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SUPPLY AND DEMAND OF MANUFACTURING OUTPUT IN OECD COUNTRIES 1970-95

CANCELO, Mª. Teresa (mcancelo@usc.es)
GUISAN, Mª Carmen (eccgs@usc.es)
FRIAS, Isidro (ecsmsif@usc.es)
University of Santiago de Compostela (Spain)

Abstract

The aim of this paper is to analyse the evolution of manufacturing in 11 OECD countries, during the period 1975-95, from two viewpoints: supply and demand. With this purpose we estimate, with a pool of data, two econometric models for explaining industrial production from the above mentioned standpoints and we select the most appropriated using non-nested linear model selection methods.

JEL Classification: C5, F0, E20, L6, O51, O52, O57

1. Introduction.

The evolution of manufacturing output in 11 OECD countries during the period 1975-90 is explained from both a supply side and a demand side econometric model. In order to select the explanation that most closely reflects reality, non-nested linear models selection methods are used.

We begin in this section presenting the structure of the paper. First of all, we see the evolution of the variable explained, manufacturing output, in section two.

In the third section, we present the estimation of the supply model for explaining manufacturing production. The explanatory variables included in this equation are industrial employment, stock of industrial capital and research and development expenditure. In the Cobb-Douglas production function an additional variable is included to collect the influence of technological development.

In the fourth section, a demand equation for industrial production is estimated, in which the explanatory variables included are domestic and foreign demands, industrial imports and relative prices.

In the last section, the selection between the two aforementioned models is made through the use of econometric testing procedures appropriated for linear non-nested models: combined model and artificial nested methodologies. In addition, the forecasting ability of both models is evaluated in order to reinforce model selection. The stability of coefficients among countries, in the equation selected, is also verified.

Finally, we present the main conclusions of this paper, followed by a reference list and an annex of data with sources and explanatory notes of variables.

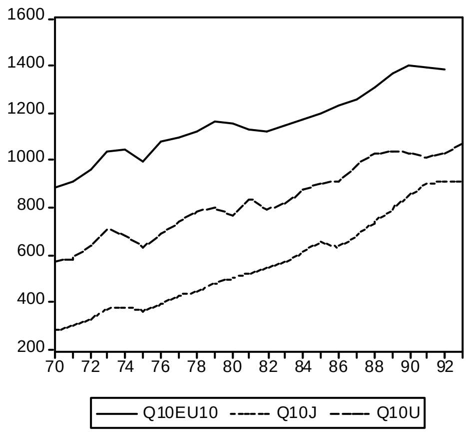
2. Evolution of industrial output.

The purpose of this paper is to analyse the main determinants of the evolution of industrial value-added per head in OECD countries, specially in the European Union, USA and Japan.

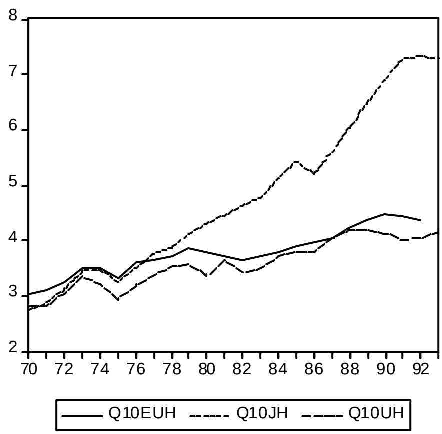
In this connection, we have estimated the econometric models proposed and we have then proceed to select the most appropriate one through the application of the most suitable econometric techniques, with a sample of 10 European Union countries, excluding Ireland and Greece for which there were not all the statistical data needed as well as the new members that did not belong in 1990 to the former European Economic Community, together with USA and Japan.

Graphs 1 to 5 show the evolution of industrial value added per head (thousands of 1990 USA$ per head) of the following areas and countries: European Union, Japan, USA, during the period 1970-93, in order to see the similarities and differences among countries. Data where elaborated from OECD National Accounts, at 1990 prices, expressed both at exchange rates and purchasing power parities (PPPs).

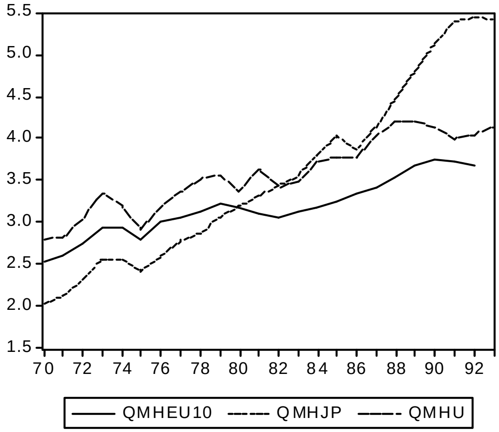
Graph1. Manufacturing output in European Union, USA and Japan, (billions of 1990 US$, at exchange rates)



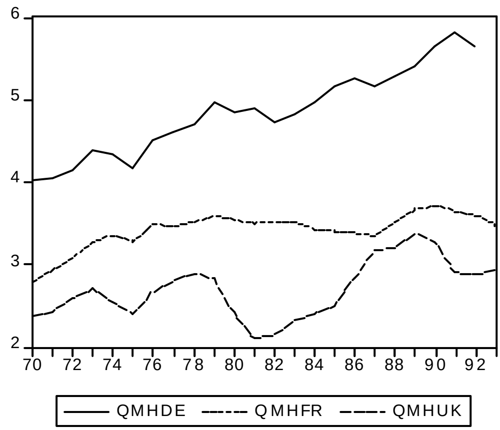
Graph 2. Manufacturing output per head in European Union, Japan and USA (thousands of 1990 USA$, at exchange rates)



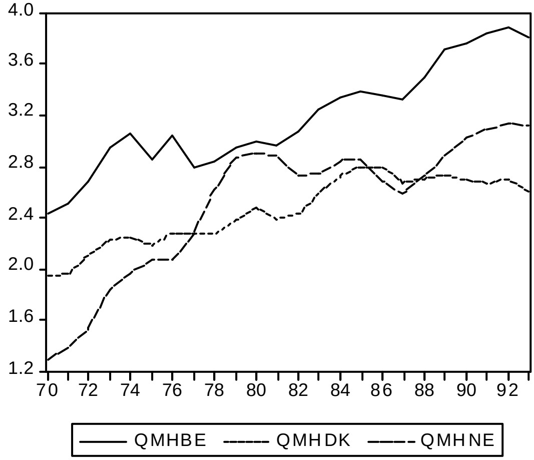
Graph 3. Manufacturing output per head in European Union, USA and Japan (thousands of 1990 USA$, at PPPs)



