Aquest document pertany al Departament d'Economia Aplicada.
Data de publicació: *setembre 1998*

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LABOUR DEMAND IN SPANISH INDUSTRY.

A PANEL DATA ANALYSIS

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ABSTRACT

A labour demand equation is analysed for ten industries of the Spanish manufacturing sector, during the period 1978-1992. Using Limdep, we estimate different panel data models and find that the level of employment is highly sensitive to the output level, so that a strong expansionary business cycle is crucial for the recovery of labour demand, whereas increases in wages have a moderatly negative effect. One of the most robust results indicate constant returns to scale for Spanish industry during this period. From our theoretical approach, we estimate a quick adjustment of the employment to its equilibrium level, although it is pointed out that other theories can more accurately capture this effect. The reduced sample size from our survey makes it very difficult to establish policy implications from this analysis.

1.- Introduction.

During the eighties the Spanish economy experienced structural change. This change had a big impact in many fields, but especially in the composition of employment by sectors, and also in the unemployment rate. Changes in the composition produced a reduction in the number of employees in agriculture and industry, and an increase in the third sector. Our research concerns the changes in employment in Spanish industry during the period 1978-1992, with a critical period between 1978-1985, with a strong industrial crisis, and a period of stability in the number of employees during 1986-92.

The industrial crisis was characterised by a huge loss of jobs and accompanied by a reduction in the number of firms in some industries. In 1984 there was a reform of the legislation concerning the labour market. Its main objective was to introduce a new range of labour contracts and a flexibility of the labour market, especially oriented to the reduction of the firing costs. This effect will be captured through the elasticity of employment with respect to wages.

From 1985 the Spanish economy began an expansionary period with the creation of two million jobs until 1991, but with a reduction in the number of unemployed of 500,000 workers. The aggregate demand, stimulated mainly by private consumption was very high during these years, and firms were compelled to hire workers. Therefore, the effect of the rise in production should be very significant in the explanation of the number of employees during this period. Also, the highest investment rates in the economy led the industry to an important change in its structure which was largely modernised, the productivity rate growing rapidly. This element makes us think that the analysis of the technical change should give interesting results; hence, we have added a section about the estimated technical change.

Labour demand in Spain has been analysed in some articles, for the whole economy and for the industrial sector in particular. These studies appeared mainly during the eighties, but we will try to establish some comparisons between their results and our findings.

Data availability has conditioned our analysis. We have time series data with a reduced number of observations, from 1978 to 1992. This data is available for ten different industries, so our approach to labour demand is done through a panel data analysis, using LIMDEP to run the regressions.

2.- The model.

2.1.- Description of the model.

We use a Cobb-Douglas production function with capital and labour as inputs, adding a trend that aims to control the effect of technical change. We assume a perfect competitive market in order to express the capital-labour rate in equilibrium as depending on the relative prices of the inputs. The model is presented as in Raymond (1983).

Being Y the output level, K the capital stock and N the number of employees, we write the aggregate production function as,

$$\ln Y = \ln A + \alpha_1 \ln K + \alpha_2 \ln N + \gamma^{\prime},$$

adding and subtracting ln N from the right hand side,

$$\ln Y = \ln A + \alpha_1 \ln K + \alpha_1 (\ln N - \ln N) + \alpha_2 \ln N + \gamma^{t}$$

collecting the terms, we obtain the capital-labour ratio in the equation,

$$\ln Y = \ln A + \alpha_1 \ln \frac{K}{N} + (\alpha_1 + \alpha_2) \ln N + \gamma^{t}$$

Define $S = \alpha_1 + \alpha_2 - 1$, as the returns to scale minus one. Then,

$$\boxed{\ln Y = \ln A + \alpha_1 \ln \frac{K}{N} + (1+S) \ln N + \gamma^{t} \qquad (1)}$$

Solving the profit maximization problem of the firm we obtain the capital-labour ratio in equilibrium. Once obtained, we will substitute it in equation (1).

$$Max\ \pi = pY - wN = p\left[AK^{\alpha_1} N^{\alpha_2}\right] - wN$$

From the first order condition with respect to N,

$$\frac{\partial \pi}{\partial N} = 0 \Rightarrow p\alpha_2 A K^{\alpha_1} N^{\alpha_2 - 1} - w = 0 \Rightarrow K^{\alpha_1} N^{-(1-\alpha_2)} = \frac{1}{\alpha_2 A}\frac{w}{p}$$

Given that $\alpha_1 = (1-\alpha_2)$,

$$\left(\frac{K}{N}\right)^{1-\alpha_2} = \frac{1}{\alpha_2 A}\frac{w}{p} \Rightarrow \frac{K}{N} = \left(\frac{1}{\alpha_2 A}\right)^{\frac{1}{1-\alpha 2}}\left(\frac{w}{p}\right)^{\frac{1}{1-\alpha 2}}$$

Once we have the optimum capital-labour ratio for the firm, and because the marginal product of each factor equals its relative price (we have assumed perfect competition), we can express the capital-labour ratio as being proportionate to the ratio between its relative prices: $\frac{K}{N} \propto \frac{P_L}{P_K}$.

As a proxy of the labour price we take all the wages paid by firms divided by the number of workers, and as proxy of the capital price we take the Industrial Price Index.

$$\boxed{\ln\frac{K}{N} = \lambda_0 + \lambda_1 \ln\frac{w}{p} \qquad (2)}$$

Now we have the capital-labour ratio at its optimum level. We can introduce this relationship in the production function in order to obtain a function where the output depends on the relative prices ratio, on the number of employees, on the wage level and the trend. Solving for the equations (1) and (2),

$$\ln N = -\left(\frac{1}{1+S}\ln A + \frac{\alpha\lambda_0}{1+S}\right) - \frac{\alpha\lambda_1}{(1+S)}\ln W + \frac{1}{(1+S)}\ln Y - \frac{\gamma}{(1+S)}t$$

Rewriting the coefficients,

$$\boxed{\ln N_t = \beta_0 + \beta_1 \ln Y_t - \beta_2 \ln W_t - \beta_3 T}$$

which is the equation to regress.

One of the crucial assumptions needed is the exogeneity of the right hand side variables, which is justified with the former assumption of perfect competition. If Spanish industry operates in a competitive market, then the output level produced by each industry does not affect either the output prices or the inputs prices (capital price and wages, as the price of the labour input). If we

can accept this assumption from an empirical point of view, that will validate the theoretical model.

