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A QUANTITATIVE STUDY OF THE RATE OF CHANGE IN SPANISH EMPLOYMENT

ANTONI ESPASA
BANCO DE ESPAÑA - MADRID

In this paper the homogeneous information available for the Spanish economy on employment, productivity and wages is processed by means of annual single equation models. The aim in this exercise is to fix ideas about the fundamental characteristics that dominate the relationships between the mentioned data. A set of conclusions is listed at the end of the paper.

Keywords: EMPLOYMENT, WAGES PER UNIT OF OUTPUT, PRODUCTIVITY.

1. INTRODUCTION.

In this study we process the homogeneous information available on employment, production wages and productivity by means of uniequational annual econometric models, the intention being that, at the end, the reader shall have a better idea of the fundamental characteristics that dominate the relationship between the observed data for the mentioned variables of the Spanish economy, during the period 1966-80. In section 8 we put forward a summary of such characteristics. Given the great deficiencies of the models used, the results of this section have not been obtained on the base of a unique model, but by comparison between the different specifications considered. The reader should be warned that any conclusions must be reached only after a global evaluation of the different estimations presented.

In this paper we restrict ourselves to the consideration of uniecuational models. The paper follows a methodology that we think useful for empirical economic work. As a first step, in section 2, we try to collect the information available for the problem in question and on the basis of these findings we decide the dimensions of our study. Then, in section 3, we perform a univariate study of the variable of interest which is, useful for illuminating the essential aspects of employment and stablishing a certain minima that must be obtained when we try to explain by econometric models the evolution of such an economic phenomenon. For this purpose we have a number of possible explanatory variables and in section 4 we explore the potentiality of such series as determinants of emloyment. Then we need to specify a theoretical model relating those variables to employment, and this is done en section 5. In this model unobservable variables appear, as occurs quite often in macroeconomic models, and in section 6 we discuss ways to approximate them and propose a specification for the econometric model. Then, in section 7 we start from the previous specification, a process of estimation, diagnostic checking and respecification until we arrive at a final model.

2. THE DATA USED IN THIS STUDY.

Given the information available on this sector of the Spanish economy we have been forced to work with annual data referring to the non-agriculture sector excluding public administration, which we defines as the private sector[(1)]. The data for employment, and

- Antoni Espasa - Banco de España - Servicio de Estudios - Alcalá, 50 - Madrid 14
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the other related variables corresponds to persons over sixteen. The sample period is 1966-1980.

One of the main purposes of this paper is to relate employment to wages and therefore we have taken the number of dependent workers as our employment variable. The data for this study was prepared by J. Rodriguez[2].

In this paper we use logarithmic transformation of data and we represent by first differences in logs the rate of growth of a variable. We denote by L the lag operator and by Δ the operator for first differences. The logarithmic transformation of the employment variable is denoted by LEIN. This variable and others used in the paper are listed in table 1.

TABLE 1

N	DATE	ΔLEIN	ΔLICPIB	SAL1	SEPO
1	66	.01222	.08078	.04434	.04434
2	67	.03265	.05272	.05278	.05278
3	68	.02456	.07399	.02192	.02192
4	69	.02803	.09883	.02519	.02519
5	70	.04255	.05813	.00000	.00000
6	71	.05208	.04897	.00195	.00195
7	72	.02856	.09758	.05623	.05623
8	73	.00883	.08421	.08588	.08588
9	74	.01920	.05395	.07278	.07278
10	75	.00162	.01179	.10190	.10343
11	76	-.00511	.02818	.10444	.11937
12	77	.00484	.03804	.11063	.11063
13	78	-.03238	.02297	.11689	.14318
14	79	-.02686	.01323	.10040	.14309
15	80	-.04659	.00307	.10412	.18142

3. THE UNIVARIATE RESULTS FOR THE EMPLOYMENT SERIES.

In this part of the study we are concerned with the explanation of the variable LEIN in terms of its own past and of dummy variables, where required. The aim in this section is to compute a summary of the characteristics of LEIN and to fix a certain minima for explaining it with a fit that uses the smallest set of information related to it.

In figure 1 we see that tha main aspect of employment is its trend. If we use purely stochastic linear schemes to explain it we obtain that Δ^2LEIN is white noise, with a negative sample mean (-0.0042) but not significantly different from zero. Its standard deviation, 0,017, is too high because it implies confidence intervals (at the 95% confidence level) for the prediction of the rate of growth of employment of 6.7 percentage points of amplitude. These confidence intervals are too wide, in the sense that it is possible for economists to use narrower intervals without having to process formally any information.