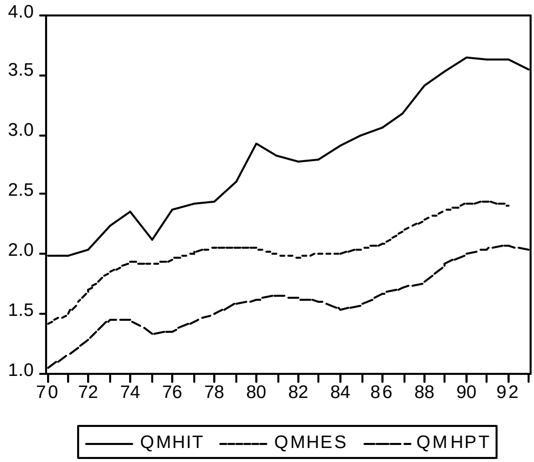
Graph 4. Manufacturing output per head in Germany, France, and United Kingdom (thousands of 1990 USA$ at PPPs)



Graph 5. Manufacturing output per head in Belgium, Denmark and Netherlands (thousands of 1990 USA$, at PPPs)



Graph 5. Manufacturing output per head in Spain, Italy and Portugal (thousands of 1990 USA$, at PPPs[1])



Note: [1] In the case of Portugal figures are an average between values at exchange rates and PPPs.

In the graphs above we can observe that industrial value added per head has increased its value in all the areas considered, with Japan being the country that has reached the highest increases.

Besides, we can see that Spain and Portugal must increase their industrial value added per head at a higher rate in order to converge with the other countries in the sample.

In some countries, like Japan and Portugal, there are some important differences between exchange rates values and those based on purchasing power parities.

In the case of Japan it seem to us more that the comparison with EU and USA based on PPPs is more realistic-

In the case of Portugal it seems to us that exchange rates undervalue that purchasing power parities overvalue the actual level of manufacturing output.

For this cause we have calculated for this country an average of both values, as it seems more realistic in comparison with Spain.

On the other hand table 1 shows the level of real manufacturing value-added per head in 1976-1995, elaborated from OECD(1997) Stan database for 19 countries. The values are expressed in thousands of US dollars at 1990 prices, both at exchange rates and PPPs. Besides that, the last columns of this table present the total manufacturing real value-added in 1995 according to PPPs.

Graphs 6 and 7 present, respectively, the percentages of increase for each country of real value-added per head and total. The OECD percentages of increase have been 31% for real value-added per head and 53% for total real value-added.

Table 1
Manufacturing real output per inhabitant in 1976 and 1995 (thousands of US$ at 1990 prices, exchange rates and PPPs), and total manufacturing value-added in 1995 (B$90 at PPPs)

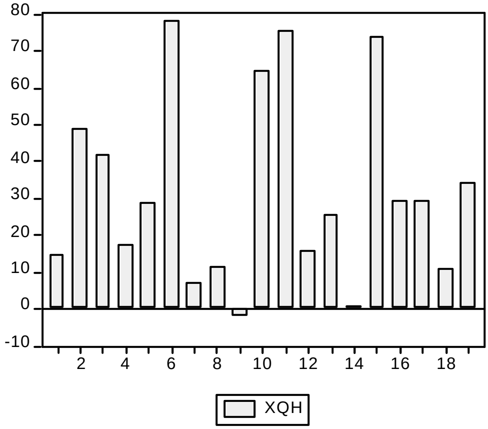
	Output p.c Exch. rates		Output p.c PPPs		Total Manuf. Value-added	
Country	**1976**	**1995**	**1976**	**1995**	**Qm76**	**Qm95**
1.Australia	2.41	2.77	2.22	2.56	31.21	46.20
2.Austria	3.69	5.48	2.99	4.45	22.65	22.82
3.Belgium	3.05	4.32	2.58	3.66	25.32	37.08
4.Canada	2.90	3.39	2.60	3.05	61.14	89.41
5.Denmark	3.38	4.35	2.23	2.87	11.31	14.97
6.Finland	3.51	6.25	2.10	3.74	9.94	19.12
7.France	4.07	4.34	3.35	3.58	177.20	212.51
8.Germany	6.01	6.69	4.64	5.18	285.67	340.02
9.Greece	0.89	0.87	1.01	0.98	9.21	10.28
10.Italy	2.77	4.56	2.34	3.85	130.14	220.54
11.Japan	3.86	6.78	2.87	5.04	323.63	632.44
12.Mexico	0.50	0.58	0.93	1.07	57.40	97.41
13.Netherland	2.93	3.67	2.46	3.08	33.83	47.58
14.Norway	3.61	3.62	2.32	2.33	9.34	10.16
15.Portugal	1.06	1.85	1.46	2.53	13.63	25.11
16.Spain	2.40	3.10	2.22	2.88	79.93	112.74
17.Sweden	4.61	5.95	2.92	3.77	24.02	33.31
18.UK	3.08	3.41	2.88	3.19	161.88	186.92
19.USA	3.25	4.37	3.25	4.37	709.47	1149.7
OECD19	3.05	4.02	2.49	3.27	2176.9	3323.3

Source: Output per capita was elaborated from OECD(1997) real value-added. Last column is the total manufacturing value-added in 1995, expressed in billions of USA$ at 1990 prices and PPPs. Last row shows the non weighted averages of columns (1) to (4) and the sum of column(5).

