The Export Activity of Spanish Manufacturing Firms: Does Innovation Matter?.

José L. Calvo
jcalvo@cee.uned.es

Abstract.

The article analyses the export behaviour of a sample of Spanish manufacturing firms for the year 2000, estimating which factors affect that behaviour, and, above all, the influence of firm's innovation activities. For doing that, it begins testing if its better to use a Tobit specification for the model rather than, following Wakelin's methodological approach, to estimate a Probit model for the decision of participating or not in foreign markets and, afterwards, estimate a Truncated model for the export propensity of firms. The results show that variables influencing the decision of participate in foreign markets are different from those that affect export propensity, rejecting the Tobit model, and show that size, age and innovation activity affect the export decision, but export propensity is independent of firm size and its innovative attitude. At the same time, been participated by foreign capital positively influences both decisions.

Introduction.

Export activity has been usually considered as an indicator of competitiveness and the ability to generate resources by firms. At the same time, technological innovation, involving the introduction of new products, the improvement of a firm's existing product range, or changes in the production process, play a key part in helping a firm to maintain or improve its market position. The relationship between innovation and export success has therefore attracted much attention in economic literature[1].

The initial controversy of the studies that make firms' exports depend on a set of variables focuses its attention on knowing if these firms use an unique decision model to establish the volume of their exports[2] or, on the contrary, if the decision process is double: first the company chooses to take or not part in international markets and, once it has decided to participate, it establishes the volume of its production that it is going to be exported[3]. The usual translation of this discussion in econometric terms consists in estimating a Tobit model with all the companies for the first case, and test it against a model of discrete election (Logit or Probit) for the first one of the decisions, to export or not, and a Truncated model for the second one, the exported production.

The present study analyses the relationships between export activity and a set of variables that define the characteristics and the strategic behaviour of a sample of Spanish manufacturing firms for the year 2000. For doing that, a Tobit model is tested against a model that includes a Probit specification for the decision of export or not, and Least Squares for the exported volume. The data come from a sample of 1833 firms, and have been obtained from the *Firms Strategic Behaviour Survey (ESEE)*[4] elaborated by Fundación Empresa Pública for the Spanish Science and Technology Ministry.

Inside the explanatory variables included in the model, innovation, process or product, reaches a special importance, as it is notified by multiple economic studies that focus their attention on the relationship between export and innovation, establishing

[1] Wakelin (1998); Nassimbeni (2001); Basile (2001); Wagner (2001); Ruper & Love (2002); and others.
[2] An example is Wagner (2001).
[3] Wakelin (1998) is a very representative case.
[4] Encuesta sobre Estrategias Empresariales.

differences depending on firm's innovative attitude[5]. That is why, and additionally to its inclusion in the initial estimated models, separate equations have been estimated for innovators and non-innovators, testing if innovating firms follow a different behaviour from non-innovating ones.

The structure of the study implies that the first section discusses the model and the variables that are included in the equations to be estimated; the second section analyses the data; section three estimates the models that allow to explain exports, and test their validity and the significance of the variables; the fourth section estimates separates models for innovating and non-innovating firms; finally, the fifth section resumes the main conclusions of the study.

I. The model and the variables.

I.1. The model.

As it has been commented in the Introduction, the initial controversy of the studies that analyses the relationships between exports and a set of variables that reflect the behaviour and characteristics of firms consist in establishing if exports follow an unique decision model or, on the contrary, if firms first decide to participate or not in foreign markets and, afterwards, they choose the amount of their production to be sold abroad.

The authors that support the first option[6] argue that firm chooses the export production that maximizes profits, and this could be zero. Therefore, the decision process should be modelized as unique, implying that a model including all the firms, exporters and non-exporters, must be estimated. And, since the independent variable is usually export propensity (the percentage of the production directed to international markets) and this is, obviously, a truncated variable (it takes values from 0 to 100%), the best way to estimate the equation consist on using a Tobit model with the whole sample.

[5] Nassimbeni (2001); Wakelin (1998); Basile (2001); Roper and Love (2002);ó Sterlacchini (1999) son ejemplos recientes.
[6] Wagner (2001).