The results just mentioned suggest that it could be convenient to consider alternative schemes for the trend of LEIN. We have used dummy variables denoted by TF. These variables take zero values till the year (F-1) and the values 1, 2,... from the year F. The best fits that we have obtained with them are the following[3]:

$$\Delta LEIN_t = \underset{(38.7)}{0.034} - \underset{(27.9)}{0.0093}\, T72_t + \underset{(5.5)}{(1-0.9996L)}\, a_t^{(1)} \qquad (1)$$

RSS (residual sum of squares) = 0.00079
number of residuals: 14(1967-80)
$\sigma_a = 0.0085$; $R^2 = 0.91$
Box-Pierce-Ljung statistic for 3 lags = 6.4
estimation method: exact maximum likelihood;
and

$$LEIN_t = 4.43 \quad 0.035\, T_t - 0.0043\, (T72)_t^2 + a_t^{(2)}, \qquad (2)$$

RSS = 0.00076
number of residuals: 15(1966-80)
$\sigma_a = 0.0079$; $R^2 = 0.99$
d(Durbin-Watson) = 1.84.

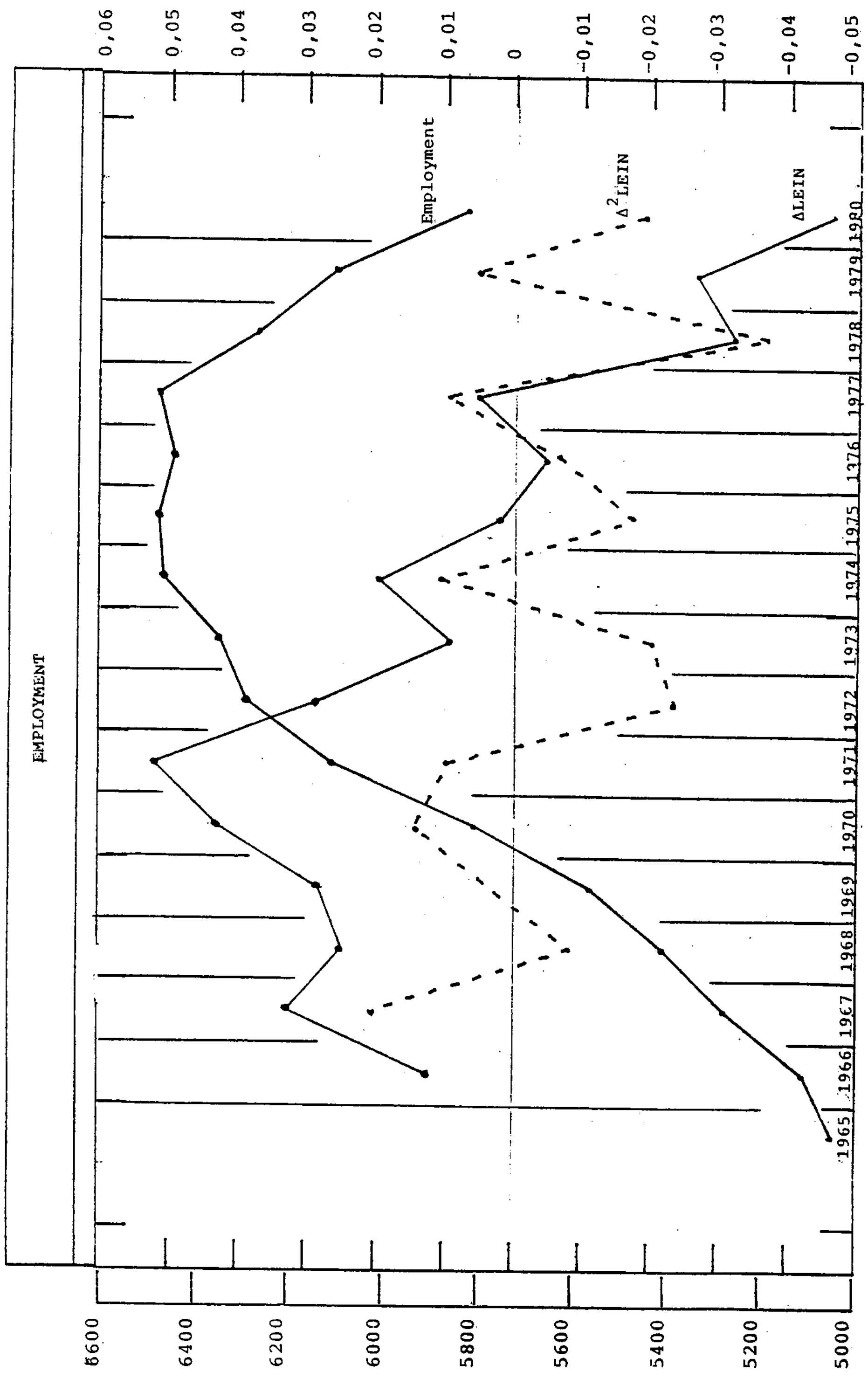

Figure 1: Employment

Note: The left hand scale refers to employment (in thousands) and the right hand scale to ΔLEIN and Δ^2LEIN.