2.2.- The statistical model.

When running the regressions we are going to add the lagged dependent variable in the right hand side of the equation. This form allows us a more general approach.

$$\boxed{\ln N_t = \beta_0 + \beta_1 \ln Y_t - \beta_2 \ln W_t - \beta_3 T + \beta_4 \ln N_{t-1}}$$

This form is known as a Partial Adjustment Model (PAM) and it is very useful for two reasons.

First, we can have a measure of the speed of adjustment of the variable that we are seeking to explain, and, also say something about its convergence to its equilibrium level. In our equation, the speed of adjustment comes from $\lambda = 1 - \beta_4$.

Second, the specification of a long-run relationship allows us to calculate the long-run elasticities of employment with respect to output and wages, giving an appropriate measure of sensitivity.

Assuming that in equilibrium $N_t = N_{t-1}$, the long-run elasticities can be expressed as,

$$\varepsilon_{N-Y} = \frac{\beta_1}{1-\beta_4} \qquad \varepsilon_{N-W} = \frac{\beta_2}{1-\beta_4}$$

The regression will also enable the calculation of the returns to scale in Spanish manufacture. These being defined by S. The theoretical model gives us the formula to calculate them: $\beta_1 = \frac{1}{1+S}$.

The analysed sample involves two different business cycles. We have divided it into two groups, in order to distinguish the change in the main elements that affect employment in the two different periods. We will have some problems derived from the reduced number of observations available, but is an important exercise towards the understandig of the nature changes which have occured in Spanish industry from the second half of the eighties.

3.- The data.

3.1.- Source and Variables.

The data used in our analysis come from a survey called Enquesta Industrial (EI from now on) (Industrial Survey) made by the Instituto Nacional de Estadistica (INE) in Spain. In this Survey the establishments with 20 or more workers are exhaustively taken into account, while only a sample analysis is carried out with respect to the others. It is a quite new survey, and data starts only from 1978, our sample ending at 1992 although data is available until 1994.

The EI provides data for 89 types of industries, 81 of which belong to the manufaturing industry. Some of these industries were analysed during the eighties by the Spanish Ministry of Industry. In these cases we do not have a homogeneous series corresponding to that industry, because the INE's series start only at the beginning of the nineties. In order to undertake our analysis of Spanish industry we have to aggregate the industries following the standard classification into 14 groups which comes from the Clasificacion Nacional de Actividades Economicas (CNAE). The main industry to be omitted is number (9) in table 3.1, transport material, so we do not have data for car production, which is an important industry in Spain. Other branches that are missed are displayed in the table below, where the column 'availability' shows which sectors will not be analysed (1,2,3,9).

Table 3.1

SECTOR	EI	CNAE (1974)	Availability
(1) Energy	1-8	11-16	Missing
(2) Metal minerals, metallurgy, steel and iron	9-11	21-22	Missing
(3) Minerals and non-metal products	12-18	23-24	Missing
(4) Chemical products	19-30	25	Complete
(5) Metal Products	31-35	31	Complete
(6) Machinery	36-37	32	Complete
(7) Office materials and others	38,46	33,39	Complete
(8) Electrical materials	39-40	34,35	Complete
(9) Transport materials	41-45	36-38	Missing
(10) Food	47-64	41,42	7/18 missing
(11) Textiles, clothes and shoes	65-74	43-45	Complete
(12) Paper and derivatives	80-82	47	Complete
(13) Rubber and plastics	83-84	48	Complete
(14) Wood, cork and other manufactures	75-79 85-89	46,49	1/8 missing

Thus, we will analyse 10 groups of industries, with data for the period 1978-1992. The analysis will be done using a panel data with 140 observations, although we display the regressions corresponding to the individual industries.

For our dependent variable we use the total number of employees in levels. This series correspond to the mean of the number of employees for four points of the year: 31st March, 30th June, 31st October and 31 December. All the people working for the firm, including home workers, are included. Before running the regressions we have transformed the series into logarithms.

For the output, our source provides the 'total production ready to be sold', which are all the goods and services arising from the economic activity of the firm. It is not relevant if they have been sold or remain in stock, what matters is if they have been produced during the year. Our source also has data concerning the added value of each industry. We have chosen the former because the Cobb-Douglas production function relates the inputs -labour and capital- to total output, and not to added value. A second reason is that we have assumed perfect competition, so the firm is 'price-taker' and the market clears. In this sense, the 'total output ready to be sold' is a better proxy than the added value.

Because the series was specified in nominal terms, we have deflated it by the Industrial Price Index, with non aggregate figures for each sector. We have then transformed the series into logarithms in order to intepret its coefficient as an elasticity. The estimated elasticicity with respect to output will indicate the aggregate demand effect on the level of employment.

With regard to wages we are interested not in net wages received by employees, consumption-wage, but in the wages paid by the firm to the workers with the social taxes included, production-wage. We have the total labour force costs, that is, the cost of employees' salaries and taxes that are paid by employers, with payments for domestic work included. This provides the total gross wages which, divided by the number of employees, gives us the gross wage per employee. As before, we have deflated the series to obtain the gross real wage and we have used logarithms in order to intepret the coefficient as an elasticity. This elasticity will reflect the sensitivity of employment with regard to gross wages increases.

Finally, following Solow's Residual concept, we add a homogeneous trend with value zero in the first year and value 14 for the fourteenth observation. This trend, in the context of a Cobb-Douglas production function, captures the technical change.

3.2. Problems.

The problems with the data arise from the reduced number of observations. Our series starts in 1978 and finishes in 1992, so we have fifteen observations per industry. We drop one to regress the PAM model, which has five parameters to estimate. That leaves us with nine degrees of freedom which is the very minimum required to run a regression. As it will be seen, because of the reduction of the number of degrees of freedom, our results are not entirely satisfactory. This problem desappears when we use panel data for all manufacturing industry.

A second problem concerns some particularities of the data, especially in the first period of the sample. Accordingly, we have plotted the series of employees numbers in order to calculate the growth rates and to check for the possibility of outliers (see appendix).

