Control
and Cybernetics
VOL. 21 (1992) No. 2

Oil prices and unemployment relationships

by

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The paper presents the regression models expressing the relation between oil prices and unemployment rates in a number of countries. First, second and higher order models are considered and identified. The models allow recognition of certain interesting properties of economic systems as represented by the variables accounted for.

1. Introduction

Starting with the middle of 70ties unemployment has become an important problem in most of the developed countries. Different factors contributed to it. This study focusses on influence caused by changes in oil prices. 1974 featured rapid rise in oil price which followed the first OPEC agreement. In 1975 a rise in unemployment was observed in most countries. Similarly, a possibly delayed pattern of oil price changes can be traced in unemployment rates of many countries in further years.

The prolonged high unemployment in many countries attracted considerable attention of economists. (Unemployment, 1991) gives excellent survey of the problem and lists over 60 references on the subject, mostly from recent 20 years, including many books. The models considered concentrate mainly on flows into and out of the unemployment pool. This paper presents another approach. Econometric models are elaborated for 20 West European and North American countries using oil price and unemployment rate observations from the period 1970-1990. This period is characterized by big variations of both variables and gives unique possibility of studying the dynamics of unemployment in different countries.

Our method allows us to split the dynamics of the unemployment rate into the part related to the cause of variations, viz. the oil price, and the one related to the ability of the economy to deal with the shock oil price disturbances.

(Hamilton, 1983) investigated the influence of basic economic variables on rapid jumps in oil prices. His conclusion based on statistical tests was that it is not possible to predict quick changes of oil price this way. This gives good motivation for using them as exogenous variables, as it is done in our model.

2. The labour-market scheme and the method used

In Fig.1 labour supply and demand curves are shown. Asume that the labour market is originally at the equilibrium E_0 with employment N_0 and the real wage $(w/p)_0$. A rise of the oil price causes the price of energy to increase, which, in turn, induces firms to use less energy. Because energy and labour are complementary, the increase in the price of energy reduces the demand for labour. This causes a shift of the labour demand curve to the left. In the case of flexible real wages the new equilibrium will be attained at the point E_1, with a lower employment N_1. In the case of inflexible real wages the new equilibrium will be attained at the point E_2, with a new employment N_2. In both cases unemployment rises.

This analysis is, however, difficult to apply in the unstable environment, when quick changes of many factors like commodity or raw material prices following the oil price jump give not enough time for the unemployment to settle. In such conditions the difference between the actual unemployment rate and that obtained from Fig.1 may be considerable.

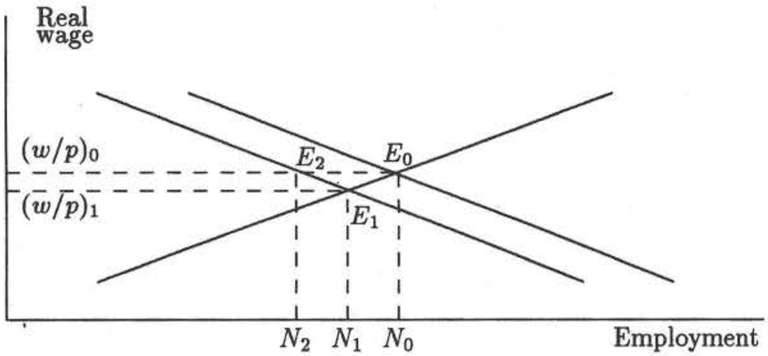

Figure 1. Shift of employment level due to a rise of the oil price.

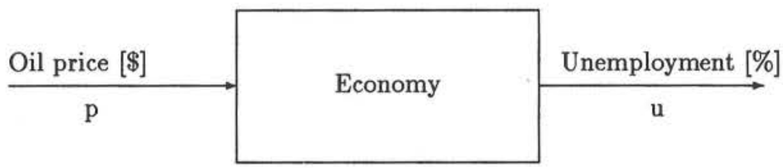

Figure 2. The estimated black-box model

To assess the dynamics of unemployment rate an econometric black-box model presented in Fig.2. was used. The oil price p influences the national economy, and the outcome is the unemployment rate u. The relation between both variables is modelled in the form of a difference equation

$$u_n = a_1 u_{n-1} + \cdots + a_R u_{n-R} + b_0 p_n + \cdots + b_S p_{n-S} + v_n \tag{1}$$

where $\{u_n\}$ is the sequence of mean unemployment rates in the period 1970-90 in percent, $\{p_n\}$ is the sequence of the mean year oil prices in US dollars per barrel, and $\{v_n\}$ is the sequence of variables unexplained by the model. The unemployment data for fitting the model were taken from Survey (1991). The least squares method was used to estimate model parameters. For this the data were shifted to achieve $u_0 = p_0 = 0$.