The estimates for model (1) suggest that the dependent variable is overdifferenced and consequently model (2) must be prefered[4]. Te results from this univariate analysis can be summarized as follows:

1) The employment series can be broken down as the sum of a deterministic trend ($R^2 = 0.99$) and a white noise residual.

2) This trend registered a breaking point in 1972.

The trend is by far the most important element in the employment variable and this is the aspect that we are interested in explaining with econometric models. In these models we would expect deterministic trend to disappear or, at least, to have a considerably smaller impact, and economic variables to enter the model with significant coefficients and also the residual sum of squares (RSS) to be smaller than the RSS of model (2).

4. EXPLANATORY VARIABLES IN A MODEL FOR THE DETERMINATION OF THE EMPLOYMENT.

As we have mentioned in the previous section, the main feature of the evolution of Spanish employment in the sample considered is a trend with a breaking point in 1972. Therefore, in our case, an econometric model for the determination of employment will be mainly a model for the determination of such a trend. On a priori economic grounds, we have two groups of variables that could explain this trend. One group includes production variables and the other relative prices of the production factors. Quite frequently in macroeconometric models the rate of growth of employment is explained by a rational distributed lag on the rate of growth of production (see for instance /3/ (p.362). More recently in /1/ the determination of the employment for the EEC countries, with annual data also, is explained by models of this type.

The production variable that we are going to use is real GDP for the Spanish private sector. We denote by LICPIB the logarithmic transformation of such a variable. The best model that we obtained was:

$$\Delta LEIN_t = \underset{(4.5)}{-0.05} + \underset{(2.6)}{0.45}\, \Delta LICPIB_t + \underset{(0.3)}{0.07}\, \Delta LICPIB_{t-1} + \underset{(2.9)}{0.55}\, \Delta LICPIB_{t-2} + a_t^{(3)} \qquad (3)$$

$RSS = 0.00235$
$\sigma_a = 0.015$
$R^2 = 0.71; \; d = 1.7$.

This fit is similar, in terms of the standard deviation of the residuals, to the fits reported for the industrial sector of the different EEC countries in /1/ table 3 .

Comparing model (3) with the univariate results, the former has a residual series with a variance 3.6 times bigger than the corresponding variance of the univariate models and therefore it must be rejected[5]. It is not surprising that the data lead us to the rejection of (3) because the two energy crises and the institutional changes occurred in Spain during the sample period, have altered the conditions under which a flexible multiplier model like (3) could be a valid simplification of a general model for the determination of employment.

We must interpret the above results in the sense that changes in the trend of the rate of growth of Spanish employment cannot be explained exclusively by the rate of growth of GDP. We need to consider also the other group of variables mentioned before.

In figure 2 we give the relative costs of labour, of the use of capital, and of energy, with respect to the GDP deflactor and in figure 3 the cost of labour relative to the cost of use of the capital and to the cost of the energy.

These figures show that the relative price of labour has a positive trend during the seventies that could contribute to explaining the negative trend of the rate of growth of employment during that decade. It is also interesting to note in figure 2 that at the very end of the sample the production conditions have worsened, as is reflected by the simultaneous increase of the relative cost of

