes that could improve their businesses. As Hadjimanolis (2000) pointed out, these regions share some specific characteristics. First, the innovation system is weak, with many innovation-related institutions missing or underdeveloped. Second, the local market is small. Third, there is a prejudice against and lack of trust in local suppliers of innovative products, so there is limited demand for technology-based products. Finally, the industrial structure is dominated by small firms, so there are relatively few medium and large firms and, consequently, a small number of sophisticated "lead users" who could stimulate innovation. Potential dynamic complementarities of small firms with large firms that have been noted in developed countries are also missing. There is little interaction between the local science and technology infrastructure and institutions of higher education. This particular situation explains why we specifically focus on a phase prior to the implementation of innovation (i.e., attitudes) and not on the processes of innovation itself. Deeper knowledge of these attitudes in peripheral regions should assist in defining new objectives and new lines of strategy for

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regional policies with respect to research and technological development directed towards stimulating innovative attitudes and a more receptive approach to innovation.

In this paper, we establish a working framework to study attitudes to innovation that combines both regional aspects related to locational advantages and sectoral factors with microeconomic analysis of innovation. In recent literature, we find, on one hand, numerous studies that confirm the positive effects of externalities on innovation. Models of regional innovation in which local institutional dynamics play a significant role (industrial districts, *milieux innovateurs*, new industrial spaces, regional innovation systems, learning regions, etc.) and econometric analysis of *spillovers* are good examples. On the other hand, other research studies demonstrate the importance of internal factors associated with companies and the sector in which they operate on their innovatory capacity (for example, Levin et al., 1985; Cohen et al., 1987; Cohen and Levin, 1989; Molero and Buesa, 1996; Beneito, 2003; Galende and de la Fuente, 2003; Galende and Suarez, 1999). However, there are surprisingly few studies that have combined these two facets (examples are Albadalejo and Romijn, 2000; Caniëls and Romijn, 2003).

From an empirical perspective, we propose a model that aims to explain the factors that affect *attitudes to innovation in companies*, which we define as a company's interest in or predisposition toward the adoption of a product or process innovation. Therefore, we consider that a company shows attitudes to innovation when it has contacted any type of public institution showing interest in new products, processes, research projects, university research, to request aid or subsidies for R&D, etc. We took the characteristics of the companies with attitudes to innovation from a list compiled by a technology network that includes all the companies with an interest in innovation (we explain the details of how this variable was obtained and the sample selection below, in Section 4). Our main objective is to advance the identification of the internal and external factors that affect attitudes towards innovation displayed by companies located in regions on the economic periphery. More specifically, our research questions are as follows.

1. What are the internal factors that predispose companies to seek access to innovation; i.e., what are the characteristics of a company that influence its decision to access the initial phase of learning that is a prerequisite to innovation? (In particular, we consider the *cost* of undertaking R&D activities and innovation; the *level of financial indebtedness*, *diversification and market power*; the *openness* to external trading; the *attitude of its personnel* towards innovation; and the *size*.)
2. To what extent do external factors such as location and technological opportunities condition or stimulate favourable attitudes towards innovation?

To answer the research questions, we estimate a binary model using a proxy of attitudes to innovation as a dependent variable and a set of regressors as explanatory variables (external and internal factors). Our empirical analysis is based on a sample of more than 2000 companies in Andalusia, an autonomous region situated in the south of Spain and on both the geographic and economic peripheries of the European Union. Note that, if the focus of our research were the innovation process instead of attitudes to innovation, there would be a risk of reverse causality associated with some of the variables included as internal to the firm (for example, stronger innovation may lead to larger firms, *market power* or *openness* to external trading are likely to be influenced by innovation, etc.). "Attitudes to innovation", however, have nothing to do with the innovation process itself (according to our definition) and the way in which we measure this variable (the company is on the list of the technology network or it is not). We base our study on cross-sectional data of firms that, following the above definition, have shown interest in knowing about issues related to innovation. The question of whether those companies listed on the network as showing positive attitudes to innovation are prepared to be classified as innovators could not be observed for this study (although this may be the subject of future research).

The article is organized as follows. In the next part of this paper, we consider various theoretical elements that provide the basis for determining the factors that affect companies' attitudes towards innovation. In Section 3 we propose the hypotheses and the methodology and continue by conducting an empirical analysis of these factors, estimating several models of binary response applied to a sample of 2496 companies operating in Andalusia. The main conclusions are presented at the end of the paper.

2. Theory and hypotheses

Our theoretical framework considering external and internal factors affecting attitudes to innovation is supported by three perspectives that stem from the analysis of technological innovation, developed mainly from an evolutionary perspective. The first approach considers the importance of flow of knowledge and proximity, and the second considers the relevance of sectoral aspects for innovation. The third aspect is focused on internal determinants. In the following paragraphs, we briefly review this literature.

First, some of the principal tendencies in regional analysis have contributed significantly to explaining how factors related to the environment influence a company's capacity to innovate. On the one hand, the theoretical literature on regional/territorial models of innovation has provided plausible explanations of the importance of territory for determining the capacity of a region for learning and innovation (see Moulaert and Sekia, 2003, for a synthesis). On the other hand, econometric research has been applied to quantify the effects of *spillovers*. The hypothesis that underlies this idea is that the cost of accessing such an external source of knowledge is lower than if the knowledge were produced internally or if it were acquired from a greater geographic distance; this implies that these companies will ultimately obtain profits or other benefits from geographic proximity. Most of the econometric analysis on this issue confirms the positive effects of such spillovers (Acs et al., 1992; Anselin et al., 1997; Audretsch and Feldman, 1996; Audretsch et al., 2005; Audretsch and Stephan, 1999; Fischer and Varga, 2003; Jaffe et al., 1993; Mowery et al., 2001; Varga, 2000).

