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Discussion Papers in Economics and Econometrics

1999

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Modelling shifts in the wage-price and unemployment-inflation relationships in Italy, Poland, and the UK.

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First version November 1997. This version February 1999.
Comments welcome.

Abstract

The relationship between wages, prices, productivity, inflation, and unemployment in Italy, Poland, and the UK between the 1960's and the early 1990's is modelled as a cointegrated vector autoregression subject to regime shifts. For each of these economies there is clear evidence of a change in the underlying equilibria of this sector of the economy. Hypotheses concerning the similarity of the transition from a rigid to a flexible labour market are tested.

*This work was done as a part of the Phare ACE Project (P95-2145-R) *Inflation and Unemployment in Economies in Transition,* funded by the European Commission, and the authors thank the other participants in the project for their comments. The authors are grateful to Roberto Golinelli and seminar participants at the European University Institute for valuable comments on a previous version of the paper, and to Elena Gennari for providing valuable background information on the Italian economy. Also Mizon is grateful for financial support from the EUI Research Council and the UK Economic and Social Research Council under grant L116251015.

1 Introduction

Many economies in Europe have experienced significant changes in economic structure and economic policies pursued during the last three decades. Some economies have undergone substantial liberalisation of their labour, financial, and foreign exchange markets, an example being the UK. Other economies of eastern and central Europe, for example Poland, have moved from being centrally planned towards free market economies. Intermediate between these extremes are economies that have slowly adopted policies to liberalise their financial and foreign exchange markets, and introduce some degree of flexibility into their labour markets e.g. Italy. In this paper we analyse the labour market characteristics of the UK, Italy, and Poland, paying attention to the possibility that there has been a substantial shift in economic policy adopted in these countries towards their labour markets. We find clear evidence for there being a major change in the underlying structure of the wage-price and unemployment-inflation relationships in each of these economies, occurring around 1979/80. Although there are clear institutional and *a priori* reasons for believing that these three economies are different, we test hypotheses for there being commonalities in the changes that have taken place in each of these three economies. The results reveal substantial differences.

Other issues raised in the process of the analysis include: the evolution of unemployment, and in particular its relationship to productivity, inflation and real earnings; and the relationship between earnings and prices. The relevance of these issues is clear when it is noted that the high rate of unemployment is one of the biggest problems facing European countries, and that since 1980 moves to achieve more flexible labour market conditions were seen as an important way to address this problem.

The analysis in this paper builds on the earlier literature, in particular the papers by Clements and Mizon (1991) and Mizon (1995) for UK, Marcellino and Mizon (1997) for Italy, Welfe (1991) and Welfe (1996) for Poland, each of which contain further information and references.

2 The Sample Data

In this section we describe the details of the variables under study, i.e., real earnings ($e-p$), unemployment (u), productivity ($prod$), and wage (earnings) inflation (Δe), and present descriptive statistics characterising their behaviour. We also discuss some of the major events which are likely to have affected their evolution over the sample period, and might therefore be relevant in the econometric analysis.

2.1 UK

The seasonally adjusted quarterly data for the UK are taken from the dataset in Clements and Mizon (1991) extended to cover the period 1965(1)-1993(1). The hourly earnings variable (e) is the log of the ratio of wages and salaries to the number of employees multiplied by the average weekly hours of work in the manufacturing sector (a). The price variable (p) is the log of the retail price index. The productivity variable $(prod)$ is the log of the ratio of total constant price GDP to total employment minus the log of $a,$ in order to have a proxy for hourly productivity which matches hourly earnings. Wage inflation (Δe) is measured as the first difference of $e,$ and so is the quarterly rate of earnings inflation. We have decided to consider wage inflation instead of price inflation because it can be more directly related to productivity and unemployment, even if the behaviour of the two measures of inflation is very similar. Finally, u is the log of the percentage unemployment rate.

The variables $(e-p)$, $prod$, u, and Δe are graphed in Figure 1. The similarity of the upward trend in real earnings and productivity, with both having a slightly lower slope in the 1980's, is evident. The big hike in the former variable in 1975 is associated with the ending of a period of statutory wage and price control, while the decline in productivity in 1984 is mainly related to the effects of the Miners' Strike, which began in 1984(2). Unemployment has also increased strongly throughout the sample period, with some business cycle fluctuations. The decline in 1966 is related to the introduction of the "selective employment tax", which aimed to increase employment in manufacturing industries, though it was subsequently reduced by 50% in 1971. The substantial reductions in unemployment in 1974 and 1988/89 are mainly the delayed consequences of pre-election expansionary policies. 1974 was a turbulent year in the UK labour market with numerous strikes and the 3 Day Week restrictions leading to a change of government, followed by a strong increase in unemployment. The increase in unemployment in the early and late 1980's is instead related to the tight monetary policy adopted to reduce the aggregate rate of inflation, and the recession induced by this policy. The peaks in wage inflation, which are similar to those in retail price inflation, are associated with the oil crises and the increase in VAT from 8% to 15% in July 1979, while its rapid decline in the early 1980's is the positive consequence of the restrictive monetary policy combined with lower raw material prices.

