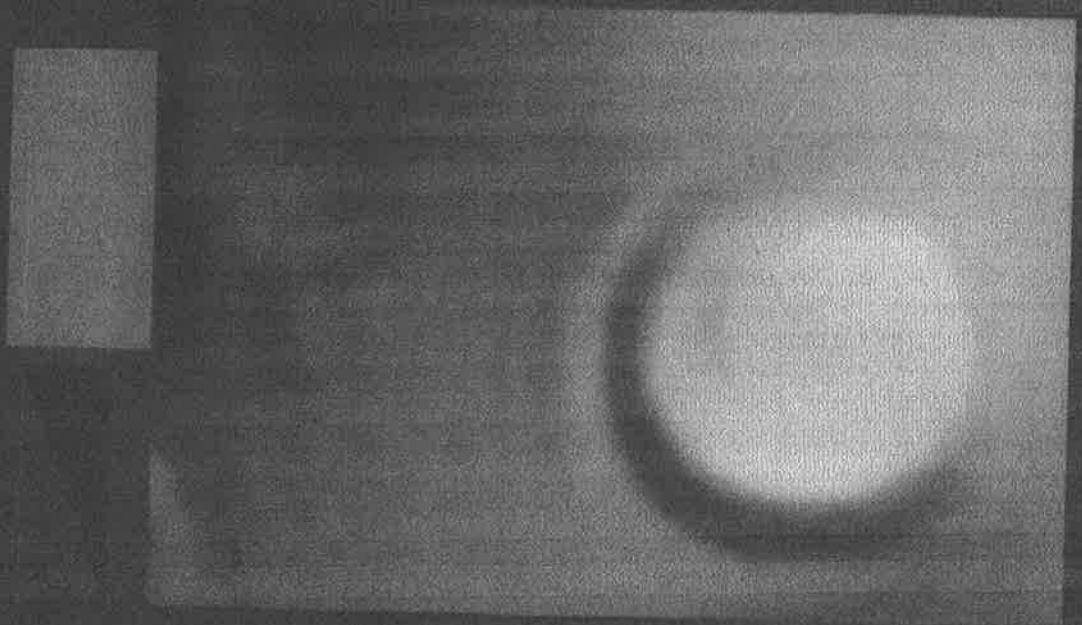
ESTUDOS III



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Factors affecting the adoption of new technologies by labour-intensive firms: an empirical exercise on European southern regions

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Resumo

O presente artigo tem como argumento teórico a hipótese de que, não apenas as condicionantes envolventes afectam o desempenho dos agentes económicos, também a forma como estes se comportam e reagem aos diferentes desafios tem um impacto nos contextos locais.

O principal objectivo deste trabalho é o de mostrar até que ponto isto se verifica, nomeadamente analisando como um conjunto de variáveis afectam a adopção de novas tecnologias pelas pequenas empresas. Distinção é feita entre o ambiente indirecto ou geral das empresas e o seu ambiente de trabalho (*task environment*) que inclui clientes, fornecedores, concorrentes, associações, sindicatos, instituições financeiras e instituições de ensino e formação. Enquanto que as empresas dificilmente influenciam o primeiro, o chamado *task environment* corresponde ao espaço decisional da empresa, aquele que permite diferentes opções estratégicas, nomeadamente no que se refere a novas tecnologias.

Empiricamente, a análise tem por base a aplicação de um inquérito a uma amostra de 167 pequenas e médias empresas, dos sectores do vestuário, têxtil e calçado, pertencentes às seguintes Nuts 2 Europeias: Norte (Portugal), Valência (Espanha), Central Macedonia, Eastern Macedonia e Thrace/ /Western Macedonia (Grécia), Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sardegna e Sicília (Itália).

Como mencionado por Pavitt (citado em Dosi, 1988), os sectores dos têxteis, vestuário e calçado, pertencem ao grupo a que o autor designou por *suplier-dominated*, onde a importância das relações de interdependência com as restantes empresas na cadeia produtiva é entendida como uma importante fonte de conhecimento tecnológico, sendo ainda reconhecida a relevância, nestes sectores, da inovação de cariz organizacional. Ambas as ideias foram

tidas em atenção aquando da definição da variável dependente – adopção de novas tecnologias – bem como da selecção da lista de possíveis factores explicativos dessa adopção.

Um modelo de regressão binária logística foi desenvolvido por forma a responder aos objectivos propostos e produzir conclusões.

Palavras-chave: Mudança tecnológica, sectores trabalho-intensivo.

Abstract

In his paper we developed a theoretical framing supported by the main hypothesis that, not only environmental conditions influence the performance of economic agents, also the way economic agents behave and respond to their changing conditions has an impact on local sets.