On the other side, other authors[7] suggest that firms decide their production volume *independently* of the markets to be sold. Only after the level of output has been selected firms choose between national or international markets, depending on which one reports higher profits. In fact, firms consider in a different way national and international markets because of the existence of specific costs related to the establishment in foreign markets. Those costs are sunk costs, since they have to be assumed even though firm fails to continue in the market[8].

If the assertions made on the previous paragraph are true, then the export activity of firms follows a double decision model: firms first decide if they export or not, what can be econometrically approached by a binomial model (Probit or Logit); and, as soon as they have decided to take part in foreign markets, they establish the volume of their exports, which forces to estimate a truncated model, since the dependent variable only is observed if it is bigger that zero (the export propensity is positive).

In fact, the assumption underlying this type of specification implies that the two stages are independent of each other, that is, the disturbances in the latent regression underlying the Probit model and those in the truncated regression are independent[9]. Additionally, the assumption of independence also implies that variables explaining one of the decisions do not have to influence the other one.

Consequently, it is possible to test the independence of the decisions of acceding or not to international markets and the exported volume of production comparing the results of a Tobit model, under the assumption of dependence and supposing that the same variables affect both decisions in the same way, with those of a Probit and a Truncated models, in which decisions are independent and the variables that explain one or another equation can differ.

[7] Wakelin (1998) or Basile (2001), for instance.
[8] Basile (2001); Bernard and Wagner (1998).
[9] Cragg (1971)

I.2. The variables.

There is an important microeconomic literature relating the export probability so much as the volume exported to some indicators on the characteristics and behaviour of firms. From the analysis of this literature and depending on the information facilitated by the data, the following variables have been included in the equations estimated in this study:

a. *Size*.- This is a variable incorporated in almost all the studies related to the export ability of firms[10]. It is included by two ways: in levels, and also as a quadratic term. The assumption underlying this kind of specification is that exports, the probability to export and the export intensity, increase with size to an optimum size level. Therefore, we should expect a positive sign for the first term (levels), and negative sign for the second one (quadratic variable).
   In this study firm size is approached by the number of employees (PERTOT).

b. *Age*.- There are no assumptions made about the effects of this variable on exports, although firms age has frequently been incorporated to estimated equations. Some studies have failed to come up with any correlation[11]; others have verified a positive relationship[12]; while still more have confirmed a negative one[13]". The variable it will be used is AGE, defined as the difference between the year the firm was born up and 2000.

c. *Standardised Product*.- The sign of this variable is not determined, since some authors[14] point out how "client tailored" product specification policies represent quite an advantage, but, on the other hand, standardised products enable scale economies and cost advantages[15], improving competitiveness.
   The variable employed in the study is EP, a dummy variable taking the value 1 if the firm produces a standardised good and 0 otherwise.

[10] Wakelin (1998); Nassimbeni (2001); Wagner (2001); Ruper & Love (2002), and for SME, Abbas & Swiercz (1991); Holzmuller & Kasper (1991); Bonaccorsi (1992); Calof (1994) or Ogbuehi & Longfellow (1994).
[11] Ong & Pearson (1982); Reid (1982), Nassimbeni (1999)
[12] Welch & Wiedersheim-Paul (1980); Abbas & Swiercz (1991); IKEI (1993).
[13] Kirpalani & MacIntosh (1980); Ursic & Czinkota (1984); Calvo (1996)
[14] Christensen et al. (1987); Nassimbeni (2001).
[15] IKEI (1993); Alonso & Donoso (1993); Fernández & Casado (1994); Nassimbeni (1999).

d. *Being part of a business group (foreign capital share)*.- Firms belonging to a business group are expected to be more likely to export, since the group allows firms to overcome the problem of lacking resources necessary to export, such as finance, physical or human capital[16]. Moreover, if business group is international, the firm could easier surpass the barriers early mentioned, as it is shown in different studies for the Spanish case[17].