The rates of growth of real earnings, productivity, unemployment, and the change in wage inflation, which will be modelled in section 4, are also graphed in Figure 1. In general, the pre - 1980 period is characterised by higher volatility, but also higher means for the growth of real earnings and productivity.

The 1980's were also a period of major changes in labour market legislation, which aimed at substantially increasing flexibility. Among the most important modifications, we mention the decrease in coverage and generosity of unemployment benefits, the weakening of union im-

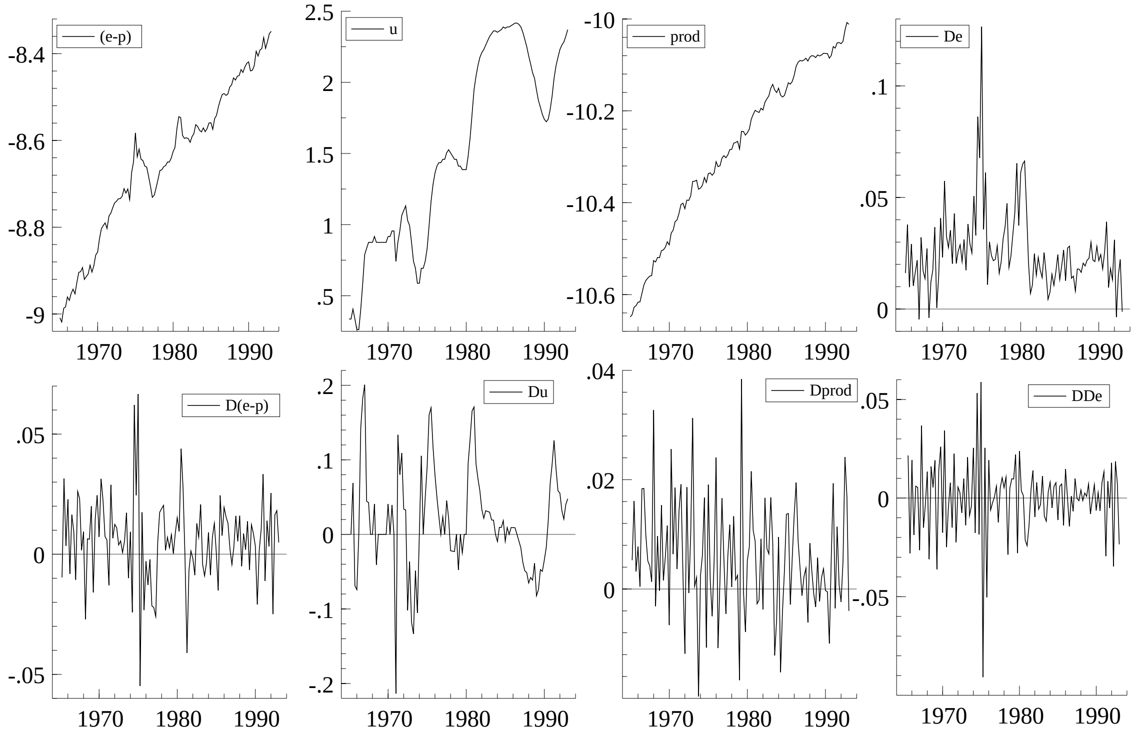

Figure 1   Full sample data, levels and first differences, UK.

munities and strengthening of the rights of non-unionised workers, and the possibility for employers not to contract with unions - see Standing (1993) and Bertola and Ichino (1995) for a more detailed description.

