TECHNOLOGICAL BEHAVIOUR AND EXPORT PERFORMANCE: A NON LINEAR RELATIONSHIP

Salvador Estrada y Joost Heijs

Documento de trabajo, nº 48. Diciembre de 2004.

Edita: Instituto de Análisis Industrial y Financiero. Universidad Complutense de Madrid

Facultad de Ciencias Económicas y Empresariales. Campus de Somosaguas. 28223 Madrid.
Fax: 91 3942457
Tel: 91 3942456
e-mail: joost@ccee.ucm.es
Imprime: Servicio de Reprografía dela Facultad de Ciencias Económicas y Empresariales. UCM.

TECHNOLOGICAL BEHAVIOUR AND EXPORT PERFORMANCE: A NON LINEAR RELATIONSHIP

Salvador Estrada y Joost Heijs
Instituto de Análisis Industrial y Financiero
de la Universidad Complutense Madrid

RESUMEN

Este documento analiza el comportamiento innovador de las empresas como un determinante de su probabilidad exportadora. En la primera parte se confirma que la innovación es un aspecto importante para penetrar en el mercado internacional. La literatura existente lo confirma tanto para los países desarrollados como para los países en desarrollo, aunque la configuración exacta es distinta, probablemente debido al las diferencias respecto al papel de la innovación en ambos tipos de países. Donde la primera parte ofrece un modelo conservador que coincide con los de la literatura existente, la segunda parte del trabajo ofrece un modelo alternativo. En este modelo se comprueba que la relación entre la probabilidad exportadora y la innovación tiene -contrario a los resultados reflejados en los estudios existentes- una forma de U invertida donde las empresas más innovadoras y las muy poco innovadoras tiene una probabilidad exportadora claramente menor a las empresas cuyo esfuerzo innovador es más bien medio. Si estos resultados se confirma para estudios futros implicaría una revisión de la literatura existente.

ABSTRACT

This paper study the innovative behaviour as an aspects that influence the export activity. Our results show -for Mexican case- that innovation is a method to reach the international standards and therefore is necessary to compete in export markets. The literature shows such a relationship both in developed and developing countries, although the exact configuration differs, probably due to the role of innovation in both types of countries. We used several subsamples showing that different type of firms are associated with distinct independent variables. These differences probably explain part of the differences and sometimes the confusing results in the existing literature.

The main conclusion of the first part is that innovative behaviour is related to the likelihood of the firm exporting from developing countries likes Mexico. All detected econometric studies define this relation as linear, however, the results of the second part of this document show that this conclusion seems to need revision. We show -with empirical data for the Mexican case that this linear modelling could be wrong. Using a logistic regression model, our data reflect a non-linear relationship in the form of an inverted "U" between the innovative behaviour and the export probability. The less innovative firms do have a lower export probability, followed by the most innovative firms, while the firms with a "medium" level of innovative behaviour are the most competitive firms on the world market.

Keywords: Innovation and competitiveness; export probability, mexico JEL: D21; F10

TECHNOLOGICAL BEHAVIOUR AND EXPORT PERFORMANCE IN DEVELOPING COUNTRIES: THE MEXICAN CASE[1]

I. INTRODUCTIÓN

Recent literature on competitiveness stresses the importance of technological innovation to sustain economic growth and social welfare. There is no doubt about the fact that innovation as an explanatory aspect of the competitive position of a firm or a country receives more and more attention. The competitive advantages of the developed countries are based on technological superiority and the most competitive and dynamic multinationals are the technological leaders. The question is if innovation is also an important factor to explain the competitiveness amongst enterprises of developing countries whose competitive advantages are based on low wages and a labour intensive production system producing standardised low-tech products.

The aim of this paper is to study the aspects that influence the export behaviour of the firms, especially the innovative behaviour of manufacturing establishments located in the State of Guanajuato (Mexico). This subject is analysed in a broad range of papers (see appendix 1). However most of the existing literature analyses this question in advanced countries and only a few in developing countries. Our main conclusion -about the case of Mexico- is that innovative behaviour is related to the likelihood of the firm exporting from developing countries such as Mexico. This conclusion is the same as the results of the existing literature that shows such relationships, both for developed and developing countries.

All detected econometric studies define this relation as linear; however, our results show that this conclusion seems to need revision. Initially we expected a non-linear relationship in which the firm needs a minimum level of R&D or innovation (critical mass) to compete on the world-market. Therefore the likelihood of exporting will grow in parallel with the innovation effort to a certain level from which the export probability remains more or less stable. We will show in this paper -with empirical data for the Mexican case, that the linear modelling could be wrong. Using a logistic regression model, our data reflect a non-linear relationship in the form of an inverted "U" between innovative behaviour and the likelihood of exporting. The less innovative firms have a lower export probability, followed by the most innovative firms, while the firms with a "medium" level of innovative behaviour are the most competitive firms on the world market.

In the following section we comment briefly on the methodological design and offer the empirical results of this paper. First we estimate a conventional model (section 2 and 3) -directly comparable with the existing literature-, followed by an alternative model (section 4) that reflects a non-linear relationship between innovation and export behaviour. Section 5 offer with some remarks about the interpretation of the non-linear relationships of the alternative model and includes the main conclusions and interpretations of our work.

2.- METHODOLOGICAL DESIGN AND EMPIRICAL RESULTS

2.1.- DATA AND STATISTICAL METHODS

[1] The authors would like to thank the "Consejo de Ciencia y Tecnología de Estado de Guanajuato (CONCYTEG)" for facilitating the database of the "*Encuesta sobre Investigación, Desarrollo Experimental, Tecnología, Innovación y Vinculación en el Estado de Guanajuato 1999"* Moreover we wish to thank Mikel Buesa and Vicente Donoso of the University Complutense de Madrid for his suggestions and ideas to improve document.

The dataset used in this article is based on the "Encuesta sobre Investigación y Desarrollo Experimental, Vinculación, Tecnología e Innovación en el Estado de Guanajuato (INEGI-CONCYTEG, 2000), which includes data of 1087 manufacturing plants and offers very detailed information about the structure of the firms, their strategy and innovative behaviour.

Table 2.1 Determinants of export behaviour: Empirical evidence of 46 studies

	Export probability		Export propensity	
	Developed countries	Developing countries	Developed countries	Developing countries
NUMBER OF STUDIES (46)[2]	11	12	24	13
STRUCTURAL CHARACTERISTICS				
Size	11/2/0	8/1/0	14/4/0	4/2/2
Size (inverted U-form)	5/1/0	0/0/1	7/1/0	2/0/2
Age	4/2/0	2/1/1	4/3/3	0/2/2
Age (inverted U-form)	1/1/0	0/1/1	1/0/0	0/1/0
Firm belonging to a group	2/2/0	1/0/0	3/2/0	2/0/0
Firm with foreign participation	1/0/0	4/1/0	2/0/0	6/1/0
INNOVATIVE BEHAVIOUR				
R&D efforts (Expenditures by sales, formal R&D activities, R&D strategies)	7/3/1	4/1/0	12/8/0	3/2/1
Acquisition of incorporated technologies[3]	6/3/0	4/2/2	6/5/0	3/5/4
Acquisition of non-incorporated technologies	0/0/0	0/0/0	1/1/0	1/2/0
Human capital	6/0/1	2/4/1	11/0/1	1/5/3
Other innovative activities (Product Engineering, design, improvement of products or processes, marketing, training and formation etc.)	1/0/0	0/0/1	2/0/0	1/2/1
Innovative results (patents, innovation, new products, percentage of sales related to new or improved products, etc.)	5/4/2	1/1/0	5/7/0	3/1/0
Product Diversification	2/1/0		3/2/1	
External relations and networking	5/1/0	1/0/0	4/1/0	1/1/0

Each cell indicates the number of studies with: positive effect / not significant / negative effect
In the case of inverted "U" form they reflect: inverted "U" / not significant / normal "U"
Source: 46 studies for details see Appendix I

To analyse which variables induce export behaviour we used two statistical instruments. First, an exploratory study that analyses the correlation between each of the independent variables and export probability[4]. Taking into account those results and the empirical evidence of 46 studies (see table 2.1 and appendix I) we found out that the main variables that influence the export probability are

[2] Some studies analyse subsamples for size or sector. Each estimation is included in this table as one "study" for details see Appendix I.

[3] It has to be pointed point out that some studies reflect contradictory results in analysing different sector. (See for example van Dijk, 2002 o Raut 2003) so those results are included in this table as three "studies" (See Appendix I)

[4] In earlier work we presented the explanatory analysis based on contingency tables and means tests. A thoroughly presentation of these exploratory analysis would take up too much space in this paper. Only a few data will be included in the text of this section. However the full results can be consulted in the website of the "Instituto de Análisis Industrial y Financiero" of the Complutense Universtity (http://www.ucm.es/bucm/cce/iaif; Estrada/Heijs, 2003). See also Estrada 2005.

the structural characteristics of the firm (size, foreign capital, sector and probably age)[5]. Moreover many studies point out that innovative behaviour of the firms -reflected in a diverse and broad range of indicators of the innovation processes and results- is also correlated with the export probability. The broad number of studies (see table 1) seems to indicate that more innovative firms seem to be more competitive. Although the empirical evidence is not totally conclusive it seems that both in developed and in developing countries innovative activities do influence the export probability.

Several studies analyse the importance of R&D or innovation for the competitive situation of firms. However before answering this question we have to point out what innovative firms are and how to define them[6]. The indicators for innovative activities used in developed countries (such as number of patents or R&D expenditures) are not satisfactory in the case of developing countries. Probably it is more appropriate to use in such countries other kinds of indicators such as the acquisition of modern production systems (the vintage model) the technical assistance of foreign firms or –instead of the R&D expenditures- the efforts in engineering.

The existing studies used a broad range different independent variables that seem to reflect the same economic reality –especially the variety of indicators for innovative activities- which could lead to different conclusions (Estrada, 2005). Therefore we decided to use in this paper a broad variety of different indicators.

The above-mentioned explorative analyses do not take into account the possible interaction between the independent variables, therefore –as in other studies- we introduced a second statistical method based on a logistic regression model. This method takes into account the simultaneous effects of the independent variables on the variable to be explained.

2.2.- THE "CONVENTIONAL" MODEL

In table 2.3 several models are estimated to analyse the possible explanatory factors[7] of export probability. As can be observed we maintain the variables related to the structural characteristics of the firms and make some changes including and excluding different variables related to innovative activities . The main conclusion of those estimations is that each of them –regardless of the indicators for innovative activities that have been used- shows that innovation efforts have a positive impact on export probability and a clear product strategy or diversification has a negative influence on export probability.

It can be highlighted that product innovation was only analysed by two studies on developing countries. As will be stated later on, these variables show a well-defined relationship that details the general relationship of innovative behaviour, moreover, Table three shows that the models that do

[5] To avoid the repetition of the discussion about the details for each specific relationship between the independent variables and export behaviour we will present this discussion in section three where we compare our own results with the existing evidence and interpret the findings.

[6] A reference and pioneer work on this topic is Katz (1976); Fransman, 1984; Lall, 1992; Bell/Pavitt, 1995. For a more recent discussion see scholars around the Science and Technology Iberoamerican Network (or RICYT its acronym in Spanish) Albornoz (1998), Benavente and Crespi (1999) Jaramillo, Lugones and Salazar (2000) or Benavente (2002)

[7] Table 4 indicates the exact way by which we measured the different variables included in the models.

include those variables (model 5-8) show an improvement in the parameters of the goodness of fit of the model with respect to the other models.

Table 2.2 Description of the variables and the expected effects based on the literature and exploratory analysis[8].

Variables	Indicators	Description	Expected Effects
Competitive level	Export Probability	1 = the firm export, 0 = the firm does not export	*Dependent Variable*
Independent Variables			
Structural characteristics	Size	Number of employees	Positive or in inverted "U" form
	Size**2	Square number of employees	
	Age	Number of years since foundation	Not significant
	Age**2	Square Number of years since foundation	
	Foreign Capital	Percentage of foreign capital	Positive
	Sector [9]	• Producers of traditional consumer goods (E.g. Food, Clothing, Footwear etc.: CNAE 15- 22, 26, 36, 37) • *Suppliers of traditional intermediate goods (Cement, Plastics etc.: CNAE; 27 28) (Reference* • *category)* • Specialised suppliers of intermediate goods and equipment (Machine tools or equipment etc.: CNAE; 25, 29, 33), • Mass production assemblers (Cars, Television sets etc.: CNAE; 30-32, 34, 35 -Except 35.3-), • R&D based sectors (Electronics, pharmaceuticals etc.: CNAE; 24 y 35.3)	Statistical significant differences between sectors
Acquisition of technologies	Machinery and equipment	Percentage of sales used to purchase machinery and equipment	Positive
	Not incorporated technology	Percentage of sales used to purchase "*Non- incorporated technology"* (Patents, licences, etc...)	Positive
	Technological services	1 = use of external technological services 0 = Non use of this kind of services	Not significant
Innovative efforts	The firm carries out formal R&D activities	1 = Yes, 0 = no	Positive
	R&D expenditures	Percentage of sales on R&D	Positive
	Engineers	Number of engineers as a percentage of the total employment	Positive
	Design	Percentage of sales used to finance design, industrial engineering or pre-production activities.	Not significant
	Marketing	Percentage of sales used for marketing of new products	Positive
	Training	Percentage of sales used for training related to new products	Positive
Innovative results	New products	Number of new products introduced in the last three years	Positive
	Product improvement	Number of new products introduced in the last three years	-
	Product Diversification	Percentage of sales related to the main product of the firm	NS
	Mono product firms	1 = yes 0 = no	Not significant

[8] To save space we do not offer –in this paper- the exploratory analysis nor do we enter into the discussion about the expected relationship. For more information see table 2.1 and 2.2 or Estrada/Heijs, 2003 and Estrada, 2005.

[9] This taxonomy proposed by Pavitt (1984) is widespread, and has been shown to be very useful in many empirical studies on trade and competitiveness both at macro and micro level (Basile, 2001).

Table 2.3 different models to analyse the explanatory variables of export probability .

