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DETERMINANTS OF SPANISH MANUFACTURING EXPORTS TO THE EUROPEAN UNION: A PANEL DATA ANALYSIS*

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This paper analyses the factors determining the Spanish manufacturing exports to the European Union in the period 1986-89. Both traditional theory variables (price/cost and external demand) and industrial organization variables (vertical and horizontal product differentiation) are included in the study. Two improvements with respect to former Spanish empirical studies are the level of sectoral disaggregation and the use of instrumental variables methods and specification tests. The results of the estimations confirm the positive effect of external demand and product differentiation variables on exports and the different sensitivity of foreign sales to changes in prices (costs) depending on sectoral technological intensity.

1. Introduction

The aim of this paper is to analyse the determinants of Spanish exports of manufactured goods to other European Union countries from a sectoral perspective. This might facilitate the implementation of different industrial policies designed to increase the export capacity of the country and to yield improvements in the industry competitiveness through the use of mechanisms not based on price (cost) variables. It has been repeatedly pointed out that Spanish firms have usually considered the export activity as a way of selling products which have not been absorbed by the internal demand. This idea has been slowly changing throughout the long foreign opening process initiated (although with ups and downs) in 1959. However, the true change of attitude has been brought about with the Spanish adhesion to the EU in 1986.

Traditional studies of foreign trade make exports depend on relative prices (costs) and external demand. The Spanish empirical evidence in this field is relatively abundant (for instance, Bonilla, 1978; Mauleón, 1986; Fernández and Sebastián, 1989; Sebastián, 1991; Buisán and Gordo, 1993) and relies heavily on time series

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aggregate export and import functions. The development of the modern theories of international trade, in the seventies, produced a deep theoretical renovation that led to the introduction in the international trade analysis of industrial organization variables. In the last few years, Martín and Moreno (1991 and 1993), Myro (1992), Moreno (1994) and Gil and Mañez (1995)[1] have carried out interesting research that supplement the available empirical evidence by both including variables derived from industrial organization trade models and employing a panel data approach. On the one hand, the approach by these authors allows them to control the unobservable sectoral heterogeneity that stay constant through time. On the other, it allows them to analyse the influence of sectoral structural characteristics on the Spanish industrial exports.

In this context, our paper seeks to extend this line of research using a degree of sectoral disaggregation that is far superior to that of previous studies. Like Moreno (1994), we try to improve the econometric methodology by using instrumental variables methods and specification tests. In this sense, from the results of the specification tests carried out in this study shed considerable doubts on the consistency of Martín and Moreno (1991 and 1993), Myro (1992) and Gil and Mañez (1995) estimations.

This study allows us to confirm the different sensitivity of Spanish manufacturing exports to changes in competitiveness depending on the degree of technological intensity. In addition, it shows the importance of technological effort and advertising and publicity expenditures in conjunction with external demand and competitiveness indices in the explanation of the export behaviour.

The structure of the paper is as follows. Section 2 presents the empirical model and its theoretical underpinning. Section 3 shows the results for the different econometric specifications of the model as well as some industrial policy implications. Section 4 offers some concluding remarks. Appendix 1 includes the data sources and the construction of the variables. Finally, Appendix 2 shows the sectoral classification.

2. Empirical model and theoretical foundations

The traditional theory of international trade based on the comparative advantage principle associates foreign trade to differences in production costs and prices among countries. The main problem of this theory is its inability to explain certain empirical regularities observed in international trade such as the increasing significance of intraindustry trade, the predominance of trade among developed countries with fairly similar factor endowments and the non-completion of the expectations of specialization foreseen in the Customs Unions models.

As a result of the bad empirical performance and lack of realism of the traditional models, several alternative explanations of the exporting possibilities of a country have arisen since the 1960's. These are mainly based

[1] This paper analyses export behaviour of La Comunidad Valenciana to the European Union countries.

on technological advantages (Posner, 1961), on product life cycle (Vernon, 1966) or on similarities in per capita income and tastes among countries (Linder, 1961). However, it was in the 70's and 80's when the deep renovation of international trade theory took place. A body of literature that relates trade to certain advantages that firms exercise in international markets in an imperfect competition context has emerged. According to these theories, competitiveness depends not only on relative costs and prices but also on industrial organization variables such as horizontal and vertical product differentiation, industry concentration, scale economies, etc.