Second, the sectoral perspective provides additional arguments to stress the role of external factors. Some early studies (Pavitt, 1984; Pavitt et al., 1989) suggested that industrial sectors differ greatly in the sources of technology that they adopt, the users of the technology that they develop, and the methods used by successful innovators to appropriate the benefits of their activities. In a similar way, Dosi et al. (2002) state that the directions and rates at which firms learn vary greatly, depending on the sectors in which they operate. Some terms have been coined in the evolutionary literature to explain the differences in innovation among sectors. The concept of "technological opportunities" is frequently used to describe why technological advances grow faster in some sectors than in others and why the underlying knowledge may differ (Nelson and Winter, 1982; Klevorick et al., 1995). In a narrower sense, the concept of technological opportunity is often used to capture the sources of technical progress with special reference to developments in the sciences and technologies underlying innovations (Palmberg, 2004; Holmen et al., 2007). A broader concept that encompasses the previous one is "technological regime", which Breschi et al. (2000) define by the specific combination of technological opportunities, appropriateness of innovation, cumulativeness of technical advances and the properties of the knowledge base underpinning firms' innovative activities, concluding that the sectoral patterns of technical change are related to the nature of the underlying technological regime. The recent perspective of sectoral systems (Malerba, 2002) also provides a useful framework for understanding the innovation process in sectors (see Malerba, 2006 for a review of the relationship between innovation and the evolution of industries).

Third, one must add to these studies a growing body of literature that, from an organizational point of view, aims to identify the internal characteristics of the companies that facilitate the exploitation of externally available knowledge (see, for example, Delmas, 2002; Almeida et al., 2003, and the abundant references included in this study). The organizational capacities that promote or hinder innovation have been the subject of much research to determine why some companies are more innovative than others (for example, Damanpour, 1991; Tabak and Barr, 1999; Galende and Suarez, 1999; Beneito, 2003; Galende and de la Fuente, 2003).

Whether from a territorial/sectoral or an organizational (i.e., company) point of view, or by combining these perspectives, the empirical confirmation of the determining factors of innovation has traditionally been approached by employing indicators of resources and results. Very little attention has been paid to the *receptivity*, *concern* or *attitude* of a company with respect to innovation or to the factor that we could refer to as the *exit barrier* blocking the company's technological trajectory. The formation of a favourable attitude towards innovation precedes a company's decision to adopt it, and this point has been made in several studies (Baldwin and Scott, 1987; Rogers, 1995). In other words, there is a phase prior to the adoption of innovations, which Carter et al. (2001) designate *initiation*, meaning the stage when the adopting unit (the company) acquires information and goes through a process of approval for the adoption of innovations. Fichman and Kemerer (1997) state that companies pass through a number of stages, such as understanding the prospective innovation and becoming interested in it before adopting it. These kinds of variables, which are antecedents to any innovation (attitude, motivation, receptivity, interest in the innovation, etc.), are, in our view, especially relevant in less-favoured regions or those on the economic periphery. On the economic periphery, the regional system of innovation is likely to be in a formative phase, when the links between university, company and government are still being established and where the principal organizations that generate innovations—the companies—are weaker, smaller, fewer, mostly operating in traditional sectors, with little previous or current innovatory activity, and more resistant to change. It may be objected that a favourable attitude towards innovation does not necessarily lead to success in transforming these regions into areas of technological progress, innovation and subsequent economic growth, but recent microeconomic research confirms that innovatory attitudes are conducive to innovation; for example, Waarts et al. (2002) conclude that, in the first stages of adoption of innovations by a company, one of the more predominant factors is its attitude towards the adoption of new products or its receptivity to new ideas. Claver et al. (1998) consider that an innovative attitude is a key factor for business success and that an essential pre-requisite for this is a predisposition or a pre-existing positive attitude to accept the changes and challenges implied by the various different options.

From the arguments presented and the three perspectives reviewed earlier, we assume that attitudes towards innovation depend on internal factors or capacities of the organizations (companies) and on external factors (location and sector in which a firm operates) related to a business activity and its environment (see an extended literature review in Table 1). In the next two sections, we state the hypotheses.

2.1. Internal factors

The microeconomic perspective analyses many aspects related to the inherent physical and behavioural characteristics of companies. Using a similar approach, we will assume that the *innovatory concerns and attitudes* of a company will depend on:

(a) the *cost* of undertaking R&D activities and innovation;
(b) its *level of financial indebtedness*, the *diversification* of its lines of business and *market power*;
(c) its *openness* to external trading opportunities and positive attitude to exporting;
(d) the *attitude of its personnel* towards innovation in the organization; and
(e) its *size*.

(a) *Cost of R&D*. In explaining the attitudes towards innovation, the cost of innovation can be a determining factor that can acts as a disincentive to companies when deciding to invest in R&D in their productive processes. In principle, it should be negatively correlated with the attitudes towards innovation. Considered in isolation,

Table 1
Research on the relationship between innovation/attitudes to innovation and internal/external factors