The main objective of the present work is to show empirically to what extend this is true, namely regarding how a set of environmental variables affect the adoption of new technologies by small firms. We distinguished between firm's indirect or general environment and firm's task environment, the one including customers, suppliers, competitors, trade associations, trade unions, financial institutions, regulatory bodies, universities and training and recruitment agencies. While firms can hardly influence the first, task environments correspond to firm's decisional space, allowing different strategic options, namely regarding technology.

Empirically, the analysis is based on a survey application to a sample of 167 small and medium sized firms from clothes, textile and leather sectors, belonging to the following European Nuts 2 regions: Norte (Portugal), Valencia (Spain), Central Macedonia, Eastern Macedonia and Thrace and Western Macedonia (Greece), Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sardegna and Sicilia (Italy).

As mentioned by Pavitt (quoted in Dosi, 1988), textile, clothing and leather sectors belong to what he called the *supplier-dominated* group of sectors, where the importance of the contacts developed within firms in the productive chain is perceived as an important source of technological knowledge. The significance, in this kind of sectors, of organisational innovations, is also pointed. Both ideas were remembered when selecting the list of factors affecting technological changes, as well the type of technological change considered.

After revising the general conceptual framework, a binary logistic regression is computed in order to accomplish the above established purposes and produce conclusions.

Key-words: Technological change, labour-intensive sectors.

1. Introduction

As Tracey, Clark and Smith (2003) explained, environments (especially task environments) influence firm's decision-making process, as their strategic options are encouraged or inhibited by their contexts. Although is very difficult for small firms (for instance) to control those contexts, is also argued that firm's strategic decisions can '...shape the boundaries of its environments...' since decisions with regard to location, markets explored, customers pursued, technology adopted or training provided can, in fact, manipulate aspects of the environmental sets.

Many authors make clear reference to the role of territory in forging competitiveness.

Camagni (2002) suggests that regions compete on the basis of absolute competitive advantages, arising when a region possess superior technological, social, infrastructural or institutional assets, which are external to firms but of their benefit. Economies open to trade and the movement of production factors should assure a certain level of growth in competitiveness, as the risk of depopulation and desertification is eminent. The author assumes that territories compete with one another and both attractiveness and local competitiveness depend on similar common factors, which goes beyond physical conditions and refer to relational capital and the learning capacity expressed by the territory. Although recognising that individual companies are the ones that compete in the international market, the author remember that these companies and these entrepreneurs are to a large extent generated by the local context and, in order to face changing and uncertain economic conditions, their decision-making process is firmly based on socialised practices (Camagni, 2002: 2396). The European Commission (1999) also mentions the existence of common features within a region, which affect the competitiveness of all firms located there. Bramanti (1999) assumes the role of space and territory in creating competitiveness and better economic performance through the interaction of four building blocks: innovation processes, learning mechanisms, governance structures and networking relations. When considering innovative activities, the importance of geographic proximity promoting interaction, has been defended by authors like Arndt and Sternberg (2000), Breschi (1999), Malmberg and Maskell (1997), Kirat and Lung (1999).

Contrarily to big firms, SMEs interact intensely with the territory in which they locate, as a signal of their *embeddedness*. The particular tight links they develop with the external environment also reduce uncertainty risks. In general, SMEs do not only locate nearby the residence of their owners but also the geographical and sociological proximities constitute their

main sources of assets and information (Julien, 1995; Vaz, 2004).This fact determines the perspectives and strategic choices of the firms, because most of the market perception arises from the inputs that the territorial institutional context supplies them. Growth determinants as competition capability, political understanding and knowledge of consumption behaviour do result from the external environment of the firm. Not surprising that the attributes of such environments become, therefore, a crucial factor for the development of entrepreneurship.

Nevertheless, such external links by themselves are not sufficient to produce technological learning. Internal factors dealing with human capital and networking aptitudes within the firm are also important variables (Vaz e Cesário, 2005). As a result, different abilities may explain the construction of different entrepreneurial strategies, namely regarding technological adjustments.

Pointing out the insufficiencies of neoclassical models, Clark, Tracey and Lawton Smith (2002) and Clark et al. (2004) reject the idea that economic agent's options are completely bounded by their regional sets. The **agent-centred perspective** (as labelled by the authors) assumes that agents or firm's strategic choices are not tightly dependent and derived from their contexts, but can be developed either through interaction or complete independent from those sets. Although not ignoring social, political and economic structures, as framing variables, the authors clearly reject that economic agents are chained to their historical or geographical conditions as *they have the cognitive capacity to interact with them.* One important presumption of this approach is the rejection of rational maximising behaviour theories. Facing the need of generalising and summing up individual behaviours, economic theory tends to marginalize the scope and nature of human decision-making process. The assumption of rationality means that all people choose the optimal according to their goals. To suppose otherwise is to suppose irrationality or, at least, inconsistency. The need to better understand empirically how and why people make their decisions, led to the acceptance of the fallibility of rationality[1].