Therefore, in an attempt to identify the determinants of Spanish manufacturing exports to the EU, we try to overcome the limitations of the conventional theory by using an eclectic perspective that seeks to explain them by combining traditional theory variables, namely external demand and relative prices (costs), with some variables derived from the new theories. Thus, aside from the traditional explanatory factors we include two variables representing vertical and horizontal product differentiation.

In a context of imperfect competition, product differentiation may be an alternative way of competition different from price (cost) variables. As pointed out by Moreno (1994), the inclusion of product differentiation variables permits to analyse both their direct effect on the export pattern (if these variables are introduced additively in the export equation) and their possible effect on price (cost) elasticities (if they are introduced multiplicatively with the real effective exchange rate). In this paper we introduce product differentiation variables additively, even though price (cost) elasticities are estimated breaking down real effective exchange rates according to the sectoral technological intensity.

This eclectic viewpoint allows us to express the general empirical model as follows:

$$ln(x)_{it} = a\ ln(ED)_{it} + b\ ln(REER)_{it} + c\ ln(TE)_{it} + d\ ln(AP)_{it} + \alpha_i + v_{it} \quad [1]$$

where $i = 1.,....82$ is the three digit level sector of the NACE classification[2], and $t = 1986\text{-}1989$.

The definition and theoretical foundation of the variables included in [1] can be summarised as follows:

The dependent variable (X) represents the Spanish manufacturing exports to the EU (8)[3] in real terms.

The external demand (*ED*) is represented by the sectoral gross value added at factor costs of the EU(8) in real terms, and the expected sign of the income elasticity is positive.

The effect of price (cost) competitiveness is represented by the real effective exchange rate index (*REER*), (Banco de España, 1980). This indicator of competitiveness is built on the basis of two alternative specifications: one

[2] The list of sectors appears in Appendix 2.

[3] Namely, Germany, France, Italy, United Kingdom, Belgium, Holland, Luxembourg and Denmark. The others EU members (Ireland, Greece and Portugal) were not considered since data for some explanatory variables were not available.

using industrial price indices and the other employing unit labour costs. There are two main reasons for using both specifications. First, because the index that uses unit labour costs does not take into account the effect that variations in both non labour costs and firms' profits may have on the competitiveness. Second, because the imperfect competition assumption requires to consider price-cost margins different across sectors. From the definition of these indices (Appendix 1) it is easy to see that an increase in them implies a loss of competitiveness. Thus, it is expected that the relationship between real effective exchange rates and exports be negative.

The remaining explanatory factors considered in [1] are closely related to the industrial organization models. They find their theoretical underpinnings in the modern theories of international trade. Within the competition strategies not based on prices (costs), the product differentiation policies (either vertical or horizontal) are present in a great part of the literature on this topic, (for example: Pagaulatos and Sorensen, 1976; Krugman, 1980; Caves, 1981; Helpman, 1981; Greenaway and Milner, 1984; Porter, 1987).

In an attempt to pick up the effect on exports of vertical product differentiation we approximate this variable by the technological effort (*TE*)[4], defined as the ratio between R&D expenditures plus payments for technological imports and gross value added. There exists agreement in the literature about the fact that vertical product differentiation is an important potential source of competitive advantage in international markets. Therefore it is expected a direct relationship between exports and *TE*.

The horizontal product differentiation is approximated by the ratio of advertising and publicity expenditures to gross value added (*AP*). In this case, we do not have a prior expectation about the sign of the coefficient of this variable. If we consider advertising as a competitive strategy of the firm, a positive effect of advertising on exports should be expected. However, if as pointed out by Caves (1981) we consider that product differentiation by advertising is country specific, then since advertising messages themselves do not generally travel well across national boundaries, this kind of product differentiation should have a negative effect.

Finally, it is important to note that equation [1] incorporates a term (α_i) which represents the effect of time invariant specific sectoral characteristics on export behaviour. This term may include unobserved variables such as managerial efficiency, managerial market conception, workers' ability or sectoral technology which are very likely to be correlated with some explanatory variables and particularly with the competitiveness indices.

3. Empirical results and industrial policy implications

In an attempt to investigate the explanatory factors of Spanish exports of manufacturing goods to the EU(8), we have started estimating an export

[4] TE is not available for the level of sectoral disaggregation used in this study. We have overcome this problem assigning the same TE ratio to technologically homogeneous sectors.

equation that only includes *ED* and *REER* as independent variables. It is generally known that, in the presence of individual unobservable effects (α_i) which are correlated with the explanatory variables, the direct application of OLS will yield inconsistent parameter estimates.