Internal factors	Theoretical arguments	Theoretical and empirical studies
Cost of innovation	The cost is a dissuading factor for innovation, a disincentive.	Cohen (1996).
Financial indebtedness	The availability of financial resources to invest encourages innovation. High levels of indebtedness hinder innovation.	Tushman and O'Reilly (1996), Hargadon (1998), and Delmas (2002) argue about the relation between the risk-averse attitude and innovation. A negative relation can be found in Tabak and Barr (1999), Hall and Bagchi-Sen (2002), Loof and Heshmati (2002), Waarts et al. (2002), and Beneito (2003).
Diversification	Positive: determinant of capacity to accept commercial risks Negative: formal and financial controls	Positive: Chen (1996), Beneito (2003), and Galende and de la Fuente (2003). Negative: Hoskisson and Hitt (1988), Baysinger and Hoskisson (1989), Hoskisson and Johnson (1992), and Hoskisson et al. (1993).
Market power	Powerful market position allows profits to be made from innovations.	Blundell et al. (1999) and Negassi (2004).
International commercial relationships	Variety and variability of demand in external markets and greater levels of competition stimulate innovation.	Nassimbeni (2001) and Loof and Heshmati (2002).
Qualification of the personnel	Higher levels of qualification lead to greater receptivity to innovations.	Lovelace (1986), Sebora et al. (1994), Tabak and Barr (1999), Zwick (2002), and Negassi (2004)
Size	Evidence in favour of large companies (scale economies, available resources, etc.) and in favour of smaller companies (flexibility, dynamism, etc.).	Favour large companies: Horowitz (1962), Lunn and Martin (1986), Braga and Willmore (1991), Henderson and Cockburn (1996), and Arundel and Kabla (1998). Against large companies: Worley (1961), Mansfield (1964), Grabowski (1968), Adams (1990), Loeb and Lin (1977), Scherer (1984), Acs and Audretsch (1988), and Graves and Langowitz (1993).
External factor	**Theoretical arguments**	**Theoretical and empirical studies**
Technological opportunities	Strong competition and sectoral dynamism acts as an incentive for innovation activities. The directions and the rates at which firms learn vary a lot depending on the sectors in which they operate.	Pavitt (1984), Pavitt et al. (1989), Dosi et al. (2002), Klevorick et al. (1995), Palmberg (2004), Holmen et al. (2007), Breschi et al. (2000), and Malerba (2002, 2006).
Location	- Importance of flow of knowledge and geographical proximity - Externalities are most likely manifested in cities	Literature on regional models of innovation (see Moulaert and Sekia, 2003, for a survey). Effects of Spillovers (Acs et al., 1992; Anselin et al., 1997; Audretsch and Feldman, 1996; Audretsch et al., 2005; Audretsch and Stephan, 1999; Fischer and Varga, 2003; Jaffe et al., 1993; Mowery et al., 2001; Varga, 2000). Locational advantages in cities (Carlino, 2007).

it would seem reasonable that higher costs would have the effect of dissuading companies from adopting innovations of process or of product. The intensity or scale of the activity in R&D is often considered to be the basic input of industrial innovation. Consequently, it is customary to include the cost of R&D as an explanatory factor (see Cohen, 1996), and, in general, it is usually significant and positive. This condition leads us to formulate our first hypothesis.

H1. The probability that a company would show a favourable attitude towards innovation decreases with the cost of innovation.

(b) *Level of financial indebtedness*. The availability of resources to invest is an essential element if a company assumes the risks and uncertainties that accompany all innovation activities (Tabak and Barr, 1999; Hall and Bagchi-Sen, 2002; Loof and Heshmati, 2002; Waarts

et al., 2002; Beneito, 2003). Therefore, the company must have sufficient resources, especially financial, and this becomes an indispensable condition for holding a favourable attitude that would permit the adoption and/or generation of innovations; this necessarily implies the existence of an adequate structure of financial liabilities in the company. This condition leads us to formulate our second hypothesis.

H2. The probability that a company would show a favourable attitude towards innovation decreases with its level of financial indebtedness.

It is well known that the literature points out the existence of contradictory results in the relationship between diversification and innovation (see Table 1); however, the more activities in which the company operates, the more channels of information will be open to it on new technologies. In other words, there will be an increase in the various different informal sources of knowledge for capturing ideas and information useful for processes of innovation, and this should stimulate or reinforce positive attitudes towards innovation. From this factor, we formulate our third hypothesis.

H3. The probability that a company would show a favourable attitude towards innovation increases when the diversification of its production is greater.

Market share can be related to innovatory attitude (Negassi, 2004). The companies with a more powerful market position and a bigger market share can be considered better equipped to realize profits from innovations and, therefore, be more likely to adopt a favourable attitude to the assumption of risks and, consequently, to innovation. Our fourth hypothesis is derived from this argument.

H4. The probability that a company would show a favourable attitude towards innovation increases when its market power is greater.

(c) *Positive attitude to exporting and importing*. The variety and variability of demand in external markets, together with greater levels of both qualitative and quantitative competition, stimulate searches for new products, designs and functions. In other words, it can be foreseen that such companies would show a favourable attitude towards innovation. Loof and Heshmati (2002) also conclude that companies with external orientation make more investments in R&D, which implies a more favourable attitude towards innovation. With this argument, we formulate our fifth hypothesis.

H5. The probability that a company would show a favourable attitude towards innovation increases if the company is engaged in international commercial activities.

(d) The attitude of the organization's personnel towards innovation. Tabak and Barr (1999) analyse how personal characteristics and the organizational context are associated with the intention to adopt technological innovations, stating that higher levels of technical qualification lead to greater receptivity to innovations. Negassi (2004) states that human capital is one of the most important resources in the analysis of innovative attitudes in the company. Therefore, our sixth hypothesis can be formulated as follows.

H6. The probability that a company would show a favourable attitude towards innovation increases when the level of qualification of the employees is higher.

(e) *Company size*. The relationship between innovation and company size is a controversial question. The empirical evidence is not conclusive (see Table 1), but all the discussion in favour of and against size as a determining factor is oriented to the analysis of the effects of company size on the innovation process or its results. We are not aware of any empirical analysis that might establish an association between size and attitudes, but, in principle, it would seem reasonable to think that large companies usually have access to more resources to finance innovatory projects and are, therefore, more likely to have a more favourable attitude. With the objective of testing whether company size is relevant to attitudes in innovation, we formulate the last hypothesis of this first group.

H7. The probability that a company would show a favourable attitude towards innovation increases with the size of the company.