	Models	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Variables	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
Structural characteristics	Size	0,003	***	0,002	***	0,002	***	0,002	***	0,002	***	0,002	***	0,002	***	0,002	***
	Size**2	-7E-07	***	-6E-07	**	-6E-07	**	-6E-07	**	-5E-07	**	-6E-07	**	-6E-07	**	-6E-07	**
	Age	0,001	NS	0,004	NS	0,004	NS	0,004	NS	0,006	NS	0,007	NS	0,006	NS	0,007	NS
	Age**2	1E-05	NS	-2E-05	NS	-4E-05	NS	-3E-05	NS	-3E-05	NS	-4E-05	NS	-3E-05	NS	-4E-05	NS
	Foreign Capital	0,027	***	0,026	***	0,026	***	0,026	***	0,028	***	0,028	***	0,028	***	0,028	***
	Sector		***		***		***		***		***		***		***		***
	Producers of traditional consumer goods	2,676	***	2,686	***	2,737	***	2,738	***	3,020	***	2,931	***	2,992	***	2,935	***
	Suppliers of traditional intermediate goods (Reference category)																
	Specialised suppliers of intermediate goods and equipment	1,027	**	1,037	**	1,044	**	1,043	**	1,086	**	1,107	**	1,098	**	1,110	**
	Mass production assemblers	1,861	***	1,694	***	1,790	***	1,810	***	1,896	***	1,830	***	1,873	***	1,836	***
	R&D based sectors	1,110	**	1,126	**	1,213	***	1,214	***	1,350	***	1,364	***	1,349	***	1,370	***
Adcuisition Of technologies	Machinery and equipment	-0,014	*	-0,016	**	-0,016	**	-0,016	**	-0,012	NS	-0,012	NS	-0,012	NS	-0,012	NS
	Non-incoprorated technologies	0,073	**	0,022	NS	0,018	NS	0,018	NS	0,012	NS	0,014	NS	0,012	NS	0,014	NS
	Technical services (d)			0,978	***	1,005	***	1,011	***	1,259	***	1,252	***	1,272	***	1,244	***
Efforts in innovation	Formal R&D activities (d)	1,022	***	0,681	*												
	R&D expenditures by sales					0,094	NS	0,096	NS	0,127	**	0,132	**	0,131	**	0,117	*
	Percentage of engineers by employment	0,018	***	0,017	***	0,019	***	0,019	****	0,022	***	0,023	***	0,022	***	0,023	***
	Expenditures in design by sales															-0,029	NS
	Expenditures in marketing by sales	0,057	NS	0,023	NS	-0,016	NS	-0,018	NS	-0,022	NS	-0,030	NS	-0,024	NS	-0,008	NS
	Expenditures in training by sales							-0,108	NS	0,028	NS	0,031	NS	0,028	NS	0,059	NS
Results of the Innovative activities	Number of new products									-0,079	***	-0,075	***	-0,079	***	-0,067	***
	Percentage of sales related to improved products									-0,006	**	-0,005	**	-0,006	**	-0,006	**
	Diversification of the portfolio of products											0,009	***			0,009	***
	Monoproducer (d)													0,159	NS		
	CONSTANT	-3,327	***	-3,512	***	-3,582	***	-3,583	***	-3,719	**	-4,386	***	-3,777	***	-4,389	***

(d) dichotomised variable. Statistical significance of the Betas * = 99%: ** = 95%: * = 90% and NS = Not statistically significant**
Source: own estimation survey INEGI-CONCYTEG (2000).
Source: own estimation on the survey INEGI-CONCYTEG (2000).

Table 2.3 (continue) Parameters of the Goodness of fit.

Models Test	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
-2 LL	1028,27	1001,87	1003,67	1003,61	982,13	975,26	981,24	974,55
Pseudo r2								
Cox y Snell	0,26	0,28	0,28	0,28	0,29	0,30	0,30	0,30
Nagelkerke	0,37	0,39	0,39	0,39	0,41	0,42	0,41	0,42
McFadden	0,24	0,26	0,26	0,26	0,28	0,28	0,28	0,28
McFadden adjusted	0,25	0,27	0,27	0,27	0,29	0,30	0,29	0,30
χ^2_{20}	333,27	359,67	357,87	357,94	379,41	386,28	380,30	387,00
(sig)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Classification								
% of correctly classified cases								
Non-exporters	79	83	82	82	80	80	80	79
Exporters	64	63	64	64	65	69	65	69
Total	74	77	76	76	75	76	75	76
N	1087	1087	1087	1087	1087	1087	1087	1087

Source: own estimation on the survey INEGI-CONCYTEG (2000).

Model six is selected as the "general model" due to its having the best goodness of fit (see table 2.3b). This model –the exact parameters of which are shown in table 2.4) shows us that a higher innovative intensity (measured by R&D efforts by sales and by the number of engineers by total employment) increase export probability. Also contracting external services related to innovation has a positive effect on export probability. A negative effect was found in relation to the variables that indicate the results of innovative activities in sales. Firms with a high number of new products, a high level of sales related to improved products or those with a diversification strategy are more oriented to the national market. However, those firms that specialise in just one product (100% of their sales are generated by their main product) are more dynamic on the international market. Mono-product enterprises increase their export probability (in relation to the mean probability) with sixteen percent while firms whose main product accounts for 50% of all the sales has eight percent less probability of exporting its products. The variables with the highest discriminatory power are the size of the firms and the presence of foreign capital. Within the group of variables that analyse the innovative behaviour contracting technology services is the most important one followed by R&D expenditures by sales and the number of engineers by total employment.

Table 2.4: General model

Variables in the equation		□*j*	*E.T.*	*Wald*	*gl*	*Sig.*	$e^{\square j}$	*Corr. parcial*	*Efectos Marginales* (1)
Structural characteristics	Size	0,003	0,001	20,55	1	0,000	1,003	0,117	0,04%
	Size**2	-0,001	0,000	5,80	1	0,016	1,000	0,053	
	Foreign Capital	0,028	0,004	49,79	1	0,000	1,028	0,187	0,51%
	Sector			92,21	4	0,000		0,249	
	Producers of traditional consumer goods	2,986	0,438	46,40	1	0,000	19,816	0,181	44%
	Suppliers of traditional intermediate goods (Reference category)								
	Specialised suppliers of intermediate goods and equipment	1,109	0,469	5,60	1	0,018	3,030	0,051	8%
	Mass production assemblers	1,867	0,619	9,09	1	0,003	6,471	0,072	19%
	R&D based sectors	1,421	0,480	8,76	1	0,003	4,140	0,070	12%
Acquisition of technologies	Technical services for R&D	1,216	0,190	41,04	1	0,000	3,373	0,169	25%
Innovative Efforts	R&D expenditures by sales	0,126	0,048	6,89	1	0,009	1,134	0,060	2,30%
	Number of engineers by total employment	0,023	0,006	16,47	1	0,000	1,024	0,103	0,43%
Innovative results	*Number of new products*	-0,072	0,021	11,64	1	0,001	0,930	0,084	-1,33%
	Percentage of sales related to improved products	-0,006	0,003	5,62	1	0,018	0,994	0,052	-0,11%
	Product Diversification	0,009	0,003	6,48	1	0,011	1,009	0,057	0,16%
	Constant	-4,388	0,502	76,45	1	0,000	0,012	0,234	-80%

Goodness of fit			
-2 LL	979,40	$\square^{2}_{13}$	382,14
		(sig)	0,000
Pseudo r2		***Percentage of correct classified cases***	
Cox y Snell	0,30	***No exporters***	80
Nagelkerke	0,42	***Exporters***	69
McFadden	0,28	***Total***	76
McFadden adjusted	0,29	***N***	1087

Source: own estimation on the survey INEGI-CONCYTEG (2000).

Looking to the goodness of fit of the model we observe that the pseudo R^2 is between 28 and 42 percent, which is a very common level in this kind of studies, and the Log likelihood and χ^2 are satisfactory. Moreover the model classifies 74% of the cases well. To assure the robustness of the models we repeated the estimation several times randomly excluding 10% of the cases. Each time we found a similar result (the same variables were significant without changes in their relative importance or their sign –positive or negative effects-) with only minor changes in the values of the Betas, marginal effects, correctly classified firms etc. Moreover we repeated the models excluding some of the variables related to innovative behaviour. We always found similar results confirming the importance of the structural variables and the influence of the innovative on export probability. Even in the case where only two variables were maintained of activities related to innovative behaviour (one for the innovative effort and the other for the product strategy) we obtained the same conclusions.

2.3.- RESTRICTED "CONVENTIONAL" MODELS

Although the estimation of a logistic regression model means that all the interaction effects are taken into account, we conceive that the sample as a whole could still be considered as heterogeneous. Therefore we repeated the analysis for the more homogeneous subsamples. As can be observed in Table 2.5, we made estimations –using the specification of the general model- for 14 different subsamples. We estimated three models for subsamples by size (small, medium and large sized firms), three models by age (new, mature and old firms), three models by property structure (individual national firms; national firms belonging to groups or holdings and firms with foreign participation); three sectors (traditional consumer goods, specialised suppliers and those based on R&D)[10] and two models classifying the firms between those that used external services for R&D (or engineering activities) and those that did not use this kind of service.

Looking to the structural characteristics, we can observe that most of them are statistically significant in almost all models. Size is a significant factor for 10 of the fourteen models, except for those based on subsamples that include mainly large enterprises (the subsamples of foreign firms, large firms and those that contract R&D services) and for the subsample of new firms. Foreign capital is an explanatory factor in each of the models and the sector is only insignificant in three subsamples: large firms, those belonging to a national groups or holdings and the sample foreign firms. In fact in all cases where we are talking about large firms, this means that advantages of being large are persistent among sectors.

Taking into account the role of innovative behaviour in each of the models, we can define three groups of models. The first ones are those models that reflect similar relationship to those found in the general model. This similarity means that innovative effort has a positive effect on export probability and at the same time the product or diversification strategy (high level of introduction of products, sales of improved products or a multi product strategy) has a negative impact on export probability. The results of the general models were confirmed by the subsamples of the medium sized firms, the three subsamples by age, for two of the three subsamples for sectors (the traditional consumer goods producers and the specialised suppliers) and for the firms that contract R&D services.

[10] Due to the limited number of firms for the other sectors it was impossible to carry out statistically acceptable estimations.

Table 2.5 . Restricted models for subsamples by size, age, property and sector and importance of technological services.

Type of variables	***Independent variables***	**GENERAL MODEL**	**SIZE**			**AGE**			**PROPERTY**			**SECTOR[(1)]**			**Contracting technical Services**	
			S	M	L	Y	A	O	IND	NG	F	TRAD	ESP	BC	NO	SI
Structural characteristics	Size	+	+	+	NS	NS	+	+	+	+	NS	+	+	+	+	NS
	Size**2	-	-	-	NS	NS	-	-	-	NS	NS	-	NS	-	-	NS
	Foreign Capital	+	+	+	+	+	+	+	Exc.	Exc.	Exc.	+	+	Exc.	+	+
	Sector	*	*	*	NS	*	*	*	*	NS	NS	Exc.	Exc.	Exc.	*	*
	Producers of traditional consumer goods	+	+	NS	NS	+	+	+	+	NS	+	Exc.	Exc.	Exc.	+	+
	Suppliers of traditional intermediate goods (Reference category)															
	Specialised suppliers of intermediate goods and equipment	+	NS	NS	NS	NS	NS	+	+	NS	r.c.	Exc.	Exc.	Exc.	NS	+
	Mass production assemblers	+	NS	NS	NS	NS	NS	NS	+	NS	NS	Exc.	Exc.	Exc.	NS	+
	R&D based sectors	+	NS	NS	NS	NS	NS	+	NS	NS	+	Exc.	Exc.	Exc.	NS	+
Acquisition of technologies	Technical services for R&D	+	+	+	NS	+	+	+	+	NS	NS	+	+	+	Exc.	Exc.
Innovative Efforts	R&D expenditures by sales	+	+	NS	NS	NS	+	NS	+	NS	NS	NS	+	NS	NS	+
	Number of engineers by total employment	+	+	NS	NS	NS	+	+	+	NS	NS	+	+	+	+	+
Innovative results	*Number of new products*	-	NS	-	+	-	NS	NS	-	NS	-	-	-	NS	+	-
	Percentage of sales related to improved products	-	NS	-	NS	NS	-	NS	-	+	NS	-	NS	+	NS	-
	Product Diversification	+	NS	-	NS	NS	NS	+	+	NS	-	NS	+	NS	+	NS
	Constant	-	NS	NS	-	-	-	-	-	-	-	-	-	-	-	-
Goodness of fitt	*PSEUDO R**2 (NAGELKERKE)*	42	49	60	19	54	63	38	43	68	41	18	51	78	45	24
	% correctly classified	74	81	82	70	82	82	73	77	84	85	60	86	96	79	70
	Number of firms	1087	700	214	173	350	325	412	959	57	71	513	215	167	838	249

S=Small (1-100 employees), M= Medium (101-250) y L=Large (over 250 employees). Y= Young (created after 1994; TLCAN), A= Adults (created in the transition period to the "apertura" 1985 -1993), O=Old firms (Created during or before industrialisation based on import substit ution; before 1985). IND= Independent firms, NG= Firms belonging to national groups, F=Foreign firms.. TRAD= Producers of traditional consumer goods, PROV= *Suppliers of traditional intermediate goods* , ESP Specialised suppliers of intermediate goods and equ ipment, IE= Mass production assemblers, BC= R&D based sectors. NO= Not using technological services, SI= users of technological services. + = A positive and statistically significant relationship at least at 10%, - = A negative and statistically significan t relationship at least at 10%, NS= Not significant relationship: Exc=Variables excluded from the model. Source: own estimation on the survey INEGI -CONCYTEG (2000).

These groups of firms confirm the general model where a higher level of innovative activities improves export probability but at the same time the firms have to specialise in one or only a few products. This could mean that in those firms innovation is more orientated to process innovation than to product related research, as mentioned by Özçelik/Taymaz (2003).

A second group of models are very concise ones where only a few variables have statistically significant effects: these being the large firms and those belonging to national groups or holdings. Both subsamples include firms with a large average size. Regarding the structural characteristics in the subsample of large firms only "foreign capital" has a positive impact on exporting. For the subsample of firms belonging to national groups size is an explanatory variable. In relation to their innovative behaviour, we found a remarkable result. Not just because only one variable was statistically significant, but because they reflect the opposite relationship to that found in the general model and the majority of the restricted models. Where most of the models show that a strategy of product differentiation and product development is related to a lower export probability, for the large firms we found the contrary. Possibly this is due to their financial and organisational power with which they could compete on the international market through a diversification strategy where other firms have to specialise to compete world-wide. The same relationship was found for the old firms, for those firms belonging to science and R&D-based sectors and for those that did not contract external R&D services. For the old firms we could consider a similar interpretation as above. For the Science- based firms however, besides the presence of a high number of large firms, even for the small and medium sized firms of this sector the invention of new or improved products is the aim of their activity. The detected relationship is not a surprise because their main activity is improvement of existing products or invention of new ones. The foreign firms -which have a relatively large size and the same financial and organisational power as the firms belonging to a national group- have a strategy of specialisation. In fact the higher the diversification of these firms the higher the possibility that they are orientated to the domestic market while those with a high specialisation in one solely product are more outwardly oriented.