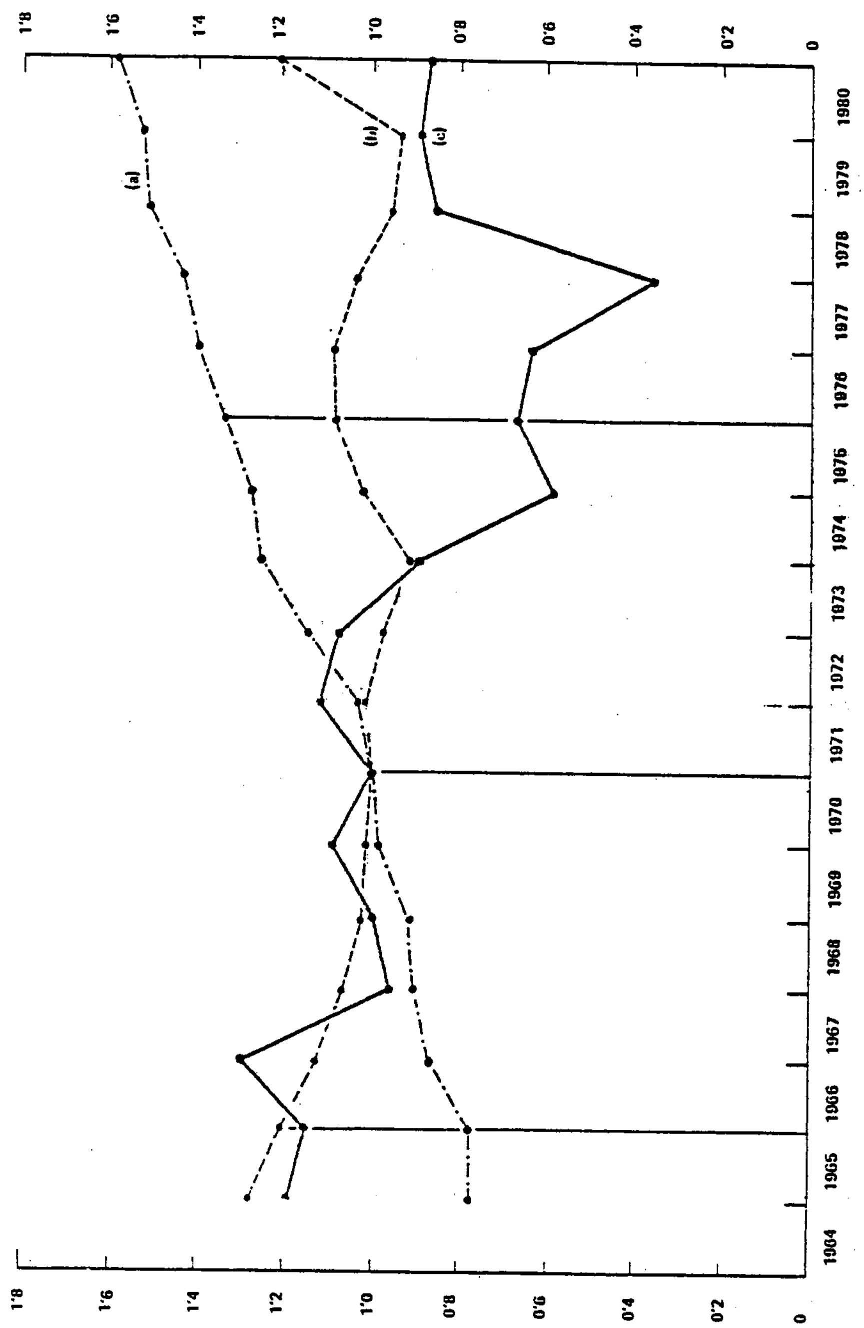

Figure 2: Relative prices of the production factors with respect to production prices