The traditional technique to overcome this problem is the application of OLS to a transformation of the original data that allows to get rid of the effect of unobservable heterogeneity. If we assume that the individual effects stay constant through time, they can be eliminated by taking the first differences of individual observations over time. An alternative procedure consists in regressing the equation by OLS after transforming the variables in deviations from individual means (over time)[5]. In the presence of strictly exogenous regressors, these methods provide (for T small and N large) consistent estimations of the parameters (Hsiao, 1986).

Table 1 shows OLS estimates using observations in first differences. It must be noted that since the equations are specified in logarithms, the estimated coefficients represent the price and income elasticities of the Spanish manufacturing exports. Columns (1) show the results obtained when the real effective exchange rate indices are computed with the industrial price indices, while columns (2) offer those obtained when such variables are constructed using unit labour costs. In these results, the first thing that attracts attention is that price elasticity is, contrary to what would be expected, positive and significantly different from zero. Moreover, cost elasticity is far away from the significance.

In relation to these surprising results, it is important to note that Martín and Moreno (1991 and 1993) and Myro (1992) found an estimated price elasticity not significantly different from zero. Besides, they pointed out that a great number of sectors showed a positive and significant price elasticity. But, due to the important industrial policy implications of an study of this type, previous results cannot be used as a justification to avoid a deeper econometric investigation that might allow us to check whether OLS estimations are consistent.

Regardless of possible errors in the computation of both competitiveness indices, the application of OLS to the observations in first differences gives consistent estimations (in the case in which the panel involves a large number of individuals, over a short period of time) provided that all the explanatory variables are strictly exogenous. However, if there is an endogeneity problem these estimations will not be consistent. In this particular case, the endogeneity problem might arise due to the likely simultaneous determination of prices and quantities[6]. If the implementation of specification tests confirms this suspicion, reasonably doubts may arise

[5] The problem of inconsistency caused by the individual effects can also be eliminated by orthogonal transformations (Arellano and Bover, 1990).

[6] We are estimating a manufacturing export demand function for Spain. Insofar as supply price elasticity is not infinite, prices and quantities will be determined simultaneously.

about the consistency of previous OLS estimations of Spanish industrial exports to the EU using panel data.

In order to overcome the measurement errors and the endogeneity problem an alternative way to proceed is based on the method of instrumental variables (IV). The IV estimator is consistent[7] provided that the matrix of instruments is correlated with the explanatory variable that creates the endogeneity problem and uncorrelated with the error term (Greene, 1993). The choice of the estimation method must be based on the implementation of specification tests (Hausman, 1978 and Hausman and Taylor, 1981). They permit to check the existence of simultaneity problems, as well as to verify the likely correlation of the explanatory variables with the unobservable sectoral effects.

The tests of simultaneity have been carried out as follows. Under the null hypothesis of no misspecification, both GLS and IV estimators[8], (both with observations in first differences in order to control for the effect of unobservable individual effects) are consistent estimators, although only the first one is efficient. But if the null hypothesis is false, only the IV estimator is consistent[9].

With regard to the tests of correlation between the explanatory variables and the unobservable sectoral effects, they have been implemented as follows. Given that, as it is shown in Table 1, the foregoing tests indicate the existence of and endogeneity problem, to perform these tests two IV estimators are necessary. Under the null hypothesis of no correlation, both IV estimators with observations in levels (taking as instrument the first lag of the competitiveness indices) and with observations in first differences (using as instrument $REER_{t-2}$) are consistent, but only the former is efficient. However, if the null hypothesis is false, only the IV estimator with observations in first differences is consistent. The application of this test to the traditional specification of the export equation leads to the rejection of the null hypothesis at 5% significance level (Table 1).

Specification test results suggest to perform the estimations using an IV estimator with the observations in first differences. This allows us to get consistent parameter estimates for the different specifications of the export equation. In the traditional specification, the two values obtained for the external demand elasticity are greater than one and show that external demand has a strong direct influence on the export behaviour (see Table 1).

[7] Under the assumption of not serially correlated errors in the underlying model.

[8] Following Anderson and Hsiao (1981) we take $REER_{t-2}$ as instrument for $\Delta REER_{t-1}$.