Concluding, the restricted models do correct the general findings in relationship to the market orientation (domestic versus foreign markets) and product specialisation or diversification. This indicates that the strategy of product specialisation improves export probability for medium sized firms, younger or mature firms, individual and foreign firms and those belonging to the traditional consumer goods or specialised suppliers. While large firms, old ones and those belonging to the science based sectors combine a diversification or product orientated strategy with their way of competing on the world market

The third group models are those which include several variables but do not confirm the global findings of the general "conventional" model.

- The subsample of *small firms* where the product strategy (diversification versus specialisation) does not play any role in explaining export probability. Possibly only a few of the smallest firms have a large number of products.
- The sample of *foreign firms* does not include –as an explanatory variable- the efforts in innovation or use of external R&D services. In relation to their innovative behaviour they include the variables related to product strategy, the interpretation of which was pointed out above
- The subsample of firms that belong to *the science-based sector* and the group of firms that do *not contract external R&D services* shows that higher innovative efforts are related to a

higher export probability and –as mentioned above- the product strategy or diversification is positively related to its export behaviour.

3. INTERPRETATION AND COMPARISON OF OUR OWN RESULTS WITH THE EXISTING EMPIRICAL EVIDENCE

3.1 INTRODUCTION

There is a rich literature that analyses the determinants or explanatory factors of export probability or propensity. A recent study (Estrada, 2005) detected over 40 studies that analyse this topic (as can be observed in the tables of Appendix I). Most of those analysed were developed countries (29) although in recent years a number of studies (17) also analysed developing countries. Without the existence of such a rich variety of studies a comparison of the results is extremely difficult and we can mention six mean problems based on the differences between: the kind of countries analysed; the way of conceptualising innovative firms; the dependent variable used; the methodological design of the studies; the diversity of the independent variables used to measure the same or similar aspects and the type of firms included in the model.

First of all the economic reality of developed and developing countries is totally different. Even the studies that analyse the developing countries can not always be compared directly due to the differences between the countries' characteristics.[11] For example the presence of foreign firms is hardly analysed within the studies of developed countries, whereas in the developing countries it is one of the most influential factors. The differences in the interpretation of the empirical results between developed and developing countries do not only depend upon the dominant position of the developed countries in the world market and their political and economical power, they are also due to the different concepts of the "innovative enterprise", which can be considered as a second problem in comparing the outcome of the studies.

A third problem in comparing the different studies is the use of the dependent variable. Some studies use export propensity (e.g. the exports as a percentage of the total sales) while others use the probability of exporting. It is difficult to decide which of the two indicators would be better. Using the probability of exporting means that you characterise the firms that have a minimum of export activity as competitive. If you use the export propensity you even discriminate between the exporting firms indicating that firms with a higher export propensity are more competitive. In this paper we use probability of exporting because we consider that a firm –in a non-border region like Guanajuato- that can compete on the international market –with its high requirements of price and quality- is clearly more competitive than comparable firms that are not able to compete internationally. We are not convinced about the fact that a higher export propensity of a certain firm can be interpreted as a more competitive position of that firm[12].

[11] For example the export behaviour of developing countries with special relationships to some developed countries due to their historical relations or proximity (such as Mexico versus USA; the Latin American countries with their former colonial -Spain, Portugal or Italy- or Morocco and Turkey with the European Union, can not be compared with countries like Ghana, Mauritius or China. Also different are the studies that analyse the transition countries of the former Eastern European communist countries.

[12] For example firm "A" which has a lower export propensity but a higher market share in the national market is less competitive than firm "B" with a higher export level. This may just be due to the fact that the success of firm "A" competing with "B" on the national market could be the cause of a lower export propensity. This

The former problem leads us directly to another problem which complicates comparability: the use of different econometric methods. The character of the data limits the use of different methods. The study that uses the probability as an indicator of competitiveness uses different kinds of logistic regression models, while the export propensity implies the use of TOBIT models. The use of various types of instruments means that we are not always sure that differences between divergent studies are based on reality or empirical setting or depends on the differences in the analytical instruments of the dependent variable.

Fifthly, the revision of almost fifty studies on the subject, classified in annex I[13], shows us the use of a large number of variables used as an indicator for innovative behaviour. The different outcomes can also be related with the use of different explanatory variables that presumably refers to the same aspects, moreover, the same variables are sometimes interpreted differently by different authors.

A final important main problem related to the comparison of the existing empirical evidence – the fifth problem- refers to the exact type of firms included in the analysis. There are certain differences in the use of the samples of firms. Not only are there differences in the size of the analysed firms but also sectoral differences. The importance of this problem was made clear by our own estimations of the restricted models where the estimations based on certain type of firms reflected different empirical results.

All those problems mean that there are only a few studies that can be considered as similar. In this revision we analyse basically the studies of the developing countries to compare them with the Mexican one.

3.2 STRUCTURAL CHARACTERISTICS OF THE FIRMS

Before commenting on the influence of innovative activities on export behaviour we refer first to the so-called structural characteristics (size, presence of foreign capital, sector, age) of the firms and their correlation with export behaviour. The inclusion of these characteristics in the model is very important to isolate the possible effect of innovative behaviour on export behaviour from other causes[14].

The **size** of the firms is probably the most analysed variable. In almost all studies the data indicates that the larger the firm the higher the export probability. From the 46 studies analysed in Estrada (2005) only the study by Obben/Maggalula, 2001 -analysing only micro-enterprises- did not find a statistically significant relationship[15]. Larger firms have scale advantages that

propensity depends not only on your exports but also on the sales on the national market. For example if you increase your domestic sales -gaining competitivity- the export propensity will diminish. This fact once again makes clear the methodological problem. On the other hand, export probability could also be influenced by the ad hoc exporters or by the practice of dumping. Both factors are not related to the competitive capacity of the firm.

[13] Although some assignments of the classification could be criticised we have to bear in mind that the studies do not always give the exact description of the variables. Therefor we used the interpretation given by the authors.

[14] For example, using the sector as a control variable, we made it clear that the higher export probability of highly innovative firms is not only explained by sectoral differences.

[15] Basile, 2001 uses three subsamples (data of 1991, 1995 and 1997) and only in the case where he includes variables related to innovative activities in the model for one of them is size not a significant explanatory

they can exploit on the world market (Sjöholm, 1999). Moreover the relationship -instead of being linear- seems to have an inverted "U" shape". The firms need a minimum size –probably related to the risks, difficulties and costs, not only in financial resources but also in Human Capital, of foreign trade- to become an exporting enterprise. However once the firm reaches a certain size more advanced ways of internationalisation could be followed, such as direct foreign investments. This non-linear relationship was also found in our own results -presented in the previous section- as in the rest of the studies analysing this aspect. Two comments can be made. First, for the developing countries we found only two studies that analysed the non-linear relationship between size and export probability. A second, more important remark, is that the studies of the developing countries that use export propensity as an indicator for competitiveness present contradictory results[16]. This shows the difficulty of comparing the empirical results based on differences in the dependent variable (e-g- export propensity vs probability)

Only a few studies estimate the models in subsamples of more homogeneous groups of firms. As we could observe in the restricted models size was a significant variable for most of the subsamples we studied. As in the few studies that also analysed subsamples by sectors (Sjöholm, 1999; Van Dijk, 2002; Raut, 2003) the data in our study also confirm the role of size in most of the sectors. However, the subsample by size indicates that even within the group of small or medium sized firms "size" is still an important explanatory variable (See also Estrada/Heijs, 2003 y Estrada 2005).

Different advantages of the size of the firms in competing on the international market are mentioned: organisational and financial capacity, power to negotiate and market power (Zhao/Zou, 2002); scale advantages (Sjöholm, 1999; Patibandla, 1995); their market power in the protected national markets (Kumar/Siddhartan, 1994; Van Dijk, 2002). Small firms however do not reach the critical mass to obtain sufficient scale advantages and to exceed transaction costs (terms of payments; costs of representation in other parts of the world, exchange rates, transport costs etc...).

Regarding the age of the firm, the existing empirical data offer very confusing information. For both types of countries –developed versus developing ones- the empirical literature reflects different effects (positive, negative or non-significant effects) so we can not give a clear answer about the relationship between age and export behaviour. For the case of Guanajuato we did not find any evidence that related the age of the firm with its export behaviour. Based on the literature, we expected such a relationship for the subsamples for small and for medium sized firms or for some sectors -as reflected in the study of Van Dijk, (2002) and Sjöholm, (1999) - but also in the restricted models related to the case of Guanajuato the age variable was not significant.

Being part of a foreign group or holding –especially in the case of modestly developed countries- is related to the firms´ position in the production chain. The literature is not totally conclusive about the effect of foreign participation in the firm on its export probability. The studies that analyse developed countries offer diverse results, although the results based on empirical data in developing countries seem to be more identical. As can be seen in Table 1 and

variable.

[16] Two studies (Kumar/Siddhartan, (1994) and Van Dijk, (2002) reflect the inverted U although Willmore (1992) and Patibandla (1995) found a normal U relationship.

Appendix 1, eight of the ten studies indicate that the ownership structure of the firm seems to have an effect on export probability. As in our own empirical results –confirmed in all the restricted samples- they indicate that firms with foreign capital do have a higher export probability than those with exclusively national capital. So it seems that the role of foreign participation is much more important for developing countries than for developed ones. This is logical taking into account that multinationals of the developed countries locate their production activities –of products orientated to the international market- in low wage countries. For the Mexican case we could assume an important role for its territorial position and its inclusion in the free trade area (TLCAN-agreement). This means that a large number of North American firms invest in Mexico -due to its low wages- with the aim of exporting the products to their home market. In any case in our data we do not have the problem of the border effect because Guanajuato is inland in Mexico.

In our sample the foreign firms have a high penetration rate in the scale-based sector of mass production assemblers and specialised suppliers of intermediate goods and equipment and a low presence in producers of traditional consumer goods. However our restricted sectoral samples -as in the studies of Sjöholm (1999) [17] and Van Dijk, (2002)- do confirm the role of foreign participation in relation to export probability. Although Kummar/Siddhartan (1994) only found this relationship in one of the 13 analysed industries.

Not all kinds of products can be traded freely on the international market so differences in export probability can be explained often by differences in the sectors the firm belongs to. Some studies decided directly to analyse only subsamples by sector while a few other studies include the sector as an independent variable (Zhao/Li, 1997; Basile, 2001; Estrada/Heijs, 2003/2004) but all of them find clear differences. Basile, 2001 –using the same sectoral aggregation as we did in this paper, based on Pavitt, 1984- found a higher export probability for firms belonging to the sectors dominated by specialised suppliers (e.g. equipment and machines) and traditional or supplier-dominated sectors (e.g. footwear, clothing food etc.). We also pointed out sectoral differences in which the most export orientated sector is the traditional consumer goods sector and the scale assemblers, showing the highest standardised beta coefficients in comparison with the suppliers of traditional intermediate goods, [18] which is the sector with the lowest export probability (only 4%). Based on the exploratory analysis [19] we can point out that the sector of producers of traditional consumer goods and the mass production assemblers reflect an export probability of 50 and 45 percent respectively and the sectors of specialised suppliers of intermediate goods, the producers of equipment and the R&D based sectors have a export probability of almost 20%. While the producers of traditional intermediate goods have an export probability of only 4%. Due to these differences the inclusion of the sector as a control variable in our logistic regression model is very important.

3.3. INNOVATIVE BEHAVIOUR

As already mentioned, the "general model" (table 4) shows us that a higher innovative intensity increases export probability. Also the acquisition of external technologies or knowledge -in this case measured by contracting external services related to innovation- has a positive effect on

[17] For most sectors (19 of 28 industries) they found a positive relationship between foreign participation and exporting.

[18] Used as the reference category in the estimation of the model

[19] See footnote 4

export probability. Nevertheless, a negative effect was found in relation to the variables that indicate the results of innovative activities.

The innovative effort

In our study we found a positive effect between *innovation efforts* and export probability using two variables: the R&D effort -a high R&D intensity means a more complex innovative activity- and the number of engineers by total employment, which can be interpreted as a measurement of innovative effort related to more simple innovative activities or as a indicator for the presence of human capital. In our model both variables are statically significant.

The empirical evidence -of developed and developing countries[20]- seems to confirm this result although a minor number of studies did not find a statistically significant relationship (See table 1). The influence of the R&D efforts on export propensity seems to be somewhat confused. The type of firms that are analysed can probably explain the differences in the results of the studies. Looking to the results of the restricted models (see table 5) we did not confirm this relationship for the newer firms, the large or medium sized firms and the firms belonging to a group of firms (national or foreign groups). The explanations of these exceptions are based, on the one hand, on the size of the firms, because those belonging to a group of firms are normally larger than the average firm. On the other hand, the absence of the positive effect in the newer firms could probably be explained by the fact that they have been operating for only a few years and probably at the moment of their creation they had a innovative product and modern production facilities and therefore they spent a lesser amount on innovation. However both interpretations are difficult to confirm with our data.

The positive relationship was confirmed for each of the sectors analysed in this paper. So in the Mexican case even in highly innovative sectors (such as the science-based sector or specialised suppliers of machinery and equipment) the most innovative firms are more prone to export than the less innovative ones. However, the data of Kumar/Siddhartan, (1994) indicate that R&D is only important to predict export behaviour in Indian firms with a medium or low technological level. They conclude that it is almost impossible –for firms of developing countries- to obtain competitive advantages in the high-tech sectors. Probably the firms in developing countries use R&D to adapt the existing products and improve their quality (Zhao/Zu, 2002) and to assimilate and exploit the existing knowledge -not create new knowledge-. This activity is not only based on R&D but also on the importing of machinery and equipment or incremental innovation -e.g. adaptation of purchased technologies or improvement of products- (Raut, 2003). This interpretation is indirectly supported by our own results while in the science based sector it is the variable "improvement of products" that is positively related with export probability while the number of new products or diversification show a statistical non-significant relationship.

In conclusion: R&D activity as well as the other innovative performance has a positive effect on export behaviour. Probably it would be the method to reach the standards of the international markets and therefore spur exporting capacity. However, this result has to be qualified by taking into account the results of the alternative non-linear model (see section 4 and 5).