2.2. External factors

In this section, we analyse what we consider to be two external factors that are relevant for explaining firms' attitudes to innovation: technological opportunities and location.

(a) Technological competition in the sector of activity, technological dynamism or technological opportunity. As noted at the beginning of the literature review, some relevant studies have stressed the importance of sources of sectoral technological opportunities in the innovative process of firms. Therefore, the more dynamic the sector, the more favourable should be the attitude of the company towards innovations (Koberg et al., 2003). This reasoning leads us to formulate our eighth hypothesis.

H8. The probability that a company would show a favourable attitude towards innovation increases when its sector of activity exposes it to greater technological opportunity.

(b) *Location*. As we mentioned earlier, an abundant literature has proliferated that identifies the importance of tacit knowledge and its transmission in the determination of innovation in geographic concentrations (see a selection of papers in Table 1). The *spillover* effects generated by a favourable company location will influence attitudes towards innovation in the same way as they influence innovation activity. Stewart and Ghani (1991)

Table 2
Definition of independent variables

Variable	Name	Hypothesis	Description	Source
Cost of the innovation	PRICE	H1	Average cost of the innovations of the sector to which the company belongs, multiplied by its sales (weighted in turn by the fixed assets of each company, to avoid the effect of the company size).	IEA and Registro Mercantil
Level of indebtedness	END	H2	A continuous variable that reflects the ratio of indebtedness of the company, measured as the total liabilities and own capital of the company less the own funds, divided by the total liabilities of the company.	Registro Mercantil
Diversification	DIV	H3	A discrete variable that reflects the number of different industrial activities in which the company has been recognized as participating, taking a level of disaggregation corresponding to the first two digits of the National Classification of Economic Activities (CNAE).	Registro Mercantil
Market power	PM	H4	A continuous variable that reflects the quotient between the turnover of the company and the total turnover of the industrial sector to which the company belongs, adopting the breakdown into the 13 sectors utilized by the National Institute of Statistics (INE).	Registro Mercantil and INE
Qualification of the personnel	CUAL	H5	A proxy variable, continuous, that reflects the quotient between the total expenditure on personnel and the number of employees of the company.	Registro Mercantil
International commercial relationships	VEXT	H6	A binary variable that reflects the international trading orientation of the company, and takes the value 1 if the company undertakes export and/or import activities, and the value 0 in the contrary case.	Registro Mercantil
Size of the company	LEMP	H7	A continuous variable that reflects (logarithmically) the number of employees of the company.	Registro Mercantil
Technological dynamism of the sector/technological opportunities	AMAT	H8	A binary variable that takes the value 1 if the company belongs to an activity sector considered by the OECD to be high or medium-high technology, and 0 if the company belongs to a sector of medium-low or low technology.	Registro Mercantil
Location in an urban area	RU	H9	A binary variable that takes the value 1 if the company is located in a municipality situated in an area considered to be an urban area or zone, and 0 in the contrary case.	Junta de Andalucía
Location: university graduates	TUNIV	H9.1	A continuous variable that reflects the number of university graduates per capita in the urban area in which the company is located.	IEA
Location: RDSI telephone lines	RDSI	H9.2	A continuous variable that reflects the number of RDSI telephone lines per capita in the urban area in which the company is located.	IEA
Location: establishments offering services to companies	SERV	H9.3	A continuous variable that reflects the number of establishments offering specialized services to companies, per capita, in the urban area in which the company is located.	IEA

Source: Authors' own compilation.

distinguish a type of spillover that they term *changing attitudes and motivation*, which operates through the exposure of economic agents to the new ideas in a particular environment. This type of *spillover* affects their predisposition to initiate a favourable change in the attitudes towards innovation that will eventually stimulate investment in technology. Additional research has emphasized that the externalities associated with knowledge are most likely manifested in cities since their dense concentration of people and jobs is best suited to exploit them (Carlino, 2007).

These arguments lead us to formulate our ninth hypothesis.

H9. The probability that a company would show a favourable attitude towards innovation is greater in companies situated in urban environments.

Location is widely recognized as an important factor because urban clusters tend to generate a flow of knowledge and learning that affects attitudes and motivations towards innovation. With the object of penetrating the "black box" of the location factor and to consider some of

Table 3
Representativity of the sample (in relation to the number of industrial companies in Andalusia: 1999)

	No. of industrial companies (INE)	No. of industrial companies (SABI)	Representativity of the sample (%)
Extractive industry, energy and water	371	151	40.70
Food, drink and tobacco	2,589	519	20.05
Textile, leather and footwear manufacturing industry	1,208	180	14.90
Wood and cork	624	117	18.75
Paper, publishing and graphic arts	634	148	23.34
Chemical industry	231	74	32.03
Rubber and plastic materials	226	94	41.59
Diverse non-metallic mineral products	1,075	286	26.62
Metallurgy and manufacture of metallic products	1,527	383	25.08
Machinery and mechanical equipment	437	115	26.32
Electrical, electronic and optical material and equipment	236	66	27.97
Transport material and equipment	265	80	30.19
Other manufacturing industry	1,271	283	22.27
Total industry	10,694	2,496	23.34

Source: INE, SABI and own elaboration.

the specific factors that generate this flow of knowledge (such as the availability of human resources, better communications and more specialized services to companies), we propose to subdivide this hypothesis into three parts.

H9.1. The probability that a company would show a favourable attitude to innovation increases in line with the increased availability of human resources.

H9.2. The probability that a company would show a favourable attitude to innovation increases in line with the increased availability of communications in the location where the company is situated.

H9.3. The probability that a company would show a favourable attitude to innovation increases in line with the increased availability of specialized services to companies in the location where the company is situated.