(a) Labour

(b) energy

(c) use of capital

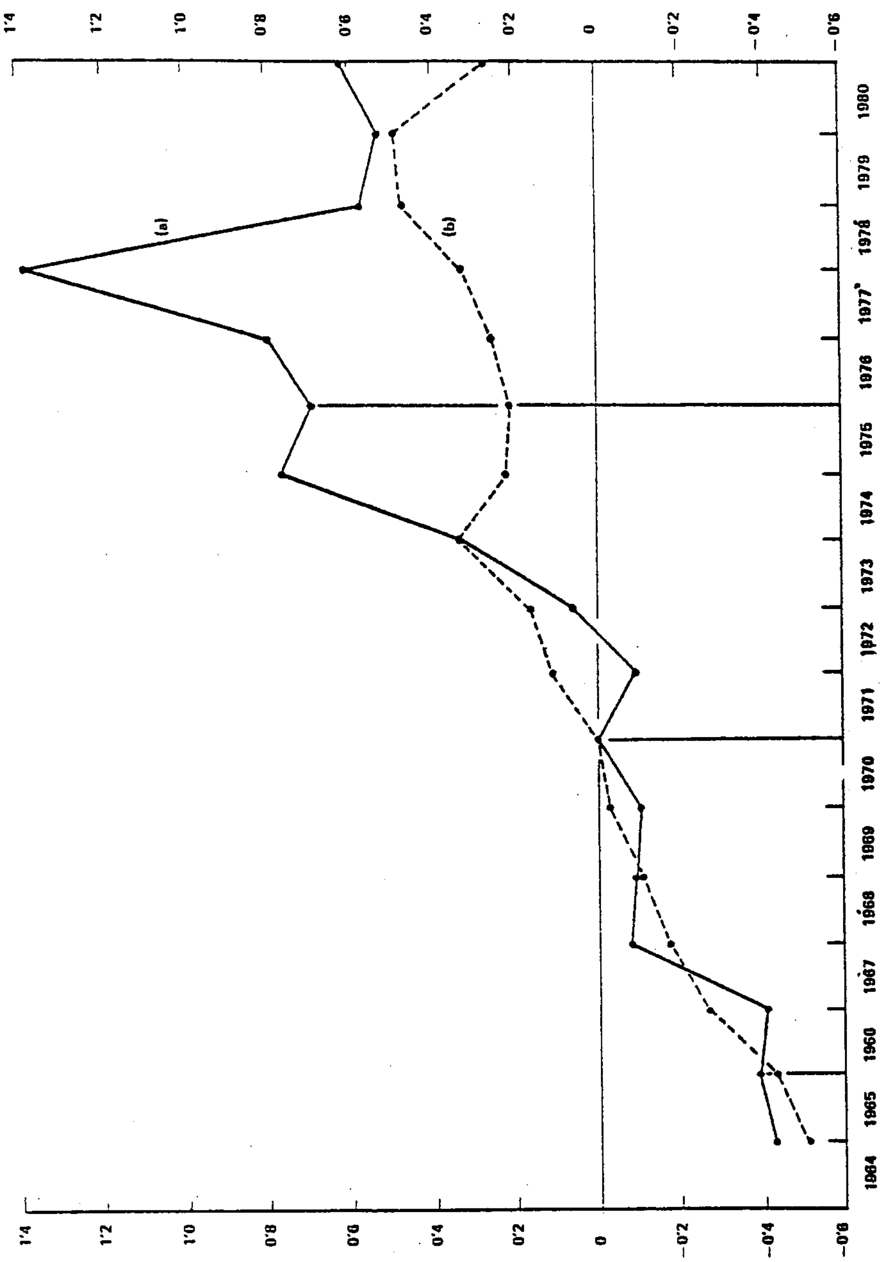

Figure 3: Relative prices of labour with respect
to energy and use of capital

(a) use of capital

(b) energy

the three production factors with respect to the production price.

We can conclude this section by saying that the evolution of the rate of growth of employment could be explained by the rate of growth of production and the relative price of labour. We need to specify now an analytical model relating these variables to employment and we are going to do this in the next section.

5. A UNIEQUATIONAL MODEL FOR THE DETERMINATION OF THE RATE OF GROWTH OF EMPLOYMENT(6)

The level of employment observed in an economy is the result of the supply of, and demand for, labour. Therefore the explanation of the rate of growth of employment by means of a uniequational model can be carried out only by using simplifying assumptions. Therefore a given uniequational model would be a reasonable instrument of analysis of the employment phenomenon depending on the reality of the assumptions used.

For the prupose of this study we have assumed that there is rationing in the labour market and a certain exogeneity of instituional character in the determination of salaries. With these assumptions we can say that the determination of employment is dictated mainly from the demand side and therefore the uniequational model is largely a problem of specification of a dynamic aggregate demand for labour.

This axiom of the determination of the employment by the demand of labour seems less acceptable for the first part of our sample. Nevertheless the variance of LEIN in that period of time (1966-1971) is 4.5 times smaller than the variance in the later years. Therefore the whole sample variance is dominated by the period for which the rationing assumption is more valid.

The static specification that we propose is the following(7):

$$\dot{E}_t = \Delta LEIN_t = c + \omega_{01}(Y^T - Y_t) + \omega_{02}\, SUP_t + \eta_t \,. \qquad (4)$$

In (4) the rate of growth of employment is determined, in the first place, by a factor c that can be considered as the equilibrium value of $\dot{E}$ in the steady state. Initially we shall assume that c is a constant and later on we will relax this assumption. In the second place, there exist a set of factors that could produced deviations of employment from its steady state path and we try to collect them with the variables SUP and $(Y^T - Y)$, that we now go on to explain.

Denote by PL the marginal productivity of labour under normal conditions of utilization of the production factors, and by SR the real wages. We define SUP as:

$$SUP_t = \log SR_t - \log PL_t \,.$$

In (4) we see that if real wages are over the "normal" marginal productivity of labour, the rate of growth of employment will tend to be below its equilibrium rate and viceversa.