[9] Under the hypothesis of no misspecification, plim $(b_{IV} - b) = 0$, while if there is misspecification, this plim will be non zero. Let V_1 be the estimated covariance matrix for the IV estimator, and let V_0 be $s^2 (X' X)^{-1}$, where s^2 is the estimate of σ^2 obtained using the IV estimator. The simultaneity test is a simply chi-squared test based on the Wald criterion: $W = (b_{IV} - b)' [V_1 - V_0]^{-1} (b_{IV} - b) \sim \chi^2 (k)$, where the degrees of freedom are the number of regressors. We have performed this test using as b the GLS estimator since under the null hypotheses this is more efficient than the OLS estimator.

However, the coefficients of the real effective exchange rates, although present the expected sign, indicate that neither the evolution of price[10] nor the evolution of cost competitiveness indices have played any significant role in the explanation of Spanish manufacturing exports.

TABLE 1
Export equations (First Differences)

	OLS Estimates		IV Estimates	
Variable	Price compet. (1)	Cost compet. (2)	Price compet. (1)	Cost compet. (2)
ED	1.32	1.40	1.15	2.05
	(4.69)	(5.00)	(3.25)	(4.5)
REER	1.25	0.02	–0.40	–0.02
	(2.46)	(1,52)	(–0.31)	(–0.09)
R^2	0.096	0.078		
F(2,244)	12.93	10.33		
Wald test			14.14(2)	15.47(2)
Hausman test: $H_0: E(u_{it} \mid x_{it}) = 0$			36.28	31.04
Hausman test: $H_0: E(\alpha_i \mid x_{it}) = 0$			15.24	23.60
Inst.			$REER_{t-2}$	$REER_{t-2}$
No. of observ.	246	246	164	164

Notes:
1. t-staistics robust to heteroskedasticity appears in parentheses under each coefficient.
2. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ^2 (*k*) under the null of no relationship, where k is the number of coefficients estimated.
3. Hausman tests are distributed as χ^2 (2) under the null hypotesis.

By making use of the possibilities that panel data offers, we have obtained price and cost elasticities using a set of sectoral dummies. In that process we have followed the OECD classification of technological intensity (high, middle and weak) of the industrial branches[11].

As pointed out by Arellano and Bond (1991), in practice there are significant efficiency gains by using GMM compared to simpler IV estimators of the kind introduced by Anderson and Hsiao (1981). Therefore,

[10] We get using consistent estimation procedures price elasticities very similar to those obtained by Martín and Moreno (1991 and 1993).

[11] In Table A2.1 beside the NACE three digit number appears the technological intensity (high, middle or weak) of the different considered sectors. Weak technological intensity group contains 51 sectors. Middle and high technological intensity groups include 17 and 13 sectors, respectively.

in Table 2 we report GMM estimates of the export equations. Under the assumption of lack of serial correlation, values of REER lagged two periods or more are valid instruments in the equations in first differences. However, it is important to note that an estimator that uses lags as instruments under the assumption of white noise errors would lose its consistency if in fact the errors were serially correlated. It is therefore essential to implement test statistics to check the absence of serial correlation. Since in this study $T = 4$ we cannot use the test statistic for second order serial correlation based on the residuals from the first difference equation ("m2"), but it is possible to use the Sargan test of over-identifying restrictions (Arellano and Bond, 1991).

As Table 2 shows price elasticities differ widely among the three sectoral groups[12]. The examination of these results indicates that behind the aggregate price elasticity there exists a sectoral heterogeneous behaviour compatible with what would be expected. Weak technological intensity sectors display a high and negative price elasticity, significant at the 10% level suggesting that this variable has a strong influence on the exports in these sectors. Middle and high technological intensity sectors exhibit a positive but not significant elasticity. This means that price competitiveness losses in these sectors can be compatible with a substantial increase in the growth rate of their exports to the EU (8). As regards cost elasticities, these are far away from the significance in high and middle technological intensity sectoral groups. In the group of weak technological intensity sectors, the coefficient presents the expected sign, but it is not significant at 10% level.

The estimations made up to this point only take into account the variables that traditionally have been considered in previous Spanish export studies. However, international trade actually takes place in an environment of imperfect competition in which firms use product differentiation strategies in order to increase their shares in foreign markets. For this reason, in what follows we introduce in the export equation variables used as proxies of horizontal and vertical product differentiation. The results are shown in Table 2. As expected, the inclusion of these variables improves the results on price elasticities. It is reaffirmed the negative sign of the price elasticity for the weak technological intensity sectors and the fact that, in the other two groups, the evolution of price competitiveness does not seem to have a significant effect on exports[13]. Thus, one could infer that in those sectors, competitiveness is likely to be more influenced by non price factors. As for cost elasticities, they remain insignificant at the 10% level for the high and middle technological intensity sectors. However, for the group of weak technological intensity sectors the cost elasticity becomes statistically significant, so for these sectors exports are negatively affected by the increase in relative costs. Comparing the value of this coefficient to that of the price

[12] In addition to this grouping according to the sectoral technological intensity we have gathered three digit sectors into two digit ones in an attemp to check if the effect of prices (costs) on exports differs sectorially. However, these estimations were not satisfactory.