3. First order models

The first order model

$$u_n = a_1 u_{n-1} + b_d p_{n-d} + v_n \tag{2}$$

where d is a delay between the change of the oil price and the corresponding reaction of the unemployment rate, has a quite simple interpretation. The parameter b_d says how much the oil price affects eventually the unemployment rate, either already in the same year, when $d = 0$, or after few years, when $d > 0$. In some countries, namely in Belgium (B) and Spain (E), a distributed delay was observed, that is the equation (1) took the form

$$u_n = a_1 u_{n-1} + b_0 p_n + b_1 p_{n-1} + v_n \tag{3}$$

such that the unemployment rate depended both on the same and the previous year oil prices. Moreover, for USA the model

$$u_n = a_1 u_{n-1} + b_1 p_{n-1} + b_4 p_{n-4} + v_n \tag{4}$$

was found statistically the best. An approximate equality of the sum of parameters b in the models (3) and (4) to b_d, for $d = 0$ or $d = 1$, of the model (2) was observed. The estimates of a_1 and b_d obtained for the model (2) are presented in Table 3..

The values of b_d are depicted against the values of energy consumption per capita in 1974 on Fig.3. Two groups of states can be distinguished. The EEC states marked with black dots extend vertically: these from the north higher and those from the south lower (with exception of Spain). The EFTA countries, marked with circles, form the second group. They take place close to each other, at the bottom of the figure. However, it seems that different factors could contribute to their position. Switzerland (CH) and Austria (A) own their situation probably to the foreign "guest workers" who are the first to loose their jobs and the last to be hired, see (Survey, 1991). In Scandinavian countries, on the other hand, the low unemployment rate is credited to centralized bargaining institutions and to short duration of unemployment benefit.

The parameter a_1 shows inertia of unemployment with respect to the rise in oil price. This parameter may be influenced by the following: duration of unemployment benefit, replacement ratio (the ratio of unemployment benefit to earnings), active labour market policy, union coverage, union co-ordination, employer co-ordination, and change of inflation. All of them were taken into

Table 1. Estimation results for the 1st order model. Estimated standard deviations in parentheses.

Country	a_1 ($\pm\sigma_a$)	b_d ($\pm\sigma_b$)	d
CDN	0.11[2]	0.150	2
	(±0.14)	(±0.024)	
USA	0.44	0.064	1
	(±0.18)	(±0.023)	
TR	0.51	0.068	0
	(±0.11)	(±0.014)	
GB	0.52	0.145	1
	(±0.07)	(±0.020)	
CH	0.56	0.014	2
	(±0.12)	(±0.004)	
NL	0.61	0.155	1
	(±0.07)	(±0.025)	
B	0.65	0.139	1
	(±0.08)	(±0.031)	
A	0.66	0.036	2
	(±0.09)	(±0.008)	
S	0.66	0.015	1
	±0.14)	(±0.006)	
D	0.67	0.082	1
	(±0.07)	(±0.016)	

Country	a_1 ($\pm\sigma_a$)	b_d ($\pm\sigma_b$)	d
DK	0.74	0.099	0
	(±0.09)	(±0.028)	
SF	0.78	0.031	1
	(±0.13)	(±0.020)	
J[1]	0.79	0.015	1
	(±0.08)	(±0.005)	
IRL	0.82	0.090	1
	(±0.05)	(±0.016)	
P	0.82	0.043	1
	(±0.12)	(±0.028)	
F	0.85	0.057	1
	(±0.04)	(±0.010)	
I	0.85	0.038	2
	(±0.06)	(±0.011)	
E	0.86	0.133	0
	(±0.03)	(±0.019)	
GR	0.97	0.027	0
	(±0.05)	(±0.008)	
N	1.01	0.010	0
	(±0.16)	(±0.009)	
YU	1.02	0.014[2]	1
	(±0.07)	(±0.017)	

Notes: *1.From the period 1970-1989.*
2.Not significant.