   KEXT is the variable used in this article, defined as the percentage of foreign capital in firm's total resources. The expected sign is positive.

e. *Geographical location and technological development of the region*.- A variable defining the geographical location of firms has been employed in some studies related to export capacity, but the conclusions on its effects diverge. Some authors[18] find that firms located in regions with high technological development have smaller export probability and propensity since "…high levels of innovative activity tend to be associated with higher regional incomes, and greater local demand in these areas may be reducing the need for local firms to export". On the other side, it can be argued that technologically developed regions increase both the probability and the propensity to export because of spill-overs.

   The variable selected in this article in order to distinguish Spanish regions with high technical capacity from other regions is CCAAHT. It takes the value 1 if the firm is located in Madrid, Catalonia or the Basque Country, and 0 otherwise.

f. *R&D Activities*.- There is not unanimity on the sign of the relationship between R&D activities and exports. In some studies a positive relationship is established between the probability of exporting or the volume of the production sold in international markets and the research activity[19]; others find a negative one[20]; and others, finally, are not able of establishing any significant relationship[21].

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[16] Roper & Love (2002); Basile (2001).
[17] IKEI (1993); Fernández & Casado (1994); Calvo (1996).
[18] Roper & Love (2002).
[19] IKEI (1993); Calvo (1996) for the export probability; Kumar y Siddharthan (1994); Hirsch & Bijaoui (1985); Ito & Pucik (1993).
[20] Calvo (1996) for the export intensity.
[21] Lefebvre et al (1998); Willmore (1992).

Three variables has been defined in order to approach firms R&D activities: GTIDV, R&D intensity measured as the percentage of resources dedicated to research; IDPER, R&D employees; and AIDAUX, dummy variable taking the value 1 if the firm develops R&D complementary activities[22].

g. *Innovation.*- Innovation, process or product, is one of the most important variables incorporated to export behaviour analysis, but again, the conclusions about its influence diverge. In general, product innovation positively affects the probability of export[23] and export intensity[24], since it can be supposed that new products increase competitiveness and open new markets. Nevertheless, this assumption is not sustained by other authors[25] reaching the conclusion that small innovating firms concentrate on local markets, been negative the innovation effect on export probability. On the other side, process innovation obtains unlike results: in some cases there is not relationship to export probability[26], or a positive effect is found on the probability and the propensity[27].

   Two variables have been used in order to represent innovation capacity of firms: INPRC is a dummy variable that values 1 if the firm has introduced process innovations in 1998, 1999 or 2000; and NINPRO is the number of product innovation introduced by the firm in that period of time.

Then, the model that will be estimated in the article can be defined as:

$$DEXP=\alpha_0 + \alpha_1 PERTOT + \alpha_2 PERTOT^2 + \alpha_3 AGE + \alpha_4 KEXT + \alpha_5 EP + \alpha_6 CCAAHT + \alpha_7 GTIDV + \alpha_8 IDPER + \alpha_9 AIDAUX + \alpha_{10} INPRC + \alpha_{11} NINPRO + \mu$$

$$PEXP=\beta_0 + \beta_1 PERTOT + \beta_2 PERTOT^2 + \beta_3 AGE + \beta_4 KEXT + \beta_5 EP + \beta_6 CCAAHT + \beta_7 GTIDV + \beta_8 IDPER + \beta_9 AIDAUX + \beta_{10} INPRC + \beta_{11} NINPRO + \mu$$

[22] R&D complementary activities are: Scientific and Technical Information Services; Quality Control Services; Efforts for Adapting Imported Technologies; Market Studies and Marketing of New Products; Design. The variable values 1 if the firm has developed any of these activities in 1998, 1999 or 2000.
[23] Nassimbeni (2001); Basile (2001); Wakelin (1998); Roper & Love (2002) in Germany and United Kingdom.
[24] Basile (2001); Roper & Love (2002)
[25] Waklein (1998).
[26] Nassimbeni (2001).
[27] Basile (2001).

Where *DEXP* is a dummy variable valuing 1 if the firm is exporter and 0 if it does not sale in foreign markets. *PEXP* is export propensity, defined as the percentage of the production sold abroad. In order to test the models, they will estimated as follows: Tobit model estimates the last equation using the whole sample; in the double decision model the first equation is estimated with a Probit specification taking *DEXP* as the dependent variable and also employing all the sample; Least Squares are used for the second equation (*PEXP*) but only the subsample of exporters is selected.