The main feature is the general reduction in the number of employees in 1980. Seven of the ten groups lost around 10% or more of the employees. Only in the chemical products industry (4) is there an increase in the number of employees, and it can be viewed as an outlier, because it is the only year before 1984 that has an increase in the number of workers. The change in 1980 in the metal products industry (5) and in food (10) is also extreme in the context of the time path of this variable in those sectors. In the last one there is also an unexpected increase in the labour force during 1983, which breaks the downwards tendency. Finally, the behaviour of firms producing rubber and plastics is somehow erratic with some strange changes before 1985. Another general feature is that after 1986, with the new business cycle, the possibility of outliers disappears and the series has a clearer pattern. As will be seen this might have affected the

regression of the whole sample and the first subsample, the one corresponding to 1986-92 being more precise.

4.- Estimation results.

4.1.- Statistical parameters of interest for individual industries.

The results of the OLS estimations, group by group, are presented in tables 4.1 and 4.2, the first one corresponding to the static model and the second to the dynamic one. The static model represents a good adjustment to the data, although it is improved by the PAM. The Durbin-Watson statistic falls, in seven of the ten groups, to the inconclusive zone, whereas in the other three groups there are no autocorrelation problems. The sign and significance of the output coefficient are correct. Only in two of the industries are they not significant. The coefficient of wages and trend do not behave as expected, with small significance in most of the groups, and the sign not always correct. This analysis leads us to try to find a better specification of the model which will consist, as we already know, in adding a lagged dependent variable to the right hand side. The results of the new specification are presented in table 4.2.

Table 4.1*

Model: Static
Procedia: OLS per each industry
Period: 1979-1992
Number of Obervations: 14

	Y	W	T	R^2	DW
(4) Chemical products	0.20	-0.11	-0.00	0.55	1.3
	(2.4)	(-1.2)	(-0.4)		
(5) Metal Products	0.52	-0.22	-0.01	0.94	1.6
	(5.5)	(-1.5)	(-0.8)		
(6) Machinery	0.54	-0.00	0.01	0.92	0.9
	(3.5)	(-0.0)	(1.1)		
(7) Office materials and others	0.24	1.1	0.07	0.64	1.4
	(1.3)	(4.2)	(3.9)		
(8) Electrical materials	0.40	0.01	-0.02	0.99	2.9
	(8.6)	(0.2)	(-9.3)		
(10) Food	0.51	-0.36	-0.00	0.43	1.3
	(1.1)	(-0.7)	(-0.3)		
(11) Textiles, clothes and shoes	0.70	-0.52	-0.02	0.99	1.5
	(8.1)	(-5.2)	(-8.4)		
(12) Paper and derivatives	0.50	-0.15	0.02	0.93	2.0
	(4.3)	(-0.9)	(3.1)		
(13) Rubber and plastics	0.32	-0.08	0.02	0.79	2.1
	(3.3)	(-0.5)	(2.4)		
(14) Wood, cork and other manufactures	0.36	0.03	0.01	0.97	1.9
	(5.8)	(0.2)	(-1.3)		

(*) t-statistic in parentheses.

With the new specification the degree of adjustment has improved, while the level of autocorrelation -following the Durbin Watson test- remains in the inconclusive zone in most of the industries. The new variable is not entirely satisfactory because in half of the industries it has the unexpected sign, although the coefficient is not significant in these cases. When it is significant, the magnitude of the coefficient is around the a-priori expected one. The output coefficient remains correct and with even more significance, and the signs and coefficients of the wages and the trend, have improved somehow, especially as far as the signs are concerned.

Table 4.2*

Model: PAM
Procedia: OLS per each industry
Period: 1979-1992
Number of Obervations: 14

	Y	W	T	N-1	R^2	DW
(4) Chemical products	0.31	-0.35	-0.01	0.98	0.86	2.5
	(5.5)	(-4.5)	(-3.7)	(4.5)		
(5) Metal Products	0.52	-0.21	-0.01	-0.00	0.94	1.5
	(5.0)	(-1.3)	(-0.7)	(-0.1)		
(6) Machinery	0.61	-0.52	-0.01	0.47	0.95	1.4
	(4.7)	(-1.7)	(-0.7)	(2.4)		
(7) Office materials and others	0.11	-0.08	-0.00	0.84	0.69	1.9
	(0.6)	(-0.1)	(-0.0)	(1.3)		
(8) Electrical materials	0.4	-0.01	-0.02	0.05	0.99	3.0
	(8.0)	(-0.2)	(-7.8)	(0.4)		
(10) Food	0.27	-0.41	-0.01	0.78	0.71	2.3
	(0.8)	(-1.0)	(-0.9)	(3.0)		
(11) Textiles, clothes and shoes	0.71	-0.52	-0.02	-0.06	0.99	1.5
	(7.0)	(-4.7)	(-5.7)	(-0.3)		
(12) Paper and derivatives	0.57	-0.13	0.03	-0.18	0.93	2.0
	(3.2)	(-0.7)	(2.2)	(-0.5)		
(13) Rubber and plastics	0.34	0.12	0.03	-0.47	0.84	1.5
	(3.8)	(0.6)	(2.9)	(-1.7)		
(14) Wood, cork, other manufs.	0.37	0.03	-0.01	-0.02	0.97	1.8
	(4.6)	(0.2)	(-1.3)	(-1.1)		

(*) t-statistic in parentheses.

The results of the non-aggregate regressions are not what was expected, so the following step, before going further in our analysis, is to pool the industries in one sample and use panel data in order to obtain better results. However, first we have to test if the data allows us to treat the different groups as a whole unit with a relatively homogeneous structure. This is what we try with the following tests.

4.2.- Tests for structural stability.

Before running the regressions with panel data we have to check the homogeneity of the coefficients and the variances. If we accept this homogeneity we can apply a fixed effects model. Following Pesaran, Smith and Yeo (1991) we can apply a likelihood ratio test to check for the homogeneity of coefficients and variances. Depending on the results we can express our model in different ways:

1.- Different coefficients and variances.

$y_{ti} = X_{ti} b_i + e_{ti}$; $e_i \sim N(0, \sigma_i^2 I)$ with $i = 1,...,10$ industries and $t = 1,...,14$ observations.

For the likelihood ratio test we need the estimated variance, which is,

$\hat{s}_i^2 = \frac{\hat{e}_i' \hat{e}_i}{t_i}$, and from here we calculate the maximized value of the log likelihood estimator: $l = -(t_i / 2) \sum_{i=1}^{10} \ln \hat{s}_i^2$.

2.- Same coefficients and same variance.