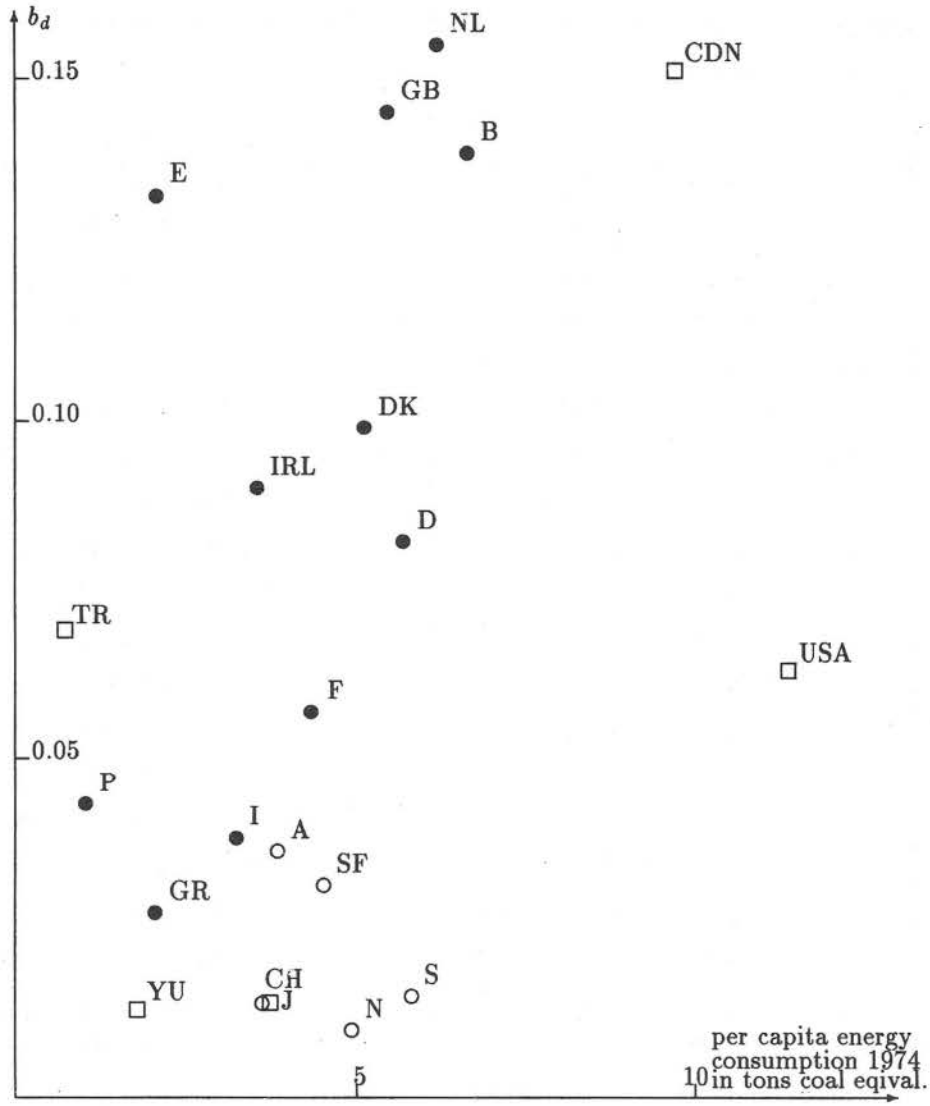

Figure 3. Estimated values of b_d versus per capita energy consumption 1974 for the 1st order model, • – EEC, ○ – EFTA, □ – other countries. Values of per capita energy consumption 1974 in tons coal equivalent taken from (Statistical Yearbook, 1975).

Table 2. Regression to explain values of a_1.

	Regression coeffitient	T-statistics
Union coverage	0.18	5.73
Change in consumption	0.17	2.47
Critical value of T	2.12	
Standard error	0.12	
Correlation coefficient	0.65	
F-statistics	5.85	
Critical value of F	3.63	

account to explain the values of a_1 coefficient in the estimated regression equation. Additionally, a new variable which was the rate of change in consumption of oil between 1970 and 1980 was introduced. The values for calculations were taken from (International Statistical Yearbook, 1984). Table 3. shows estimation results. Only statistically significant variables are displayed, of which there turned out to be only two: union coverage and change in consumption of oil between 1970 and 1980. It is worth noting that, in particular, also the active labor market policy was found statistically insignificant. Over 20% reduction of standard deviation for the dependent variable was recorded.

4. Second order models

For many countries second order models

$$u_n = a_1 u_{n-1} + a_2 u_{n-2} + b_0 p_n + b_1 p_{n-1} + b_2 p_{n-2} + v_n \tag{5}$$

were statistically better, as indicated by statistical tests: F-test, or Akaike's AIC and FPE tests, see e.g. (Freeman, 1985) for their short description. Similarly to the first order models also only one of the b parameters was statistically significant in most second order models. Exceptions were again: Belgium, with significant parameters b_0 and b_1, and USA where besides b_1 also b_4 was significant. Additionally, in the model for Great Britain (GB) the parameters b_1 and b_3 were detected significant. Also here the sum of these two b parameters was

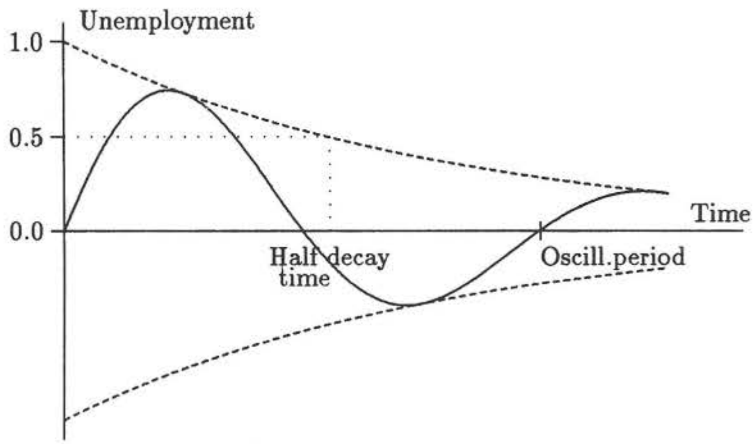

Figure 4. Damped oscillatory response to an impulse oil price disturbance

approximately equal to the value of b_1 in the one-b-parameter model in all the above cases.