[20] Although it appears those four studies did not confirm such a relationship and one study reflects a negative relationship this is only true if we analyse each variable individually. Most of those studies include several variables measuring the innovative effort and at least one of them shows a positive and statically significant relationship with the export probability. For example Özçelik/Taymaz found a negative relationship between R&D expenditures by sales and export probability, however two additional variables of the innovative effort (human resources) do reflect a positive relationship.

The studies of the firms in developed countries –using a broad range of different indicators (see Appendix 1)- indicates that the presence of *highly qualified human capital* increases export probability (6 studies) and propensity (11 studies). Only one study reflects a negative relationship Both for the probability and for the propensity (Roper and Love, 2002) and there were no studies that denied such a relationship. The interpretation of these results probably is that qualified personnel are more dynamic and entrepreneurial, which implies that they are more prone to take the initiative in searching for foreign markets and, moreover they are better prepared to assimilate the firms behaviour to international standards. Not only is this so in relation to the products (quality and performance) but also in the way to do business and the organisation of their activities in the search for creative solutions. The studies that analyse developing countries offer confusing results. Most of those studies do not find any statically significant relationship between *human capital* (or investment in human capital) and export activities. Although some of them find a negative effect others point out -as in the case of Guanajuato- a positive relation.

The acquisition of technologies

The acquisition of technologies as a determinant for export behaviour is analysed by a large number of studies using a broad range of different variables. The studies include, on the one hand, the investment in *incorporated* technologies (procurement of new machines and equipment), the capital intensity, the improvements in the production processes (automation, vintage model) as well as the acquirement of *non-incorporated* technologies (licenses, royalties for knowhow, technological services or consultancy, etc.) especially in the case of developing countries.

Most studies in the developed countries (6) show a positive relationship between the innovative level of the firms measured by *acquisition of incorporated technologies* versus the probability or propensity to export. Although three studies did not find statistically significant differences none of them found a negative relationship. The studies of developing countries offer more confused results: four of them reflect a positive relationship, three of them show a negative relationship and three studies did not find statistically significant differences. The same confusing results were found in studies that analyse export propensity as well as those studying export probability.

As can be observed in Table 6, the relationship shows clear sectoral differences -also confirmed by the existing literature- which could partially explain the contradictory results. Kumar/Siddhartan (1994) found positive effects for six of the thirteen industries and van Dijk (2002) for 8 of the 28 analysed sectors. Moreover, Raut, 2003, indicates that the acquisition is not related to export behaviour in the case of traditional consumer goods and is positively related in the traditional or specialised providers and chemicals.

Table 6 The effect of the acquirement of incorporated technologies on export behaviour

	Positive effect	Not significant	Negative efect
Developed countries Export Probability	Wakelin (1998) Smith et.al.(2002) Basile (2001) Lefebvre y Lefebvre (2001)	Lefebvre y Lefebvre (2001)	
Developing countries	Sjöholm (1999) Söderbom y Teal (2000) Özçelik y Taymaz (2004) Raut (2003)	Rankin (2001)	Zhao y Li (1997) Zhao y Zou (2002)
Developed countries Export Propensity	Wakelin (1998) Smith et.al.(2002) Mechling et al. (1995) Wagner (1995) Lefebvre y Lefebvre (2001)	Sterlacchinni (1999) Basile (2001) Lefebvre y Lefebvre (2001)	
Developing countries	Özçelik y Taymaz (2004) Raut (2003)	Zhao y Li (1997) Zeufack (2002)	Zhao y Zou (2002) Raut (2003)
Sectoral differences (Dependent variable Export Propensity)			
Kumar y Siddhartan (1994) (Capital intensity)	Electrical engineering, drugs and pharmaceutical industry	Textiles; Manufactured metal products; Transport equipment; Basic industrial chemicals and dyestuffs; Non electrical machinery	Food processing, Cement. Paper, Rubber products; industrial and other chemicals
Van Dijk (Indonesia; 2002) (Capital intensity) The sectoral classification used is the one of the author)	Supplier dominated sectors Beverage, Tabacco; textile; wood, Clothes; Leather, Scale intensive Non ferrous metals, Electrical machinery, Clay Science based sectors Basic chemical Specialised suppliers Machinery	Supplier dominated sectors Food, Furniture, , shoes; Printing and publishing, Metal products, other non metallic materials Scale intensive Rubber, Plastic, Porcelain, Glass, Cement, Iron and steel, , Transport Science based sectors Measuring equipment	pulp and paper
Raut (2003) Import of capital goods	Heavy Industries	Light or traditional industries	

The literature offers different interpretations of those results. First, in developing countries a non-significant or a negative effect could be expected due to its abundant labour market and low wages (Kumar/Siddhartan, 1994). In a low wage country a higher capital intensity (and the purchase of capital goods) is not per se an advantage to compete on the international market or could even imply a certain disadvantage. On the other hand the positive influence of purchasing incorporated technologies on export behaviour is explained by the existence of learning and the scale effects related to the introduction of new machinery and equipment (Wakelin, 1998; Van Dijk, 2002). This second interpretation could be supported by the fact that the acquirement of incorporated technologies has a positive effect on export propensity especially in high-tech sectors (Raut, 2003; Kumar/Siddhartan, 1994; See also Table 6)[21], since they are complex sectors were learning is an important aspect.

[21] Raut measures the incorporated technologies by "importing of capital goods" and Kumar/Siddhartan use the level of capital intensity

In fact, the study of Kumar/Siddhartan (India, 1994) reflect a negative relationship between capital intensity and export propensity in low and medium technology sectors and a positive one in two high-tech sectors (electrical engineering and drugs and the pharmaceutical industry). This means that a higher degree of capital intensity (as a measurement for incorporated technologies) does not improve the export behaviour of low or medium tech firms or, even has a negative effect, while for some of the high tech sectors investment rates do spur export behaviour. In these sectors labour-intensive processes appear to be inefficient despite low wages (Kumar/Siddhartan, 1994). On the one hand the paper of van Dijk, (2002) confirms the positive impact of capital investment on exporting in high tech and medium tech sectors. On the other hand, he offers very heterogeneous results in relation to the low-tech sectors. His interpretation of the positive effects in some of these sectors is that supplier-dominated sectors seem to require certain degree of automation even for firms operating in relatively low technological industries to break into foreign markets.

The *acquisition of non-incorporated technologies* (Licenses for patents, royalties or agreements for know-how transfers) is only analysed for developing countries. Only three studies analysed this aspect. Two of them did not find any relationship between the acquisition of non-incorporated technologies and export behaviour (Kumar/Siddhartan, 1994; Özçelik/Taymaz, 2004) and the study of Aitken et all (1997) reflected a positive effect.

Our own results -as can be observed in model 1 to 4 of Table three- show a positive effect on export probability both for the incorporated technologies (acquirement of machinery) and for non-incorporated technologies (acquirement of non-incorporated technologies or technological services). Although once we include variables related to product diversification the positive effect of acquiring incorporated technologies disappears. The only variable related to this aspect included in the general model is the purchase of "technological services". Firms that acquire technology by consultancy services do have a higher export probability: This relationship is confirmed for each of the sectors analysed and only the restricted models that include mainly the large firms (over 250 employees, firms belonging to a group of firms and those with foreign capital) do not reflect this relationship.

To conclude; acquisition of technologies seems to increase export probability and the confusing results in the existing literature about developing countries could be explained (partially) by sectoral differences. However -as we see in section 4 and 5- the alternative non-linear model probably does model the real relationship better.

Technological results

The variables reflecting the acquirement of technologies -used in this paper- are mainly related to the innovation process, while the ones used for the *results of innovative activities* are related to product innovation. The model reflects a negative relationship between the results of the innovation process and export probability. Firms more oriented to the national market seem to have a higher level of diversification based on innovation, the introduction of a higher number of new products, a higher level of sales related to improved products and they produce a broader range of different products (diversification strategy). On the other hand, those firms that specialise in one sole product (100% of their sales are generated by their main product) are more dynamic on the international market. They increase their export probability (in relation to the mean probability) by sixteen percent while firms whose main product accounts for 50% of all the sales have eight percent less probability of exporting their products (See table 4 ; marginal effects).

Our results do not coincide with the existing empirical evidence reflected in similar studies related to developed countries. Most of those studies indicate a positive effect of diversification and product innovation on export probability. This is not suprising because the developed countries compete on the world market not by price competition, rather they penetrate world markets by good quality and highly innovative products, while low wage countries offer cheap technologically standardised products with an acceptable quality. Our result does not conflict with nor confirm the outcome of the only two studies that analyse the innovative results as determinants for exporting in developing countries. Özçelik y Taymaz did not find a statistically significant relationship between product innovation and export probability or propensity. Wignaraja however, found a positive relationship but using export propensity as a dependent variable.

The restricted models do not confirm this negative relationship for all types of firms because in some subsamples we found a positive relationship, which probably could partially explain why we found different results from Özçelik and Taymaz (2004) and Wignaraja (2001).

The restricted models based on the small firms -most of them specialised in one or a few products- do not reflect any statistically significant relationship between product innovation and export. The subsample of large firms shows a positive effect between the number of new products and export probability. The firms belonging to a national group or holding and those of the science-based sector show a positive relationship between the percentage of sales corresponding to improved products and their national export probability. The medium sized firms and the ones with foreign capital show a positive relationship between product diversification and export.

Those differences seem to be logical. The competitive strategy of larger firms (including those belonging to national or foreign groups or holdings) is more often related to product innovation and diversification. The Mexican science-based firms do not gain better export probabilities by introducing new products or diversification strategy, rather, their international competitiveness seems to increase by better incremental innovation reflected in product improvements. So our results seems to be reasonable and introduces a new aspect into the international literature about the explanatory factors of export behaviour. However the product strategy as determinant of export should be analysed more broadly, especially in the case of the developing countries

3.4 CONCLUSION OF THE "CONVENTIONAL MODEL"

This paper study the aspects that influence the export activity of the firms in developing countries with special attention to their innovative behaviour. The aim of this paper is to study the aspects that influence the export activity of the firms in developing countries with special attention to their innovative behaviour. Most of the existing literature analyses this question in advanced countries and only recently several studies began to analyse this aspect in developing countries.

The main conclusion of this paper is that innovation is important to explain export behaviour in the Mexican case. Innovation and highly qualified human resources would be a method to reach the international standards of the world market and therefore it is necessary to compete in export markets. The literature shows such a relationship both in developed and developing countries. Although the relationships in both type of countries are not always the same, probably due to the contrast between the importance of innovation for the production process and international competitiveness reflected in firms' innovative strategies, and as mentioned above, especially in the case of product strategy. Most firms in developing countries have a product specialisation strategy

-based on low wages and process innovations of standardised and incrementally improved products- to compete on the world market while the enterprises of the developed countries and of some specific sectors of developing countries do have a product innovation strategy.

The rich literature about this subject offers sometimes confusing empirical evidence. The differences in those results could partially be explained by the following causes: (1) differences in the particularities of each of the analysed countries. Here we made a distinction between developed and developing countries but even within those two main groups we see differences (large vs small countries; technological leader vs followers; developing vs transition countries); (2) the use of a similar concept of "innovative" in studies about developing and developed countries; (3) differences in the dependent variable (export propensity vs probability); (4) differences in the econometric models; (5) wide range of variables used to express the same indicator especially those that express various aspects of innovative behaviour and (6) the inclusion of different types of firms (small vs large firms; broad range of firms vs firms of some particular sectors or only innovative enterprises, etc...). Moreover not all studies clearly express the type of firms included in the sample or the exact description of the variables, and this made it very difficult to interpret the results. Probably this is because most of the studies use data (surveys), as in our case, not especially designed for the analysis of export behaviour.

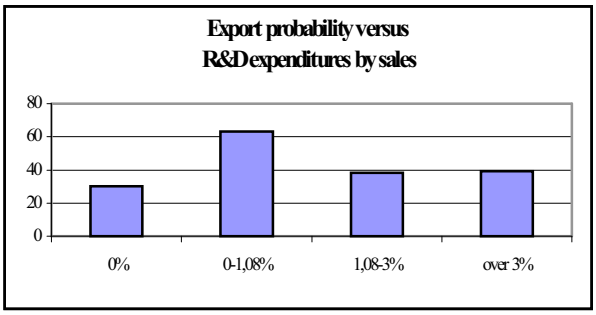
The restricted models (see Table 5) show us clearly that different type of firms are associated with distinct independent variables that explain their export behaviour. So an important conclusion for the comparison of the outcome of different studies and the interpretation of our own models is the need for a clear description of the enterprises included in the analysis. These differences probably explain part of the differences and sometimes the confusing results in the existing literature.

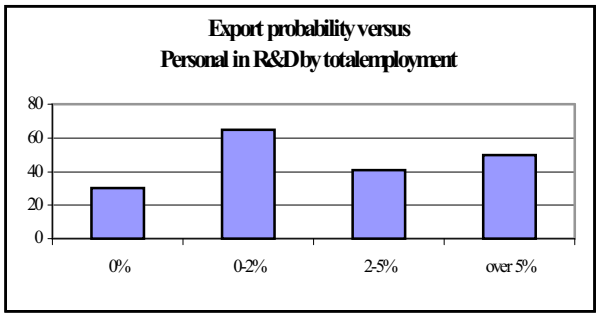
4. THE ALTERNATIVE -NON LINEAR- MODEL

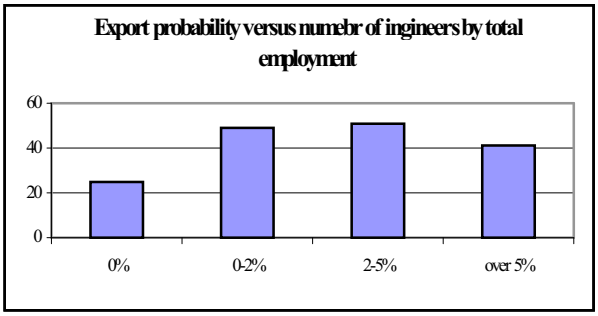
The exploratory analysis (see graphic 1) shows us that the bilateral relationship between the export probability and the innovative behaviour is non-linear in the form of an inverted "U" for most of the variables related to innovative behaviour. However, for the percentage of sales related to the improved products and those related to the sales of the main product (diversification) the non-linear relationship is not totally clear. These exploratory analyses convinced us that we should not only estimate a conventional model but also an alternative one, including non-linear relationships.