$y_{ti} = X_{ti} b + e_{ti}$; $e_i \sim N(0, \sigma^2 I)$ with $i = 1,...,10$ industries and $t = 1,...,14$ observations. The variance will be,

$\hat{s}_0^2 = \frac{\hat{e}_0' \hat{e}_0}{t_0}$, with the maximized likelihood function,

$l_{b_\sigma} = -(t_0 / 2) \ln \hat{s}_0^2$

3.- Different coefficients, same variance.

$y_{ti} = X_{ti} b_i + e_{ti}$; $e_i \sim N(0, \sigma^2 I)$ with $i = 1,...,10$ industries and $t = 1,...,14$ observations. The variance is,

$\hat{s}_i^2 = \sum_{i=1}^{10} \hat{e}_i' \hat{e}_i / t_0$, and the maximized likelihood function,

$l_\sigma = -(t_0 / 2) \ln \hat{s}^2$

With all this information, we can now test which one of the models is a better representation of our data generation process.

A.- First of all we test equality of variance not conditional on coefficient equality.

$LR_\sigma = 2(l - l_\sigma) \sim x_r^2$, where r is the number of restrictions involved in obtaining the null from the alternative hypothesis.

This a test for homoscedasticity. If we do not reject the null hypothesis means that all the variances are the same, so we have homoscedasticity. The test shows that we reject homoscedasticity, and each sector has a variance that differs from the others.

STATIC MODEL	PAM
LR=2(491-462) =58 ; X^2_9=16.92	LR=2(531-478) =106 ; X^2_9=16.92

B.- Coefficient equality conditional on variance equality.

$LR_{b/\sigma} = 2(l_\sigma - l_{b\sigma}) \sim x_r^2$

We have not the same variances per industry, but assuming that this was true, can we say that the coefficients are the same in each group? If yes, this test provides a justification for running a fixed effects model. But again, we reject the null hypothesis and we have to consider aech sector as having its own different structure.

STATIC MODEL	PAM
LR=2(462-351) =222 ; X^2_{27}=40.11	LR=2(478-427) =102 ; X^2_{36}=49.52

C.- Finally we test equality on both coefficients and variances.

$LR_{b\sigma} = 2(l - l_{b\sigma}) \sim x_r^2$

Along with the former results we also reject the possibility of equality of the coefficients and variances.

STATIC MODEL	PAM
LR=2(491-351) =280 ; X^2_{36}=49.52	LR=2(531-427) =208 ; X^2_{45}=61.37

We reject the null hypothesis in all the cases, so we have to conclude that each industry has a particular structure and, thus, has different coefficients and variances. Having undertaken the test, then, we have not found a justification to use panel data. However, the small number of observations and the possibility of outliers makes us think that is useful to group the data in order to reduce the measurement errors by aggregation. In the next section we present the models that we have estimated using panel data.

4.3.- Panel data models.

The regressions have been run specifying one way fixed effects, random effects, and a random coefficients model, following Swamy (1974). In order to estimate the changes in the technical progress we have also tried a two ways fixed effects model.

1. Fixed Effects Model (FEM):

$y_{it} = \alpha_i + \beta' X_{it} + e_{it}$; $e_{it} \sim N(0, \sigma^2 I)$ with $i = 1,\ldots,10$ industries and $t = 1,\ldots,14$ observations. This model assumes that differences across groups can be captured in differences in the constant term, and is estimated using OLS. In fact, this model is a particular case of the random coefficients model, as we will explain.

> "The fixed effects model is a reasonable approach when we can be confident that the differences between units can be viewed as parametric shifts of the regression function". (Greene, 1992, pp. 469).

2.- Random Effects Model (REM):

$$y_{it} = \alpha_i + \beta' X_{it} + e_{it} \quad ; \quad \alpha_i = \alpha + \mu_i \quad ; \quad e_{it} \sim N(0, \sigma^2 I)$$

$$y_{it} = \alpha + \mu_i + \beta' X_{it} + e_{it} \quad \text{with } E[\mu_i] = 0$$

$$= \alpha + \beta' X_{it} + \varepsilon_{it} \quad ; \quad \varepsilon_{it} = (\mu_i + e_{it})$$

The random effects model views the individual specific terms as randomly distributed across cross-sectional units, and is estimated by GLS. In the first stage we use the FEM to estimate the variance of the errors. We then substitute this estimate to regress the REM. This estimator is a weighted average of the FEM and the OLS; that is, it is a weighted average between the within variation and the between variation. The weight of each source of variation

depends on $\phi = 1 - \dfrac{\text{var}(\varepsilon_{it})}{t\,\text{var}(\mu) + \text{var}(\varepsilon_{it})}$, which depends on the variances of each model. If $\phi = 1$ the REM is like the FEM, the second one being a special case of the first one.

3.- Random Coefficients Model (RCM):

Some authors have suggested that is not realistic to assume no parameter variation across groups. This heterogeneity, between industries in our case, can be reasonably viewed as due to stochastic variation. We can write, then,

$$y_{it} = \alpha + \beta_i' X_{it} + e_{it} \quad ; \quad \beta_i = \beta + \eta_i \quad ; \quad e_{it} \sim N(0, \sigma^2 I)$$

$$y_{it} = \alpha + \eta_i X_{it} + \beta' X_{it} + e_{it} \quad \text{with } E[\eta_i X_{it}] = E[\eta_i] E[X_{it}] = 0$$

$$= \alpha + \beta' X_{it} + u_{it} \quad ; \quad u_{it} = (\eta_i + e_{it})$$

The GLS estimator in this case is a weighted average of the OLS estimators for the different groups.

4.- Two ways FEM.

We have estimated this model in order to more closely analyse the technical progress. With the one way FEM we have a homogeneous trend and do not allow it to vary across years. In this case the group differences are captured through individual intercepts as before, but we also let the trend vary between years. It is essentially the same model, but it allows us to look at the changes in the importance of the technological change.

$$y_{it} = \alpha_i + \alpha_t + \beta' X_{it} + e_{it} \quad ; \quad e_{it} \sim N(0, \sigma^2 I)$$

4.4.- Statistical parameters of interest using panel data.

Tables 4.3 and 4.4 present the result of the regressions for these three models, in the case of both, the static and the dynamic specification.