Most of the estimated models were of the oscillatory type, i.e. with complex poles. Their response to the pulse of oil price raise is of the damped oscillatory type shown on Fig.4. This response can be characterized by the oscillation period T and half decay time τ, see Fig.4. Table 4. shows the estimated results for these countries for which the second order models were statistically better than the first order ones. As compared with Table 3., the countries with big a_1 parameter estimate in the first order model tend to have rather bigger value of the estimated half decay time in the second order model, and to the contrary. An exception is Japan (J) with rather big value of a_1 estimate and small estimated half decay time. Also estimates of the b_d parameters for the first and second order models are similar, both as to the estimated values and to the values of d, which are actually identical. As far as the values of b_d are concerned considerable changes in them are observed only for Portugal (P) and Finland (SF). They can be noticed when comparing Figs.3 and 5.

Excepting Japan (J) and Greece (GR) the oscillation periods in all the second order models are between 8 and 12 years, or at least close. This seems to be closely related with ten year business cycle. For Ireland (IRL), Spain (E) and Yugoslavia (YU) second order non-oscillatory models were obtained.

Thus, it can be claimed that the second order models are consistent with the first order ones. The differences can be connected either with the better

Table 3. Estimated oscillation periods and half decay times for the 2nd order model.

Country	Oscill.period [years]	Half decay time [years]	b_d	d [years]
CH	9.4	1.03	0.014	2
J[2]	58.6	1.10	0.015	1
NL	12.8	1.11	0.130	1
TR	9.4	1.12	0.058	0
CDN	5.2	1.14	0.149	2
GB	9.5	1.21	0.124	1
B	12.5	1.49	0.111	1
S	8.5	2.32	0.019	1
IRL	.	2.40	0.077	1
GR	48.0	2.68	0.014	0
E	.	2.79	0.095	0
N	9.8	3.24	0.018	1
YU	.	6.62	0.016	1
SF	8.5	7.94	0.069	1
P	10.5	9.02	0.075	1
Mean	9.5[1]	2.87	0.065	