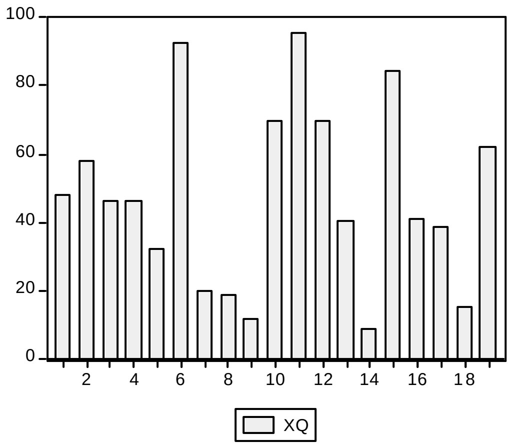
There are some differences among countries that explain some peculiarities of this table. For example it could be expected that USA would be at the top position in manufacturing value-added per inhabitant.

This type of differences are due in many cases to the different degree of services outsourcing in industrial firms, so some countries with the same production in physical units may have differences in value-added if they have differences in the way of producing business services, inside or outside the firm.

Graph 6. Percentage of increase of manufacturing real value-added per inhabitant in OECD countries, 1976-95



Graph 7. Percentage of increase of manufacturing real value-added in OECD countries 1976-95



3. Supply equation for manufacturing production.

First of all, industrial production is estimated as a supply equation. A Cobb-Douglas production function is used, we additionally include the R&D expenditure to collect the influence of the technological activities.

In order to collect the effect of technological activities over production we can chose among several variables: R&D expenditure, as a proxy of resources, number of patents, as a proxy of results, technological balance of payments, as a proxy of impact, or some combinations of them, see Fagerberg(1988) and Sanchez(1993).

We have chosen R&D expenditure for two reasons, on the one hand, in some countries like Spain there is a low propensity to patent (low correlation between R&D expenditure and number of patents, as has been pointed out by Buesa(1992) and Sanchez(1993) and, on the other hand, patents data in OECD statistics are not industrial specific.

Let's have the following equation:

(1) $$Q10_{it} = \beta_0 \; L10^{\beta_1}{}_{it} \; SK10^{\beta_2}{}_{it} \; BRD10^{\beta_3}{}_{it} \; e^{\varepsilon_t}$$

After log-linear transformation:

(2) $$\log Q10_{it} = \log \beta_0 + \beta_1 \log L10_{it} + \beta_2 \log SK10_{it} + \beta_3 \log BRD10_{it} + \varepsilon_t$$

where the variables, except L10, are measured in Billions of dollars at 1990 prices and exchange rates:

Q10 = Manufacturing Production (B$90).

L10 = Manufacturing Employment, (thousand workers).

SK10 = Manufacturing stock of capital (B$90).

BRD10 = R&D expenditure of business enterprises in the manufacturing sector (Billion US$90).

The sample is a pool of data of 11 OECD countries for the period 1975-90. The countries considered are Belgium (including the sum of Belgium and Luxemburg), Denmark, France, Germany, Italy, The Netherlands, Portugal, Spain, United Kingdom, Japan and United States.

In the Least Squares estimation of equation 2 the Durbin-Watson statistic has a value of 0.10 indicating first order serial correlation. For this reason, the equation was re-estimated by Generalized Least Squares, with the following results:

Table 2. GLS estimation of Equation 2
Output equation. Supply side

LS // Dependent Variable is LOG(Q10)				
Sample: 1975 1990				
Included observations: 165				
Convergence achieved after 7 iterations				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.985175	0.306652	-3.212683	0.0016
LOG(L10)	0.409511	0.071455	5.731003	0.0000
LOG(SK10)	0.412910	0.095887	4.306198	0.0000
LOG(BRD10)	0.206164	0.033107	6.227225	0.0000
AR(1)	0.893538	0.022459	39.78488	0.0000
R-squared	0.998966	Mean dependent var	4.768376	
Adjusted R-squared	0.998941	S.D. dep. var	1.317219	
S.E. of regression	0.042875	Akaike info criterion	-6.269099	
Sum sq.resid	0.294122	Schwarz criterion	-6.174979	
Log likelihood	288.0758	F-statistic	38658.27	
Durbin-Watson stat	1.411801	Prob(F-statistic)	0.000000	
Inverted AR Root	.89			

The results show the positive impact of labour, capital and R&D expenditure over industrial production. The biggest elasticity corresponds to the capital stock, which highlight the importance of this variable.

Regarding to the impact of R&D expenditure we must add that, although we have used the data of business enterprises expenditure, there are also other types of R&D expenditure that have also a significant effect on manufacturing production, but they are so highly correlated with BRD10 that they are not included in order to avoid multicollinearity.

Even more, the highest impact of R&D expenditure in economic development, according to our experience with econometric models, is usually the corresponding to research performed at universities. So the variable BRD10 should be interpreted only as a proxy representing the general degree of research expenditure.

4. Demand equation for manufacturing output.

The interest of demand equation is that it let us analyse how exports impinge upon total output and, in this way, we can asses the importance of structural competitiveness factors in economic growth, as shown in Cancelo and Guisan (1998) and (2002).

The factors that influence output from the demand side are mainly domestic demand, foreign demand, imports and relative prices.

As a proxy of domestic demand we have chosen each country GDP lagged 1 period (GDP90L), because we think that it often explain better this concept than the sum of private and public consumption and investment. GDP data, in milliards of 1990 US$, are from OECD National Accounts.

As proxy of foreign demand we have included manufacturing exports from each country to the other OECD countries (XR10). Exports data, milliards of 1990 US$, calculated from OECD *Foreign Trade Statistics* and *National Accounts* and Eurostat *National Accounts*.

Manufacturing imports (MR10) are from the same data sources and they also expressed in milliards of 1990US$.

As a proxy of relative prices we have calculated an Index of Relative Prices (PR10) from OECD *Foreign Trade Statistics* and *National Accounts* and Eurostat *National Accounts*. This index is the ratio of manufacturing export prices of each country to a weighted average of manufacturing export prices of the other countries in the sample (explanatory notes in the annex).

The equation, in log-linear terms, states:

(3) $\log Q10_{it} = \log \beta_0 + \beta_1 \log GDP90(-1)_{it} + \beta_2 \log XR10_{it} + \beta_3 \log MR10_{it} + \beta_4 \log PR10_{it} + \varepsilon_t$

where:

Q10 = Real Value Added of Manufacturing (B$90)

GDP90(-1) = Real GDP lagged 1 period (B$90)

XR10 = Real Exports of Manufactures (B$90)

MR10 = Real Imports of Manufactures (B$90)

PR10 = Relative Prices of Manufacturing Exports.