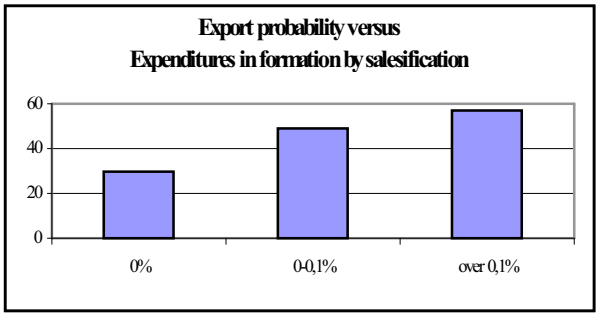
The results of the conventional model (see former sections) shows us that a higher innovative intensity (measured by R&D efforts by sales and by the number of engineers by total employment) increase export probability. Also contracting external services related to innovation has a positive effect on export probability. A negative effect was found in relation to the variables that indicate the results of innovative activities in sales. Firms with a high number of new products are more oriented to the national market. However, those firms that specialise in just one product are more dynamic on the international market. The variables with the highest discriminatory power are the size of the firms and the presence of foreign capital. Within the group of variables that analyse the innovative behaviour contracting technology services is the most important one followed by R&D expenditures by sales and the number of engineers by total employment. Like we argued in the former section in general these findings are similar to the results in the empirical literature, which probably proves that our data do not offer ad hoc interpretations that could harm the credibility of our main findings of the non-linear model.

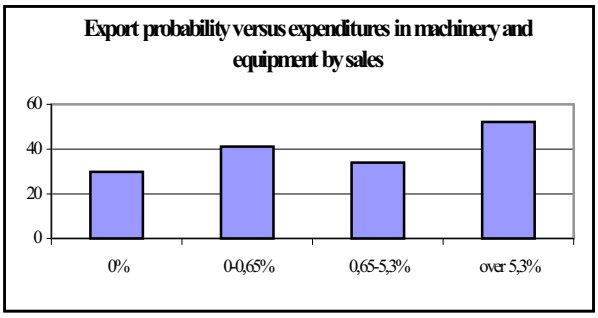
Graphic 1: Export probability by innovative behaviour

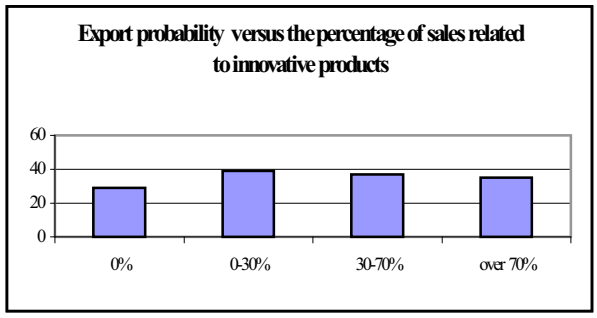


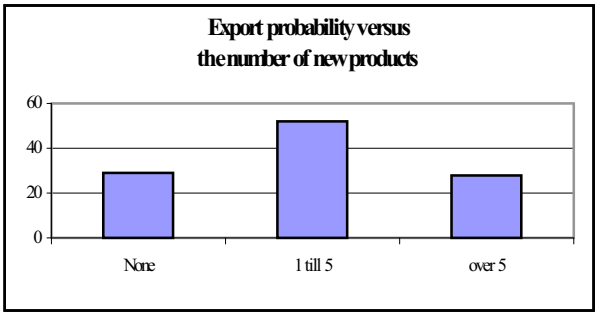


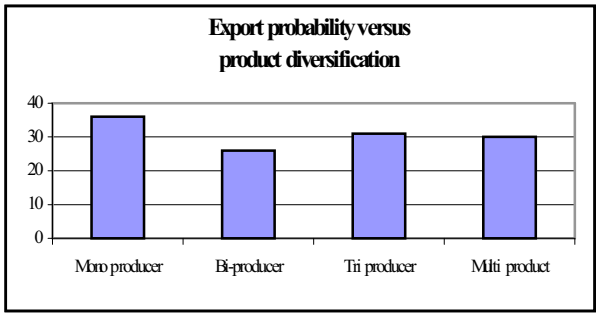












(Export probability of total sample 32%; Al diferentes are statistically significant)

On the one hand, the alternative model confirms the positive linear relationship between the likelihood of exporting and product specialisation and the negative relationship between exporting and the percentage of sales related to improved products also found in the conventional model. On the other hand, the alternative model shows a non-linear relationship in the form of an inverted "U" between the variables related to the innovative efforts and the acquisition of technologies on the one hand and the export probability on the other.[22] This seems to confirm the relationship observed by the explanatory analysis (as shown in figure 1). For the variables acquisition of machinery and equipment, Number of engineers by total employment and the number of new products, the less innovative firms and the most innovative firms have a lower export probability than those with a medium level of innovative activities.

Table 3: General models: conventional versus alternative model

		Conventional model			Alternative model		
		Beta	Significance	Marginal effect (%)	Beta	Significance	Marginal effect (%)
	Size	0,003	0,000	0,04%	0,003	0,000	0,04%
	Size**2	-0,001	0,016		-0,001	0,008	
	Foreign Capital	0,028	0,000	0,51%	0,030	0,000	0,48%
	Sector						
Structural characteristics	Producers of traditional consumer goods	2,986	0,000	44%	2,964	0,000	41%
	Suppliers of traditional intermediate goods (Reference category)						
	Specialised suppliers of intermediate goods and equipment	1,109	0,018	8%	1,055	0,037	7%
	Mass production assemblers	1,867	0,003	19%	1,476	0,025	11%
	R&D based sectors	1,421	0,003	12%	1,042	0,049	7%
	Machinery and equipment	NS	NS	NS	0,102	0,000	0,91%
Acquisition of technologies	Machinery and equipment **2				-0,003	0,000	
	Technical services for R&D	1,216	0,000	25%	1,053	0,000	20%
Innovative	R&D expenditures by sales	0,126	0,009	2,30%	-0,583	0,003	-8,87%
	R&D expenditures by sales**2				0,059	0,000	
Efforts	Number of engineers by total employment	0,023	0,000	0,43%	0,102	0,000	1,54%
	Number of engineers by total employment**2				-0,001	0,000	
	Expenditures in Marketing	NS	NS	NS	-0,138	0,009	-2,22%
	Number of new products	-0,072	0,001	-1,33%	0,162	0,025	2,30%
	*Number of new products**2*				-0,011	0,004	
Innovative results	*Percentage of sales related to improved products*	-0,006	0,018	-0,11%	-0,010	0,001	-0,16%
	Percentage of sales realted to the main product (Product Diversification)	0,009	0,011	0,16%	0,009	0,012	0,15%
	Constant	-4,388	0,000	-80%	-4,667	0,000	-75%

[22] To assure the stability and reliability of both models we estimated similar models in which we maintained the variables related to the structural characteristics of the firms and made some changes including and excluding different variables related to innovative activities. In all those models each of them –regardless of the indicators for innovative activities that have been used- confirmed the role of the structural characteristics and the specific relationships between innovation and export (For details see Estrada 2005).

The variable R&D expenditure by sales shows a remarkable and contradictory result. The explanatory analysis shows for this variable an inverted "U"-shaped relationship while the logistic regression model reflects a normal shaped "U" instead of an inverted one. So for this variable the relationship -taking into account simultaneously other innovation-related variables- is non-linear although it has the form of a normal "U". In this case the highest export probability is related to a low or a high R&D intensity while the intermediate firms have a lower export probability[23].

The exact interpretation of these results seems to be complicated. An initial interpretation of these contradictory results could be the interaction effect because the model includes simultaneously eight variables of innovative behaviour. This fact could generate a problem of colinearity and therefore affect the exact shape of the relationship of one of the other variables[24].

Goodness of fit

	Conventional model	*Alternative model*		*Conventional model*	*Alternative model*
-2 LL	979,40	909,90	χ^2_{13}	382,14	451,65
			(sig)	0,000	0,000
Pseudo r2			***Percentage of correct classified cases***		
Cox y Snell	0,30	0,34	No exporters	80	83
Nagelkerke	0,42	0,48	Exporters	69	70
McFadden	0,28	0,33	Total	76	78
McFadden adjusted	0,29	0,34	***Number of cases***	1087	1087

Source: own estimation on the survey INEGI-CONCYTEG (2000).

Certainly, some colinearity between those variables is expected, albeit the correlation between them is not extremely high. However, we did some tests including and excluding different variables related to innovative behaviour and there were no changes in the signs and the significance of other variables[25]. We estimated models excluding one by one the other variables related to the innovative behaviour and in each of the combinations the R&D expenditure by sales shows a normal "U" shaped relationship. Although these preliminary models had a lower percentage of correctly classified firms and the X^2 was somewhat lower in relation to the final model presented in this paper. These preliminary tests assure us, on the one hand that the relationship seems to be shaped as a normal "U", and on the other indicate the absence of the problem of colinearity and confirm the robustness or stability of the model[26].

[23] As we will see in the next section analysing the restricted models, this variable has a less stable behaviour. Although excluding it from the analysis the results we showed before do not change, therefore its inclusion does not impede statistically reliable results of the non-linear model.

[24] It could be that the variables of expenditures in machinery and equipment, the number of engineers by total employment in engineering and the number of new products already reflect the relationship in the form of an inverted "U". While the R&D effort explains an additional or a partial relationship.

[25]. As well as the variables related to the structural characteristics of the firms, those reflecting their innovative behaviour do show the same relationships as presented in the paper. There were no changes in the signs of the variables. Only the Betas changed slightly and the parameters of the goodness of fit were slightly lower.

[26] Despite the difficulties with the interpretation and the differences of its influence on export behaviour observed in the restricted models, we decided to maintain this variable in the model. Firstly, because of the improvement of the parameters of the goodness of fit, secondly because these expenditures -especially in developing countries- reflect a very specific part of innovative activities.

Once we rejected the possibility that the normal "U" shaped relationship is a result of interaction effects we have to explain why there exist simultaneously two seemingly opposite relationships. For example, why do firms with a low R&D intensity have a higher export probability than those with an intermediate intensity and simultaneously why do the other innovation-related variables show that a low innovative level is related to a low export probability? Probably these apparently contradictory facts could be connected to the type of products they export, related to their position in the product life cycle. Probably these are products with a high level of standardisation (not innovative products), the production of which was relocated to low wage countries geared to taking advantage of the relative Mexican advantages of low salaries and natural resources. Therefore R&D activities are not profitable. However -at the same time- the investment in other innovative activities, especially process innovation, reduces their export probability, when, to be competitive the standardised products need to have lower production costs. This kind of process innovation can be achieved by the purchase of incorporated technologies (acquisition of or investment in machinery and equipment) or by good human capital.

Other differences between the conventional and alternative model are the inclusion of the acquisition of machinery and expenditures in marketing as a statically significant explanatory variable. Especially is this the case with the acquisition of machinery -which implies the purchase of incorporated technologies- and could be an important variable to explain export behaviour in developing countries like Mexico.

Looking to the goodness of fit of both models, we observe that all parameters are higher in the case of the alternative model. The Log Likelihood is clearly less (910) in the alternative model compared with the conventional model (975); the pseudo R^2 of Nagelkerke (48%) is two points higher in the case of the conventional model (46%) and the alternative model predicts moderately better the export probability of the firms (76% vs. 78%). This brings us to the conclusion that the non-linear model seems to predict the export probability of the Mexican manufacturers better than the conventional model does.

To assure the robustness of the models we repeated the estimation several times randomly excluding 10% of the cases. Each time we found a similar result (the same variables were significant without changes in their relative importance or their sign –positive or negative effects-) with only minor changes in the values of the betas, marginal effects, correctly classified firms etc. Moreover, we repeated the models excluding some of the variables related to innovative behaviour. We always found similar results confirming the importance of the structural variables and the non-linear relationship between the innovative behaviour and the export probability. Even in the case where only two variables related to innovative behaviour were maintained (one for the innovative effort or acquisition and the other for the product innovations or product strategy), we obtained similar conclusions.

2.3.- RESTRICTED ALTERNATIVE MODELS

Although the estimation of a logistic regression model means that all the interaction effects are taken into account, we conceive that the sample as a whole could still be considered as heterogeneous. Therefore we repeated the analysis for the more homogeneous subsamples. As can be observed in Table six, we made estimations –using the specification of the general model- for 14 different subsamples. We estimated three models for subsamples by size (small, medium and large sized firms), three models by age (new, mature and old firms), three models

by property structure (individual national firms; national firms belonging to groups or holdings and firms with foreign participation); three sectors (traditional consumer goods, specialised suppliers and those based on R&D)[27] and two models classifying the firms between those that used external services for R&D (or engineering activities) and those that did not use this kind of services.

Looking to the structural characteristics, we can observe that most of them are statistically significant in almost all models. The size is a significant factor for 10 of the fourteen models, except for those based on subsamples that include a high percentage of large enterprises (the subsamples of large firms, the firms belonging to a national group or holding, those of the science based sectors and those that contract R&D services). An unexpected relationship is found for the subsample of foreign firms in which size is negatively related to export probability. E.g. small foreign firms are more oriented to the international markets whereas large foreign firms operate more in the domestic market.

Foreign capital is an explanatory factor in each of the models. The sector is only insignificant in three subsamples: large firms, those belonging to a national group or holdings and the sample foreign firms. In fact, in all cases where we are talking implicitly about large firms, this means that advantages of being large are persistent among sectors.

[27] Due to the limited number of firms in our sample that belong to the other sectors it was impossible to carry out statistically acceptable estimations for all sectors.

Table 4 . Restricted ALTERNATIVE MODELS for subsamples by size, age, property and sector and importance of technological services.