[1] According to Herbert Simon (1955) an 'economic man', as postulated by the traditional economic theory, is assumed to have clear knowledge of the relevant aspects of his environment and a well-organised and stable system of preferences. For the alternative courses of action available, he is able to choose the one that will permit him to reach the highest attainable point on his preference scale. This concept was a matter of drastic revision. In substitution, he suggests a 'choosing organism' of limited knowledge and ability, placed in an environment with which he interacts. The author use the concept of 'bounded rationality', explaining that rationality is bounded when there are failures in knowing all the alternatives, uncertainty about

At the end, this approach is all about recognising the importance of humans' cognitive skills. Although also recognising the influence of institutions on agent's choices, as the institutional-centred approach, the big difference between both is that the agent-centred model treat institutions only as **resource endowments**, so different regions, with different institutional settings, have different resource endowments affecting agent's decision-making and regional competitiveness (Clark et al., 2004).

Accepting that different territories may provide different competitive conditions and following the arguments of the agent-centred perspective, agents should have the cognitive capacity to move from their inherited institutional contexts when these ones are not providing favourable conditions. Hence, '...the concept of **embeddedness** may neglect the capacity of agents to understand the world of which they are part' (Clark et al., 2004), as it implies that firms are passive in terms of their choices. As seen by Granovetter (1985) the argument of embeddedness applied to economic behaviour means that agents and institutions are so constrained by ongoing social relations that to consider them as independent is a serious misunderstanding (Granovetter, 1985: 482). Although recognising the importance of the concept, the agent-centred perspective rejects such constraint in agent's capacity.

Another important clarification is introduced by this approach when assuming the concept of **inheritance**. Contrarily to Arthur's (Arthur, 1994) assumption that social capital results from the positive feedback generated by the region-industry specific path accumulation process, Clark at al. (2004) explain that national and regional institutions and practices can be inherited rather than simply accumulated in a growth and development process.

While recognising the utility of the path dependence concept, the authors emphasize the interaction between agent's cognitive capacities and their place-specific inheritances and endowments. The capacity of agents to strategically adapt to European integration and **globalisation** is very much the result of that interaction.

'...integration was nor bringing similarity, but specialisation, a form of regionalization.' (Storper, 1995: 192)

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relevant exogenous events and inability to calculate consequences (Simon, 1979: 502). In order to characterise the mechanisms of choice under conditions of bounded rationality, he uses the concepts of search and satisficing: 'If the alternatives for choice are not given initially to the decision maker, then he must search for them...As soon as he discovered an alternative for choice meeting his level of aspiration, he would terminate the search and choose that alternative.'

Economic globalisation is leading firms to face an increasingly openness to rival producers, whatever their original location of production. Not only firms but also industries and regions are now much more vulnerable to price and quality competition.

In this context, the importance of knowledge and learning for competitiveness is clear, being these new economic geographic conditions seen, by many, as an irreversible trend towards knowledge based economies. This led to another important challenge faced by firms that regards **technological change**. Firms are being forced to invest in information and process technology in order to innovate and be more competitive. There are, yet, several constraints for that to happen, mainly for small firms more lacked of financial resources[2]. This segment, particularly important in Europe is struggling to survive in such competitive environments.

When referring to technological trajectories, Dosi (1988) mentions the importance of both the *public elements of knowledge*, as *untraded interdependencies* between sectors, technologies and firms that represent a structured set of technological externalities for individual companies, but also the *local and firm-specific* technological competences.

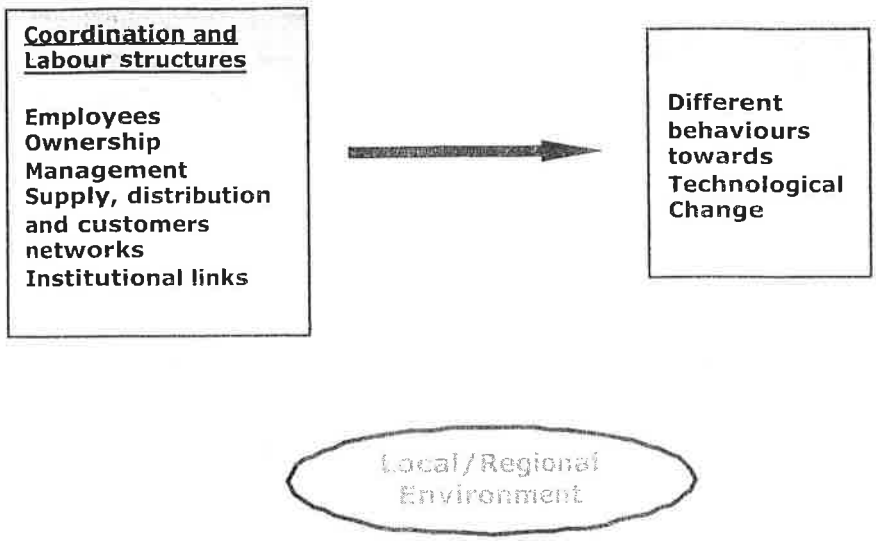
Having this in mind, in this paper we analyse those factors from small firm's task environment that better explain different behaviours towards technological change.