[13] The unavailability of export unit value indices in order to approximate relative prices may explain the existence of many sectors displaying non negative price elasticities.

specification it can be seen that the export sensibility to variations in competitiveness is higher in this latter case. This can be due to the fact that sometimes firms do not completely translate into prices increases in costs.

Table 2 also reveals that horizontal product differentiation has a positive and highly significant impact on export behaviour (both in the price and cost specifications). However, the vertical product differentiation proxy[14] has the expected sign and is significant at the 10% level in price specification but is far away from significance when competitiveness is measured using unit labour costs. Price specification results are similar to those obtained by Moreno (1994) who found product differentiation elasticities around 0.2.

TABLE 2
Export equations, First Differences. Two steps GMM estimates

Variable	Price compet. (1)	Cost compet. (2)	Price compet. (1)	Cost compet. (2)
ED	1.04	1.88	0.79	1.78
	(2.20)	(4.35)	(1.86)	(4.20)
REER (high)	1.50	−0.19	1.09	−0.29
	(0.86)	(−0.38)	(0.50)	(−0.66)
REER (middle)	1.37	0.03	1.65	0.22
	(0.71)	(0.05)	(0.29)	(1.16)
REER (weak)	−4,83	−1.07	−5.10	−1.47
	(−1.88)	(−1.60)	(−1.94)	(−2.02)
TE			0.29	0.22
			(1.65)	(1.16)
AP			0.13	0.29
			(2.34)	(3.00)
Wald test	27.9(4)	45.12(4)	30.50(6)	55.76(6)
Sargan Test:	9.85(6)	12.23(6)	10.78(6)	11.72(6)
Inst.	REER (high, middle, weak)	REER (high, middle, weak)	REER (high, middle, weak)	REER (high, middle, weak)
No. of observ.	164	164	164	164

Notes:
1. t-staistics robust to heteroskedasticity appears in parentheses under each coefficient.
2. The Wald statistic is a test of the joint significance of the independent variables asymptotically distributed as χ^2 (*k*) under the null of no relationship, where k is the number of coefficients estimated.
3. Sargan test is asymtotically distributed as χ^2 (k-p) where *p* refers to the number of colums in the instrumental matrix.
4. Degres of freedom for χ^2 statistics are reported in parentheses.

[14] Vertical product differentiation has also been approximated by the technical assistance expenditure/gross value added ratio which is available for the level of sectoral disaggregation used in this study. Estimation results show the expected sign (in both price and cost specification) but are not significant at the 10% level.

As it was pointed out in the Introduction, one of the aims of this study is to detect the determinants of the Spanish manufacturing exports in order to help in the design of an appropiate sectoral industrial policy. In this connection, the low sensitivity of intra-EU exports in high and middle technological intensity sectors to changes in real effective exchange rates suggests that the future of Spanish exports, at least to the EU market, will be influenced by competitiveness factors different from prices, costs and exchange rates. Therefore, firms' product differentiation policies can play an important role in the export behaviour of these sectors, and policies designed for fomenting exports should be based on helping firms in their product differentiation strategies.

4. Concluding remarks

The results obtained in this paper can be summarised as follows. First of all, we have computed consistent estimators for the price (cost) and external demand elasticities of Spanish intra-EU manufacturing exports. In this respect, this analysis has shown that due to the existence of an endogeneity problem, previous estimations of such elasticities are likely to be inconsistent. Second, this analysis has confirmed the different sensitivity of the manufacturing intra-EU exports to changes in competitiveness (defined both in price and cost terms) according to the sectoral technological intensity. These results suggest that whereas relative prices (costs) homogeneized by the nominal effective exchange rates have a strong effect on intra-EU export behaviour in weak technological intensity sectors, they do not present a significant influence in middle and high technological intensity sectors, although since export unit value indices are not available price elasticity results based on industrial prices must be considered cautiously. Finally, the introduction of factors related to the specific structure of sectors, such as R&D expenditures plus payments for technological imports and advertising and publicity expenditures, has revealed the important role that both of them play on export behaviour.