Type of variables	***Independent variables***	**GENERAL MODEL**	**SIZE**			**AGE**			**PROPERTY**			**SECTOR[(1)]**			**Contracting technical Services**	
			S	M	L	Y	A	O	IND	NG	F	TRAD	ESP	BC	NO	SI
Structural characteristics	Size	+	+	+	NS	+	+	+	+	NS	-	+	+	NS	+	NS
	Size**2	-	-	-	NS	-	-	-	-	NS	NS	-	NS	NS	-	NS
	Foreign Capital	+	+	+	+	+	+	+				+	+	+	+	+
	Sector ***Suppliers of traditional intermediate goods (Reference category)***	*	*	*	NS	*	*	*	*	NS	NS				*	*
	Producers of traditional consumer goods	+	+	NS	NS	+	+	+	+	+	+				+	+
	Specialised suppliers of intermediate goods and equipment	+	NS	NS	NS	NS	NS	NS	+	NS	NS				NS	NS
	Mass production assemblers	+	NS	NS	NS	NS	NS	NS	NS	NS	NS				NS	+
	R&D based sectors	+	NS	NS	NS	NS	NS	NS	NS	NS	NS				NS	+
Acquisition of technologies	Machinery and equipment	+	+	NS	+	+	+	NS	+	NS	NS	+	+	+	+	+
	Machinery and equipment **2	-	-	NS	-	-	-	-	-	NS	NS	-	-	-	-	-
	Technical services for R&D	+	NS	+	NS	+	+	+	+	+	NS	+	+	NS		
Innovative Efforts	R&D expenditures by sales	-	NS	NS	NS	NS	NS	NS	-	NS	NS	+	NS	NS	NS	-
	R&D expenditures by sales**2	+	NS	NS	NS	NS	NS	NS	+	NS	NS	-	NS	NS	NS	+
	Number of engineers by total employment	+	+	+	+	NS	+	+	+	NS	NS	NS	+	NS	+	NS
	Number of engineers by total employment**2	-	-	-	-	NS	NS	-	-	NS	NS	NS	-	NS	-	NS
	Expenditures in marketing for new products by sales	-	+	NS	NS	NS	+	-	+	NS	NS	-	NS	+	NS	-
Innovative results	*Number of new products*	+	+	NS	NS	NS	NS	NS	+	NS	NS	+	NS	-	NS	+
	*Number of new products**2*	-	-	NS	NS	NS	NS	NS	-	NS	NS	-	NS	+	NS	-
	Percentage of sales related to improved products	-	NS	-	-	NS	-	NS	-	NS	NS	-	NS	+	-	-
	Percentage of sales related to the main product (Product Diversification)	+	NS	-	+	NS	NS	+	NS	NS	-	NS	NS	-	+	NS
	Constant	-	-	-	NS	-	-	-	-	NS	+	-	-	NS	-	-
Goodness of fitt	*PSEUDO R**2 (NAGELKERKE)*	48	58	65	44	63	70	46	51	66	66	33	78	85	49	45
	% correctly classified	78	85	87	80	85	83	78	80	79	90	66	92	98	81	72
	Number of firms	1087	700	214	173	350	325	412	959	57	71	513	215	167	838	249

Taking into account the role of innovative behaviour in each of the models, we observe for three variables (R&D expenditures, product differentiation or marketing) some unstable and possibly contradictory results. The question is if these instabilities generate problems, which could affect the credibility of the estimations or reflect the particularities of different type of firms. E.g. the apparent contradictory results reflect the different role of some specific aspects of innovative behaviour in different type of firms. Therefore we repeated these restricted models excluding those three variables. These additional estimations did not change the sign and significance of the other variables. Because of the limitations of the data base the interpretation of the seemingly contradictory results is rather difficult, therefore the following remarks have to be considered as reasonable ad hoc explanations rather than empirically contrasted facts.

The R&D expenditures by sales show a non-linear "U"-shaped relationship for the whole sample, the sample of individual firms and for those firms that contract technical services. While an inverted "U" shaped relationship was detected for the producers of traditional consumer goods, for most of the subsamples (11) no statistically significant relationship was found. It can be stated that in underdeveloped countries like Mexico R&D is normally a marginal activity and often supports other innovative activities. So their exclusion of most of the models could be due to the inclusion of other innovation related variables. Another reason could be that in smaller subsamples the test for significance requires a higher correlation, so the significance could fade away due to the number of observations. In any case, with our data it is impossible to confirm those interpretations.

It has to be taken into account that R&D reflects specific innovative activities that are considered of a higher level than just engineering or the purchase of incorporated technologies. Therefore it is not suprising that its role in each of the restricted samples could be different. The normal "U" shaped relationship is found for the total sample of 1087, for the subsample of 959 individual firms and for the ones that contract external R&D services. A statistically non-significant relationship was found for 11 of the subsamples including those of the 700 small firms and the 838 firms that do not contract external technical services. Most of the firms of those two subsamples do not carry out R&D. An opposite relationship was found for the producers of traditional consumer goods. In this subsample the firms with a moderate R&D effort have the highest export probability while the firms with a very low or a very high effort export less frequently.

The second variable that shows irregular results is the expenditures in marketing for new products by sales. This variable is significant for the subsamples of small, individual and mature firms. It seems that especially these type of firms need a marketing strategy to assure a positive image in the international market. The same is true for the science-based firms, who also have to convince foreign markets about the quality of their new innovative products. For those subsamples related to large firms (medium and large firms, firms belonging to national or foreign groups or holdings) a marketing strategy does not increase their export probability. Also for new firms, this variable is not statically significant, possibly due to the low number of new firms that export[28]. The positive relationship for the subsample of mature firms could be explained by their particular situation in which they still do not have an established image. More difficult is to explain the negative

[28] The statistical requirements of the significance test could hide a positive relationship. In fact here we only analyse the main relationship. This does not mean that in certain individual enterprises the marketing strategy could be very important to initiate export activities.

relationship found for the old firms[29], the producers of traditional consumer goods and those firms that contract technical services.

The third unstable variable with apparently contradictory results is the percentage related to the main product. For the sample as a whole, product ***specialisation*** is related to a higher export probability, however for some of the subsamples the higher export probability is related to a strategy of product ***differentiation*** and product development. This is the case for large firms with their financial and organisational power that possibly allows them to be competitive on the international market through a diversification strategy, whereas smaller firms have to specialise to compete worldwide. The same relationship was found for the old firms and for those that did not contract external R&D services. For the old firms we could consider a similar interpretation as above. We find a negative relationship for the medium sized firms, the foreign ones and science-based industries. These types of firms need or opt for a specialisation strategy based on a few relatively good products instead of a broad range of differentiated products. Concluding, the restricted models colour the general findings with regard to the market orientation (domestic versus foreign markets) versus the product specialisation or diversification. This indicates that the strategy of product specialisation improves export probability for medium sized and foreign firms and those belonging to science-based sectors. While large firms, old ones and those that do not contract technical services use a diversification or product-orientated strategy to compete on the world market. An important methodological implication of these apparently "unstable" variables is that they could partially explain the differences of the results in the existing literature. The results of the studies that use a non-representative sample of firms (only large firms or only small ones, some specific sectors etc...) could be the result of the different role of those variables and they explain apparently contradictory results.

Observing the results of the fourteen restricted alternative models -and leaving out those unstable variables- we can define three groups of models (see table 4). The first one includes those models that reflect similar relationships to those found in the general alternative model estimated for the whole sample. This similarity is defined, on the one hand, by a non-linear effect in the form of an inverted "U" between the innovative efforts and the export probability. Thus, the less innovative firms and the most innovative ones have the lowest export probability while the firms with an intermediate innovative level have the highest export probability. This relationship should be reflected by at least one of the following variables: the number of engineers by total employment, the number of new products or by the expenditures in machinery and equipment[30]. On the other hand, this similarity is defined by a linear negative impact of the percentage of sales related to improved products on export probability. These general results were confirmed by the subsamples of the medium size and the large firms, the mature firms, for the sectors of traditional consumer goods producers and for both subsamples related to the contract of technical services.

A second group of models are very concise ones, where only one or two variables of the innovative behaviour show a statistically significant relationship with the export probability. As can be observed in table four, the new firms, those belonging to national or to a foreign groups or holdings show that most aspects of their innovative behaviour are not related to their export probability. For the foreign firms the product diversification is negatively related to their export

[29] For the old firms we could expect a statistically insignificant relationship due to their long experience and already well established international relationships.
[30] In this defintion we do not include the relationship in the form of a normal "U" for R&D expenditures because this variable is only statistically significant in three of the fourteen restricted models.

probability. This means probably that foreign firms that invest in Mexico to compete on the domestic markets have a strategy of product diversification while the foreign ones that invest in Mexico to export their product on the international market compete on prices and therefore produce only one or a few standardised products taking advantage of the low wages. A second very concise model includes the firms that are part of a national group, for which only the use of technical services shows a positive relationship with export probabilities. A last group of firm where only a few variables of the innovative behaviour are related to the export behaviour are the new firms. In this subsample we observe a positive relationship between variables that reflect the acquisition of technologies (expenditures in machinery and equipment and contracting technical services) and the export probability while no relationship was found for the variables that reflect the innovative effort or results.

The third group of restricted models includes those subsamples in which we found a non-linear relationship between the innovative efforts while the percentage of sales related to improved products is not related to export probability. This is the case for the smallest firms, the oldest ones and those belonging to the sector of specialised suppliers of intermediate goods and equipment.

A last restricted model -not included in the aforementioned groups- shows different results in comparison with the rest of the subsamples: the firms of the science-based sector. This is not suprising due to the special role of innovation in this sector. In these sectors innovation is one of the core activities because the innovative level of the product is the aim of their business. In this model there are two variables related to innovative behaviour that show a different relationship -only in this subsample- with the export probability. Only for this restricted model did we find a positive relationship between the percentage of sales related to improved products and export probability. And also solely for this subsample we found a non-linear relationship in the form of a "U" between the number of new products and export behaviour. Thus, the firms with a low or a high number of new products are the most exporting firms while the firms with an intermediate number of new products seem to have a lower export probability.

5.- THE NON-LINEAR RELATIONSHIP: SOME REMARKS

There is no doubt about the fact that innovative behaviour is an important explanatory factor for export probability. Analogous to the conventional literature we made clear that innovation is important to explain export behaviour, however, in addition to this literature we state that the relationship is non-linear. Our analysis reflects the fact that the less innovative firms and the most innovative ones have a lower export probability than the enterprises with an average innovative level. Our logistic regression models include eight variables related to innovative activities and in all models -the general model and the restricted models- at least one of them shows, in a statically significant way, this non-linearity.

We analysed three aspects of innovative behaviour -acquisition, innovative efforts, and the innovative results- and in ten of the fourteen restricted models, at least one of the variables of these three aspects is included as an explanatory variable, and most of them indicate an inverted "U" shaped relationship. The more innovative the firm is the higher its export probability, although on reaching a certain innovative level the additional increase of this level is correlated with a decreasing export probability. These results confirm the explorative analysis (See graph one), which also shows that the highest export probability is observed for the firms with a

intermediate innovative level, while firms with a low or a high innovative level show a lower export probability.

Leaving aside the R&D activities (see section 2.2) the exact interpretation of the non-linear relationship in the form of an inverted "U" between innovation and the export probability seems to be complicated. We need to explain why (a) a low innovative level is related to a low export probability and (b) why the highest innovative firms show a lower export probability than the firms with an intermediate innovative level.

As already mentioned, probably this relationship could be connected to the type of products they export, related to their position in the product life cycle. The innovation process-except R&D- is a way to increase competitiveness for standardised products. The purchase of incorporated technologies (acquisition or investment in machinery and equipment) or good human capital can bring down production costs. So more innovative firms are more competitive, that is, they have a higher export probability.

The relatively low export probability of firms with a low innovative effort -reflected by the purchase of machinery and equipment or the number of engineers or new products- can also be interpreted by taking into account the particularity of innovative activities. The theory shows that innovation -especially R&D- is an activity with a high level of indivisibilities (Arrow, 1962), which requires a minimum level innovation to make it profitable. The firms with a low level of innovative activities probably do not reach the critical mass or minimum threshold that makes innovation profitable for the world market as reflected in export activities. However, firms that clearly opt for innovation activities are competitive at an international level[31]. So, on the one hand, the firm needs a minimum level of innovation and therefore the less innovate ones do not export. On the other hand, on the international markets a combination of an intermediate innovative level with low wages seems to be a valid competitive strategy.

This fact probably could explain the low export probability of less innovative firms. However, the fact that the most innovative firms -with the highest relative innovative efforts- have a lower export probability is more difficult to understand. A feasible explanation could be the possible position of these highly innovative firms within the vertical production chain as providers of exporting firms (such as, for example the mass assemblers). A second reasonable explanation could be the fact that developing countries like Mexico compete on the world market by low prices and acceptable quality. They need some innovative efforts to compete -complementary to their low costs- however due to their limited innovative capacity it would be difficult to compete on the world market by a clear innovation strategy. Therefore it could be possible that the "highly innovative" Mexican firms are geared to compete in the domestic markets rather than on export markets. The firms oriented to the domestic market have to compete with the most competitive national and foreign enterprises. These firms have to be more innovative than their competitors because it is not possible to compete on low wages in the home market.

Another explanation, not applicable to the Mexican case, could account for such a relationship for small highly innovative firms in some specific developed countries such as Germany, Japan or the USA. In this case it could be that the most innovative enterprises do not export because the market

[31] This interpretations presented in this paper are more theoretical or abstract ad hoc explanations. Moreover the critical mass concept is used -in this case- for the relative variable of R&D expenditures by sales while in the theory the absolute expenditures indicate the reach of the critical mass.

of the highly innovative products needs -in the case of consumer goods- a high level of income, or they are providers for larger firms, so their export is indirect.

We are aware that we offered a few possible and apparently reasonable interpretations of the non-linear relationship that we cannot confirm statically with our empirical data. E.g. our data set does not permit our interpretation to be compared. However, in the mainstream literature we also did not find any justification for the linear relationship, therefore, further research is needed.

5.- FINAL CONCLUSION

In this paper we proved the importance of innovative activity to compete on the world market. This conclusion was confirmed by both models -the conventional and the alternative ones-. Also we explained briefly the difficulties in comparing results of the existing literature and in fact the sometimes apparently contradictory results could be explained by the particularities of each of the studies. This was especially so where different studies use different kinds of samples (large versus small firms or specific sectors. This problem was clearly corroborated by the different outcomes for the restricted models.

The results of the conventional model show that innovation and highly qualified human resources would be a method to reach the international standards of the world market and therefore it is necessary to compete in export markets. We situated the results of the conventional model in the existing literature and found that they are very similar to those of other studies and, and more important, it seems that the existing differences could be interpreted. So our data set does not generate ad hoc results. This is important to ensure the credibility of our alternative models that colour the results of the mainstream literature.

This alternative model shows -with a better goodness of fit than the conventional one-, on the one hand, a non-linear effect in the form of an inverted "U" between the innovative efforts and export probability. That is,. the least innovative firms and the most innovative ones have the lowest export probability while the firms with an intermediate innovative level have the highest export probability. This relationship is reflected by the number of engineers by total employment, the number of new products and by the expenditures in machinery and equipment[32]. On the other hand, the model defined a linear negative effect for two variables (product diversification and the percentage of sales related to improved products) on export probability. So the firms most specialised in only one or a few products (percentage of sales related to the main product) are more competitive on the world market than the firms with a broad range of products.

Our final conclusion is that the innovative activities are related to export probability in a non-linear way. We admit that the interpretations for the non-linear relationship presented in this paper are theoretical and abstract explanations and our data set does not allow us to confirm them. However, the conventional studies did not justify the linear relationship either. This means that the relationship between innovation and international trade has to be analysed more broadly.