2. Conceptual model

Focusing on the analysis of the factors that better explain different behaviours towards technological change by small and medium firms (indicated in figure 1 with the arrow in black), we rely on Hall (1972), quoted in Tracey et al. (2003) who distinguishes between general and specific (or task) firm's environments. The first one including technological, legal, economic, demographic and cultural conditions and, the second, including customers, suppliers, competitors, trade associations, trade unions, financial institutions, regulatory bodies, universities and training and recruitment agencies. While firms can hardly influence the first, task environments correspond to firm's decisional space.

[2] For empirical exercises on the barriers to innovation on SMEs see: Pihkala, Ylinenpaa and Vesalainen (2002) and McAdam, McConvery and Armstrong (2004).

FIGURE 1
Methodological Framework



Source: own elaboration

When looking to figure 1, *Local/Regional Environment* (not subject of analysis in this paper) can be considered as firm's indirect or **general environment**, the one they can hardly influence, more even when we are dealing with small and medium sized firms. *Coordination and Labour Structures* constitute what we can label as firm's **task environment**, the one allowing different decisions, hence different strategic options, namely regarding technology.

Following Storper's arguments (1995) technological change is path dependent because it involves interdependencies between choices made over time. These choices have a spatial dimension, and though direct input-output relations may play a role, when organisations travel along a technological trajectory they have interdependencies that are *untraded* and include labour markets, conventions, common languages and rules.

Firms may differently decide about their employees (where they come from, what skills upgrading are provided), about their ownership and management, about the way they relate with suppliers, customers, universities or trade associations. Firm's may also have different geographical scales in terms of their supply, distribution and customers networks. All these variables are included in the following econometric exercise.

3. Sampling

Empirically, the analysis is based on a survey application[3] to a sample of 167 small and medium sized firms from clothes, textile and leather sectors, belonging to the following European Nuts 2 regions: Norte (Portugal), Valencia (Spain), Central Macedonia, Eastern Macedonia and Thrace and Western Macedonia (Greece), Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sardegna and Sicilia (Italy).

TABLE 1
National disparities in GDP per capita and unemployment in the UE – 2005

	GDP per capita in PPS EU25=100	Labour Productivity per person employed EU25=100	Total unemployment rate %
EU-25	100.0	100.0	8.7
EU-15	108.4	106.1	7.9
Austria	122.5	:	5.2
Belgium	117.6	127.8	8.4
Denmark	124.3	105.7	4.8
Finland	113.4	108.2	8.4
France	108.8	118.9	9.5
Germany	109.7	101.7	9.5
Greece	**82.0**	:	**9.8**
Ireland	136.9 (f)	126.4 (f)	4.3
Italy	**102.7**	**107.9**	**7.7**
Luxembourg	247.4 (f)	160.4	4.5
Netherlands	123.3	107.9	4.7
Portugal	**71.3** (f)	**65.5**	**7.6**
Spain	**98.5**	**98.6**	**9.2**
Sweden	114.6	104.3	7.8 (p)
United Kingdom	116.6 (f)	106.5	4.7

(f) Forecast; (p) Provisional value; (:) Not available
Source: EUROSTAT data.

[3] This survey was carried out in the frame of the European project **RASTEI** – Regional Adjustment Strategies to Technological Change in the Context of European Integration, aiming to study how local adjustment strategies designed to enhance productivity utilising technological change in labour-intensive industries has affected, and will affect in the future, European non-metropolitan regions in terms of their employment potential. The results for the Greek, Italian and Spanish firms were gently yielded by the project coordinator for the present research. The same questionnaire was later applied to Portuguese firms by the author.

A common survey was applied in each region, allowing a cross-country analysis among the four EU countries with the lowest GDP per inhabitant (EU-25=100) in 2005 and whose economic dependence to labour intensive sectors, particularly sensitive to the recent enlargement to East, is a common threat (see table 1). Appendix 1 gives the design of questionnaire.

Tables 2 and 3 summarise the sample distribution. Around 74% of sample firms are from textiles and clothes industry. A less representative proportion (26%) corresponds to footwear and leather industry. This happens accordingly to the proportion of theses sectors in the studied regions.