3. Model and variables

In our model, we define innovatory concern or attitude towards innovation as an interest, predisposition or favourable attitude by a company regarding the adoption of product or process innovation. Before a company becomes an innovator, it should demonstrate its receptivity in an initial learning phase comprising an interest in acquiring tacit or codified information from the market, government or other organizations with the object of improving its competitive position by a process of generation and/or adoption of innovations. To measure attitudes towards innovation and innovative concerns (the dependent variable of the model, INQ), we use a binary variable that takes the value 1 if the company is considered to be one of those shown to be receptive to information related to technology and innovation and the value 0 in the contrary case. Because the dependent variable is of the binary type, the most appropriate specification for its empirical treatment is a *Logit* type model. The vector of independent variables is given by $X_i = (\mathrm{PRICE}_i, \mathrm{END}_i, \mathrm{DIV}_i, \mathrm{PM}_i, \mathrm{CUAL}_i, \mathrm{VEXT}_i, \mathrm{LEMP}_i, \mathrm{AMAT}_i, \mathrm{RU}_i, \mathrm{TUNIV}_i, \mathrm{RDSI}_i, \mathrm{SERV}_i)$. The estimation procedures can be found in Greene (2003).

Table 2 presents the set of independent variables incorporated in the model, the specific hypothesis to which the variable is related, and the statistical sources. The details of how all the variables are measured are explained in the next section.

4. Data

The operation of the preceding model requires microeconomic information (internal factors), together with the data necessary for producing the location indicators. The microeconomic information is obtained from the annual accounts of each company in the Companies Register (these data correspond to the year 1999). The company accounts consist of the balance sheet, profit and loss account, annual report, management report and audit report (where the company is obliged to provide this). These data are incorporated in a database (Sistema de Balances Ibéricos, SABI) that contains accounting and financial information on approximately 200,000 companies, more than 20,000 of which are companies located in Andalusia. To obtain our sample, we have selected all the companies incorporated in this database with four or more workers because smaller companies would be too small to undertake R&D and innovation activities. In addition, we selected only companies that belonged to the industrial sectors (manufacturing industries, companies supplying energy, water, and non-energy minerals, and those in the chemical and metals industries). With this criterion, a sample of 2496 companies was obtained (after eliminating the companies with missing data, 2480 observations were included in the models).

Two tests were applied to determine the sample's degree of representation. First, the sample was compared to the population of industrial companies of the same size in Andalusia.[1] From Table 3, it can be seen that the sample selected represents 23.34% of the population of industrial companies of Andalusia. By sector, the maximum repre-

[1] The population of industrial companies of Andalusia was taken from the National Institute of Statistics (INE).

Table 4
Representativity of the sample: Market share in Andalusia. 1999

	Net turnover (INE) (thousands of euro)	Net turnover (SABI) (thousands of euro)	Representativity of the sample (%)
Extractive industry, energy and water	5,570,303	1,819,978	32.67
Food, drink and tobacco	9,663,626	4,573,436	47.32
Textile, leather and footwear manufacturing industry	1,044,316	513,576	49.17
Wood and cork	548,681	183,553	33.45
Paper, publishing and graphic arts	1,147,694	368 762	32.13
Chemical industry	1,902,250	214,014	11.25
Rubber and plastic materials	541,163	299,837	55.40
Diverse non-metallic mineral products	2,302,736	801,862	34.82
Metallurgy and manufacture of metallic products	3,166,127	1,748,958	55.23
Machinery and mechanical equipment	729,106	403,436	55.33
Electrical, electronic and optical material and equipment	1,107,703	464,335	41.91
Transport material and equipment	2,158,738	1,077,788	49.92
Other manufacturing industry	902,021	466,284	51.69
Total industry	30,784,465	12,935,819	42.02

Source: INE, SABI and own elaboration.

sentativity corresponds to rubber and plastic materials (41.59%), and the minimum corresponds to wood and cork (18.75%). Second, we also decided to analyse the representativity of the sample in respect of market share, comparing the data provided by the INE to that from our sample, also grouped by industrial sectors according to the INE's breakdown. For this, we have taken the net value of turnover for the year 1999. The results are shown in Table 4. It can be observed that, utilizing this indicator, an average representativity of 42.02% is obtained.

4.1. Dependent variable: attitudes to innovation

It is well known that it is difficult to measure entrepreneurial attitude, and it is especially hard to obtain data at the regional level. Some empirical studies about entrepreneurial attitudes have assessed it indirectly by allowing for region-specific effects (Georgellis and Wall, 2000), using a proxy for regional culture (Beugelsdijk and Noorderhaven, 2004; Kangasharju, 2000). To our knowledge, however, there is very little empirical research that has tried to measure attitudes to innovation from a microeconomic point of view (Chan et al., 1998, is an exception). In this study, entrepreneurial attitude is also measured indirectly using an evaluation scale of factors considered to be relevant for these attitudes, which were completed by the director or manager. For this, we propose to identify from our sample of 2480 companies those demonstrating some kind of favourable attitude, concern or interest in technology and innovation (our dependent variable).