The full sample was split at 1979(2) to coincide with the election of the Thatcher Conservative government in May 1979 - Mizon (1995) provides further evidence for a similar choice. As a provisional indicator of the degree of integration of the variables Augmented Dickey-Fuller test statistics were calculated for the sub-samples 1965(1)-1979(2) and 1979(3)-1993(1), with the hypotheses that $(e-p)$, u, $prod$, and Δe are each integrated of order one (I (1)) being accepted, and those that they are integrated of order two (I (2)) rejected. This result is confirmed in the subsequent multivariate analysis. Table 1 presents descriptive statistics for the first differences of the variables for the sub-samples. In addition to the earlier observation based on visual inspection of the time plots of the variables, that there was higher variability and lower unemployment before 1980, these statistics provide evidence of substantial changes in the cross-correlations between the growth rates. In particular, the correlation between $\Delta(e-p)$ and Δu is negative before, but positive after, 1980, while three of the other correlations change in magnitude substantially. However, these are simple correlations, and so fuller interpretations must await the multivariate analysis undertaken below.

Table 1. Descriptive Statistics, UK

	1965(2)-1979(2)				1979(4)-1993(1)			
	$\Delta(e-p)$	Δu	$\Delta prod$	$\Delta^2 e$	$\Delta(e-p)$	Δu	$\Delta prod$	$\Delta^2 e$
Mean	0.007	0.019	0.007	0.000	0.006	0.018	0.004	-0.001
S.D.	0.02	0.08	0.01	0.02	0.01	0.06	0.01	0.01
Correlations								
$\Delta(e-p)$	1				1			
Δu	-0.10	1			0.45	1		
$\Delta prod$	0.28	0.12	1		0.09	0.24	1	
$\Delta^2 e$	0.75	-0.19	0.31	1	0.39	-0.26	0.31	1

Given this evidence in favour of there being different behaviour in the variables pre- and post- 1980 we will continue the analysis separately for the two sub-samples, under the assumption that all the variables are $\mathsf{I}(1)$.

2.2 Italy

The data for Italy are quarterly, seasonally adjusted, for the period 1970(1)-1994(4), and are taken from the dataset in Marcellino and Mizon (1997). e is measured as the log of the ratio of total earnings of non self-employed to the units of labour non self-employed. p is the log of the consumer price index. $prod$ is the log of the ratio of constant price GDP to the units of total labour employed. u is the log of the unemployment rate, and Δe quarterly earnings inflation.

From Figure 2, real earnings and productivity show a marked upward trend, with a slowdown in the early 1980's due to the effects of changes in the wage indexation system, which was introduced in 1975, and to the recession determined by a tight monetary policy which managed to substantially reduce inflation. Unemployment is also dominated by an upward trend, with a peak around 1973, corresponding to the recession associated with the first oil crisis, and an apparently temporary decrease in 1992 which is associated with a permanent change in definition. On average u was much lower in the 1970's than in the 1980's. Wage inflation on the other hand is characterised by a higher mean and greater variability in the 1970's, with two peaks coinciding with the oil crises in 1973 and 1979. The graphs of the first differenced variables given in Figure 2 highlight the lower mean and also variability of the growth in real earnings and productivity after 1980, and the spikes in the growth in unemployment in 1973 and 1992, related to the aforementioned events.