TABLE 2
Sample distribution by country and sector

	Footwear and Leather Products	Textiles and clothes	Total
Portugal	14	52	**66**
Greece	14	36	**50**
Italy	-	24	**24**
Spain	15	12	**27**
Total	**43**	**124**	**167**

Source: own elaboration.

Regarding the distribution by size, most of the inquired firms (44%) have between 10 and 50 employees.

TABLE 3
Sample distribution by sector and firm size

Number of Employees	Footwear and Leather Products	Textiles and clothes	Total
Less than 10	11	31	**42**
10 - 49	16	58	**74**
More than 50	14	37	**51**
Total	**41**	**126**	**167**

Source: own elaboration.

4. Determinants of technological change

The first step of the following empirical exercise is the choice of factors expected to explain the adoption of new technologies in the sample firms.

As mentioned by Pavitt (quoted in Dosi, 1988), textile, clothing and leather sectors belong to what he called the *supplier-dominated* group of sectors, where "...innovations are mainly process innovation: innovative opportunities are generally embodied in new varieties of capital equipment and intermediate inputs, originated by firms whose principal activity is outside these sectors themselves. Thus the process of innovation is primarily a process of diffusion of best-practice capital-goods and of innovative intermediate inputs... The knowledge base of innovation in these sectors mainly relates to incremental improvements in the equipment produced elsewhere, to its efficient use and to organisational innovations. Appropriability of firm-specific technological capabilities is rather low and firms are typically not very big..."

Two major ideas to keep: the importance of the contacts developed within firms in the productive chain, as important sources of technological knowledge, and the importance, in this kind of sectors, of organisational innovations, where employees and managers play an essential role. Both ideas were remembered when selecting the list of factors affecting technological changes, as well the type of technological change considered.

In accordance, in the following empirical exercise, the dependent variable is given by the adoption of new technologies by the sample firms. A positive answer is considered when at least one of the following technologies was adopted: inventory control, production process technology, product design technology, marketing technology, e-mail, web site/internet or business to business electronic networks.

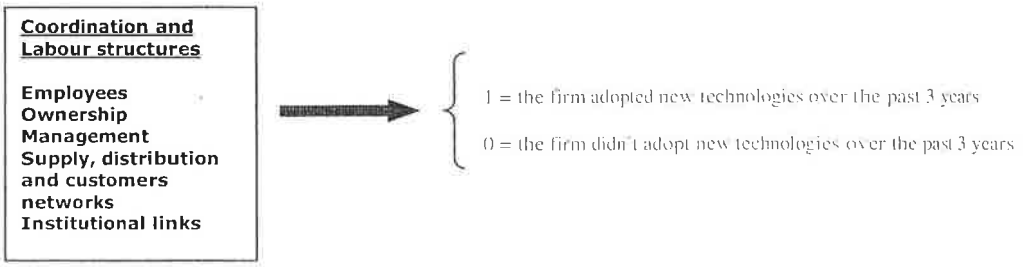
Following the methodological framework discussed above and having the theoretical arguments earlier described as reference, the following variables were considered as possible factors affecting firm's behaviour:

- **employees**, considering their importance as sources of technological learning (their origin and training provide by firms are took into account).
- type of **ownership and management**, as it is expected that the nature of ownership and management matters in investment decision-making.
- **supply, distribution and customers links**, recognising that small firms are frequently component parts of extended networks with different possible geographies (local, regional, national, EU, international). Camagni (1991, 1995) refers to the concept of networking as the channel trough which this risk of rigidity may be overcame. By accessing other markets, assets and technologies, firms free themselves from the limits of local and internal competences and gain control over the technological trajectories of his competitors. Morgan

(1996) defends the importance of interactive learning among business networks as the most effective and credible way for knowledge acquisition.

- **institutional links**, here considering mostly informal contacts that occur inside firms or between them and other surrounding agents, as they may constitute important sources of technological knowledge The term 'untraded interdependencies' was used by Storper (1995) to define regionalized relationships which extend beyond traditional customer/supplier links (also referred as input-output linkages or traded interdependencies) and embrace formal and informal collaborative and information networks. With a similar view but a different conceptualisation, Cooke and Morgan (1998) reefer to a collective social order that induces firms to collaborate and display *'associational behaviours'*.

Summarising, the following flow of influences was modelled:



It's believed that this list of variables, by themselves related with entrepreneurial behaviours, can explain firm's decision-making regarding technological change.