Table 4.3*

Model: Static
Procedia: Panel Data
Period: 1979-1992
Number of Observations: 140

	Y	W	T	R^2
EFM	0.19	0.18	0.01	0.99
	(3.9)	(2.2)	(1.5)	
REM	0.32	0.01	0.00	0.48
	(7.1)	(0.1)	(0.1)	
RCM	0.43	-0.03	0.00	0.60
	(7.5)	(-0.2)	(0.5)	

(*) t-statistic in parentheses.

Table 4.4*

Model: PAM
Procedia: Panel Data
Period: 1979-1992
Number of Observations: 140

	Y	W	T	N-1	R^2
EFM	0.15	-0.17	-0.00	0.77	0.99
	(5.0)	(-3.2)	(-1.2)	(15)	
REM	0.11	-0.15	-0.00	0.87	0.99
	(5.8)	(-4.9)	(-0.8)	(42)	
RCM	0.40	-0.23	-0.00	0.29	0.87
	(6.2)	(-2.6)	(-0.7)	(1.8)	

(*) t-statistic in parentheses.

As we can see, the partial adjustment model provides better estimations of the parameters with all the models. All the coefficients, except the trend (which is in fact a residual that captures the effects not captured by the other variables) and, in the random coefficients model, the lagged dependent variable, are significant. In the static specification, wages are not significant either in the random effects or in the random coefficients model. In the dynamic regression, all the signs are correct, although the coefficients of the trend are not significantly different from zero. The coefficient of determination is also higher in the dynamic specification. We conclude, then, that the PAM version of the model better fits our data, and accordingly will be our reference.

Within the PAM specification, we still have to determine which one of the models have a better adjustment. The differences between the results are especially relevant in the coefficient of the lagged dependent variable. The RCM has a coefficient of 0.29 non significant (only with a critical value of 7.5% would be significant), whilst the FEM and the REM have a coefficient of

0.77 and 0.87 respectively. All the other coefficients, which are commented on in section 5.2 below, are very similar. Using the estimated variances we obtain a value ϕ=0.84, which indicates that the estimates from the REM are close to the FEM ones. Limdep could not run the Hausman test, but from similar coefficients and high value of ϕ we can conclude that the REM would be accepted.

The RCM represents a 28% error in fitting the actual values on average, much larger than the other models (5% and 5.1% respectively for the FEM and the REM). The RCM imposes less restrictions and is more realistic, what is coherent with the rejection of homogeneus structures of the industries.

In the FEM, the estimated autocorrelation is -6.6%. In the REM, is -13.1%, while the average estimated correlation of the errors within a group, from year to year is 12,2%. This is reasonably low. For this model, the output from Limdep represents a LM test for autocorrelation, LM=0.54 vs. X^2_1=3.99 ; hence, we accept the hypothesis of non-autocorrelation of the errors.

To test for heteroscedasticity we have run a reset test. Limdep regress the squared residuals in different ways such that we can test for different kinds of heteroscedasticity.

Table 4.5: Heteroscedasticity tests.

	MLL		MLL		
$\hat{e}^2_{it} = \alpha$ (1)	515.2	$\hat{e}^2_{it} = \alpha_i$ (3)	518		
$\hat{e}^2_{it} = \alpha + \beta \hat{y}^2_{it}$ (2)	521.3	$\hat{e}^2_{it} = \alpha_i + \beta \hat{y}^2_{it}$ (4)	526		
LR test	LR	$x^2_{5\%}$	Res.(5%)	Prob. Value	Res.(1%)
(2) vs. (1)	12.2	x^2_9= 16.2	ACCEPT	0.20175	
(3) vs. (1)	5.7	x^2_1= 3.84	REJECT	0.01711	ACCEPT
(4) vs. (1)	21.6	x^2_{10}= 18.31	REJECT	0.01727	ACCEPT

At 5% we do not reject the restrictions imposed for model 1 with respect to model 2. There is not heteroscedasticity between groups which is important. The other tests show some relationship between the independent variables, but we would accept homoscedasticity at a 1% level. We can conclude, then, that the model does not have important problems of heteroscedasticity. The estimates are unbiased even with heteroscedasticity and that does no affect our long run elasticities. The only effect could be a slight change in the significativity of the parameters, but not enough important to affect its significativity.

Finally, we have tested the functional form. The Cobb-Douglas production function, on the contrary of a CES function, assumes that there are no cross-products. To test this we have regressed $\hat{e}_{it} = \alpha + \beta \hat{y}_{it}^2$ with H_0: $\beta = 0$. $\hat{\beta}$= 0.00008 with a t-statistic of 0.29. We accept the null hypothesis and we conclude that we have estimated the correct functional form.

We have estimated two other FEM. The two ways FEM, in order to estimate the technological progress, and the one way FEM with lagged independent variables. When presented, in both cases we show that the restrictions imposed by the first one are not accepted. However we maintain our analysis in terms of the one way FEM because it is the one comparable with the REM and the RCM. A technical justification comes from the Akaike information criteria that, because it penalises the excess of parameters, provides the higher value for the one way FEM. Other criteria that penalises still more the excess of parameters would be judged on the same direction.

In the introduction we have already mentioned that the Spanish economy experienced a deep change from the middle of the eighties. There is a new business cycle and the effects of the different variables may have changed. Table 4.6 provide the results of this exercise. Owing to the reduced number of degrees of freedom we only display the results of the FEM, which is the most restricted model.

Table 4.6*

Model: PAM
Procedia: Panel Data
Number of Obs.: 70

	Period	Y	W	T	N-1	R^2
FEM	1978-85	0.07	-0.07	-0.02	0.6	0.99
		(1.8)	(-0.4)	(-0.8)	(5.3)	
FEM	1986-92	0.34	-0.70	-0.01	0.61	0.99
		(6.1)	(-6.1)	(-3.1)	(7.1)	

(*) t-statistic in parentheses.

The estimations confirm what we already know. It is in the first period where data problems could exist. The models look similar, but the coefficients are less significant in the first subsample. The coefficients of determination are very high in both cases, although the average error is 5.4% in the first case, whereas it is 3.1% in the second period. The log-likelihood is also greater in the second period. The long-run elasticities are commented in section 5.2.

4.5.- Technological progress.

As we have already mentioned during the description of the theoretical model, the trend introduced in the model takes account of the technical progress in the analysed period. In the model we have defined a homogeneous trend which varies every year, but have the same value for each group. An interesting exercise is to drop this trend from the model and estimate a two ways fixed effect, with group dummy variables and period effects[1]. The results are shown in tables 4.7 and 4.8.