First, we have to refer to the "Centro de Enlace del Sur de Europa" (CESEAND). This is the statistical source of the basic information used to construct this variable. CESEAND is a technology network situated in the region of Andalusia. CESEAND has taken the list of companies obtained in the census of the Inventory of Technological Resources of Andalusia (IRTA), conducted by the Instituto de Fomento de Andalucía (IFA: part of the Regional Government of Andalusia), and has identified those companies that have shown some interest in topics related to new technological developments and innovation. From this source, we obtained the list of companies corresponding to the Inventory of Technological Resources of Andalusia (IRTA) and, therefore, those companies that could be classified as showing particular *concerns or favourable attitudes* towards technology inherent in their having shown some interest in topics relating to new developments in technology and innovation. The list of companies showing some concern for innovation was prepared by CESEAND from the list of companies included in the census of the Inventory of Technological Resources of Andalusia (IRTA) conducted by the Instituto de Fomento de Andalucía (IFA) and published in 1992 (initially with a total of 480 companies from all the sectors). On the basis of this original inventory of technological resources, CESEAND has continued to update their database of companies, including any that have since shown a "minimum interest" in questions of technology and innovation. The intention of CESEAND in maintaining this list was to have available information on the companies by applying a criterion of the *bottom-up* type in such a way that their responses to a questionnaire surveying their concerns, wishes, requirements, problems and disadvantages with respect to new technologies and innovation could be compiled to study supply and demand for various kinds of technologies and services. Any company that has made contact with any type of public institution, organization or other entity (CESEAND, university, public research centre, etc.) with respect to possible innovations has been incorporated into this list. (For example, companies included might involve the following types of contacts: companies that have contacted institutions to participate in research projects, companies that have contacted universities and others research centres because of interest in their research and technological developments, companies that have initiated contacts that could lead to collaborative projects and cooperation, or companies that have contacted public bodies to request aid or subsidies for R&D projects). Therefore, any company that has contacted any of these bodies is considered to have had some relevant interest in technology and innovation, and it has consequently been included in the inventory of CESEAND.

Second, from our representative sample of the industrial sector of Andalusia, comprising 2480 companies, we have identified all those with favourable interest in innovation collected by CESEAND. By applying the information

Table 5
Independent variables: descriptive statistics

	Mean	Median	Maximum	Minimum	Standard deviation
PRICE	0.339	0.041	303.001	0.000	6.414
END	75.667	79.035	434.720	0.000	27.057
DIV	1.061	1.000	3.000	1.000	0.241
PM	0.002	0.001	0.227	0.000	0.009
CUAL	16.862	15.167	93.571	0.000	8.080
VEXT	0.242	0.000	1.000	0.000	0.428
LEMP	2.877	2.773	8.268	1.386	0.929
AMAT	0.122	0.000	1.000	0.000	0.328
RU	0.487	0.000	1.000	0.000	0.500
TUNIV	0.087	0.068	0.169	0.045	0.037
RDSI	0.014	0.015	0.023	0.007	0.005
SERV	0.043	0.014	0.148	0.000	0.053
No. of observations	2,480	2,480	2,480	2,480	2,480

obtained from CESEAND to our sample of 2480 companies, 187 companies were found that have shown concern or favourable attitudes towards innovation.

4.2. Independent variables

With respect to the independent variables, to determine the potential cost of the possible investments or costs that each company would have to face to implement innovations, the following procedure has been applied. First, the "Survey on Innovation in Industrial Companies", which breaks industry down into 14 sectors, has been referred to. For each of those sectors, the average cost of the innovations or average unit cost (total expenditure on innovations of the sector per unit of sales of the sector: $C_u = C_s/V_s$) has been obtained; this ratio has then been multiplied by the sales of each company in the sample to obtain the potential total cost of innovations for each company i: $C_i = C_u \times V_i$. To avoid duplicating the effect of the size of the company with another of the variables included, C_i has been weighted by the fixed assets of each company AF_i; that is, $C_i/AF_i = C_u \times V_i/AF_i$; by doing this, it can be observed that, for a particular sector, C_u (average cost of innovations by unit of sales) is fixed and will vary in each company according to the productivity of the fixed assets V_i/AF_i; therefore, within that particular sector, those companies that may require a higher return from the asset (higher asset productivity) will need to make a bigger investment. For different sectors, the average cost (C_u) of implementing innovations in each sector (which will be higher in line with the increasing degree of complexity and technological competition) will also influence this value.

The rest of the variables that describe the internal characteristics of the companies were obtained from the database described previously (with information from the Register of Companies). With respect to the variables relating to location, discrimination was made between the companies located in urban areas and those not located in urban areas. The delimitation of the municipalities that form part of the urban areas within each province of Andalusia was conducted by the Junta de Andalucía (the Autonomous Regional Government) according to the strong functional interrelationship that exists between the municipalities. These metropolitan areas or urban centres are defined by a criterion of size (having a nucleus of more than 100,000 inhabitants), physical continuity and maximum travelling distance. In all the provinces of Andalusia, with the exception of the province of Cádiz, areas considered as urban correspond to the provincial capital and those neighbouring municipalities within its radius of influence or action. The peculiarities of the province of Cádiz allow two separate urban areas to be distinguished: the first and more important is constituted by the two cities of Cádiz (the capital) and Jerez de la Frontera; the second is constituted by Algeciras and the municipalities over which it exerts a

Table 6
Descriptive statistics for independent variables

	Mean			Standard deviation		
Variable	Dep = 0	Dep = 1	All	Dep = 0	Dep = 1	All
PRICE	0.358	0.107	0.339	6.670	0.213	6.414
END	76.427	66.341	75.667	26.938	26.852	27.057
DIV	1.061	1.053	1.061	0.242	0.226	0.241
PM	0.002	0.006	0.002	0.007	0.023	0.009
CUAL	16.440	22.032	16.862	7.883	8.681	8.080
VEXT	0.208	0.647	0.242	0.406	0.479	0.428
LEMP	2.791	3.925	2.877	0.851	1.181	0.929
AMAT	0.109	0.278	0.122	0.312	0.449	0.328
RU	0.479	0.583	0.487	0.500	0.494	0.500
TUNIV	0.087	0.096	0.087	0.036	0.039	0.037
RDSI	0.014	0.015	0.014	0.006	0.005	0.005
SERV	0.043	0.050	0.043	0.052	0.054	0.053
No. of observations	2,293	187	2,480	2,293	187	2,480

Table 7
Results of the estimations (logit)