Equation (3) was estimated by GLS in order to obtain the Best Linear Unbiased Estimators in presence of serial correlation, and the results are shown in table 3.

As expected, domestic demand (GDP90(-1)) and manufacturing exports (XR10) have a positive influence on manufacturing output and relative prices (PR10) have a negative influence. Therefore, our previous statement about structural competitiveness is confirmed.

Nevertheless, the sign of the manufacturing imports coefficient (MR10) is unexpectedly positive. This result may be explained by the presence of multicollinearity in the equation and because they can be acting as a proxy of the consumption of intermediate inputs in the industrial process.

Table 3. GLS Estimation of Equation 3.
Output equation. Demand side

LS // Dependent Variable is LOG(Q10)				
Sample: 1975 1990				
Included observations: 165				
Convergence achieved after 11 iterations				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.793070	0.516933	-5.403157	0.0000
LOG(GDP90(-1))	0.736865	0.066857	11.02149	0.0000
LOG(XR10)	0.320267	0.053108	6.030527	0.0000
LOG(MR10)	0.218374	0.039060	5.590708	0.0000
LOG(PR10)	-0.192742	0.060924	-3.163671	0.0019
AR(1)	0.965266	0.008886	108.6251	0.0000
R-squared	0.9992	Mean dependent var	4.768376	
Adjusted R-squared	0.9991	S.D. dep. var	1.317219	
S.E. of regression	0.038877	Akaike info criterion	-6.459018	
Sum squared resid	0.240316	Schwarz criterion	-6.346075	
Log likelihood	304.7441	F-statistic	37621.55	
Durbin-Watson stat	1.7182	Prob(F-statistic)	0.000000	
Inverted AR Roots	.97			

5. Specification tests and model selection

In this section, we are in charge of selecting between the output equations estimated above. The relevant question to be answered is whether any of them, or a combination of both, is better suited to explain output.

As we have two different models to explain manufacturing output, we have to resort to non-nested linear specification tests.

As Guisan (1997) states, there are three ways of testing the specification of a model when it is linear: likelihood ratio, artificial nesting and combined model approaches. In this paper we follow the last two procedures.

First of all, we use an artificial nested approach in which both equations are expressed as a weighted lineal combination, with weights λ and $(1-\lambda)$:

$H_0 : Y = X\beta + u_0$	X	TxK_0 matrix	(
$H_1 : Y = Z\gamma + u_1$	Z	TxK_1 matrix	

(4) $$Y = (1-\lambda) X \beta + \lambda Z ?+ \varepsilon;$$

This method is based in testing the null hypothesis $\lambda = 0$ through a t-Student statistic in the latter equation, for which we have to replace γ by a consistent estimator under H_1, and for that purpose we substitute Z ? in (4c) by the LS estimated value of Y under H_1.

Davidson and Mc Kinnon (1981) suggest using the least squared estimator of γ under H_1 ($\hat{\gamma}$):

$$\hat{\gamma} = (Z'Z)^{-1} Z'Y$$

Then, they propose substituting this estimated vector in the artificial nested model in order to test the hypothesis $\lambda = 0$ through the suitable t-statistic, which under the null hypothesis follows a Student's t distribution with $T-k_0-1$ degrees of freedom.

Davidson and McKinnon procedure

1) We estimate by OLS the output equation from the supply side, and we estimate output under H_1 (YFS). Considering demand side equation as H_0 and supply side equation as H_1.

We have included the lagged value of industrial production (Q10(-1)) as an explanatory variable in the OLS estimation of equation (2) in order to capture serial correlation. This variable can also be considered a proxy of the production capability of the country (lagged supply).

Therefore we estimate the following equation:

(4) $\log Q10_{it} = \log \beta_0 + \beta_1 \log L10_{it} + \beta_2 \log SK10_{it} + \beta_3 \log BRD10_{it} + \beta_4 \log Q10(-1)_{it} + \varepsilon_t$

2) We test the influence of demand side factors as well as supply side factors in a nested model. Thus, we have estimated the equation that follows:

(5) $\log Q = C(50)*YFS + (1 - C(50)) \log Q^d$

Where, Q^d collects the explanatory variables in equation 3 in addition to the lagged industrial production in order to get rid of serial correlation problems as we did in the supply side equation. The equation to be estimated is as follows:

(6) $\log Q10_{it} = C(50)*YFS_{it} +(1 - C(50)) * (C(60) +C(61) * \log PIB90R_{it} + C(62) * \log XR10_{it} + C(63) * \log MR10_{it} +C(64) * \log PRI10_{it} + C(65) * \log Q10R_{it}) + \varepsilon_t$

Then we test if in equation (6) the coefficient C(50) is significantly different from 0.

Table 4. LS estimation of equation (4)

LS // Dependent Variable is LOG(Q10)				
Sample: 1975 1990				
Included observations: 176				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(L10)	0.000116	0.011796	0.009853	0.9922
LOG(SK10)	0.065469	0.019333	3.386381	0.0009
LOG(BRD10)	0.009758	0.006404	1.523769	0.1294
LOG(Q10(-1))	0.927540	0.021215	43.72003	0.0000
R-squared	0.998721	Mean dependent var	4.756015	
Adjusted R-squared	0.998699	S.D. dep. var	1.312430	
S.E. of regression	0.047338	Akaike criterion	-6.078406	
Sum squared resid	0.385437	Schwarz criterion	-6.006349	
Log likelihood	289.1665	F-statistic	44780.38	
Durbin-Watson stat	1.586547	Prob(F-statistic)	0.000000	

With the estimated industrial production corresponding to the latter equation YFS, we estimate equation (6) by non linear least squares obtaining the following results:

$$\log Q10_{it} = 0.745\ YFS_{it} + (1 - 0.745) * (-0.288 + 0.158 * \log GDP90(-1)_{it} + 0.069 * \log XR10_{it} - 0.064 * \log MR10_{it} - 0.116 * \log PR10_{it} + 0.852 * \log Q10(-1)_{it})$$

In them, we observe that the coefficient corresponding to output from supply side (C(50)) is equal to 0.74 and, besides, it is statistically significant at 4% (t-statistic 2.07). Therefore, if we test the null of C(50) = 0, this hypothesis is rejected with a probability of 96% of taking the right decision.