Table 4.7*

Model: PAM
Procedia: Panel Data
Period: 1986-1992
Number of Observations: 140

	Y	W	N-1	R^2
Two ways FEM	0.09	-0.20	0.79	0.998
	(3.5)	(-2.4)	(17)	

(*) t-statistic in parentheses.

We still explain a substantial amount of the dependent variable, with an average error for sector and year of 4.1%. The significance and signs of the coefficients are satisfactory and only their magnitudes change. The main change is in the reduction in the output coefficient, although in terms of long-run elasticities this magnitude is not so small. However, what really matters at this stage is the estimated period effects shown in the table below.

[1] This is a more general model than the one way FEM; in fact, we would not accept its restrictions.

LR = 2(264.1 - 228.1) = 72 ; χ^2_{13} = 19.68 $\Rightarrow$ Reject H_0: one way FEM

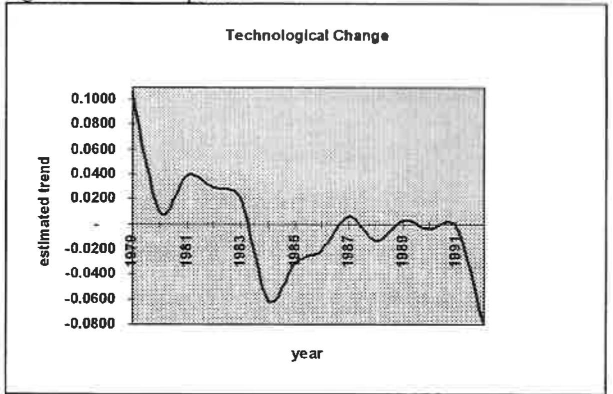
Table 4.8: Estimated period effects.

Model: PAM
Two Ways FEM

	Coefficient	Standard error	T-statistic	Technical Change
1979	0.10554	0.05642	1.9	**10.55%**
1980	0.00936	0.04811	0.2	**0.94%**
1981	0.03869	0.03810	1.0	**3.87%**
1982	0.02865	0.02731	1.0	**2.87%**
1983	0.02003	0.01723	1.2	**2.00%**
1984	-0.06096	0.01630	-3.7	**-6.10%**
1985	-0.03050	0.02182	-1.4	**-3.05%**
1986	-0.02076	0.02304	-0.9	**-2.08%**
1987	0.00588	0.0269	0.2	**0.59%**
1988	-0.01386	0.02747	-0.5	**-1.39%**
1989	0.00266	0.02781	0.1	**0.27%**
1990	-0.00406	0.02606	-0.2	**-0.41%**
1991	-0.00136	0.02691	-0.1	**-0.14%**
1992	-0.07932	0.02330	-3.4	**-7.93%**

The t-statistics are not very significant for most of the years and there is also a problem with the signs, which varies from period to period. Perhaps the best way to consider these estimates is through the next figure.

Figure 4.1: Estimated period effects.



The fact to stress here is some downward trend in the technical change. We can also distinguish a change from 1984, when the job legislation change takes place, and some stability from 1987 to 1991, during the strong expansion period. In fact, we can refer to two different periods that roughly coincide with the different business cycles that we have estimated. We can

argue that the sharp reduction in the trend in the first period corresponds to a reduction in productivity, which is consistent with the strong reduction in the production level and in the number of firms during this period.

Table 4.9: Index of productivity.

	I*4	I5	I6	I7	I8	I10	I11	I12	I13	I14
1978	211.4	193.6	208.6	63.9	122.5	158.4	198.6	213.3	258.2	253.5
1979	194.9	168.3	166.2	57.8	114.3	144.0	175.9	200.0	276.1	198.2
1980	158.2	155.5	148.0	47.4	110.1	172.5	155.6	194.7	188.5	140.7
1981	131.8	138.3	133.9	70.1	104.0	168.6	146.8	166.3	160.6	105.0
1982	117.5	125.8	123.0	65.9	111.3	131.5	134.4	142.0	141.7	111.6
1983	109.6	114.3	109.5	61.3	104.8	120.8	125.0	124.7	131.9	100.0
1984	104.7	107.8	101.8	104.6	99.6	112.4	113.4	119.5	117.3	89.4
1985	105.7	103.8	100.9	122.7	94.8	102.3	102.0	109.9	102.7	91.2
1986	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1987	110.9	102.5	105.2	85.5	106.7	100.8	100.4	102.2	101.9	99.9
1988	122.2	106.6	103.0	82.7	116.8	103.5	102.4	102.7	104.5	102.1
1989	123.9	109.5	102.8	83.4	130.5	99.8	105.4	102.9	103.2	109.8
1990	122.5	106.0	98.6	65.7	138.0	99.1	106.7	99.5	101.6	117.5
1991	123.1	104.3	95.8	76.7	137.9	105.2	109.5	98.9	100.1	124.9
1992	128.7	103.9	95.2	77.2	138.6	111.7	114.7	102.5	103.2	131.1

(*) I refers to industry.

During the second period, 1986-92, productivity slightly increases in most industries. The change is not very strong, which is consistent with the roughly stable estimated trend during 1987-91.

5.- Interpretation of the results.

5.1.- Interpretation of the adjustment process.

The PAM specification comes from an equation where the dependent variable is a fraction of the difference between the desired level of the dependent variable (or long-run solution) and its previous level. Because to adjust to the desired level is supposed to be costly, the PAM assumes a constant adjustment λ.

Table 5.1: Adjustment coefficients

	$\lambda = 1 - \beta_4$
FEM	0.23
REM	0.12
RCM	0.70

We observe different degrees of adjustment depending on the model. The two first models have a lagged dependent variable slightly biased towards 1, which explains the reduced value of the coefficient of adjusment. They are also the most restricted models, whereas the more realistic assumption is some variability across coefficients (RCM). Thus, we can consider that every year the actual value of unemployment adjust 70% towards the long-run equilibrium level. However we have to recognise that this result is highly conditioned by the theoretical model, as described below.

5.2.- Long-run elasticities.

The calculation of the estimated long-run elasticities for individual industries shows no clear pattern that permits us to interpret these coefficients. Again we will have to refer to the pooled estimations.