II. The data.

The data used in the article come from the *Firms Strategic Behaviour Survey (ESEE)*. This is a survey of Spanish manufacturing firms that began in 1990 and is conducted annually for about 2000 firms. It includes a very complete questionnaire about each firm's structure and strategic decisions, producing a good insight into the Spanish manufacturing industry[28].

Once the data have been filtered, the sample is reduced to 1820 firms, having full information for the period 1998-2000. The selection of a three years period crucially depends on R&D and innovation variables, since it is supposed that R&D activities and innovation need a long period of time to reach any result[29]. The other variables (size, age,…) are referred to 2000.

In order to know if variables defined in the last section can be used to distinguish between exporters and those firms oriented to national markets, an ANOVA analysis is conducted for non-dummy variables of both samples. The results are included in Table 1.

[28] The methodology, questionnaire and general results of ESEE can be found in www.funep.es.
[29] The three years period is the assumption employed, for instance, in the *Firms Innovation Survey* made up by the Spanish Statistical National Institute, in which all the innovation references are related to a period of three years. See INE (2001).

As it can be seen, all the variables selected have a different behaviour depending on export activity. The average size is bigger for exporting firms (385 employees). The same happens with age, its average been10 years higher for exporters; and foreign capital share, 29% for exporters and 2,9% for non-exporting firms on average.

R&D and innovation variables also present an unlike behaviour depending on the export capacity of the firm: the average number of R&D personnel is almost 12 for exporting firms and it does not reach 1 (0,57) in non-exporting ones; and the number of product innovation introduced from 1998 to 2000 is, on average, 11 in the first group and it is less than 2 in the other subsample. Only the expenditure on R&D as a percentage of sales is not significantly different in both subsamples, although non-exporters R&D intensity is five times this of exporters.

On the other side, and related to dichotomous variables, Table 2 includes firms' distribution depending on been exporters or not and the selected variable.

As we can observe, the distribution of firms depending on selling or not abroad is very different for all variables, exception made of CCAAHT. For the rest of the variables so much the number as the percentage of firms that carry out complementary activities of R&D, innovate in process, or standardized the product, are significantly bigger for exporting businesses.

III. Estimation of the model.

The model to be estimated has been defined in the second section[30]. Tobit model is clearly rejected against Probit and Least Squares combination based on a Maximum Likelihood Test[31]. The estimated parameters of these two specifications are included in Table 3.

[30] Nineteen industry variables have also been included in all the equations, but Tables do not include their results. Complete results are upon request.

[31] The test is: $\chi(31) = -2[l^R - l^{NR}]$ where l^R is the log of the likelihood function from the Tobit model, and l^{NR} is the sum of the logs of the likelihood functions of Probit and Least Squares estimations. The value is 3997. 8.

It is evident that the variables affecting export decision are not the same as those establishing the export volume of Spanish manufacturing firms, what reinforces Tobit specification refusal. Thus, meanwhile the variables of size have the predicted effect and are significant for the probability to export, augmenting it to an optimum size, it does not occur the same with the export propensity, since they are not significant. Age and standardised product are also significant in the Probit model, revealing that older is the firm and more standardised be the product greater is the probability of export, but this is not true for Least Square specification. The only significant variable in both equations is foreign capital share, increasing so much the probability of export as export propensity.

R&D employees, but above all complementary activities of R&D, increase the probability of participate in foreign markets, but only complementary activities rise up the percentage of sales directed to those markets. R&D intensity does not affect to any decision.

Finally, innovation variables play a definitive role in both elections, though with different characteristics depending on the equation. Product innovation increases the export probability, where as process innovation do not have any effect on it. For the export propensity the situation is inverted, and now process innovation is significant, staying in a second level product innovation.

Consequently, we can affirm that there exists a defined profile of the Spanish exporter manufacturing firm: big in terms of size, reaching an ideal dimension; installed some time ago on the market; producing a standardized good; participated by foreign capital; developing R&D complementary activities; and introducing product innovation. On the contrary, the information adduced by the estimation leaves an image much more blurred of the characteristics that influence export propensity: we only can say that the bigger foreign capital participation; R&D complementary activities; and process innovation, the bigger the amount of the production dedicated to foreign markets.