In addition to the effect of SUP on $\dot{E}$, we could expect that the cyclical oscillations of production around a certain trend or path of "normal" values, also have an effect on the rate of growth of employment, in the sense that $\dot{E}$ will tend to be above or below its equilibrium values depending on whether the production is in the rising or the declining phase of the cycle. We have denoted by Y_t^T the logarithm of the "normal" (trend) production(8) and by Y_t the logarithm of the current production, then the variable $(Y_t^T - Y_t)$ that appears in (4) will capture the mentioned cyclical effect on $\dot{E}$.

The variable $(Y^T - Y)$ takes account of the cyclical oscillations of aggregate demand on employment. But this way of incorporating aggregate demand in the determination of employment is problematical when trend production registers strong disturbances from the supply side. In this case the estimation of Y^T can be extremly difficult and we cannot attribute the evolution of $(Y^T - Y)$ to oscilations in demand. Consequently, we see that model (4) cannot be used to separate causalities, because if it is correct to say that the variable SUP captures essentially the effects of labour costs in employment, and the variable $(Y^T - Y)$ incorporates mainly the effects of the final demand, it is also true that there exists an interrelation between both that prevents us from singling out the net effect of each one on employment. For that purpose we would need models of greater complexity and dimensionality which are beyond the scope of this paper In part, this work tries to be an initial exploration, of those factors which condition employment in the Spanish economy, which could be useful for the formulation of a complete model in a future study.

If in (4) we allow for adjustment costs we will end up with a dynamic model of the type:

$$\Delta LEIN_t = c + \omega_1(L)/\delta_1(L) \quad (Y_t^T - Y_t) + \\ + \omega_2(L)/\delta_2(L) \quad SUP_t + \eta_t \quad , \quad (5)$$

where ω_j and δ_j (j=1,2) are polynomials of very low order on the lag operator and η_t is a stationary residual that we assume to be generated by an ARMA(p,q) model.

The model (5) will be our general formulation for the relation between employment, production and wages which we are going to estimate, The main problems in this estimation process can be classified as follows:

a) measurement of the cyclical component $(Y^T - Y)$,

b) measurement of the "normal" marginal productivity,

c) the dynamic specification of (5), and

d) a study of the stability of c.

In the remaining sections we shall explore these problems.

6. NORMAL PRODUCTION AND PRODUCTIVITY.

"Normal" production and productivity are unobservables and we need to evaluate them. In this paper the production variable, Y, that we use is LICPIB and we approximate $(Y_t^T - Y_t)$ by ΔLICPIB. As we shall see, this approximation turns out to be quite incorrect and something better can be done approximating Y^T by grafted polynomials on LICPIB.

For the variable SUP we are going to work with two approximations. In both cases we will assume that wages and production have the same deflator. Our first approximation will be the variable SAL1 defined as:

$$SAL1_t = \log IS_t - LEIN_t - \log IP_t + \log IO_t \quad (6)$$

where IS is the total amount paid for wages and salaries, IP is the nominal production and IO is the number of workers (including the self-employed). We see then that in SAL1 we are approximating the "normal" marginal productivity by the average productivity. Certainly, this is a very crude approximation and a better one is the ratio between nominal production and the maximum level to date of workers employed (IOM). With it we construct the SEPO variable as:

$$SEPO_t = \log IS_t - LEIN_t - \log IP_t + \log IOM_t \quad (7)$$

This is our second way of approximating SUP. Certainly SEPO is a biased estimate of SUP, because substituting "normal" marginal productivity for average productivity we introduce a negative bias and substituting average productivity by the productivity for the maximum level of occupation we introduce a positive bias. The final bias is difficult to evaluate and it will depend on the form of the aggregate production function.

With these two variables the specification models that we are going to estimate are:

$$\Delta LEIN_t = c + \omega_1(L)/\delta_1(L) \quad \Delta LICPIB_t + \\ + \omega_2(L)/\delta_2(L) \quad SAL1_t + \eta_t \quad (8)$$

and

$$\Delta LEIN_t = c + \omega_1(L)/\delta_1(L) \quad \Delta LICPIB_t + \\ + \omega_2(L)/\delta_2(L) \quad SEPO_t + \eta_t \quad . \quad (9)$$

7. ECONOMETRIC ESTIMATIONS

Working with lag polynominals up to order one in models (8) and (9) we arrive at the following estimations:

$$\Delta LEIN_t = \underset{(6.9)}{0.069} - \underset{(5.9)}{0.295}/(\underset{(6.9)}{1-0.69L})\, SAL1_t + a_t^{(10)} \quad (10)$$

RSS = 0.00161
number of residual: 14 (1967-81)
σ_a = 0.0121

residual correlogram: no significant values;

and

$$\Delta LEIN = \underset{(12.8)}{0.051} - \underset{(5.3)}{0.369}/(1-\underset{(2.0)}{0.327}L)\, SEPO_t + a_t^{(11)} \qquad (11)$$

RSS = 0.00074
number of residuals: 14 (1967-81)
σ_a = 0.0082
residual correlogram: no significant values.