	MOD I	MOD II	MOD III	MOD IV	MOD V
C	−5.254[a] (0.575)	−5.620[a] (0.608)	−5.666[a] (0.617)	−5.252[a] (0.575)	−6.630[a] (0.690)
PRICE	−0.768[b] (0.443)	−0.842[b] (0.458)	−0.815[b] (0.452)	−0.762[b] (0.441)	−0.745[b] (0.450)
END	−0.008[a] (0.004)	−0.008[a] (0.004)	−0.008[a] (0.004)	−0.008[a] (0.004)	−0.008* (0.004)
DIV	−0.410 (0.375)	−0.413 (0.375)	−0.411 (0.375)	−0.409 (0.375)	−0.373 (0.380)
PM	−3.715 (6.051)	−4.161 (6.053)	−4.309 (6.039)	−3.731 (6.066)	−3.862 (6.018)
CUAL	0.027* (0.009)	0.025* (0.009)	0.026* (0.009)	0.027* (0.009)	0.029* (0.009)
VEXT	1.359* (0.177)	1.371* (0.177)	1.372* (0.177)	1.358* (0.177)	1.391* (0.179)
LEMP	0.788* (0.087)	0.784* (0.087)	0.784* (0.086)	0.788* (0.087)	0.806* (0.087)
AMAT	1.167* (0.218)	1.171* (0.219)	1.174* (0.219)	1.169* (0.218)	1.236* (0.221)
RU	0.051 (0.179)				−0.997 (0.395)
TUNIV		4.711* (2.340)			15.657* (5.052)
RDSI			32.242* (16.284)		31.065 (22.770)
SERV				0.349 (1.586)	−2.966 (2.496)
log L	−500.0	−498.1	−498.1	−500.1	−492.3
McFadden R^2	0.246	0.249	0.249	0.246	0.258
LR[c]					15.4
Observation 0	2,293	2,293	2,293	2,293	2,293
Observation 1	187	187	187	187	187
No. of observations	2,480	2,480	2,480	2,480	2,480

[a] Significant to 5%.
[b] Significant to 10%.
[c] LR = $-2[\ln L(\text{MOD V}) - \ln L(\text{MOD I})]$.

direct influence. The descriptive data of the independent variables are presented in Tables 5 and 6.

5. Results and discussion

To obtain results that are as robust as possible, a series of models have been estimated sequentially (Table 7). In Model I, we present the results of the estimation of a model that includes the effects of the internal factors, sectoral effects and the location in an urban area on companies' attitudes towards innovation. The coefficient of the variable PRICE (cost of the innovation) is statistically significant and with negative sign in all the models, which implies that this variable acts as a disincentive with respect to company attitudes towards innovation. The same happens with the coefficient of the variable END (level of indebtedness of the company), also with negative sign, suggesting that carrying more debt reduces the probability that a company would show a favourable attitude towards innovation. Furthermore, it can be observed in this model that the internal variables or company characteristics with significant coefficients are the following: CUAL (the technical qualification of the employees), VEXT (export/import activity) and LEMP (size). All these variables present a positive sign; therefore, all have a favourable effect in increasing the probability that innovative attitudes are stimulated. AMAT (a variable that indicates whether the company belongs to a sector of high or medium-high technology) also has a significant coefficient. However, the coefficient of the variable RU (location in an urban area) is not statistically significant; therefore, on average, there is no difference in the probability of showing innovatory attitudes between those companies located in urban areas and the rest. However, when the effects of location are incorporated with a continuous variable (Models II, III and IV, respectively, include the variables TUNIV (the presence of qualified human resources in the business environment), RDSI (communications facilities) and SERV (specialized services to companies)), the coefficients of TUNIV and RDSI are statistically significant to 5%. In Model V, the three previous variables have been introduced jointly, but, as can be appreciated in the table, the multicollinearity between them causes the coefficients of both to appear now as statistically insignificant, even with changes of sign, which prevents the individual significance of each variable from being analyzed in this model. However, the combined relevance of all the variables has been tested by applying the LR test (ratio of maximum likelihood) to the model with all the variables (MOD V) against the model that excludes them (MOD I); in other words, LR = $-2[\ln L(\text{MOD V}) - \ln L(\text{MOD I})]$. The value of the corresponding statistic has been compared using a chi squared with three degrees of freedom (the variables included in the complete model, with respect to the restricted model). The result of this test is LR = 15.4, a value found to be significant to 5%. It can consequently be confirmed, with a 95% degree of confidence, that an increased availability of qualified human resources (TUNIV) and an increase of communications (RDSI) jointly increase the probability that companies would show innovatory concerns and favourable attitudes towards innovation.

In short, we note the following (Table 8 summarizes the results).

- *Internal factors*: All the estimations of our models support our hypotheses H1, H2, H5, H6, and H7. In other words, in all the models of binary response, the internal variables with significant coefficients are: the potential cost of the innovation, the degree of indebtedness of the company, the technical qualification of its employees, its participation in exporting and/or importing, and company size. The first two variables have a negative sign, suggesting that both decrease the probability that innovative attitudes would be stimulated. The other variables have a positive sign; therefore, all of them have the effect of

Table 8
Testing of hypotheses: summary of results[a]

Hypothesis	Independent variables	MOD I		MOD II		MOD III		MOD IV		MOD V	
		Relation	Significance[a]	Relation	Significance[a]	Relation	Significance[a]	Relation	Significance[a]	Relation	Significance[a]
H1	PRICE	–	**	–	**	–	**	–	**	–	**
H2	END	–	*	–	*	–	*	–	*	–	*
H3	DIV										
H4	PM										
H5	CUAL	+	*	+	*	+	*	+	*	+	*
H6	VEXT	+	*	+	*	+	*	+	*	+	*
H7	LEMP	+	*	+	*	+	*	+	*	+	*
H8	AMAT	+	*	+	*	+	*	+	*	+	*
H9	RU										
H9.1	TUNIV			+	*					+	*
H9.2	RDSI					+	*			+	*
H9.3	SERV										

[a] *Significance 5%; **Significance 10%.

increasing the probability that the firms would show a favourable attitude to innovation.