Table 5.2 shows the estimation for different panel data models. Because of the theoretical model behind, the lagged dependent coefficient is biased towards one in the FEM and the REM. That is why we should trust the RCM estimation. The problem is that in the FEM the elasticities are highly significant, whereas they are not in the other models.

Table 5.2: Long-run elasticities*.

Model: PAM
Procedia: Panel Data
Period: 1979-1992
Number of Observations: 140

	ε_{N-Y}	ε_{N-W}
EFM	0.64	-0,75
	(5.1)	(-3.3)
REM	0.90	-1.22
	(0.8)	(-0.8)
RCM	0.57	-0.32
	(0.5)	(-0.6)

(*) t-statistic in parentheses.

It turns out that the FEM is the most restricted model between these three, and we have not accepted the imposed restrictions. These restrictions make the groups being treated as if they were homogeneous, that reduces the variance of the industries and, thus, the standard errors. This is why the long-run elasticities are so significant in the most restricted model and less so in the

other two. As we have described above, the RCM let the independent variable's coefficients be different between groups, and in our opinion this should be the considered estimation, for this is the most realistic approach.

We have regressed the FEM with lagged independent variables in order to know if the long-run elasticities substantially differ from the one way FEM.

Table 5.3: Long-run elasticities*.

Model: PAM**
Procedia: Panel Data
Period: 1979-1992
Number of Observations: 140

	ε_{N-Y}	ε_{N-W}
EFM	0.75	-1.01
	(4.3)	(-3.1)

(*) t-statistic in parentheses.
(**) The PAM specification is

$$\ln N_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln Y_{t-1} - \beta_3 \ln W_t - \beta_4 \ln W_{t-1} - \beta_5 T + \beta_6 \ln N_{t-1}$$

The long-run elasticities are significant and higher than before. The same reasoning as before can be made in this case, so even if this estimation should be more precise than the former FEM[2], we still maintain that the estimations from the RCM are the relevant ones. The reason is that we are not allowed to consider our set of industries as having a homogeneous structure.

The estimation of the long-run elasticity with respect to output is 0.57, and with respect to wages is -0.32. Although the elasticity with respect to output looks smaller than in the former model, a standard t-test shows that we can accept the hypothesis of the coefficient being equal to one. This result is similar to the one found for Raymond (1983) using the same model, but for the Spanish economy. This result indicates that the degree of sensitivity of employment with respect to production is very high, so the level of employment should very sensitive to the business cycle.

The value of -0.32 means that if there is an increase of 1% in wages, employment is reduced by 0.32%. This proves the a-priori negative effect of wages increases on the level of

[2] In order to discriminate between the one way FEM and the FEM with independent variables we use a Likelihood Ratio test.

$LR = 2(235.7 - 228.1) = 15.2$; $\chi^2_2 = 5.99 \Rightarrow$ Reject H_0: one way FEM employment, but this can not be strongly defended without considering the kind of model used. This is considered in the next section.

In the results for the two subsamples, we only provide the long-run elasticities of the FEM, because there are not enough degrees of freedom to estimate the other models. The problem, again, is that this model is the more restricted one, and treats the groups as homogeneous, but we think it is a good exercise to look at the results.

Table 5.4: Long-run elasticities*.

Model: PAM
Procedia: Panel Data
Number of Observations: 70

	ε_{N-Y}	ε_{N-W}
FEM	0.17	-0.17
Period: 1978-1985	(1.8)	(0.4)
FEM	0.87	-1.72
Period: 1986-1992	(6.2)	(-6.1)

(*) t-statistic in parentheses.

Despite these differences, we can say that in the second period the sensitivity of the employment has increased substantially with respect to wages. This is probably showing the effects of the legislation changes in the middle of the eighties. From 1984 the labour market is substantially deregulated, with new figures such as temporary part time contracts and, especially, with reduced firing costs. An increase in the sensitivity of employment with respect to wages is perfectly consistent with the aim of the legislative changes, and is an effect well reported by other studies, as described below.

The same kind of explanation can be given for the increase in the sensitivity with regard to production. Firing costs are relatively higher in Spain with respect to other OCDE countries. After the first legislative reform in 1984 they were reduced, although the big reduction came in 1994. We can argue, then, that even if firms wished to reduce the number of workers during the depression of the early eighties, they had a big obstacle in terms of high firing costs, in such a way that reductions in the production were not accompanied by the desired reductions in the number of employees. This provides an explanation of why there is a reduction in the productivity

during these years, as we have already mentioned. On the other hand, after 1985, with the expansionary business cycle, the rise in production demand had a major effect on the level of employment. In conclusion, we can state that even if the models are not perfect, they provide some information which is consistent with the explanations of the actual facts.

5.3.- Returns to scale.

The specification of the theoretical model allows us to calculate the returns to scale for Spanish industry. Using a simple standard t-ratio we can test if the elasticity of employment with respect to output is 1 or not. If we have a positive answer, then we have $1 = 1/(1+S)$, so $S = 1$ and we can accept constant returns to scale. The results from the different models presented are shown in table 5.6.

Table 5.6: Returns to scale

	L-R Elasticity	Standard Error	t under H_0*	H_0: Ctt. returns scale
FEM (One way)	0.64	0.12545	-2.8	REJECT
REM	0.90	1.0732	-0.0	ACCEPT
RCM	0.57	1.1583	-0.4	ACCEPT
FEM (lag. ind. vars.)	0.76	0.17526	-1.4	ACCEPT
FEM (Two ways)	0.43	1.2999	-0.4	ACCEPT
FEM (1979-1985)	0.17	0.09357	-8.9	REJECT
FEM (1986-1992)	0.87	0.14115	-0.9	ACCEPT

(*): H_0: Long-run elasticity=1; hence, following the definition from the model, we have constant returns to scale.

Only in two cases is the null hypothesis rejected. In the one way fixed effects model and in the same model for the period 1978-1985. In the first case the calculated returns to scale would be 0.56 and in the second case 4.96.

The first specification has been rejected against other specifications (two ways fixed effects or the fixed effects model with lagged independent variables) by an LR test. To be consistent we have to trust those two models, which give the same result, rather than the random effects model and the random coefficient model. The conclusion, then, should be that we have constant returns to scale for the Spanish industry during the period 1978-1992. We could argue that the long-run elasticities are highly significant in the one way FEM, but the same holds for the

FEM with lagged independent variables, and the later model has been accepted against the former one.