Based on the previous discussion, the following extended model was used as starting point:

$$TECH_i = \alpha + \beta EMPL_{ir} + \gamma SKILL_i + \delta OWNE_i + \varepsilon MANG_i + \zeta NET_{ir} + \eta LINK_{ir} \quad (4.1),$$

where *i* stands for a sample firm and *r* for the option of the corresponding question, when variables are divided in different binary variables.

The 27 independent variables used to predict the adoption of new technologies can be grouped in six main groups, identified in table 4.

The variable **EMPL** distinguishes between five different sources of employment: family members, local community, people from outside the region, joint venture partner and parent firm (five different variables are considered). Sample firms were also asked about the skills upgrading of their employees. Variable **SKILL** has a yes/no possibility standing for the

upgrading or not of employee's skills. Regarding the type of ownership (**OWNE**) firms may be owned by one person, a partnership, family owned, a co-operative, a joint venture, a limited company or a subsidiary of another firm. According to the type of ownership, different management situation are possible. Variable **MANG** aggregates the following options regarding firm's manager: owner-manager, other family personnel, external manager, co-op member from the community, non-member from the community and outsider. In these two later situations, as the options are mutually exclusive, only one variable is considered. Variable **NET** includes supply (NETS), distribution (NETD) and customer (NETC) links and distinguishes between different five possible network geographies: local associations firms, other local/regional firms, national firms, EU firms and international firms. In this case, a total of fifteen variables are considered (five geographies times three network scopes). Variable **LINK** is used to identify the contacts (mostly informal) used as sources of technological knowledge by sample firms and differentiates between internal personnel, customers, suppliers, industry associations and universities/colleges. For this, five variables are included.

TABLE 4
Description of database variables

Variable	Description	Variable type
	Predictor variables	
EMPL	Employment Sources	Binary
SKILL	Skills upgrading of employees	Binary
OWNE	Ownership	Categorical
MANG	Management	Categorical
NET	Supply, distribution and customers networks	Binary
LINK	Institutional links	Binary
	Dependent variable	
TECH	The adoption of technological changes	Binary

Source: own elaboration

5. Econometric analysis

Since the dependent variable and the various predictors are qualitative, equation (4.1) was estimated using a **binomial logistic regression model**. Binomial (or binary) logistic regression is a form of regression which is used when the dependent is a dichotomy and the independents are of any type. Although discriminant function analysis is also appropriate when the depen-

dent is nonmetric, logit analysis is preferred as it does not face the strict assumptions about the distributions of the predictor variables as in discriminant analysis (Hair et. al, 1992).

For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories. In this case, the **probability that sample firms adopted new technologies in the past 3 years**. Our regression model will be predicting the logit, that is, the natural log of the odds of having made one or the other decision. That is, $\ln(\text{ODDS}) = \ln\left(\frac{\hat{Y}}{1-\hat{Y}}\right)$, where $\hat{Y}$ is the predicted probability of the event which is coded with 1 (the firm adopted new technologies), while $1-\hat{Y}$ is the predicted probability of the other decision (the firm didn't adopt new technologies).

Using SPSS, the model will be constructed by iterative maximum likelihood estimation (MLE). The program starts with arbitrary values of the regression coefficients and constructs an initial model for predicting the observed data. It will then evaluate errors in such prediction and change the regression coefficients so as make the likelihood of the observed data greater under the new model. This procedure is repeated until the model converges, that is, until the differences between the newest model and the previous model are minor.

6. Results

Logit coefficients (logits), also called unstandardized *logistic regression coefficients* or *effect coefficients* or simply "parameter estimates" in SPSS output, correspond to b coefficients in OLS regression. Both can be used to construct prediction equations and generate predicted values. Logit coefficients are easier to interpret when converted to an **odds ratio** using the exponential function. Table 5 lists the b coefficients, the Wald statistic and its significance, and the odds ratio (labelled Exp(b)). To note that the odds ratios are simply measures of effect size and will be used only to comment on their relative sizes when comparing independent variables effect.

The **Wald statistic** is commonly used to test the significance of individual logistic regression coefficients for each independent variable (that is, to test the null hypothesis in logistic regression that a particular logit (effect) coefficient is zero). If the Wald statistic is significant (i.e., less than 0.05) then the parameter is significant in the model. Of the list of independents initially considered, the following are significant: employment sources –

people from outside the region (q8.c), type of management (q10), suppliers – associated local firms (q15.a), suppliers – other local/regional firms (q15.b), suppliers – national firms (q15.c), suppliers – EU firms (q15.d), distributors – associated local firms (q17a), sources of technological knowledge – internal personnel (q37.a), sources of technological knowledge – customers (q37.b) and employees skill's upgrading (q43rec) are significant. All the others are not.