Appendix 1: Data sources and construction of variables

–Exports:

Data supplied by the Statistical Office of the European Communities (Eurostat) in ECU's and nominal terms. They are deflacted using Spanish industrial price indices expressed in ECU's. These are obtained from Industrial Trends Monthly Statistics, and are converted into pesetas using the exchange rate peseta/ECU of the base year 1985.

–Gross value added at factor cost:

Data obtained from Eurostat-CD (Electronic Statistical Yearbook of the European Communities) in ECU and nominal terms for each of the EU(8) countries. Following Argimón (1994), each country gross value added in

ECU's is deflacted by its industrial price index in ECU's. After that, they are aggregated for getting the EU(8) gross value added that is transformed into pesetas using the exchange rate peseta/ECU from 1985.

–Real effective exchange rate index:

Index of competitiveness built both in price and cost terms. As Martín (1991) indicates, the computation of this index seems straightforward but, in practice, it involves two important decisions: the choice of the price/cost variable and the selection of the weighting system that will be used in the aggregation. As regards the former choice there are several alternatives: the use of labour costs implies to assume either that their evolution is the main determinant of total costs or that the evolution of the remaining costs is similar among the considered countries. The measurement of the labour costs can be made by means of net wages, gross wages or unit labour costs. The last ones are the most suitable and they are usually used in competitiveness analysis. In this study the unit labour costs are computed as the ratio between remuneration per employee and average real productivity per employee (defining this last variable in terms of value added at constant prices). The source of this data is Eurostat-CD.

The indices that can be used in order to measure variations in relative prices, are usually constructed using consumption prices, output deflactors, industrial prices and export prices. The first two are not appropriate to make international comparisons, since they take into account changes in prices of goods and services which are not subject to foreign trade. In the case of consumption prices an additional disadvantage is that capital goods prices are not included. The third, gives a more direct measure of international competitiveness in the manufacturing sector, since it basically includes goods subject to foreign competition. Even though the export prices would be the best alternative for international competitiveness studies, the data availability leads us to use industrial prices.

As regard the choice of the weighting system necessary for doing the aggregation we use a weighting geometric average (Banco de España, 1980), giving rise to the following expressions:

$$REERC_{it} = [\prod_{j=1}^{8} (NEER^{j}_{t})^{T_{ij}}] \left[\frac{ULC_{it}}{\prod_{j=1}^{8} (ULC^{j}_{it})^{T_{ij}}} \right]$$

$$REERP_{it} = [\prod_{j=1}^{8} (NEER^{j}_{t})^{T_{ij}}] \left[\frac{IPI_{it}}{\prod_{j=1}^{8} (IPI^{j}_{it})^{T_{ij}}} \right]$$

where:

$NEER^{j}_{t}$ = nominal effective exchange rate index in terms of foreign currency/peseta.

ULC_{it} = Spanish unit labour cost index of sector i in year t

ULC_{it}^{j} = j-th country's unit labour cost index of sector i in year t.

IPI_{it} = Spanish industrial price index of sector i in year t.

IPI_{it}^{j} = j-th country's industrial price index of sector i in year t.

T_{ij}= sectoral weighting matrix defined as:

$$T_{ij} = \frac{X_{ij} + M_{ij}}{\sum_{j=1}^{8} (X_{ij} + M_{ij})}$$

where

i = 1......82 sectors, j = 1......8 EU countries, X_{ij} = Spanish exports of sector i to country j in the period 1986-89, and M_{ij} = Spanish imports of sector i from country j in the period 1986-89.

T_j= weighting vector, similar to the previous matrix, but for the whole of manufactures.

–Product differentiation:

Advertising and technical assistance expenditure data have been supplied by the Instituto Nacional de Estadística (INE) from the Encuesta Industrial. They belong to the three-digit level of the Clasificación Nacional de Actividades Económicas (CNAE). This classification has a direct correspondence with the NACE used in this study.

R&D expenditures and payments for technological imports have been obtained from the Estadística sobre Investigación Científica y Desarrollo Tecnológico (INE) and Main Science and Technology Indicators (OCDE), respectively.

Appendix 2: Sectoral Classification.