In second place, we apply both stages of the procedure considering the supply side equation as H_0 and the demand side equation as H_1.

First of all, we estimate equation (3) by OLS, including lagged output in order to overcome serial correlation. Demand equation, which allows obtaining YFD, is specified as follows:

(7) $\log Q10_{it} = \log \beta_0 + \beta_1 \log GDP90(-1)_{it} + \beta_2 \log XR10_{it} + \beta_3 \log MR10_{it} + \beta_4 \log PR10_{it} + \beta_5 \log Q10R_{it} + \varepsilon_t$

Table 5. Estimation of equation (7) by OLS

LS // Dependent Variable is LOG(Q10)				
Sample: 1975 1990				
Included observations: 176				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.131998	0.040558	-3.254539	0.0014
LOG(GDP90(-1))	0.078755	0.022484	3.502633	0.0006
LOG(XR10)	0.032239	0.012423	2.595048	0.0103
LOG(MR10)	-0.026798	0.012859	-2.084061	0.0386
LOG(PR10)	-0.013072	0.03130	-0.417600	0.6768
LOG(Q10R)	0.923929	0.021521	42.93176	0.0000
R-squared	0.998719	Mean dependent var		4.756015
Adjusted R-squared	0.998681	S.D. dep.var		1.312430
S.E. of regression	0.047659	Akaike criterion		-6.053892
Sum squared resid	0.386127	Schwarz criterion		-5.945808
Log likelihood	289.0093	F-statistic		26508.35
Durbin-Watson stat	1.587743	Prob(F-statistic)		0.000000

After estimating industrial output from the demand side (YFD), it can be used to estimate the following equations (as we did with the supply side equation):

(8) $\log Q = C(80)*YFD + (1 - C(80)) \log Q^S$

(9) $\log Q10_{it} = C(80) * \log YFD_{it} + (1 - C(80))* (C(91) * \log L10_{it} + C(92) * \log SK10_{it} + C(93) * \log BRD10_{it} + C(94)* Q10(-1)_{it}) + \varepsilon_t$

Non linear least squared estimators of equation (9) are as follows:

$\log Q10_{it} = 0.619 * \log YFD_{it} + (1 - 0.619) * (-0.001 * \log L10_{it} + 0.105 * \log SK10_{it} + 0.013 * \log BRD10_{it} + 0.924 + \log Q10(-1)_{it})$

Coefficient C(80) in equation (9), corresponding to industrial output from demand side, is equal to 0.62. This coefficient is not statistically significant at standard significance levels (t-statistic 1.84).

Hence, this results suggest that supply side factors are those that at a greater extent influence industrial output.

Combined Model procedure.

This approach combines both hypotheses without using any weighting coefficient. Then, hypothesis $\gamma = 0$ in combined model is tested, in such a way that the null hypothesis: $Y = X\beta + u_0$ is accepted if $\gamma = 0$ is not rejected. In a similar fashion, the alternative hypothesis is accepted when $\beta = 0$ is not rejected.

This approach consists in estimating an equation including all supply and demand side factors, testing the significance of the subsets of coefficients corresponding to each model.

Thus, equation (10) is as follows:

(10) $\log Q10_{it} = \beta_0 + \beta_1 \log L10_{it} + \beta_2 \log SK10_{it} + \beta_3 \log BRD10_{it} + \beta_5 \log GDP90(-1)_{it} + \beta_6 \log XR10_{it} + \beta_7 \log MR10_{it} + \beta_8 \log PR10_{it} + \beta_9 \log Q10(-1)_{it} + \varepsilon_t$

Table 6. OLS estimation of equation (10).
Combined model of output

LS // Dependent Variable is LOG(Q10)				
Sample 1975 1990				
Included observations: 176				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.427891	0.138210	-3.095957	0.0023
LOG(L10)	0.033972	0.017006	1.997717	0.0474
LOG(SK10)	0.024249	0.025113	0.965600	0.3356
LOG(BRD10)	-0.013625	0.012587	-1.082457	0.2806
LOG(GDP90(-1))	0.101879	0.036949	2.757292	0.0065
LOG(XR10)	0.062405	0.021608	2.887994	0.0044
LOG(MR10)	-0.030255	0.014346	-2.108916	0.0364
LOG(PR10)	0.019441	0.039806	0.488393	0.6259
LOG(Q10(-1))	0.851351	0.031422	27.09386	0.0000
R-squared	0.998807	Mean dependent var		4.756015
Adjusted R-squared	0.998750	S.D. dep. var		1.312430
S.E. of regression	0.046409	Akaike criterion		-6.090751
Sum squared resid	0.359680	Schwarz criterion		-5.928624
Log likelihood	295.252	F-statistic		17473.56
Durbin-Watson stat	1.57879	Prob(F-statistic)		0.000000

The testing procedure consists of using a F-statistic test of joint significance of a subset of coefficients. Then, in order to test the nullity of the coefficients of the demand equation, the corresponding F-statistic is defined as:

$$F = \frac{(SCE^{C} - SCE^{S}) / (K - K^{S})}{SCE^{C} / (T - K)}$$

where:

SCE^{S} = Sum of squared residuals from the equation of supply side model (4) of table 3.

SCE^{C} = Sum of squared residuals from the equation of combined model (10) of table 5.

K = Total number of coefficients combined model = 9.
K^S = Number of coefficients in supply side model = 4.
T = Number of observations.
$K-K^S$ = Number of excluded coefficients.

F-statistic is equal to 2.39. Under null hypothesis, this statistic follows a Snedecor's F- distribution with $K-K^S$ (5) and T-K (167) degrees of freedom, whose critical value for a significance level of 5% is 2.27.

Therefore, the null hypothesis corresponding to joint nullity of the coefficients of the demand side model is marginally rejected at 5%.

The F-statistic that tests the joint nullity of coefficients of the supply side model is, in this case, equal to 4.09 and the critical value of the corresponding F-Snedecor distribution equal to 2.67. Then, this null hypothesis is rejected at 5%.