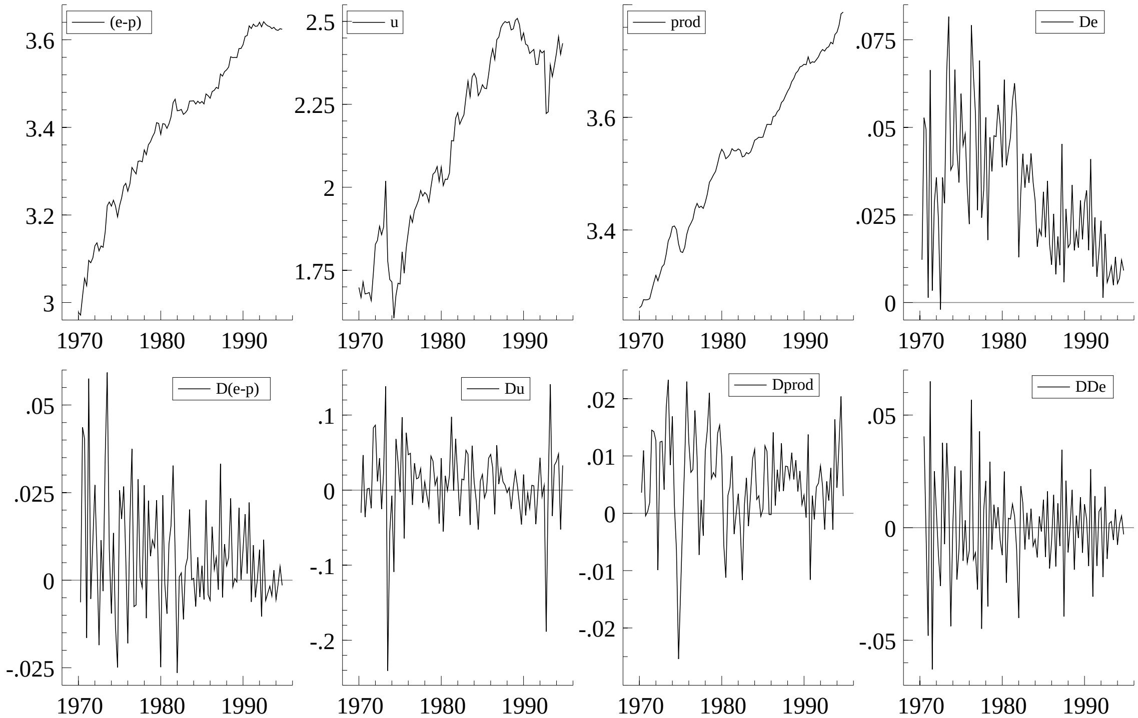

Figure 2 Full sample data, levels and differences, Italy.

As for the UK, after 1980 there was a move to increase labour market flexibility in Italy, with the introduction of such measures as the reduction of payroll tax in 1980; the progressive decrease of wage indexation in 1983 and 1986, which ended in its elimination in 1992; the introduction of temporary contracts in 1984, and the extension of their range of applicability in 1987 - see Bertola and Ichino (1995), and Erickson and Ichino (1994) for a more detailed description. Yet, as Bertola and Ichino (1995) noted, there were also measures which were not coherent with a more flexible labour market, e.g. the reform of the firing regulations in 1990. This decreased the credibility of the transition from a rigid to a flexible labour market, and therefore reduced the expected beneficial effects in terms of unemployment.

As a provisional indicator of the degree of integration of the variables Augmented Dickey-Fuller test statistics were calculated for the sub-samples 1965(1)-1979(4) and 1980(2)-1994(4), with the hypotheses that $(e-p)$, u, $prod$, and Δe are each integrated of order one ($\mathsf{I}(1)$) being accepted, and those that they are integrated of order two ($\mathsf{I}(2)$) rejected. Table 2 presents descriptive statistics for the first differences of the variables, which agree with the graphs in indicating a substantial difference in the pre- and post- 1980 values. Notice the different means and correlations between the two sub-periods 1970(1)-1979(4), 1980(2)-1994(4).

Table 2. Descriptive Statistics, Italy

	1970(3)-1979(4)				1980(2)-1994(4)			
	$\Delta(e-p)$	Δu	$\Delta prod$	$\Delta^2 e$	$\Delta(e-p)$	Δu	$\Delta prod$	$\Delta^2 e$
Mean	0.01	0.01	0.007	0.001	0.004	0.06	0.004	-0.001
S.D.	0.02	0.06	0.01	0.03	0.01	0.05	0.006	0.02
Correlations								
$\Delta(e-p)$	1				1			
Δu	-0.27	1			-0.04	1		
$\Delta prod$	0.16	-0.11	1		0.01	0.12	1	
$\Delta^2 e$	0.63	0.01	0.02	1	0.74	0.05	0.04	1

Given this evidence in favour of there being different behaviour in the variables pre- and post- 1980 we continue the analysis separately for the two sub-samples, under the assumption that all the variables are I (1), just as for the UK.

2.3 Poland

The annual data for Poland are taken from the dataset in Welfe (1991) and Welfe (1996), and cover the period 1960-1989. Golinelli and Orsi (1994) and Golinelli and Orsi (1996) contain related analyses using quarterly data. The earnings variable, e, is the log of average wages at current prices excluding the agricultural and forestry sectors. p is the log of the cost of living index. $prod$ is the log of a measure of labour productivity, which matches with e. Instead of u a measure of excess demand for labour (ex), defined as the ratio of the number of vacancies to the number of registered unemployed multiplied by the number of employees in the socialized sector of the economy, is used. This variable has been found to perform better than unemployment in the analysis of Welfe (1991) and Welfe (1996). Notice that the measure of excess demand for labour, despite its definition implying that it is non-negative, is sometimes negative in the 1960's, so that we cannot take logs. Δe, annual wage inflation, is the first difference of e.

The variables are graphed in Figure 3. Real earnings and productivity steadily increase in the 1960's and 1970's, while there is a major drop in the early 1980's followed by a partial recovery. Excess demand for labour and inflation also substantially increase in the 1980's, and they are slightly higher on average in the 1970's than in the 1960's. The quite different behaviour of the variables in the 1980's is also evident from the graph of their first differences in Figure 3.