In both cases the variable ΔLICPIB has been omitted because when we include it, it appears with non-significant coefficients. This result must be interpreted in the sense that ΔLICPIB is a poor proxy for (Y^T-Y) and not as evidence against a cyclical effect of production on employment.

The standard deviation of the residuals of model (11) is of an order of magnitude similar to the values obtained with univariate models, but the residual standard deviation of model (10) is of a greater magnitude. This can be taken as evidence in favour of the corrections made in average productivity to construct the variable SEPO. An observation is required on this point. The difference between SEPO and SAL1 occurs only from the period 1975 onwards. In those years SEPO Keeps growing and SAL1 only grows up to 1978, and at a slower rate than SEPO. In our model, c represents the natural rate of growth of employment, which will be given by the difference between the natural rate of growth in the production and "normal" productivity. Therefore if, during the last few years, this rate of growth in production had been decreasing and/or the system had been incorporating technological innovations, which had caused substantial increases in productivity, the result would be that the SEPO variable would be correlated with the variables incorporating these aforementioned changes, that are not considered in model (11). If this is the case the effect of SEPO, in absolute terms, in model (11) will be positively biased.

In order to reduce this possible bias we consider models with the natural rate of growth, c, in employment, changing during the last part of the sample. The best model that we could obtain was:

$$\Delta LEIN_t = \underset{(11.3)}{0.045} - \underset{(2.7)}{0.0053}\, T77_t - \underset{(6.7)}{0.399}\, SEPO_t + a_t^{(12)} \qquad (12)$$

RSS = 0.00057
number of residual: 14 (1967-80)
σ_a = 0.0072
no significant values in the residual correlogram.

Comparing (12) with (11) we see that the σ_a is smaller in the former than in the later and therefore we are going to take (12) as the preferred model.

In (12) the natural rate of growth of employment is given by 0.045 - 0.0053 T77. This means that this rate had a constant value of 4.5% till 1976 and has been decreasing since 1977 by 0.5 percentage points each year.This way of considering two different regimes in the sample period used seems quite important in trying to explain the evolution of Spanish employment.

On this point it could be argued that it is the effect of the wage per unit of output variable on employment which has changed in the sample. If we allow for different coefficients in the variable SEPO from one particular year onwards, we find that the best results are obtained by fixing that point in 1978. Thus, we denote a variable with the SEPO values till 1977 and zero values otherwise by SEPO 177 and denote a variable with the SEPO values since 1978 and zero values otherwise by SEPO 278.

The estimated model was:

$$\Delta LEIN_t = \underset{(14.7)}{0.044} - \underset{(8.5)}{0.384}\, SEPO\,177_t - \underset{(16.5)}{0.510}\, SEPO278 + a_t^{(13)} \qquad (13)$$

RSS = 0.00042
number of residuals: 14 (1967-80)
σ_a = 0.0062
no significant values in the residual correlogram.

If we add a trend TF variable to model (13) the fit does not change and this variable does not appear with a significant coefficient. Model (13) has the great disadvantage that the variable SEPO278 is very much correlated with those changes in the natural rate of growth in production and in productivity, that we suspect have occurred during the last years of the sample. If this is true, the use of model (13) for simulations will impute to wages falls in employment that are due to these other factors. It is for this reason that we do not recommend the use of (13).

The rejection of (13) does not mean that effect of the wages on employment is not more incisive now than before but simply that it is dangerous to evaluate such change with model (13). In that sense it must be said that breaking down SAL1 in a similar way we arrive at the model:

$$\Delta LEIN_t = \underset{(11.0)}{0.044} - \underset{(1.5)}{0.006}\, T77_t - \underset{(6.3)}{0.380}\, SAL1\ 177_t - \underset{(4.3)}{0.564}\, SAL1\ 278_t + a_t^{(16)} , \quad (14)$$

RSS = 0.00062,
number of residuals: 14 (1967-82)
$\sigma_a = 0.0079$

no significant values in the residual correlogram.

In this case the presence of the T77 variable could help to capture part of the changes that might have been occurring in recent years and therefore the effect of SAL1 278 would be more reliable. Nevertheless the correlation between the estimated coefficients of T77 and SAL1 278 is of -0.90 and therefore the estimation of the net effect of each variable could not be very precise. As a conclusion of the examination of these estimations we can say that for the appreciation of a more incisive effect of wages we had better use (14) rather than (13), but in any case we still take model (12) as the preferred one.