Notes: *1.Excluding estimates for GR and J*
2.For the period 1970-1989

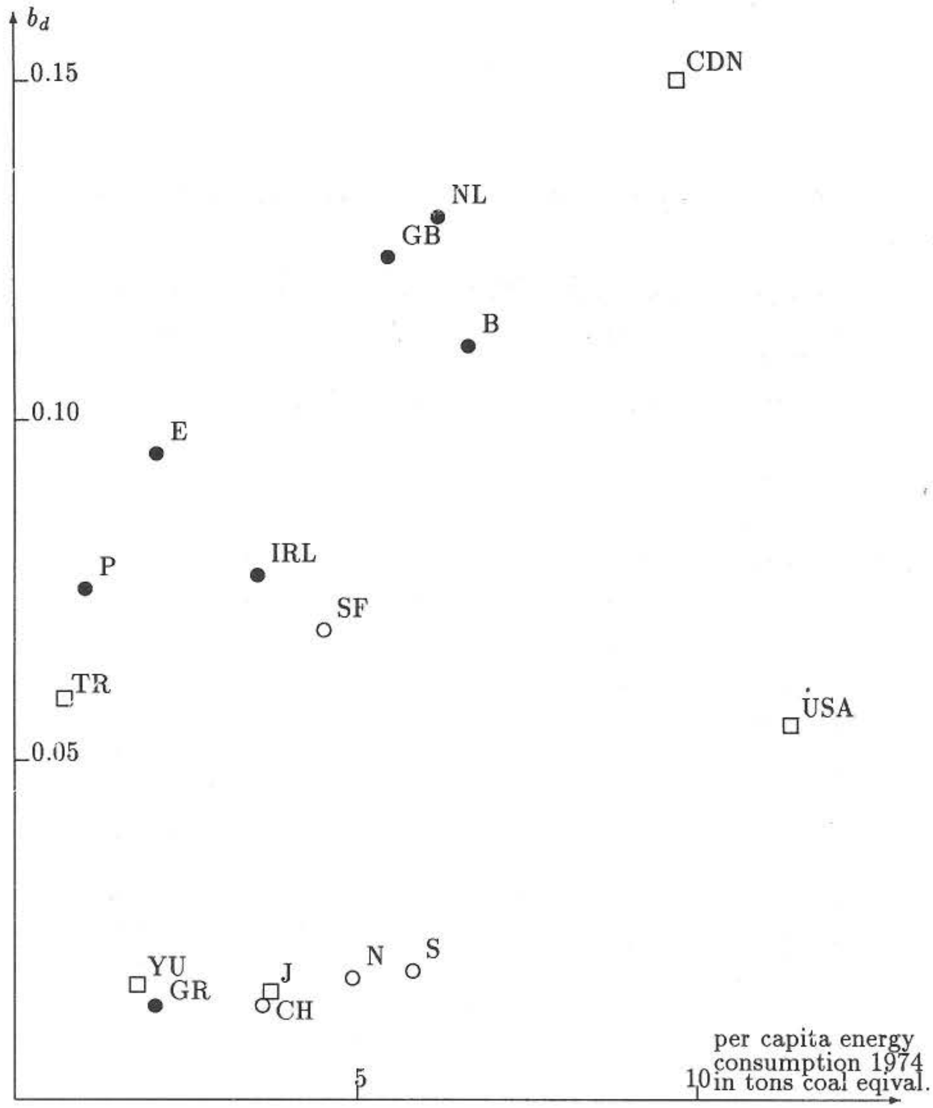

Figure 5. Estimated values of b_d versus per capita energy consumption 1974 for the 2nd order model, • – EEC, ∘ – EFTA, □ – other countries. Values of per capita energy consumption 1974 in tons coal equivalent taken from (Statistical Yearbook, 1975).

Table 4. Estimates for the higer order models.

Country	Oscill.period [years]	Half decay time [years]	Real pole	b_d	d [years]
		Third order models			
NL	5.3	1.29	0.64	0.129	1
GR	7.3	1.56	0.95	0.015	0
GB	5.0	2.50	0.39	0.119	1
		Fourth order model			
CDN	7.3	1.97		0.196	2
	2.5	1.30			
		Sixth order model			
N	10.9	1.99		0.018	1
	3.9	2.92			
	2.4	2.38			

accuracy of the second order parameter estimates or with the estimation errors caused by short observations samples.

5. Higher order models

For few countries, models of higher than second order were found better after applying statistical tests. The dependence on oil price here was again simple with exception of Great Britain where b_1 and b_3 were found significant and Canada (CDN) with significant parameters b_2 and b_3. In the latter case also the model with three parameters b_1, b_2 and b_3 was very good. The details of the finally chosen higher order models are given in Table 5.. Again good agreement in the values of b_d and d with those of the lower order models was obtained. Also oscillatory terms still prevail in the model dynamics. The comparison with the second order models is, however, more difficult here. The estimates of oscillation periods and half decay times are in the same range in all models, but the exact values differ. However, assuming that these of the higher order are correct, those of the second order must be only some approximation to them and therefore good agreement cannot be expected. Alternatively, the higher order models may

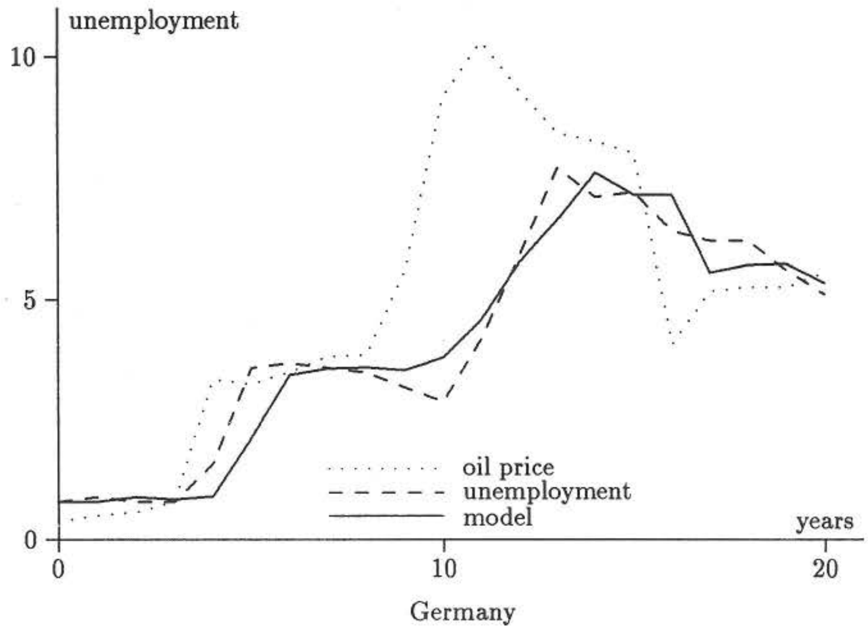

Figure 6. Oil prices, unemployment and unemployment model for Germany.

be more sensitive to disturbances which makes the parameter estimates to be less accurate. The latter may be particularly severe due to a small number of observations. This makes at present the higher order models rather less usable, even if they have been tested as better than the lower order ones.