Therefore, both with the combined model procedure and with the artificial nesting procedure we have found more empirical support for our supply side model. This empirical support is even stronger when we compare their forecasting ability as we do bellow.

Forecast evaluation

We have forecasted industrial output in 1991 and 1992 for the 11 OECD countries considered with the following estimated equations: supply side equation (table 3), demand side equation (table 4) and a new equation that includes both demand and supply side factors.

Thus, we also forecast industrial output using both supply and demand sides, following an equation presented above:

(11) $Q10 = 0.74 * Q10FS + 0.26 * Q10FD$

where:

Q10FS is industrial output forecast with the supply side model (equation 2 and table 1).
Q10FD industrial output forecasting with the supply side model (equation 3 and table 2).

In Table 7 we show some measures that allows us to evaluate the forecasting ability of the aforementioned equations.

Table 7. Forecasting evaluation.
Industrial output forecasts in 11 OECD countries, 1991-92

Model	Table	% RMSE	% MAE.	Theil's U
Supply side	3	2.6269	2.090	0.0087
Demand side	4	5.7117	2.231	0.0189
Combined Model	Equation (6)	3.8936	1.808	0.0132

Note: RMSE = Root mean squared error; MAE = Mean absolute error.

We can conclude that the supply side model offers the best predictions, as it has the lowest values of RMSE and Theil's U. Besides, the forecasting capability is high, as RMSE is under 3%, Theil's U is close to 0 and MAE is close to 2%.

Stability test

Finally, we have addressed the issue of testing the stability of coefficients in the selected model in order to verify whether it can be maintained that the coefficients are stable among the different sections (countries) in the pool, as far as the sample is a pool of data for 11 countries in the period 1975 1990.

First of all, we computed the test of total stability of coefficients. If this hypothesis were binding, the procedure is concluded, otherwise, we would need to test if it is enough to include fixed effects or if it is needed to estimate a different equation for each section in the pool.

With this purpose, we calculate the following statistic:

$$F = \frac{(S2 - S1) \; / \; (gl2 - gl1)}{S1 \; / \; gl1}$$

Where:
S2 = sum of the sums of squared of model 2 (fixed effects).
gl2 = degrees of freedom of model 2 = T – k.
S1 = Sum of squared residuals of model 1 (total stability).
gl1 = degrees of freedom of model 1 = T - p k.
T = Number of observations.
p = number of sections in the pool, 12 countries.
k = number of explanatory variables in the model (including intercept).

Under null hypothesis of total stability of coefficients, the F-statistic follows a Snedecor's F distribution with (gl2-gl1) and gl1 degrees of freedom.

F statistic for supply side model is equal to 1.27, which is lower that the critical value of an F distribution with 50 and 110 degrees of freedom. Consequently, null hypothesis of total stability of coefficients can not be rejected.

6. Conclusions

The main conclusions of this study are as follows:

1) Although with some peculiarities, all the 11 countries analysed have undergone a significant rise in their real value added of manufacturing along the period 1975-1990. In particular we

highlight the increases in this magnitude in the USA and Japan, both in relative and in absolute terms.

2) Industrial output per head in Spain and Portugal, although it has followed a positive path, is well below the average of the other ten countries included in the econometric models.

3) The Davidson and McKinnon test and the F test of the combined model support the hypothesis of the supply side explanation of the evolution of manufacturing output, being

4) In spite of the prevalence of supply side factors, there are also some indications of demand side effects. As Cancelo and Guisan (1998) have shown, when it is analysed causality between industrial output and industrial exports (included in demand side models), it can be concluded that industrial exports are Granger cause of industrial output.

Besides, it must be added that industrial investment (included in supply side models) is collecting some effects that correspond to demand side models, issue that should be addressed in future studies.

5) Industrial investment is the main variable in explaining the performance of industrial output, which can be observed from the estimation of the supply side equation.

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Annex of Data

Most of manufacturing output series (variable Q10) are from OECD *"National Accounts."* They are expressed in milliards of 1990 USA$. However, we needed to use other data sources for some countries such as Spain (INE National Accounts) or the United Kingdom (Eurostat).

R&D expenditure series (variable BRD10) are from OECD *"Research and Development expenditure in industry: 1973-92"* and collect R&D activities undergone by business enterprises in manufacturing. This variable was expressed in real terms with the aid of GDP price index 1990=100, and in USA$ using 1990 rates of exchange.

Industrial employment data, expressed in thousands of persons, are from OECD *"National Accounts"*. For Spain, data are from INE "Encuesta de Población Activa."

The stock of industrial capital is expressed in Billion US$ at 1990 prices and exchange rates. This variable was elaborated with the permanent stock methodology, which incorporates the capital accumulation of capital from gross investment in preceding years, taking in account depreciation. Gross fixed investment in manufacturing series, in 1990 prices, are from OECD National Accounts. For Spain, gross fixed investment in manufacturing is from Mas, Pérez and Uriel (1995). More information in capital stock series can be seen in Cancelo (1996).

Foreign trade data, exports and imports, have been elaborated using series from OECD *Foreign Trade by Commodities*. We have got to proceed putting away crude materials from manufactures. Detailed information of the trade classification used can be seen in Cancelo (1996).

The price indexes used to express trade series in real terms were elaborated with the price index of gross value added in manufacturing and the total export and import price indexes from

OECD National Accounts. More information in this index can be obtained from Cancelo (1996).

Table 8.1 Manufacturing value added in France, Germany, Italy, Japan, UK and USA, (Billion US$90 at exchange rates)

	France	Germay	Italy	Japan	UK	USA
1975	210.19	333.54	138.87	361.78	144.04	632.20
1976	224.51	359.18	156.69	394.33	160.61	692.47
1977	222.99	366.37	160.18	425.64	168.88	740.26
1978	227.82	373.19	162.09	444.52	173.55	782.76
1979	233.27	394.38	173.78	477.92	170.18	800.73
1980	231.80	386.76	195.42	501.92	146.04	766.38
1981	230.15	390.60	188.57	524.33	126.91	834.40
1982	232.21	377.02	186.80	548.09	128.94	794.03
1983	233.22	382.68	188.16	569.60	139.36	817.62
1984	228.98	394.08	196.58	614.51	145.13	877.99
1985	228.16	408.70	203.10	655.25	150.99	900.84
1986	227.68	414.82	207.96	632.32	172.66	909.77
1987	225.63	407.42	216.16	680.58	194.05	978.36
1988	239.15	420.34	232.07	738.18	195.17	1028.0
1989	251.43	434.85	240.60	795.10	207.18	1038.2
1990	256.11	458.88	245.23	852.58	201.40	1032.2
1991	252.12	476.20	244.67	900.96	179.35	1009.0
1992	250.94	464.95	244.56	910.89	178.39	1034.3

Source: Own elaboration based on OECD statistics.