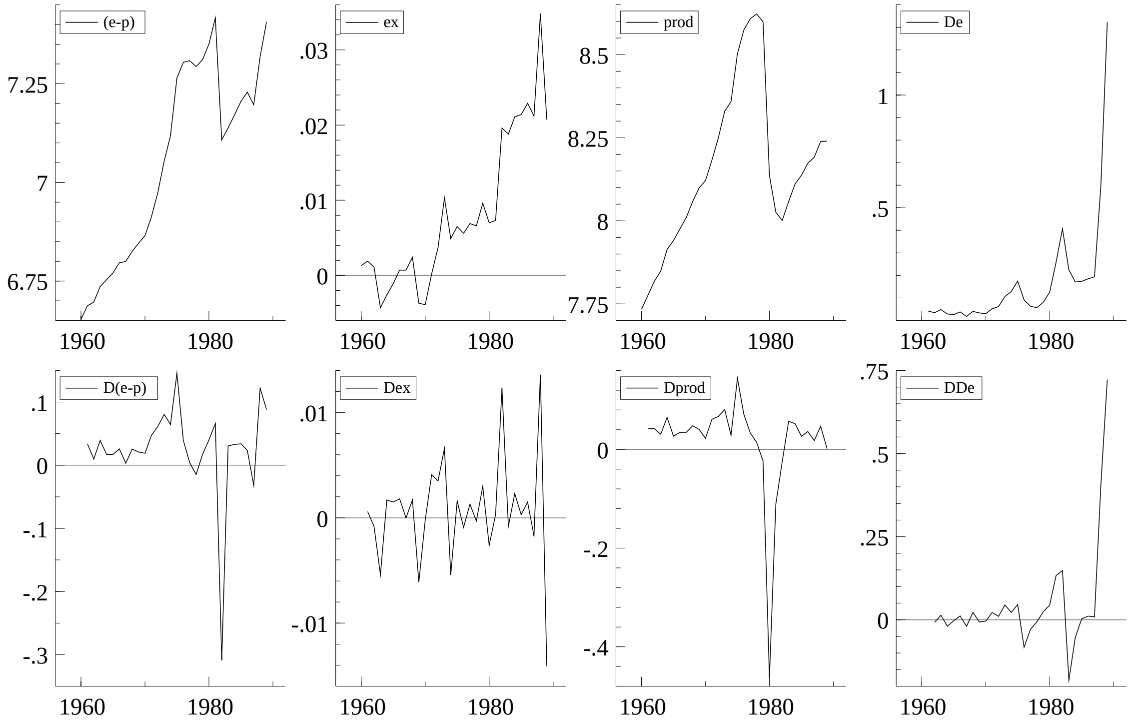

Figure 3 Full sample data, levels and first differences, Poland.

The 1980's were a period of major reforms in Poland associated with the rise of the Solidarity Movement. In particular, there were the first attempts to move towards a market system, even if their extent cannot be compared with the changes in the 1990's when central planning was abandoned since we only have data to 1989. The need for changes was emphasized by the aforementioned big modifications in excess demand for labour and inflation in 1980-81. Among the most relevant reforms, bargaining between the government and the producers on production plans, instead of a purely centralized decision, was introduced into several sectors. The subsidy system which compensated producers for the imposed low prices, which generated excess demand, was gradually reduced and by the mid 1980's the prices of most goods were "negotiable", which basically meant that firms could freely price their products. The close monitoring of wages and personal income was also gradually relaxed - see Welfe (1991) for further details.

The descriptive statistics in Table 3 confirm that the 1980's are quite different from the earlier period. Notice, in particular, the different correlation of excess demand for labour with the other variables. This suggests that the period 1960-1979 has to be analysed on its own. According to the results of the unit root tests, all variables can be considered as $\mathsf{I}(1)$ in this sample period. Further evidence on the break will emerge from the econometric analysis of section 4.