With the strong positive returns to scale for the first sub-period, 1978-1985, we have to be very cautious. First, it is a model with a reduced number of degrees of freedom, and secondly, it has already been pointed out that the presence of outliers could disturb the fitness of the regression. Additionally, the long-run elasticity was not significant for this sub-sample. For the 1986-1992 subsample, the long-run elasticity is clearly significant, and we have not found outliers that could affect the regression. The result should then be more reliable, and in this case we are accepting constant returns to scale.

We conclude, then, that we have found constant returns to scale in Spanish industry.

5.4.- Other published estimates.

Table 5.7 present a summary of our results estimated with the RCM, in order to make some comparisons with some alternative analysis.

Table 5.7*: Calculated elasticities.

Period: 1978-92	Industry	
	s-r	l-r
Elasticity employment/output	0.40	1.00
Elasticity employment/wages	-0.23	-0.32

(*) s-r: short-run; l-r: long-run.

The tables shown below correspond to different studies made either for the whole economy or for industry. All these analyses, except Jaumeandreu (1987) whose methodology is slightly different, specify a labour demand equation that comes from a Cobb-Douglas production function. The results differ between them, but the estimated parameters are somehow similar.

Table 5.8

Period: 1955-82	Economy	
	s-r	l-r
Elasticity employment/output	0.43	1.00
Elasticity employment/wages	-0.32	-0.66

Source: Made from Raymond (1983).

Table 5.9

Period: 1955-84	Economy		Industry	
	s-r	l-r	s-r	l-r
Elasticity employment/output	0,30	1,00	0,20	1,00
Elasticity employment/wages	-0,15	-0,51	-0,05	-0,46

Source: Made from Garcia-Polo-Raymond (1986).

Table 5.10

Period: 1968-82	Economy	
	s-r	l-r
Elasticity employment/output	-	-
Elasticity employment/wages	-0.15	-0.94

Source: Made from Dolado-Malo de Molina (1987).

Table 5.11

Period: 1964-85	Industry	
	s-r	l-r
Elasticity employment/output	0,63	1,25
Elasticity employment/wages	-	-0,29

Source: Made from Jaumeandreu (1987).

Table 5.12

Period: 1964-86	Economy		Industry	
	s-r	l-r	s-r	l-r
Elasticity employment/output	0,38	1,00	0,33	1,00
Elasticity employment/wages	-0,26	-0,67	-0,13	-0,40

Source: Made from Carrasco-Lorente (1988).

The tables above show a range of elasticities perfectly coherent with our estimates, although we have used a survey that none of them use. The long-run elasticity with respect to output is one in all the cases, except Jaumeandreu (1987), wich is the only one that uses a slightly different approach. This is especially coherent with Raymond (1983) -we are using the same theoretical model- who finds constant returns to scale for the Spanish economy. With respect to wages, our estimates are slightly higher than his, which is also coherent with a higher sensitivity of wages in the whole economy with respect to industry as shown by Garcia-Polo-Raymond (1986) and Carrasco-Lorente (1988). Our estimated values are especially close to those from Carrasco-Lorente, yet they fit without difficulty in the range of the other estimates.

6.- Conclusions with regard to reliability of results.

Our model provides a good description of the determinants of unemployment. It gives plausible values to the coefficients (the signs and magnitudes of the coefficients being as expected) similar to other studies, and offers some significant conclusions in terms of technological change, long-run elasticities and returns to scale. It is not only the conclusions which point in the same direction as other studies, but the econometric tests also show that the model is essentially well specified. It would be desirable to have a larger sample of observations, but the main weakness arise from other considerations and factors.

The crutial assumption of the theoretical model is perfect competition, which requires that all the prices are exogenous. It would be useful to implement an exogenenity test, but more valuable to estimate a wage equation in order to explain the wage determination. We would then need an approach with imperfect competition, which would better fit the explanation of the labour market. This kind of model would allow us to calculate the equilibrium rate unemployment and to go further in our conclusions.

We rely upon our results in terms of their econometric accurancy, something that is also supported by the results obtained from other analyses using the same approach. Hence, the results are not less reliable because of some possible misspecification problems, but because of the simplicity of the model. For example, an increase in wages can only have a negative effect on the level of employment, whereas in other approaches, such as the insider-outsider theory or searching and matching models, this effect is not predetermined. In our opinion these are the models that can provide some explanation of the fact that, between 1986-1990, two millions new jobs could only reduce the number of unemployed workers by 500,000.

From our model we are not in the position to advise upon the relevant policy issues. From the econometric point of view, our parameters are not stable through time, as we have observed when dividing the samples. Additionally, we would need to test for super-exogeneity. This problem is also related to the small sample size that we have used. From the economic point of

view, the results depend on the approach. For example, we could argue that a reduction in wages would raise employment, although -as the elasticities suggest- is more effective an expansionary business cycle with positive growth in output. Other elements that can affect this relationship are missing from our theoretical approach. Yet our model offers some significant results, these being coherent with the actual facts and with other literature using the same approach. In order to obtain more accurate estimates, our first step would be to increase the sample size.

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NUM	TITOL	AUTOR	DATA
98.01	El mejor orden de ejecución de una serie de proyectos de inversión	Joan Pasqual i Rocabert	gener 1998
98.02	Impacto de la inversión en infraestructuras sobre el producto, la ocupación y la inversión privada en España	Oriol Roca i Sagalés	gener 1998
98.03	Externalidades y cambio técnico endógeno. Un repaso a la literatura sobre crecimiento regional y local	Iván Muñiz Olivera	març 1998
98.04	Marshallian external economies and local growth	Iván Muñiz Olivera	març 1998
98.05	Estimación del cambio técnico y sus determinantes para el sector farmacéutico : estudio comparativo para nueve países de la OCDE	Pablo D'Este Cukierman	març 1998
98.06	Distritos industriales y crecimiento endógeno	Iván Muñiz Olivera	maig 1998
98.07	Economías de aglomeración y convergencia regional en la industria española 1978-1992	Iván Muñiz Olivera	juny 1998
98.08	Dispersión regional en la estructura sectorial del empleo y en los niveles de renta de la Unión Europea (1980-1994)	Josep Lladós Masllorens	juliol 1998
98.09	Labour demand in spanish industry. A panel data analysis.	Hèctor Sala Lorda	setembre 1998