IV. Export firms versus non-exporters.

We have seen in the last section that product innovation increases the probability of export meanwhile process innovation augments export propensity. An additional step can be taken in the study analysing how the model behaves depending on firms' innovating characteristics. Nevertheless, the estimated results show that the only interesting analysis consists on using product innovation as an argument to differentiate the election of participating or not in foreign markets (Probit model) and employ process innovation to establish the exported volume (Least Squares). The results are included in Tables 4 and 5.

Tables 4 and 5 have a double structure: in the upper side the estimators of separated equations from innovating and non-innovating firms are included, product innovators in Table 4 and process innovators in Table 5; in the lower side a Maximum Likelihood test is presented in order to decide if separated estimations improve the results[32], and Wald tests about equality of the estimated parameters in a joined estimation from innovating and non-innovating firms are also included.

The results of Table 4 show that innovation implies two different models of choosing to participate in foreign markets, as it can been seen by Maximum Likelihood test and Wald test for all variables. Moreover, size, age and foreign capital estimators are different depending on product innovating attitude of the firm.

On the contrary, that is not the case for export propensity, since Maximum Likelihood test and Wald tests for the estimators do not show any significant difference depending on process innovating capacities of firms.

[32] The value of the test is: $\chi^2 = -2[l^R - l^{NR}]$ been l^R the likelihood log from a joined estimation including all the variables by a double way: in its original form and also multiplied by a dummy variable that values 1 if it is an innovating firm and 0 otherwise. l^{NR} is th sum of the likelihood logs of separated estimations.

V. Conclusions

The probability that a Spanish manufacturing firm directs part of its production to foreign markets positively depends on the size of the firm, the time elapsed since its creation, foreign capital share, R&D activities, specially design, marketing, o the effort to assimilate external technology, and the number of product innovations introduced in the market.

On the other side, the data of the study do not allow us to have a clear image of the characteristics that delimit the exported volume by Spanish manufacturing firms adventuring in foreign markets, since we only can affirm that the export propensity increases with foreign capital participation; R&D complementary activities; and process innovation.

The special interest related to innovation variables and their role played in the estimated equations has stimulated to distinguish between innovative and not innovative firms, product innovation in the probability of export, and process innovation in the propensity to export. The results show how product innovation clearly separates the decision of selling abroad or not, whereas it can not be said the same for the relationship between process innovation and export intensity, since there has not been stated any significant difference depending on innovations in the productive process of firms.

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Table 1.- *ANOVA analysis. Exporters versus Non-exporters.*

VARIABLES	**Exporters** Mean	**Non-Exporters** Mean	F Statistics	Significant
KEXT	29.06	2.89	216.96	0.000
PERTOT	385.17	53.40	76.82	0.000
AGE	26.72	15.40	132.46	0.000
GTIDV	1.03	5.35	1.32	0.251
IDPER	11.92	0.40	14.93	0.000
NINPRO	11.26	1.71	16.67	0.000

Source: Drawn up by author.

Table 2.- *Firms' distribution. Exporters versus Non-exporters.*

	Exporters				***Non-exporters***			
Val***ue of the Variable***	1		0		1		0	
	Nº	%	Nº	%	Nº	%	Nº	%
EP	772	65.6	404	34.4	371	57.6	273	42.4
CCAAHT	599	50.9	577	49.1	267	41.5	377	58.5
AIDAUX	917	78.0	259	22.0	276	42.9	368	57.1
INPRC	733	62.3	443	37.7	270	41.9	374	58.1

Source: Drawn up by author.