- *External factors*: Our econometric results support the hypothesis related to the "technological opportunities": the company's participation in an activity sector of medium-high or high technology increases the probability of a favourable attitude to innovation. The estimations do not support the general hypothesis H9, but H9.1 and H9.2 are supported. In other words, the coefficient of the variable RU (location in an urban area) is not found to be statistically significant; therefore, on average there is no difference between those companies located in urban areas and those in other areas in the probability that innovative attitudes appear. However, when the effects of company location are incorporated with a continuous variable (the presence of qualified human resources in the business environment and communications facilities), the coefficient of these variables is statistically significant to 5%.

The results of this study generate various reflections on possible political initiatives for promoting positive attitudes towards innovation in peripheral regions. In relation to the internal determinants, the statistically significant factors observed can be grouped under two main headings. One is related to the company's willingness and/or capacity to assume new risks—a variable that is reflected in the cost of innovating (the greater the cost, the greater the risk), the level of indebtedness (the higher the indebtedness, the lower the willingness to assume new risks), and company size (the greater the size, the greater the capacity for confronting new risks). The other group of factors is related to the possibilities of acquiring knowledge; that is, companies show more favourable attitudes towards innovation when they have more possibilities of acquiring knowledge, either by necessity (companies that operate in sectors of moderate and high technical complexity), because they have a well-qualified workforce, or because they have the opportunity to associate with a varied selection of customers and suppliers (for example, companies that undertake importing and/or exporting). The negative relationship between favourable attitudes and the variables of cost and indebtedness, encompassed within the notion of "willingness to assume new risks", suggests not only that the potential cost of innovating acts as a dissuasive factor but also that the level of indebtedness has a negative influence. Therefore, financial incentives intended to reduce the levels of risk or risk perception would be advantageous for promoting innovative attitudes. In addition, it should be noted that there is a positive relationship between attitudes and company size, which could justify introducing factors of discrimination in promotional policies, based on this variable. This observation is important because, in peripheral regions such as Andalusia, there is a clear predominance of small companies, which are, according to our results, those that present less favourable attitudes towards innovation. However, the positive and significant relationship between variables related to the acquisition of knowledge and innovative attitudes would imply that policies orientated towards increasing the stock of relevant knowledge (scientific, technological, marketing, etc.) in companies would be beneficial for promoting positive attitudes to innovation. These initiatives could be implemented either indirectly (assistance directed towards improving the technical qualification of employees, encouraging the establishment of sectors of high or intermediate complexity, or help in the procedures of export/import) or by direct measures of information that is not only directed at the processes of innovation or at the sources of technological knowledge but also information on new or potential markets that would encourage the internationalization of companies.

In relation to the external variables, it is typical that the variable of company location (in an urban/rural environment) is insignificant in explaining attitudes towards innovation. This is a very generic variable, and it indicates only whether the company is situated in an urban area or in a rural environment. The problem with this variable is that factors that may encourage positive attitudes towards innovation (for example, access to more tacit knowledge) may intervene in the company's location in an urban zone, but there are other factors that act in the opposite direction. For example, in Andalusia, the companies located in urban locations have to support land costs that are much higher than in rural areas; this factor is very relevant particularly in the initial years of business operation, where high levels of indebtedness are frequent as a result of the high fixed costs of establishment (and as has been demonstrated, the indebtedness–attitudes relationship is negative). How-

ever, if the "black box" of location is analyzed in greater depth and is considered with respect to the urban environment by providing, for example, more qualified human resources or better communications, a positive relationship is confirmed between these variables and attitudes towards innovation. The political reflection that emerges from this result is that if we intend companies to show favourable attitudes towards innovation, it is not enough to simply create specific zones in urban settings and "force" companies to locate in them (in Andalusia, the creation of industrial estates is a common policy measure); this decision must be accompanied by measures to help companies cope with the level of debt incurred by setting up operations in these zones.

6. Conclusions

The principal message of this article is that, in peripheral regions, attention must be paid to variables that precede the technological trajectory initiated by an innovating company. Deeper knowledge of variables such as "attitudes to innovation" can help in defining new objectives and new lines of strategy for the regional policy of R&D and innovation that are aimed at stimulating innovatory attitudes and receptivity towards innovation in less-favoured regions. In this study, we have undertaken an in-depth analysis of this subject, accepting that the attitudes of companies towards innovation in peripheral regions depend on both internal and external factors. From a sample of more than 2000 companies located in a peripheral region (Andalusia, Spain), we found that the potential cost of the innovation, the indebtedness of the company, the technical qualification of its employees, its participation in exporting and/or importing, and company size are all related to the firm's attitudes to innovation (the first two variables with negative sign). However, our econometric results support the hypothesis related to the "technological opportunities", inasmuch that a company's participation in an activity sector of medium-high or high technology increases the probability of a favourable attitude to innovation. Our last variable, location—measured with different indicators—also has a positive effect on attitudes to innovation.

Finally, it must be taken into account that this study represents the first consideration of the causes that may operate in this prior phase of forming a positive attitude to innovation; therefore, it is necessary to be cautious in interpreting these results. Our analysis presents certain limitations that we shall try to improve upon in future research, such as the definition of the dependent variable (constructed only on the basis of a binary response, without considering possible graduations using a scale) or some of the independent variables included in the factors of location, which are restricted to those factors for which it has been possible to obtain data. More empirical research is required in other peripheral regions to give more substance to our conclusions. In addition, although the sample utilized is representative of the industrial sector, it would also be necessary in successive investigations to study attitudes towards innovation in the services sector.

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