[32] In this defintion we do not include the relationship in form of a normal "U" for R&D expenditures because this variable is only statistically significant in three of the fourteen restricted models.

REFERENCES

Abbas, A. y Swiercz, P.M. (1991) "Firm size and export behavior: lessons from the Midwest". *Journal of Small Business Management,* pp.71-78.

Aitken, B., Gordon, H.H. y Harrison, A.E. (1997). "Spillovers, foreign investment and export behavior". *Journal of International Economics.* 43, pp. 103-132.

Basile, R. (2001) "Export behaviour of Italian manufacturing firms over the nineties: the role of innovation". *Resarch Policy* 30, pp.1185-1201.

Becchetti, L.y Rossi, S. (1998). "The positive effects of industrial district on the export performance of Italian firms". *Luiss Working Paper*, No. 54.

Benavente, J.M. (2002): "Determinants of Industrial Research and Innovation: The case of Chile ", unpublished DPhil Thesis, University of Oxford.
Benavente, J.M. and G. Crespi (1999): "Informe Final. Encuesta sobre la Innovacion Tecnologica en la Industria Manufacturera Chilena", manuscript, University of Chile.

Bernard, A. y Wagner, J. (1997) "Exports and success in German manufacturing. *Weltwirtschaftliches Archiv* 133, pp. 134-57.

Bernard, A.B. y Jensen, J.B. (1995) "Exporters, jobs and wages in U.S. Manufacturing, 1976-1987". *Booking papers on Economic Activity, Microeconomics.* Washington, D.C.

Bernard, A.B. y Jensen, J.B. (1997a) "Exporters, Skill-Upgrading, and the Wage Gap". *Journal of International Economics.* (42) pp. 3-31.

Bernard, A.B. y Jensen, J.B. (1997b) "Why some firms export: experience, entry costs, spillovers and subsidies". Mimeo. Yale.

Bernard, A.B. y Jensen, J.B. (1997c) "Inside the U.S. Export Boom". *National Bureau of Economic Research Working Paper* No. 6438.

Bernard, A.B. y Jensen, J.B. (1999). "Exceptional exporter performance: cause, effect or both?" *Journal of International Economics.* (47) pp. 1-25.

Bernard, A.B., Wagner, J. y Jensen, J.B. (1997) "The good go abroad" in *The Evolutions of Firms and Industries*. Seppo Laarsonen, Ed. Statistics Finland. Helsinki.

Bonaccorsi, A. (1992). "On the relationship between firm size and export intensity. *Journal of International Business Studies* 23, 605-35.

Buck, T., Filatotchev, I., Demina, N. y Wright, M. (2000). "Exporting Activities in Transitional Economies: An Enterprise-Level Study". *The Journal of Development Studies* 37 (2); pp. 44-66.

Calvo, J.L. (2003) "The Export Activity of Spanish Manufacturing Firms: Does Innovation Matter?". *23th Congress of the European Regional Science Associaton.* Jyväskyla, Finland. Agosto.

Estrada, S. (1997) "Vínculos entre la Universidad Autónoma Metropolitana y la Industria en Materia de Ingeniería Ambiental". Tesis de Maestría en Economía y Gestión del Cambio Tecnológico. Universidad Autónoma Metropolitana. Unidad Xochimilco.

Estrada, S. (2002) *Factores explicativos de la conducta exportadora: evidencia empírica del caso mexicano.* Memoria de Investigación. Diploma de Estudios Avanzados. Doctorado Interuniversitario en Economía y Gestión de la Innovación y Política Tecnológica. Universidad Autónoma de Madrid. Madrid.

Estrada, S. y Heijs (2003) *Innovación tecnológica y competitividad: Análisis microeconómico de la conducta exportadora en México.* Documento de trabajo, nº 36. Instituto de Análisis Industrial y Financiero. Universidad Complutense de Madrid.. Madrid. (http://www.ucm.es/bucm/cce/iaif).

Hirsch, S., Bijaoui, I. (1985) "R&D intensity and export performance: a micro view". *Weltwirtschaftliches Archiv.* 121, 138-251.

INEGI- CONACYT (1994, 1996, 1998, 2000) *Encuesta de Investigación y Desarrollo Experimental (ESIDE).* Instituto Nacional de Estadística Geografía e Informática. México.

Ito, K., Pucik, V. (1993) "R&D spending, domestic competition and export performance of Japanese manufacturing firms. *Strategic Management Journal*. 14, 61-75.

Johanson, J. y Vahlne, J.E. (1977) "The Internationalization Process of the Firm: A Model of Knowledge Development and Increasing Foreign Markets Commitments". *Journal of International Business*. 8 (1), pp. 23-32.

Katz, J. (1984). "Domestic Technological Innovations and Dynamic Comparative Advantage: Further Reflexions on a Comparative Case-Study Program". *Journal of Development Studies.* 16 (1-2), pp. 13-38.

Katz, J. (1987). *Technology Generation in Latin America Manufacturing Industries.* Macmillan. London.

Katz, J. y Stumpo, G. (2001). "Regímenes competitivos sectoriales, productividad y competitividad internacional. *Serie Desarrollo Productivo*. No. 103. Red de Reestructuración y Competitividad. CEPAL.

Kirpalani, V.H., MacIntosh, N.B. (1980) "International Marketing effectiveness of technology-oriented small firms.

Journal of International Business Studies. 11, pp. 81-90.
Kumar, N. Siddhartan, N.S. (1994). "Technology, firm size and export behaviour in developing countries: the case of Indian enterprise". *Journal of Development Studies* 32 (2), pp. 288-309.
Lal, K. (2003). "E-Business and Export Behavior: Evidence from Indian Firms". *World Development.* 32 (3), pp. 505-517.
Lall, S. (2000). "The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-1998". *Queen Elizabeth House, University of Oxford Working Paper Series.* No.44.
Lefebvre, É, Lefebvre, L.A. y Bourgault, M. (1998) "R&D-related capabilities as determinants of export performance. *Small Business Economics.* 10, pp. 365-377.
Lefebvre, É, Lefebvre, L.A. y Bourgault, M. (1998) "R&D-related capabilities as determinants of export performance. *Small Business Economics* 10, 365-377.
Nassimbeni, G. (2001) "Technology, innovation capacity, and the export attitude of small manufacturing firms: a logit/tobit model". *Research Policy* 30, 245-62.
Obben, J. y Magagula, P. (2003). "Firm and managerial determinants of the export propensity of small and medium-sized enterprises in Swaziland. *International Small Business Journal*. 21 (1), pp. 73-91.
Özçelik, E.; Taymaz, E. (2004) "Does innovativeness matter for international competitiveness in developing countries? The case of Turkish manufacturing industries". *Research Policy*. 33 (3), pp. 409-24.
Patibandla, M.(1995). "Firm Size and Export Behaviour: An Indian Case Study". *The Journal of Development Studies.* 31 (6), pp.868-82.
Pavitt, K. (1984) "Sectoral patterns of technological change: towards a taxonomy and a theory". *Research Policy* 13, pp. 343-474.
Ramstetter, E.D. (1999). "Trade propensities and foreign ownership shares in Indonesian manufacturing". *Bulletin of Indonesian Economic Studies.* 35.
Rankin, N. (2001) "The Export Behaviour of South African Manufacturing Firms".*Trade and Industrial Policy Strategies 2001 Annual Forum.* Misty Hills, Muldersdrift. Johannesbourg, South Africa. Septiembre 10-12.
Raut, L.K.(2003). "R&D Activities and Export Performance of Indian Private Firms". Department of Economics. California State University at Fullerton. Mimeo.24pp.
Reid, S.D. (1982) "The Impact of size on export behaviour in small firms" en Czinkota, M.R., Tesar, G. (eds.) *Export Management: An International Context*, Praeger, N.Y. pp. 18-38.
Roberts, M.J. y Tybout, J.R. (1997) "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs". *The American Economic Review*, 87 (4) pp. 545-64.
Roper, S. y Love, J.H. (2001) "The Determinants of Export Performance: Panel Data Evidence for Irish Manufacturing Plants". *NIERC Working Paper Series.* No. 69.
Roper, S. y Love, J.H. (2002) "Innovation and export performance: evidence from the UK and German manufacturing plants" *Research Policy* 31, 1087-1102.
Sjöholm, F. (1999). "Do Foreign Contacts Enable Firms to Become Exporters?".Stockholm School of Economics, Sweden. Mimeo.26 pp.
Smith, V., Madsen, E.S. and Dilling-Hansen, M.(2002) "Export Performance and Investment in R&D". *The Danish Institute for Studies in Research and Research Policy Working Papers.* No. 2002/4.
Söderbom, M. y Teal, F. (2000) "Skills, investment and exports from manufacturing firms in Africa". The *Journal of Development Studies* 37 (2), 13-43.
Soete, L. (1981). "A General Test of Technological Gap Trade Theory". *Weltwirtschaftsliches Archiv*. 117, pp. 638-59.
Sterlacchini, A. (1999) "Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance". *Research Policy* 28, pp. 819-832.
Unger, K. (2001a). "La globalización del sistema innovativo mexicano", en Dutrénit, G. Garrido, C. y Valenti, G. (eds.) *Sistema Nacional de Innovación Tecnológica. Temas para el Debate en México.* Universidad Autónoma Metropolitana. México. Pp. 213-26.
Ursic, M.L., Czinkota, M.R. (1984) "An experience curve explanation of export expansion", *Journal of Business Research* 12, pp.159-168.
Van Dijk, M. (2002) "The Determinants of Export Performance in Developing Countries: The Case of Indonesian Manufacturing". *Eindhoven Centre for Innovation Studies Working Paper*. No. 02.01.
Venables, A. J. (1996) "Trade policy, cumulative causation and industrial development". *Journal of Development Economics*. 49, pp.179-98.
Wagner, J.(1995)"Exports, firm size and firm dynamics". *Small Business Economics* 7, 29-39.
Wagner, J. (2001). "A Note on the Firm Size Export Relationship". *Small Business Economics.* 17, pp. 229-37.
Wakelin, K. (1997) *Trade and Innovation*. *Theory and Evidence*. Cheltenham, Edward Elgar.
Wakelin, K. (1998) "Innovation and export behaviour at the firm level"*Research Policy* 26, 829-841.

Welch, L.S., Wiedersheim-Paul, F. (1980) "Initial exports –a marketing failure? *Journal of Management Studies* 17, pp.334-344.
Wignaraja, G. (2001) "Firm size, technological capabilities and market-oriented policies in Mauritius". *UNU/INTECH Discussion Paper Series.* No. 2001-1.
Willmore, L. (1992). "Transnationals and foreign trade: evidence from Brazil". *Journal of Development Studies* 28 (2), pp. 314-335.
Zeufack, A. (2001). "Export Performance in Africa and Asia's Manufacturing: Evidence from Firm-level Data". *Journal of African Economies*. 10 (3), pp. 258-81.
Zhao, H. y Li, H. (1997). "R&D and Exports: An Empirical Analysis of Chinese Manufacturing Firms". *The Journal of High Technology Management Research* 8 (1), pp. 89-105.
Zhao, H. y Zou, S. (2002). "The Impact of Industry Concentration and Firm Location on Export Propensity and Intensity: An Empirical Analysis of Chinese Manufacturing Firms". *Journal of International Marketing*. 10 (1), pp. 52–71.
Aitken, B., Gordon, H.H. y Harrison, A.E. (1997). "Spillovers, foreign investment and export behavior". *Journal of International Economics* 43, 103-132.

APPENDIX 1
TABLE 1.1. Revision of the e*mpirical results: DEVELOPED COUNTRIES*

VARIABLE	Indicators	Authors	Export Probability	Export Propensity
a) STRUCTURAL CHARACTERISTICS				
Size	Employment	Wagner (1995) [a]		+
		Bernard y Wagner (1997)	+	
		Wakelin (1998)	+	+
		Bernard y Jensen (1999)	+	
		Sterlacchini (1999) [a]		NS
		Basile (2001)[b]	NS + +	NS NS +
		Barrios et.al.(2001)	+	+
		Lefebvre y Lefebvre (2001)[c]	+ +	+ +
		Roper y Love (2001) [a]		+
		Wagner (2001)[d]		+
		Roper y Love (2002)[e]	+ +	NS NS
		Smith et.al. (2002)	+	+
		Calvo (2003)	+	+
	Squared Employment	Wagner (1995)		-
		Bernard y Wagner (1997)	-	
		Wakelin (1998)	-	-
		Wagner (2001)		-
		Barrios et.al.(2001)	-	-
		Roper y Love (2001)		-
		Roper y Love (2002)	- -	NS NS
		Smith et.al.(2002)	-	-
		Calvo (2003)	NS	-
	Sales	Hirsch y Bijaoui (1985)		+
		Bonaccorsi (1992)		+
		Ito y Pucik (1993) [f]		+
		Wagner (1995)		+
		Bernard y Wagner (1997)	+	
		Sterlacchini (1999)		+
		Nassimbeni (2001)	+	
	Squared Sales	Sterlacchini (1999)		-
		Nassimbeni (2001)	-	
Age of the firm	Age	**Kirpalani y MacIntosh (1980)**		-
		Welch y Wiedersheim-Paul (1980)		+
		Ong y Pearson (1982)		NS
		Reid (1982)		NS
		Ursic y Czinkota (1984)	+	-
		Abbas y Swiercz (1991)	+ +	+
		Barrios et.al. (2001)	NS	+ +
		Lefebvre y Lefebvre (2001)		-
		Nassimbeni (2001)	NS	
		Roper y Love (2001)	+	NS
		Smith et.al. (2002)		
		Calvo (2003)		
	Squared Age	**Barrios et.al. (2001)**	-	-
		Smith et.al. (2002)	NS	
Property	Subsidiary of a group of firms	Basile (2001)	+ + NS	NS NS +
		Sterlacchini (1999)		NS
		Barrios et.al. (2001)	+	+
		Roper y Love (2002)	NS NS	+ +
	Participation of foreign capital	Roper y Love (2001)		+
		Calvo (2003)	+	+