Table 3.- *Estimation Results.*

	Probit	***Least Squares***
Constant	-0.670*** (2.97)	11.39** (2.25)
PERTOT	0.002** (7.12)	0.001 (0.67)
$PERTOT^2$	-2.23E-07*** (6.13)	4.15E-08 (0.23)
AGE	0.012*** (5.43)	-0.028 (0.79)
KEXT	0.009*** (6.39)	0.079*** (4.19)
EP	0.198** (2.41)	-2.74 (1.57)
CCAAHT	-0.043 (0.56)	-1.899 (1.17)
GTIDV	-0.001 (0.96)	0.326 (1.29)
IDPER	0.036*** (2.72)	-0.0001 (0.01)
AIDAUX	0.448*** (5.66)	5.145*** (2.64)
INPRC	0.114 (1.49)	3.900** (2.40)
NINPRO	0.001*** (2.98)	0.0217* (1.69)
Log. Likelihood	-828.7721	-5455.984
Adjusted R^2	-----	0.11
Industry variables test	χ^2= 76.88	χ^2= 83.81
Size variables test.	χ^2=52.01	χ^2=2.85
R&D variables test.	χ^2=43.00	χ^2=9.43
Number of observ.	1820 Observ. with Dep=1: 1176 Observ. with Dep=0: 644	1176

Source: Drawn up by the autor.

*** Significant at 99%
** Significant at 95%
* Significant at 90%

Table 4.- *Estimation Results for the Probit model. Product Innovators versus Non-innovators*[33].

	Innovators	***Non-innovators***
Constant	-0.148 (0.26)	-0.718*** (2.88)
PERTOT	0.002*** (3.17)	0.002*** (6.26)
$PERTOT^2$	-2.40E-07** (2.46)	-2.24E-07*** (5.68)
AGE	-0.010** (2.04)	0.014*** (5.48)
KEXT	0.009*** (2.71)	0.010*** (5.91)
EP	0.254 (1.25)	0.186** (1.99)
CCAAHT	-0.055 (0.30)	-0.057 (0.66)
GTIDV	-0.006 (0.27)	-0.001 (0.77)
IDPER	0.035 (1.59)	0.027 (1.36)
AIDAUX	0.018 (0.08)	0.488*** (5.52)
INPRC	0.018 (0.09)	0.085 (0.99)
Log. likelihood	-154.18	-653.17
Nº Observations	529	1291
Maximum Likelihood Test	40.67***	
Wald Tests		
All variables	χ^2= 48.84***	
Size	χ^2 = 6.67**	
Age	χ^2 = 4.43**	
Foreign capital	χ^2 = 4.45**	
Standardization	χ^2 = 0.292	
Geographical location	χ^2 = 2.13	
R&D	χ^2= 6.09	
Process Innovation	χ^2 = 0.95	

Source: Drawn up by the autor.

*** Significant at 99%
** Significant at 95%
* Significant at 90%

[33] Estimations include nineteen industrial dummies.

Table 5.- *Estimation Results for the Truncated Model. Process Innovators versus Non-innovators*[34].

	Innovators	***Non-innovators***
Constant	14.463* (1.78)	13870** (1.99)
PERTOT	0.0006 (0.30)	0.006 (0.90)
$PERTOT^2$	1.5E-07 (0.78)	-6.1E-07 (.35)
AGE	-0.042 (0.87)	-0.016 (0.28)
KEXT	0.072*** (3.12)	0.074** (2.22)
EP	-2.948 (1.34)	-3.467 (1.87)
CCAAHT	-2.819 (1.36)	-0.520 (0.19)
GTIDV	1.127*** (2.62)	-0.121 (0.39)
IDPER	-0.021 (1.25)	0.019 (0.48)
AIDAUX	2.524 (0.87)	7.127*** (2.57)
NINPRO	0.020 (1.33)	0.022 (0.88)
Log. Likelihood	3398.09	2038.54
Nº Observaciones	733	443
Maximum Likelihood Test	30.67*	
Wald tests		
All variables	$\chi^2 = 15.02$	
Size	$\chi^2=0.895$	
Age	$\chi^2=0.327$	
Foreign capital	$\chi^2=1.851$	
Standardization	$\chi^2=4.139$**	
Geographical location	$\chi^2=0.161$	
R&D	$\chi^2=4.436$	
Product innovation	$\chi^2=0.078$	

Source: Drawn up by the autor.

*** Significant at 99%
** Significant at 95%
* Significant at 90%

[34] The estimations include nineteen industrial variables.