Table 5. presents residual standard deviations and values of the AIC tests, chosen to represent the group of tests applied.

Examples of the fits of different models to the data are given in Figs.6, 7, 8, 9, 10, 11 and 12.

6. Conclusions

The econometric models of the oil price – unemployment relation have been considered in the paper. In the models obtained the dependence on the oil price is quite simple, usually only on one or rarely on two consecutive annusl mean oil prices. Only for Great Britain and USA the dependence is more complicated, involving one and three year earlier oil prices in the former case, and for one and four year earlier oil prices in the latter. In many cases also model dynamics

Table 5. Residual standard deviations and values of the AIC tests.

Model order		1	2	3	4	5	6	7
Country								
A	s	0.29	0.29	.	.	.	.	.
	AIC	11.41	13.37	.	.	.	.	.
B	s	0.65	0.57	0.57	.	.	.	.
	AIC	47.76	44.00	45.80	.	.	.	.
CDN	s	0.59	0.52	0.43	0.41	0.41	.	.
	AIC	41.72	37.96	32.48	32.31	33.98	.	.
CH	s	0.13	0.13	0.12	.	.	.	.
	AIC	-21.31	-21.82	-20.82	.	.	.	.
D	s	0.56	0.53	0.52	.	.	.	.
	AIC	39.01	39.07	41.06	.	.	.	.
DK	s	0.85	0.81	0.79	.	.	.	.
	AIC	56.57	56.70	57.50	.	.	.	.
E	s	0.75	0.70	0.70	.	.	.	.
	AIC	53.24	50.76	52.39	.	.	.	.
F	s	0.36	0.35	.	.	.	.	.
	AIC	20.06	23.46	.	.	.	.	.
GB	s	0.66	0.53	0.50	0.49	.	.	.
	AIC	45.81	40.70	40.08	41.85	.	.	.
GR	s	0.61	0.49	0.45	0.45	.	.	.
	AIC	42.63	35.27	33.80	35.79	.	.	.
I	s	0.42	0.42	0.41	.	.	.	.
	AIC	27.03	28.94	30.28	.	.	.	.
IRL	s	0.76	0.72	0.72	.	.	.	.
	AIC	52.23	52.01	53.83	.	.	.	.
J[1]	s	0.15	0.15	0.14	.	.	.	.
	AIC	-14.38	-14.52	-12.90	.	.	.	.
N	s	0.57	0.51	0.48	0.44	0.40	0.33	0.32
	AIC	39.99	37.35	36.64	33.51	28.80	20.72	21.67
NL	s	0.67	0.61	0.58	0.58	.	.	.
	AIC	46.81	45.03	44.97	46.97	.	.	.
P	s	0.82	0.42	0.42	.	.	.	.
	AIC	55.43	29.25	30.79	.	.	.	.
S	s	0.29	0.23	0.23	.	.	.	.
	AIC	11.56	4.29	5.98	.	.	.	.
SF	s	0.79	0.49	0.49	.	.	.	.
	AIC	53.53	35.73	37.71	.	.	.	.
TR	s	0.51	0.47	0.46	.	.	.	.
	AIC	34.91	33.64	34.79	.	.	.	.
USA	s	0.64	0.64	0.62	.	.	.	.

is simple. Most models are of low orders: first or second. In these cases their interpretation is quite easy. Particularly the second order models reveal oscillations with the period 8-12 years which agree well with the ten year business cycle. For few countries higher order models were found statistically better.

The most common model estimated is of the second order, with an average 9.5 year oscillation period and about 3 year half decay time. Taking into account the delay, this gives about 3 years to reach the first unemployment maximum after unit year rise of the oil price. The maximum value differs for different countries but for EEC countries lying more to the north the maximum tends to be higher than for those lying to the south. The same may be true for other countries with exception of EFTA countries which recorded small dependence of unemployment rate on the rise of oil price.