TABLE 5
Results from Logistic Regression estimation

Predictors	B	Wald $\chi 2$	p-value	EXP(B)
Employment Sources				
q8.a – family members	-1.265	0.881	0.348	0.282
q8.b – local community	0.963	0.338	0.561	2.619
q8.c – people from outside the region	-9.026	6.808	**0.009**	0.000
q8.d – joint venture partner	33.188	0.000	1.000	2.59E+14
q8.e – parent firm	24.759	0.000	1.000	5.66E+10
q10 – **Type of Ownership**		8.441	**0.038**	
q10(1) – owned by one person (dummy)	15.647	6.737	0.009	6244389.741
q10(2) – a partnership (dummy)	7.928	4.704	0.030	2773.402
q10(3) – family owned (dummy)	6.065	3.296	0.069	430.633
q11 – **Type of Management**		2.007	0.367	
q11(1) – the owner manager (dummy)	-26.009	0.000	0.999	0.000
q11(2) – other family personnel (dummy)	-30.088	0.000	0.999	0.000
Supply, distribution and customers networks	-4.335	4.749	**0.029**	0.013
q15.a – suppliers: associated local firms	5.385	5.095	**0.024**	218.003
q15.b – suppliers: other local/regional firms	4.551	5.151	**0.023**	94.699
q15.c – suppliers: national firms	-4.441	3.979	**0.046**	0.012
q15.d – suppliers: EU firms	2.263	1.789	0.181	9.614
q15.e – suppliers: international	10.789	5.747	**0.017**	48499.152
q17.a – distributors: associated local firms	-.010	0.000	0.995	0.990
q17.b – distributors: other local/regional firms	-3.777	2.788	0.095	0.023
q17.c – distributors: national firms	4.627	3.236	0.072	102.182
q17.d – distributors: EU firms	-5.326	2.491	0.114	0.005
q17.e – distributors: international	-3.581	3.111	0.078	0.028
q19.a – customers: local/regional market	5.469	3.334	0.068	237.122
q19.b – customers: national market	0.532	0.042	0.837	1.703
q19.c – customers: EU market	4.754	2.754	0.097	116.084
q19.d – customers: international				
Institutional links	12.414	8.922	**0.003**	246180.391
q37.a – internal personnel	-5.903	5.059	**0.025**	0.003
q37.b – customers	2.949	3.094	0.079	19.091
q37.c – suppliers	-1.962	1.127	0.288	0.141
q37.d – industry associations	19.427	0.000	0.998	2.74E+08
q37.e – universities and/or colleges	10.216	7.564	**0.006**	27328.758
q43rec - **Skills upgrading of employees**	4.758	0.000	1.000	116.521
Constant				

Source: own elaboration based on SPSS outputs

As stated before, the analysis of the odds rations allows comparing the effect size of each one of the independents on the odds of the dependent. In other words, among the significant predictors earlier identified, which ones have bigger positive or negative effects (odds ratios bigger or smaller then one) on the odds that the sample firm adopted new technologies.

Employing people from outside the region (q8.c) reduces the odds of adoption of new technologies by firms, the same happening with the use of associated local firms (q15.a) or European firms (q15.d) as suppliers. Another negative effect is given by the use of customers as sources of technological knowledge (q37.b).

Positive effects are given by the use of associated local firms as distributors (q17a) followed by employees skill's upgrading (q43rec), the use of internal personnel as source of technological knowledge – (q37.a) and the use of local/regional firms (q15.b) as well as national firms (q15.c) as suppliers. Also, the type of management (q10) appears as a significant factor, being the option *owned by one person* the one that most increases the odds that the sample firm adopted new technologies.[4]

Following, the Hosmer and Lemeshow Goodness-of-Fit Test was computed and the null hypothesis that there is no difference between the observed and predicted values of the dependent was not rejected (p-value= 0.972) implying that the model's estimates fit the data at a very good level. From the 112 firms that adopted new technologies, 96.4% were correctly predicted, while from the 35 firms that didn't adopt new technologies, 88.6% were too correctly predicted. The overall percent of correctly predicted cases – 94.6% is also a very good one. See annex 1 for detailed information.

7. Conclusions

The process of economic globalisation has brought peripheral regions into the centre of rapid technological and economic change. A great deal of research has focused on the factors behind technological change in central European regions. In this paper, however, we have been concerned with those geographical environments that are not "...blessed by clusters, special factors, or new growth industries. Rather our focus has been on provincial regions with labour-intensive industries vulnerable to low-wage competition from within and without Europe." (RASTEI, 2002).

[4] In this case, because the independent is categorical, the interpretation of the odds ratios needs to be done regarding the effects of each category – dummy variables created by the SPSS – in comparison to the left-out reference category – the option *limited company*.