The sectoral division used in this study is the three-digit level NACE classification (Table A2.1) offered by the Statistical Office of the European Communities (Eurostat). This classification considers 126 industrial branches. Energy and Water branches are not considered due to their special technological and market characteristics (both high regulation and public intervention and almost absence of foreign competition). Thus, the scope of the study is cut down to what commonly is known as manufacturing sectors. Data availability for the different variables leads to include in the analysis only 82 from the 112 manufacturing sectors.

TABLE A2.1
Three digit level NACE (Manufacturing sectors)*

221 (weak)	Iron and steel industry.
222 (weak)	Manufacture of steel tubes.
223 (weak)	Drawing, cold rolling and cold folding of steel.
224 (weak)	Production and preliminary processing of non-ferrous metals.
231 (b)	Extraction of building materials and refractory clays.
232 (b)	Mining of potassium salt and natural phosphates.
233 (b)	Mining of common salt.
239 (b)	Mining of others minerals.
241 (weak)	Manufacture of clay products for constructional purposes.
242 (b)	Manufacture of cement, lime and plaster.
243 (weak)	Manufacture of concrete, cement or plaster products for constructional purposes.
244 (weak)	Manufacture of articles of asbestos (except articles of asbestos-cement).
245 (weak)	Working of stone and of non-metallic mineral products.
246 (weak)	Production of grindstones and other abrasive products.
247 (weak)	Manufacture of glass and glassware.
248 (weak)	Manufacture of ceramic goods.
252 (middle)	Petrochemical products.
253 (c)	Manufacture of others basic industrial chemicals.
255 (middle)	Manufacture of paint, painter's fillings, varnish and printing ink.
256 (middle)	Manufacture of other chemical products for industrial and agricultural purposes.
257 (middle)	Manufacture of pharmaceutical products.
258 (middle)	Manufacture of soap, synthetic detergents, perfume and toilet preparations.
259 (middle)	Manufacture of other chemical products, chiefly for household and office use.
260 (c)	Manufacture of synthetic and artificial fibres.
311 (weak)	Foundries.
312 (weak)	Forging, drop forging, closed dieforging, pressing and stamping.
313 (weak)	Secondary transformation, treatment and coating of metals.
314 (weak)	Manufacture of structural metal products (including integrating assembling and installation).
315 (weak)	Bollermaking, manufacture of reservoirs, tanks and other sheet metals containers.
316 (weak)	Manufacture of tools and finished metals goods, except electrical equipment.
319 (a)	Other metal workshop not elsewhere specified.
321 (middle)	Manufacture of agricultural machinery and tractors.
322 (middle)	Manufacture of machine-tools for working metal, and of other tools for use with machines.
323 (middle)	Manufacture of textile machinery and accessories; manufacture of sewing machines.
324 (middle)	Manufacture of machinery for the food, chemical and related industries.
325 (middle)	Manuf. of plant for mines, the iron and steel industry and foundries, civil engineering and the building trade.
326 (middle)	Manufacture of transmission equipment for motive power.
327 (middle)	Manufac. of other machinery and equipment for use in specific branches of industry.

328 (middle)	Manufacture of other machinery and equipment.
330 (high)	Manufacture of office machinery and data-processing machinery.
341 (high)	Manufacture of insulate wires and cables.
342 (high)	Manufacture of electrical machinery (comprising electric motors, electricity generators, transformers, switches...).
343 (high)	Manuf. of electrical apparatus and appliance for industrial use; manufacture of batteries and accumulators.
344 (high)	Man. of telecom. equipment electrical and electronic measuring and recording equip, and electromedical equip.
345 (high)	Man. of radio and television receiving sets, sound reproducing and recording equipment (except computers).
346 (high)	Manufac. of domestic type electric appliances.
347 (high)	Manufacture of electric lamps and other electric lighting equipment.
348 (c)	Assembling and installation of electrical equipment and apparatus.
351 (b)	Manufacture and assembly of motors vehicles and manufacture of motor vehicles engines.
352 (b)	Manufacture of bodies for motor vehicles and of motor-drawn trailers and caravans.
353 (middle)	Manufacture of parts and accessories for motor vehicles.
361 (middle)	Shipbuilding.
362 (b)	Manufacture of standard and narrow-gauge railway and tramway rolling-stock.
363 (b)	Manufacture of cycles, motor-cycles and parts and accessories thereof.
364 (b)	Aerospace equipment manufacturing and repairing.
365 (high)	Manufacture of other transport material non previously specified.
371 (high)	Manufacture of measuring, checking and precision instruments and apparatus.
372 (high)	Manufacture of medical and surgical equipment and orthopaedic appliances (except orthopaedic footwear).
373 (high)	Manufacture of optical instruments and photografic equipment.
374 (high)	Manufacture of clocks and watches and parts thereof.
411 (weak)	Manufacture of vegetable and animal oils and facts.
412 (b)	Slaughtering, preparing and preserving of meat (except the butcher's trade).
413 (b)	Manufacture of dairy products.
414 (weak)	Processing and preserving of fruit and vegetables.
415 (weak)	Processing and preserving of fish and others sea foods fit for human consumption.
416 (weak)	Grain milling.
417 (weak)	Manufacture of spaghetti, macaroni, etc.
418 (weak)	Manufacture of starch and starch products.
419 (weak)	Bread and flour confectionery.
420 (weak)	Sugar manufacturing and refining.
421 (weak)	Manufacture of cocoa, chocolate and sugar confectionery
422 (b)	Manufacture of animal and poultry foods (including fish meal and flour).
423 (weak)	Manufacture of other foods products.
424 (weak)	Distilling of ethyl alcohol for fermented materials; spirit distilling and compounding.
425 (b)	Manufacture of wine of fresh grapes.
426 (b)	Other beverages obtained from fermentation of fruit juices.
427 (weak)	Brewing and malting.