[a] Tobit Model
[b] Each symbol is a different year (1991, 1994 and 1997).
[c] Each symbol is a different year (1991 and 1997).
[d] Linear Model with a LOGIT function (Papke y Woolridge 1996).
[e] Great Britain and Germany.
[f] Ordinary Minimum Square Regression Model

b) ACQUISITION OF TECHNOLOGY				
Technology	Capital intensity.	Wakelin (1998)	+	+
		Smith et.al.(2002)	+	+
	Technological level of the stock of capital (Distance from the maximum level of automation).	Sterlacchinni (1999)		NS
	Level of automation.	Lefebvre y Lefebvre (2001)	+ +	+ +
	Investment in capital for innovative activities	**Sterlacchini (1999)**		NS
	Investment strategies:			
	Development of new products.	Basile (2001)	+ + +	NS NS NS
	Downsize of employment.	Basile (2001)	+ + NS	NS NS NS
	Use of advanced manufacturing technologies.	Mechling et al. (1995)		+
		Wagner (1995)		+
	Modernisation of equipment and machinery (age; vintage model).	Lefebvre y Lefebvre (2001)	NS NS	NS NS
	Improvement of generic technologies	Lefebvre y Lefebvre (2001)	+ +	+ +
External relationships of networks	**External co-operation for R&D.**	Lefebvre et al. (1998)		+
	Participation in external R&D laboratories	Beccheti y Rossi (1998)	+	+
	Commercial agreements and strategic alliances.	Lefebvre y Lefebvre (2001)	+ +	+ +
		Nassimbeni (2001)	+	+
	Participation in joint ventures (acquirements, technological developments marketing or sales)	Nassimbeni (2001)	NS	NS
		Bernard y Wagner (1997)	+	
	Contracting foreign Services.	Bernard y Jensen (1999)	+	
	Previous export Experience (proxy for the costs of the development of commercial networks).			
c) TECHNOLOGICAL EFFORT				
R&D efforts; expenditures	Intensity R&D expenditures	Ong y Pearson (1984)		+
		Ito y Pucik (1993)		NS
		Braunerhjelm (1996)		+
		Beccheti y Rossi (1998)	NS	NS
		Lefebvre et al. (1998)		NS
		Barrios et.al.(2001)	+	+
		Wagner (2001)		+
		Smith et.al. (2002)		+
	Informal R&D activities	Calvo (2003)	NS	NS
	Formal R&D activities	**Roper y Love(2001)**		+
	Internal R&D activities.	**Roper y Love (2002)**	- +	+ NS
		Lefebvre y Lefebvre (2001)	+ +	+ +
		Roper y Love (2001)		+
		Roper y Love (2002)	NS +	+ NS
	Product oriented R&D strategies.	Smith et.al. (2002)	+	
	Process oriented R&D strategies.	Basile (2001)	+ + +	NS + +
		Basile (2001)	+ + +	NS NS +
Human capital	Employment in R&D.	Hirsch y Bijaoui (1985)		+
	Investment in formation.	Braunerhjelm (1996)		+
	Employment with a scientific or technical training.	Lefebvre et.al.(1998)		+
		Barrios et.al.(2001)	+	+
	Intensity of the technical knowledge (no. of engineers, scientists or technicians	Lefebvre y Lefebvre (2001)	+ +	+ +
	Employment with university degree.	Roper y Love (2001)		+
		Roper y Love (2002)	+ -	+ -
	Level of qualification (average salary).	Wagner (1995)		+
		Wakelin (1998)	+	+
		Bernard y Jensen (1999)	+	
		Wagner (2001)		+
		Smith et.al. (2002)	+	+
Innovative activities different from R&D	Innovative activities different from R&D [33]	Sterlacchini (1999)		+
	Innovative capacity (improvement of design materials or functional nature).	Nassimbeni (2001)	+	+

[33] Investment in design, engineering and "preproduction".

d) INNOVATIVE RESULTS				
Results of innovation	Innovative condition .	Enthorf y Pohlmeier (1990)		NS
		Wakelin (1998)	-	+
		Sterlacchinni (1999)		NS
	Introduction of new or improved product	Roper y Love (2002)	+	NS
	Process innovation.	Calvo (2003)	NS	+
	Innovative intensity (no. Of product changes by employee).	Roper y Love (2002)	NS	NS
	Number of innovations .	Wakelin (1998)	+	NS
	Number of product innovations.	Calvo (2003)	+	+
	Investment in innovation (next 5 years).	Nassimbeni (2001)	NS	NS
	Commercial impact (% of sales related to new products).	Roper y Love (2002)	NS –	+ NS
	No. Of patents.	Moini (1995)	+	
	Brandmarks or patents.	Lefebvre y Lefebvre (2001)	+ +	+ +
Diversification	Range of products or product lines	Lefebvre y Lefebvre (2001)	+ NS	+ -
	Production of small number	Roper y Love (2001)		+
	Production of large number	Roper y Love (2001)		NS
	Standardisation.	Calvo (2003)	+	NS
	Diversification strategy	Namiki (1988)		+
e) SECTORAL PATTERNS OF INNOVATION				
Technological sectoral taxonomy	Dominated by providers	Basile (2001)	+ + +	+ + +
	Specialised providers		+ + +	+ + +
	Scale intensive		NS + NS	+ + NS
	Science base (reference category).			

Source: Own elaboration

TABLE 1.2. Revision of the e*mpirical results: DEVELOPING COUNTRIES*

VARIABLE	Indicators	Authors	Export Probability	Export Propensity
a) STRUCTURAL CHARACTERISTICS				
Size	Employment	Willmore (1992)	+	-
		Aitken et.al. (1997)	+	
		Zhao y Li(1997)	+	+
		Sjöholm (1999)	+	
		Buck et.al. (2000)	+	
		Söderbom y Teal (2000)	+	
		Obben y Magagula(2001)[a]		+
		Rankin (2001)	+	
		Wignaraja (2001)[b]		NS
		Van Dijk (2002)[c]		+
		Zeufack(2002)	+	
	Squared Employment	Willmore (1992)	-	+
		Van Dijk (2002)		-
	Sales	Kumar y Siddhartan (1994) [a]		+
		Patibandla (1995) [b]		-
		Obben y Magagula (2001)	NS	NS
		Lal (2003) [a]		NS
	Squared sales	Kumar y Siddhartan (1994)		-
		Patibandla (1995)		+
	Sales/Employment	Zhao y Zou (2002)	+	
	Fixed capital	Raut (2003)[d]	NS	NS -
	Stock of capital	Roberts y Tybout (1997)	+	
Age	Age of the firm	Roberts y Tybout (1997)	+	
		Sjöholm (1999)	-	
		Söderbom y Teal (2000)	+	
		Obben y Magagula (2001)		NS
		Rankin (2001)	NS	
		Wignaraja (2001)		NS
		Van Dijk (2002)		-
		Zeufack (2002)		-
	Squared age	**Söderbom y Teal (2000)**	-	
		Obben y Magagula (2001)		NS
		Rankin (2001)	NS	
Property structure	Part of a group of firms or holding	Roberts y Tybout (1997)	+	
		Van Dijk (2002)		+
		Patibandla (1995)		+
	Participation of foreign capital	Willmore (1992)	+	+
		Kumar y Siddhartan (1994)		NS
		Aitken et.al. (1997)	+	
		Ramstetter (1999)		+
		Sjöholm (1999)	+	
		Rankin (2001)	NS	
		Wignaraja (2001)		+
		Van Dijk (2002)		+
		Zeufack (2002)		+
		Özçelik y Taymaz (2004)	+	+

[a] Tobit regression
[b] Ordinary Minimum Square Regression Model.
[c] Linear Model with a LOGIT function (Papke y Woolridge 1996).
[d] Tobit model and Cragg model (Cragg 1971).

b) ACQUISITION OF TECHNOLOGY				
Technology	Average capital intensity.	Kumar y Siddhartan (1994)		NS
		Zhao y Li (1997)	-	NS
		Sjöholm (1999)	+	
		Söderbom y Teal (2000)	+	
		Rankin (2001)	NS	
		Van Dijk (2002)		+
		Zeufack (2002)		NS
		Zhao y Zou (2002)	-	-
	Import machinery and equipment	Özçelik y Taymaz (2004)	+	+
		Raut (2003)	+	+ -
	Licences or agreement to acquire "know how"	Özçelik y Taymaz (2004)	NS	NS
	Payments of royalties	Kumar y Siddhartan (1994)		NS
		Aitken et.al. (1997)	+	
External relations or networks	Technological collaborations	Lal (2003)		NS
	Import of intermediate products (as a proxy de foreign contacts)	Sjöholm (1999)	+	+
c) TECHNOLOGICAL EFFORTS				
R&D efforts: expenditures	R&D intensity of R&D expenditures	Willmore (1992)	NS	NS
		Zhao y Li (1997)		+
		Sjöholm (1999)	+	
		Raut (2003)	+	+ NS
		Özçelik y Taymaz (2004)		+
	Actividades intramuros de I+D.	Zhao y Li (1997)	+	
		Zhao y Zou (2002)	+	-
Human capital	Intensity of technological knowledge (no. Engineers and technicians).	Wignaraja (2001)		NS
		Özçelik y Taymaz (2004)	-	-
	Education level.	Sjöholm (1999)	+	
		Söderbom y Teal (2000)	NS	
	Qualification level (average salary).	Willmore (1992)	NS	-
		Aitken et.al. (1997)	+	
		Ramstetter (1999)		-
	Qualified employees.	Zeufack (2002)		NS
		Özçelik y Taymaz (2004)	NS	NS
	Experience level.	Zeufack (2002)		NS
		Lal (2003)		+
		Söderbom y Teal (2000)	NS	
	Training of staff	Obben y Magagula (2001)		NS
Innovative activities different from R&D	Expenditures in marketing.	Kumar y Siddhartan (1994)		+
		Patibandla (1995)		-
		Özçelik y Taymaz (2004)	-	-
	Expenditures in training.	Van Dijk (2002)		NS
d) INNOVATIVE RESULTS				
Innovative results	Innovative Condition .	Özçelik y Taymaz (2004)		+
	product Innovation.	Özçelik y Taymaz (2004)	NS	NS
	process Innovation.	Özçelik y Taymaz (2004)	+	+
	Technological Competencies (indicator that measures the improvement de products and processes collaboration and investment in new equipment).	Wignaraja (2001)		+
Diversification				
e) SECTORAL PATTERNS OF INNOVATION				
Sectoral patterns of innovation	Technological level of the industry (low, medium and high tech sectors).	Zhao y Li (1997)	+	

Source: Own elaboration

ÚLTIMOS TÍTULOS PUBLICADOS

25.- *Justificación de la política de innovación desde un enfoque teórico y metodológico.* Joost Heijs (2001).

26.- *Los sistemas nacionales de innovación: una revisión de la literatura.* Mikel Navarro (2001).

27.- *El análisis y la política de clusters.* Mikel Navarro (2001).

28.- *Los sistemas regionales de innovación del País Vasco y Navarra*. Mikel Buesa (2001).

29.- *Centralisation or dispersion?: a spatial analysis of the impact of the single market programme on the activity of us manufacturing affiliates.* Andrew Mold (2001)

30.- *El sistema regional de innovación de la Comunidad de Madrid*. Mikel Buesa (2002).

31.- *Economía de la secesión: Los costes de la 'No-España' en el País Vasco*. Mikel Buesa (2002).

32.- *The spanish public financial support accesible for small and medium sized firms: organisations, programes, instruments and measures*. Joost Heijs (2002).

33.- *Los determinantes de la capacidad innovadora regional: una aproximación econométrica al caso español. Recopilación de estudios y primeros resultados.* Thomas Baumert y Joost Heijs (2002).

34.- *Recursos y resultados de los sistemas de innovación: elaboración de una tipología de sistemas regionales de innovación en España.* Mónica Martínez Pellitero (2002).

35.- *Medida de la capacidad innovadora de las Comunidades Autónomas: construcción de un índice regional de innovación.* Mónica Martínez Pellitero y Thomas Baumert (2003)

36.- *Innovación tecnológica y competitividad: análisis microeconómico de la conducta exportadora en México.* Salvador Estrada y Joost Heijs (2003).

37.- *Indicadores de la sociedad de la información en España.* Salvador Estrada (2003)

38.-*Los centros tecnológicos y el sistema regional de innovación. El caso del País Vasco.* Mikel Navarro Arancegui y Arantza Zubiaurre Goena (2003).

39.- *Ciencia y Tecnología en la España democrática: la formación de un sistema nacional de innovación*. Mikel Buesa (2003).

40.- *Las empresas del País Vasco ante la secesión* Mikel Buesa, Joost Heijs, Thomas Baumert y Mónica Martínez Pellitero (2003)

41.- *Difusión y adicionalidad de las ayudas públicas a la innovación: una estimación basada en "propensity score matching".* Liliana Herrera y Joost Heijs (2004).

42.- *Relaciones e interacción entre los agentes del sistema nacional de innovación de España: resultados de la encuesta-IAIF/FECYT.* Joost Heijs, Andrés Fernández Díaz, Patricia Valadez y Alicia Coronil (2004).

43.- *Evaluación de la efectividad de la política de cooperación en la innovación.* Joost Heijs, Andrés Fernández Díaz, Patricia Valadez y Alicia Coronil (2004).

44.- *Patrones regionales de uso y consumo de TIC´S: hacia un índice regional de la Sociedad de la Información. Salvador Estrada* (2004). (Disponible en ingles)

45.- *Configuración estructural y capacidad de producción de conocimientos en los sistemas regionales de innovación: Un estudio del caso español.* Mikel Buesa, Joost Heijs, Mónica Martínez Pellitero y Thomas Baumert (2004). (Disponible en íngles)

46.- *The distribution of R&D subsidies and its effect on the final outcome of innovation policy.* Joost Heijs and Liliana Herrera (2004).

47.- *El papel de las empresas extranjeras en el desarrollo tecnológico de España*. Joost Heijs (2004).

48.- *Technological behaviour and export perfomance: a non linear relationship.* Salvador Estrada y Joost Heijs (2004).

49- *Unidad de mercado y secesión: el caso del país Vasco.* Mikel Buesa (2005).

50.- *Guerra y Terrorismo: El modelo de economía depredadora de la guerra*. Mikel Buesa (2005).

Normas de edición para el envío de trabajos:

Texto: Word para Windows
Tipo de letra del texto: Times New Roman 12 Normal
Espaciado interlineal: Sencillo
Tipo de letra de las notas de pie de página: Times New Roman 10 Normal
Numeración de páginas: Inferior centro
Cuadros y gráficos a gusto del autor indicando programas utilizados
En la página 1, dentro de un recuadro sencillo, debe figurar el título (en negrilla y mayúsculas), autor (en negrilla y mayúsculas) e institución a la que pertenece el autor (en letra normal y minúsculas)
En la primera página del trabajo, se deberá incluir un *Resumen* en español e inglés (15 líneas máximo), acompañado de *palabras clave*

Los trabajos habrán de ser enviados en papel y en soporte magnético a la dirección del Instituto de Análisis Industrial y Financiero.