Table 8.2. Manufacturing value added in Belgium[1], Denmark, Netherlands, Portugal and Spain (B$90 at exchange rates)

	Be+Lu	Denm.	Nether.	Portug.	Spain
1975	34.16	16.71	33.76	15.15	73.00
1976	36.58	17.58	33.98	13.77	75.71
1977	33.51	17.56	37.47	11.44	78.83
1978	34.24	17.54	43.48	12.05	81.54
1979	35.53	18.47	47.93	12.88	82.50
1980	36.08	19.24	48.94	13.32	82.46
1981	35.84	18.54	48.83	13.69	81.21
1982	37.21	18.88	46.43	13.57	80.51
1983	39.22	20.11	46.97	13.45	82.58
1984	40.41	21.12	48.82	12.93	82.82
1985	41.00	21.72	49.20	13.24	84.62
1986	40.57	21.68	46.51	14.07	86.55
1987	40.23	20.77	45.14	14.46	91.55
1988	42.50	21.03	48.00	14.80	95.11
1989	45.33	21.28	50.95	16.00	98.72
1990	46.04	20.99	53.80	16.65	101.19
1991	47.08	20.85	55.49	17.00	102.15
1992	47.94	21.15	56.61	17.19	101.26

Source: Own elaboration based on OECD statistics.

[1] Be+Lu corresponds to Belgium and Luxembourg.

Table 9.1. Gross Domestic Product in France, Germany, Italy, Japan, UK and USA (B$90 at exchange rates)

	France	Germany	Italy	Japan	UK	USA
1975	818.49	1003.8	697.05	1565.88	687.77	3586.5
1976	854.51	1058.1	742.91	1631.83	703.21	3759.4
1977	884.71	1088.4	767.98	1708.74	718.46	3929.4
1978	914.63	1120.5	796.26	1791.94	744.07	4119.5
1979	943.65	1169.1	843.93	1891.13	764.59	4222.2
1980	956.75	1184.2	879.69	1959.83	752.05	4205.4
1981	968.17	1189.0	884.54	2029.97	742.25	4297.9
1982	990.43	1184.4	886.43	2094.14	753.74	4205.1
1983	998.26	1206.4	895.01	2150.71	780.50	4356.7
1984	1013.1	1240.4	919.05	2242.46	800.01	4647.0
1985	1031.5	1268.5	942.95	2354.22	828.24	4793.2
1986	1056.3	1301.7	970.50	2416.08	864.67	4926.5
1987	1079.2	1328.7	1000.9	2515.28	905.84	5078.5
1988	1125.1	1379.0	1041.6	2671.42	950.97	5278.5
1989	1167.4	1428.2	1072.2	2797.38	971.69	5422.4
1990	1195.4	1501.0	1095.1	2932.09	975.51	5489.6
1991	1204.8	1557.8	1108.3	3056.97	956.23	5464.7
1992	1221.0	1566.6	1116.4	3090.66	951.14	5600.1

Source: OECD. National Accounts Statistics.

Table 9.2. Gross Domestic Product in Belgium[1], Denmark, Netherlands, Porgual and Spain (B$90 at exchange rates)

	Bel-Lu	Denm.	Nether	Portugal	Spain
1975	143.63	93.33	200.69	39.13	335.02
1976	151.45	99.38	210.97	41.83	346.09
1977	152.23	100.99	215.86	44.17	355.92
1978	156.49	102.48	220.95	45.41	361.12
1979	159.84	106.11	225.87	47.98	361.27
1980	166.48	105.64	228.59	50.18	365.97
1981	164.93	104.70	227.43	50.99	365.33
1982	167.41	107.86	224.79	52.08	371.05
1983	168.37	110.58	228.63	51.99	379.28
1984	172.36	115.43	236.15	51.01	384.85
1985	173.96	120.38	243.42	52.44	394.90
1986	176.62	124.77	250.12	54.61	407.54
1987	180.22	125.14	253.66	57.64	430.53
1988	189.12	126.59	260.29	60.98	452.75
1989	195.80	127.31	272.47	64.48	474.20
1990	202.35	129.13	283.67	67.24	491.94
1991	206.92	130.86	290.11	68.68	503.10
1992	210.71	131.94	295.99	69.43	506.46

Source: OECD National Accounts Statistics.
[1] Be+Lu corresponds to Belgium and Luxembourg.

Table 10.1. R&D Expenditure of Business Enterprises in the Manufacturing : France, Germany, Italy, Japan, UK and USA (Billion$90 at exchange rates)

	France	Germany	Italy	Japan	UK	USA
1975	8.09	12.93	2.79	16.78	7.92	52.98
1976	8.40	13.50	2.68	17.46	8.42	55.52
1977	8.58	14.01	2.74	18.33	8.67	57.39
1978	8.81	16.02	2.76	19.04	9.31	59.29
1979	9.29	17.73	3.19	21.59	10.47	62.29
1980	9.76	18.36	3.44	24.36	10.39	66.29
1981	10.44	18.79	3.83	27.29	10.37	70.69
1982	10.92	19.70	4.02	29.99	10.23	74.90
1983	11.09	20.14	4.29	33.32	10.03	79.50
1984	11.84	20.98	4.68	36.69	10.58	86.29
1985	12.65	23.54	5.48	42.04	10.99	92.51
1986	12.82	24.45	5.80	42.55	11.57	93.57
1987	13.40	26.02	6.17	45.23	11.66	95.27
1988	14.04	27.19	6.61	50.03	12.15	94.02
1989	15.11	28.32	7.00	56.03	12.44	91.69
1990	16.10	28.53	7.41	61.47	12.57	88.93
1991	16.42	28.21	7.49	63.50	11.24	85.51
1992	16.38	27.26	7.40	61.07	11.13	86.05

Source: Own elaboration based on OECD statistics.