428 (weak)	Manufacture of soft drinks, including the bottiling of natural waters.
429 (weak)	Manufacture of tobacco products.
431 (weak)	Wool industry.
432 (weak)	Cotton industry
436 (weak)	Knitting industry.
437 (a)	Textile finishing.
438 (weak)	Manufacture of carpets, linoleum and other floor covering.
439 (weak)	Miscellaneous textile industries.
441 (weak)	Tanning and dressing of leader.
442 (weak)	Manufacture of products for leather and leather substitutes.
451(weak)	Manufacture of mass-produced footwear excluding footwear made completely of wood or of rubber.
453 (weak)	Manufacture of ready-made clothing and accessories.
455 (weak)	Manufacture of household textiles and other made-up textile goods.
456 (weak)	Manufacture of furs and fur goods.
461 (b)	Sawing and processing of wood.
462 (weak)	Manufacture of semi-finished wood products.
463 (weak)	Manufacture of carpentry and joinety components and of parquet flooring.
464 (weak)	Manufacture of wooden containers.
465 (weak)	Other wood manufactures (except furniture).
466 (weak)	Manufacture of articles of cork and articles of straw and other plaiting materials.
467 (weak)	Manufacture of wooden forniture.
471 (weak)	Manufacture of pulp, paper and board.
472 (weak)	Processing of paper and board.
473 (weak)	Printing and afflied industries.
474 (c)	Publishing.
481 (middle)	Manufacture of rubber products.
482 (c)	Retreating and repairing of rubber tyres.
483 (middle)	Processing of plastics
491 (c)	Man. of art. of jewellery and goldsmiths' and silver smiths'wares, cutting or other working of precious stones.
492 (c)	Manufacture of musical instruments.
493 (c)	Photographic and cinematographic laboratories.
494 (c)	Manufacture of toys and sport goods.
495 (c)	Miscelaneous manufacturing industries.

Notes:

* The technological intensity grouping to which each sector belongs appears in brackets after the sector number.

(a) Sectors excluded given that export and import statistical information is not available at this level of sectoral disaggregation.

(b) Sectors eliminated since technical assistance and advertising expenditure data are not available. For these sectors the institutions that make the statistics only provide the Instituto Nacional de Estadística with global information on purchased services without distinction among the integrated items.

(c) Sectors non included due to statistical information on gross value added for all EU(8) countries is not available.

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Resumen

El objetivo de este trabajo es determinar cuáles son los factores explicativos de las exportaciones manufactureras de España a la UE en el período 1986-89. En él se combinan las variables explicativas tradicionales, precio/coste y demanda externa, con variables que permiten una explicación más realista del comercio internacional en un contexto de competencia imperfecta (diferenciación de producto vertical y horizontal). Las dos aportaciones fundamentales del trabajo son el nivel de desagregación utilizado y el uso de técnicas econométricas que permiten la obtención de estimadores consistentes. Los resultados de nuestras estimaciones muestran que la sensibilidad de las exportaciones manufactureras españolas a variaciones en los precios (costes) depende de la intensidad tecnológica sectorial. Además, confirman la positiva influencia de la demanda externa y de la diferenciación de producto sobre las exportaciones.

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