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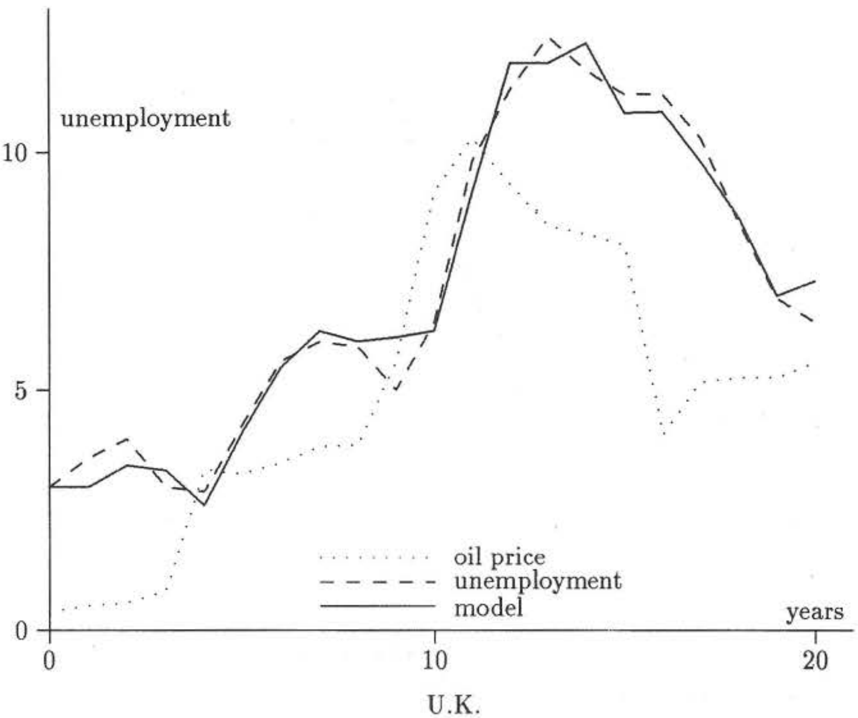

Figure 7. Oil prices, unemployment and unemployment model for U.K.

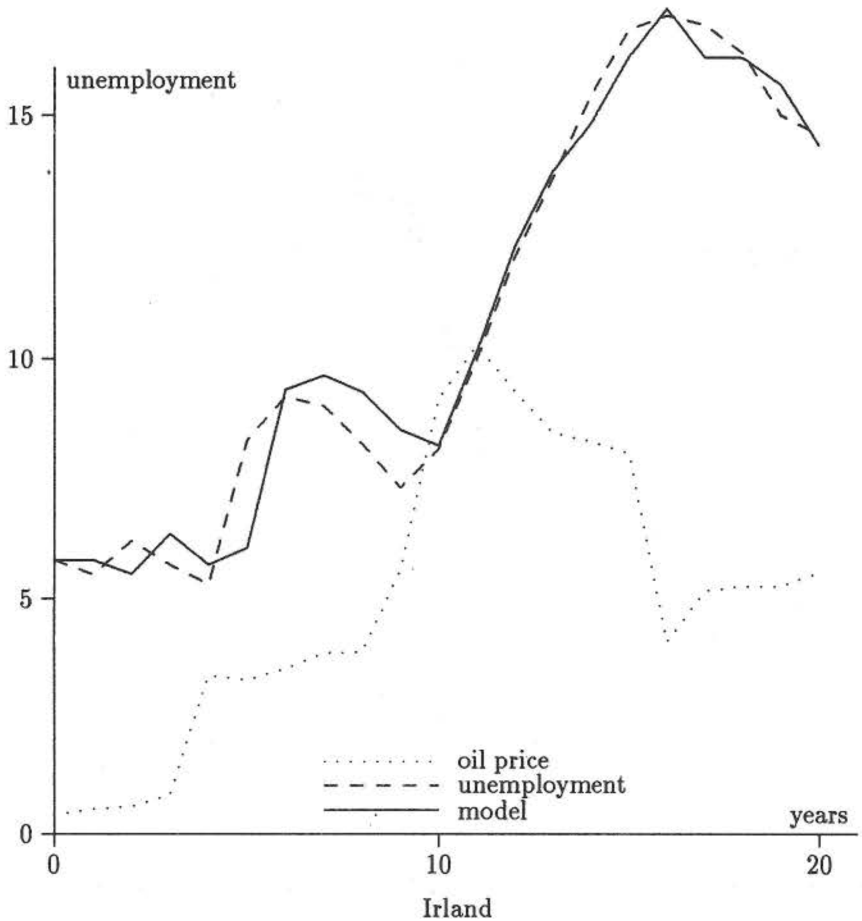

Figure 8. Oil prices, unemployment and unemployment model for Ireland.