The main goal was to identify the factors affecting the adoption of new technologies by such industries, considering technological adjustments as the needed way for the promotion of productivity and local development in such vulnerable areas. When considering the list of factors proposed in this work (related to firm's task environment or, as also labelled, firm's decisional space), and its capacity to positively or negatively influence technological behaviours, some conclusions can be drawn.

Contrarily to what could be expected, a negative effect was given by the employment of people from outside the region, while the remaining sources of employment didn't denote statistical significance. This indicates that firm's technological initiatives were not inspired by outside firm's initiatives, where the workers were previously employed.

Another negative effect was produced by the use of associated local firms (with small expression in the sample) and EU firms as suppliers, against the positive effects produced by the use of local/regional and national firms. This has a twofold significance: the importance of the networks with suppliers and the tendency of small firms to mostly rely on geographical proximity networks, as confidence and sociological proximity constitute a major source of assets and information for this segment.

When considering the distribution links, positive effects are given by the use of associated local firms (with a higher expression in this case, as a bigger number of firms has their own associated firm as distributor), again emphasising the role of proximity in the development of networks.

In what concerns the institutional links as sources of technological knowledge, positive effects are produced by the use of internal personnel, while customers come out as giving a negative impact, indicating that the adoption of new technologies is face by small firms as an internal need (process and organisational need) as well as instigated by supplier demanding and less by customer demanding mechanisms.

The role of internal personnel is again evident by the positive effect created by the employees skill's upgrading.

Regarding the type of ownership, the option "owned by one person" produces the higher positive effect when comparing with the other categories, indicating that the importance of technological adjustments is recognised by the owners-entrepreneurs, even when we are dealing with small firms from labour intensive sectors, such as textile, clothes and leather and integrated in geographical restricted environments.

In conclusion, the adoption of new technologies can be characterised as a process:

- driven by internal needs;
- developed in geographical proximity;
- supplier dominated.

Acknowledgments

We are very grateful to the coordinator, as well as to the all consortium, of the European project **RASTEI** – Regional Adjustment Strategies to Technological Change in the Context of European Integration, who gently yielded the survey results for the Greek, Italian and Spanish firms.

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Annex 1
SPSS outputs for Logistic Regression (commented)

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	147	88,0
	Missing Cases	20	12,0
	Total	167	100,0
Unselected Cases		0	,0
Total		167	100,0

a. If weight is in effect, see classification table for the total number of cases.

The case processing table, above, shows that 20 cases were classified as missing values, representing 12% of total sample.

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
OWNERSHIP/ MANAGEMENT OF THE FIRM	OWNED BY ONE PERSON	13	1,000	,000	,000
	A PARTNERSHIP	72	,000	1,000	,000
	FAMILY OWNED	51	,000	,000	1.000
	A LIMITED COMPANY	11	,000	,000	,000
OWNED FIRM IS MANAGED BY	THE OWNER-MANAGER (PARTNER)	129	1,000	,000	
	THE FAMILY PERSONNEL (RELATED TO A PATRNER)	16	,000	1,000	
	EXTERNAL MANAGER	2	,000	,000	

Above is SPSS's parameterization of the categorical independent variables: type of ownership and type of management. Note that parameter coefficients for the last category of such variables are 0's, indicating the last category is the omitted value for each set of dummy variables (in the first case, the omitted option is **A subsidiary of another firm** and, in the second case, **External manager**). The parameter codings are the X values for the dummy variables. They are multiplied by the logit (effect) coefficients as part of obtaining the predicted values of the dependent, much as one would compute an OLS regression estimate.

Block 0
Beginning Block

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0 Constant	1,163	,194	36,078	1	,000	3.200

Above SPSS prints the initial test for the model in which the coefficients for all the independent variables are 0. The finding of significance above indicates this null model should be rejected.

Block 1
Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	120,481	30	,000
	Block	120,481	30	,000
	Model	120,481	30	,000

The chi-square goodness-of-fit test tests the null hypothesis that the step is justified. Here the step is from the constant-only model to the all-independents model. When, as here, the step was to add a variable or variables, the inclusion is justified if the significance of the step is less than 0.05. Had the step been to drop variables from the equation, then the exclusion would have been justified if the significance of the change was large (ex., over 0.10).

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	40,888[a]	,559	,839

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

The Cox-Snell R^2 and Nagelkerke R^2 are attempts to provide a logistic analogy to R^2 in OLS regression. The Nagelkerke measure adapts the Cox-Snell measure so that it varies from 0 to 1, as does R^2 in OLS.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	2,257	8	,972

The Hosmer and Lemeshow Goodness-of-Fit Test divides subjects into deciles based on predicted probabilities, and then computes a chi-square from observed and expected frequencies. The p-value=0.972 here is computed from the chi-square distribution with 8 degrees of freedom and indicates that the logistic model is a very