As a way of validating (12) we have broken SEPO down in two ways:

$$SEPO_t = SE_t + POM_t \quad \text{and} \quad (15)$$

$$SEPO_t = SP_t + EOM_t , \quad (16)$$

where

$$SE_t = \log IS_t - LEIN_t , \quad (17)$$

$$POM_t = \log IP_t - IOM_t , \quad (18)$$

$$SP_t = \log IS_t - \log IP_t \quad \text{and} \quad (19)$$

$$EOM_t = LEIN_t - IOM_t . \quad (20)$$

Then we have reestimated (12) allowing first for different coefficients for SE and POM and second, for different coefficients for SP and EOM. In both cases the estimated coefficients had opposite signs and they were very similar indeed in absolute value. Therefore (12) is the model that we suggest as more interesting in order to examine the evolution of Spanish employment by means of single models.

8. CONCLUSIONS.

In this study we have tried to estimate an econometric relationship for the determination of the rate of change in Spanish employment. The evolution of this rate has been marked by a negative trend since 1972, as we have seen in section 3. Our approach in the construction of the econometric model has consisted of considering real wages divided by productivity, and the deviations of production from its "normal" path as explanatory variables. We have also checked to see if the natural rate of growth of employment has changed with time.

Referring to the production variable, we have seen that the first differences of production did not enter in the model with a significant coefficient and this must be interpreted in the sense that such differences are not a good proxy for the deviations from the "normal" path.

We have obtained better results in the variable wages over productivity, by deflating production by the maximum level of workers employed up to time t. In the study of the stability of the "natural" rate of growth of employment we have seen that this rate has been declining since 1977. All these characteristics are incorporated in model (12).

Evaluating all the models presented in this paper we can draw the following conclusions:

a) The negative trend of employment during the seventies cannot be explained by a flexible multiplier model on production.

b) The cyclical effect of production on employment has not appeared with the proxy variables that we have used.

c) Wages per unit of product is an important variable to explain the evolution of Spanish employment.

d) In the definition of this variable it is better to use the historical maximum level of workers to deflate production.

e) It is possible that wages have now a more incisive effect on employment than before 1978, but the estimation of this effect is problematical because it appears at a time in which we suspect that the process of adjustment of employment has been accelerated and therefore both effects are mixed up.

f) The natural rate of growth of employment has been decreasing since 1977 in such a way that its value in 1980 is one half of the constant value estimated for the period 1966-76.

g) The models in this paper cannot be used to separate causalities, that is, on basis of them, we cannot say how much reduction in employment comes from supply and how much comes from aggregate demand, but they show that both effects are present.

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10. NOTES

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(1) Recent works by other authors on data for employment and wages are producing quarterly series on those variables and we expect that soon this type of study will be able to be done with quarterly data and for a small number of different sectors.

(2) The construction of the data is commented on in the appendix of the Spanish version of this paper.

(3) The values in brackets under the estimated coefficients are their corresponding t values. The a_t residuals of the different models are denoted with an index referring to the number of the model.

(4) In the estimation of model (1) restricting the moving average parameter to the value 0.85 we have the following results:

$$\Delta LEIN_t = \underset{(34.6)}{0.034} - \underset{(26.4)}{0.0093}\, T72_t + (1-0.85L)a_t$$

$$RSS = 0.00091;\ \sigma_a = 0.0091;\ B\text{-}P\text{-}L(3) = 6.4 \qquad (1.bis)$$

(5) In Jenkins et.al./1/ the econometric re_ sults are not worse than the univariate ones, in the sense described in the text but it can be partly due to the fact that the sample period considered by them, 1960-78, includes a good number of years, 1960-1973, for which the flexible multiplier model could be a valid simplification.

(6) I am grateful to J.L. Malo for his suggestions in this section.

(7) A similar model can be found in Jonson et. al./2/

(8) It must be noted that our trend production refers to a kind of trend in the output, caused by the demand, that is not the potential output. The later concept can be strongly criticized in a context where the relative prices of the production factors are changing, because then a certain part of the installed capacity will be absolete. I am grateful to A. Rojo for calling my attention to this point, which also affects the trend production. Nevertheless, for the purpose of this paper a certain concept of trend production is useful to establish in a simple way, a theoretical reference context for the econometric models that we are considering. But it should be kept in mind that the changes in the trend can be, in part, due to changes in the structure of the relative prices.