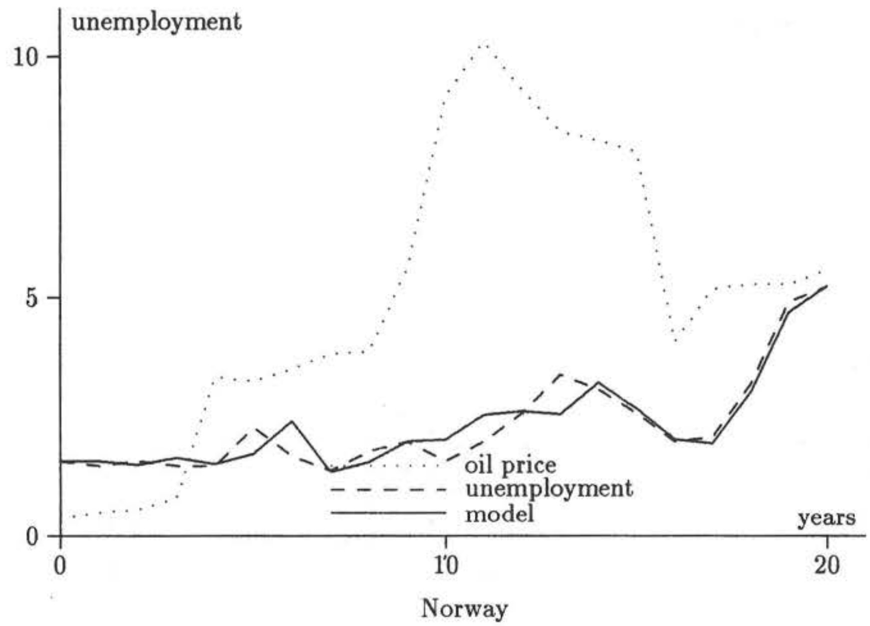

Figure 9. Oil prices, unemployment and unemployment model for Norway.

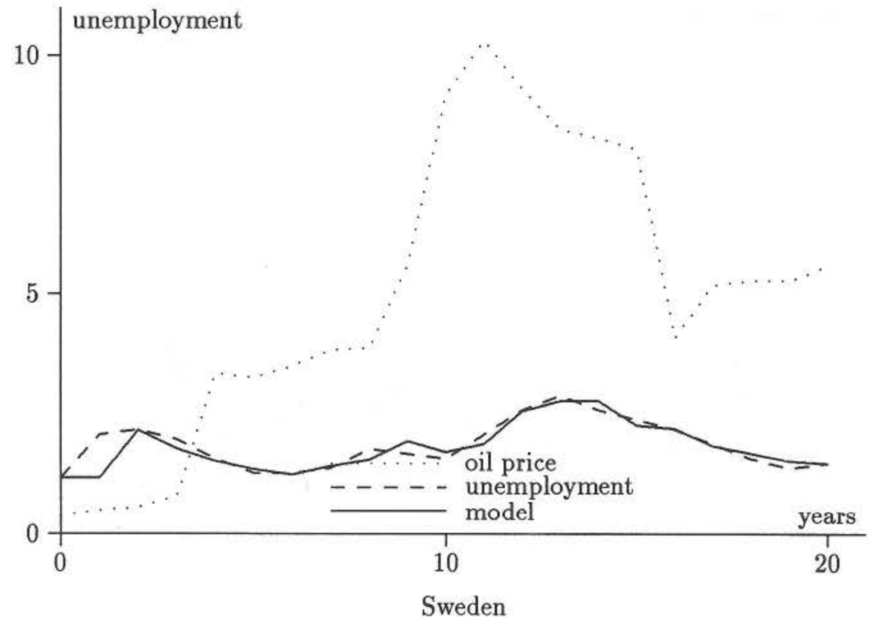

Figure 10. Oil prices, unemployment and unemployment model for Sweden.

Figure 11. Oil prices, unemployment and unemployment model for USA.

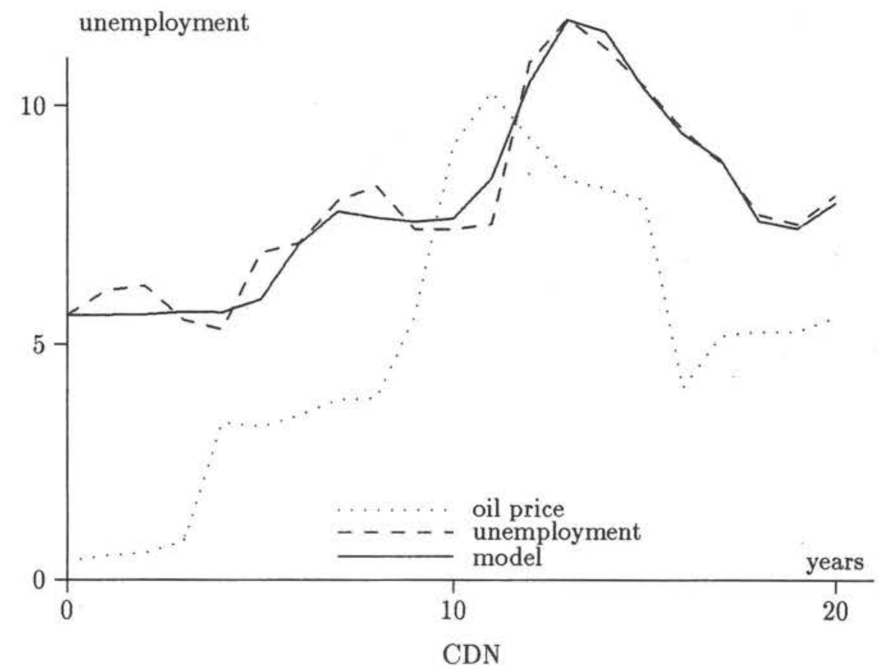

Figure 12. Oil prices, unemployment and unemployment model for CDN.