Table 10.2. R&D Expenditure of Business Enterprises in Manufacturing: Belgium[1], Denmark, Netherlands, Portugal and Spain (B$90 at exchange rates)

	Bel-Lu	Denm.	Nether	Portugal	Spain
1975	1.13	0.35	1.94	0.02	0.47
1976	1.19	0.38	1.96	0.02	0.49
1977	1.23	0.38	1.87	0.02	0.52
1978	1.28	0.39	1.90	0.01	0.54
1979	1.31	0.41	1.94	0.02	0.56
1980	1.37	0.43	1.98	0.03	0.66
1981	1.40	0.46	2.01	0.03	0.59
1982	1.48	0.51	2.02	0.03	0.76
1983	1.56	0.57	2.20	0.03	0.75
1984	1.68	0.60	2.22	0.04	0.85
1985	1.77	0.63	2.55	0.04	1.00
1986	1.81	0.70	2.92	0.04	1.14
1987	1.89	0.76	3.15	0.04	1.22
1988	1.96	0.79	3.18	0.04	1.45
1989	1.92	0.81	3.11	0.06	1.56
1990	1.94	0.86	2.90	0.07	1.93
1991	1.96	0.92	2.63	0.07	1.93
1992	1.96	0.92	2.54	0.07	1.81

Source: Own elaboration based on OECD statistics.
[1] Be+Lu corresponds to Belgium and Luxembourg.

Table 11.1. Manufacturing Stock of Capital, B$90, in France, Germany, Italy, Japan, UK and USA

	France	Germany	Italy	Japan	UK	USA
1975	335.19	502.86	341.61	769.07	281.63	1091.5
1976	350.60	501.52	349.96	796.00	287.85	1112.5
1977	366.19	501.04	357.15	850.13	292.77	1133.5
1978	380.58	501.44	363.76	862.55	298.12	1158.8
1979	394.12	501.50	367.61	911.11	304.24	1191.7
1980	407.23	503.90	372.22	927.64	310.60	1228.0
1981	421.44	508.09	395.96	986.31	313.37	1263.9
1982	432.25	522.92	413.48	1028.8	313.08	1315.9
1983	440.15	532.84	427.36	1043.7	311.78	1354.9
1984	446.13	542.77	437.82	1074.3	309.76	1368.7
1985	451.29	551.50	449.34	1148.9	310.24	1394.9
1986	458.19	565.34	458.35	1174.1	313.01	1431.1
1987	465.60	582.91	467.70	1218.9	313.89	1449.3
1988	473.75	602.94	481.09	1269.1	315.82	1473.3
1989	484.83	623.61	500.94	1328.5	319.98	1496.3
1990	497.85	649.01	516.58	1395.5	326.63	1537.4
1991	513.26	681.35	531.41	1470.9	331.87	1581.4
1992	524.98	716.10	545.74	1548.4	334.05	1619.9

Table 11.2. Manufacturing Stock of Capital, B$90, in Belgium[1], Denmark, Netherlands, Portugal and Spain

	Bel-Lu	Denm.	Nether	Portugal	Spain
1975	43.34	32.45	101.08	22.25	118.85
1976	44.94	33.25	103.47	23.16	126.93
1977	46.61	34.39	104.92	24.05	134.32
1978	48.21	35.33	107.11	25.13	140.18
1979	49.56	36.13	109.76	26.37	144.71
1980	50.92	36.92	112.44	27.67	148.59
1981	53.03	37.71	114.78	29.10	151.09
1982	54.60	37.99	115.91	30.69	152.31
1983	56.51	38.09	116.55	32.66	152.43
1984	58.33	38.14	117.15	34.06	151.39
1985	60.33	38.68	118.77	34.77	149.88
1986	62.65	39.88	120.67	34.82	148.68
1987	65.65	41.43	123.18	35.89	147.40
1988	68.93	42.56	125.51	37.57	146.92
1989	73.36	43.55	127.05	39.56	147.04
1990	79.31	44.46	128.59	41.82	148.24
1991	86.82	45.25	130.67	44.29	150.01
1992	94.05	46.30	132.72	46.79	153.54

Table 12.1. Manufacturing Employment in Germany, France, Italy, Japan, UK and USA (thousands of workers)

	Germany	France	Italy	Japan	UK	USA
1975	9106	5604	5626	14228	7654	18690
1976	8915	5548	5641	14156	7411	19412
1977	8927	5571	5831	14014	7461	19557
1978	8906	5497	5793	13816	7427	20417
1979	9011	5397	5887	13791	7395	20959
1980	9094	5318	5966	14057	7081	20180
1981	8930	5232	5750	14204	6365	20120
1982	8669	5150	5602	14131	6005	18631
1983	8379	5049	5382	14360	5664	18340
1984	8341	4904	5140	14654	5579	19300
1985	8445	4774	5070	14780	5561	19104
1986	8580	4687	5043	14701	5430	18889
1987	8585	4570	4993	14519	5395	18962
1988	8569	4504	5076	14817	5476	19375
1989	8692	4528	5120	15118	5512	19441
1990	8932	4558	5140	15348	5494	19111
1991	9061	4488	5041	15834	5313	18431
1992	8899	4348	4853	16060	5193	18076

Table 12.2. Manufacturing Employment in Belgium[1], Denmark, Netherlands, Portugal and Spain (thousands of workers)

	Bel-Lu	Denm.	Nether	Portugal	Spain
1975	1143	504	1112	910	3536
1976	1098	505	1067	912	3234
1977	1019	503	1039	911	3280
1978	978	500	1014	925	3156
1979	950	499	1004	947	3086
1980	910	490	993	970	2967
1981	860	472	963	976	2834
1982	838	470	922	962	2671
1983	820	471	883	956	2604
1984	812	495	873	919	2536
1985	800	523	903	906	2442
1986	792	542	914	1076	2491
1987	774	535	924	1091	2612
1988	771	523	931	1114	2666
1989	781	517	944	1134	2756
1990	787	517	962	1205	2833
1991	779	505	959	1241	2759
1992	776	499	949	1167	2685