Table 3. Descriptive Statistics, Poland

	1961-1979				1981-1989			
	$\Delta(e-p)$	Δex	$\Delta prod$	$\Delta^2 e$	$\Delta(e-p)$	Δex	$\Delta prod$	$\Delta^2 e$
Mean	0.03	0.000	0.04	0.002	0.006	0.001	0.01	0.13
S.D.	0.04	0.003	0.03	0.03	0.12	0.008	0.05	0.27
Correlations								
$\Delta(e-p)$	1				1			
Δex	0.18	1			-0.40	1		
$\Delta prod$	0.78	0.24	1		0.19	0.06	1	
$\Delta^2 e$	0.53	0.27	0.16	1	0.22	-0.25	-0.21	1

3 The Modelling Framework

3.1 Economic Theory

Relationships among real earnings, productivity, unemployment, and inflation have been studied extensively in the economics literature *e.g.*, Layard and Nickell (1985). One possible equilibrium relationship for real earnings is:

$$(e-p) = \beta_{10} + \beta_{11} u + \beta_{12} prod + \beta_{13} \Delta e. \quad (1)$$

That real earnings should depend on productivity can be derived from the classic theory of the firm (see *e.g.*, Kaufman, 1994, chapter 4). The insider-outsider model of wage bargaining would instead predict that unemployment is not relevant $(\beta_{11} = 0)$, but if instead it appears in the objective function of the unions, it can also be expected to have a negative effect on real wages $(\beta_{11} < 0)$ (see *e.g.*, Lindbeck and Snower, 1988). The effect of inflation on real wages depends on the nature of wage agreements, and in particular on the existence of indexation clauses - the wage indexation mechanism is considered as one of the main determinants of inflation and of its persistence.

Unemployment would be expected to rise with increases in real wages, when these lead to higher costs for firms and are not the result of lower taxation. Higher real wages could also lead to an enlargement of the labour force and therefore increase unemployment even in the presence of stable employment. The effects of productivity are difficult to determine *a priori*. On the one hand it can be expected to reduce labour demand, but on the other the implied lower product prices and higher wages stimulate aggregate demand and thus the demand for labour (see *e.g.,* Kaufman, 1994 chapter 5). These considerations lead to a potential relationship of the form:

$$u = \beta_{20} + \beta_{21}(e-p) + \beta_{22} prod \tag{2}$$

Efficiency wage considerations (see *e.g.,* Akerlof and Yellen, 1986) imply that real wages can have a positive effect on productivity $(\beta_{32} > 0)$, and the same is true of unemployment when it provides an incentive for the workers to stick to their jobs $(\beta_{31} > 0)$. Wage inflation instead should play a minor role, unless myopic agents consider changes in nominal wages instead of real wages when deciding on their level of effort. Hence a relationship of the form:

$$prod = \beta_{30} + \beta_{31}u + \beta_{32}(e-p) + \beta_{33}\Delta e \tag{3}$$

might be relevant.

The relationship between unemployment and inflation has been discussed at length in the literature on the Phillips curve (see Phillips, 1958), which postulates a negative relationship $(\beta_{41} < 0)$ on the grounds that unemployment when associated with reductions in aggregate demand will lead to lower inflation.

$$\Delta e = \beta_{40} + \beta_{41}u + \beta_{42}(e-p). \tag{4}$$

The presence of agents forming rational expectations of inflation should rule out such a possibility, at least in the long run (see *e.g.,* Friedman, 1968 and Phelps, 1967). Similarly, increases in real wages not compensated by increases in productivity can lead to increased inflation $(\beta_{42} > 0)$.

Note that in this discussion of potential relationships amongst the variables to be modelled no mention has been made of the status of variables, of the likely short run relationships between the variables, of the statistical properties of the variables, or of the identification of the relationships. In particular, if some variables in a relationship are non-modelled then it is necessary that they be weakly exogenous for the parameters of interest for there to be no loss of information (see Engle, Hendry and Richard, 1983). Further, the fact all four variables appear to be I(1), see Section 2, implies that there will be fewer than four such relationships. In addition, economic theory considerations suggest that only one of (1) and (3) is likely to apply.

3.2 The Statistical Model

Having characterized on *a priori* grounds a set of possible equilibrium relationships among the variables, we now adopt a statistical model that is capable of representing these relationships as equilibria, as well as providing a description of the short run movements out of equilibrium.

The chosen statistical model must also be capable of representing the time series characteristics of the data, and so in the light of the descriptive analysis in Section 2 a cointegrated VAR with deterministic variables (such as constant, trend, and event specific dummies) included is adopted for the subsequent analysis. If the variables to be modelled cannot be well represented as a multivariate linear process then the VAR will not be congruent (see Bontemps and Mizon, 1996 and Hendry, 1995), and thus will exhibit signs of misspecification. Were this to be the case reformulation of the model (perhaps by variable transformation or by the inclusion of intervention dummy variables), will often enable the reformulated system to be well characterised by a VAR.

For k lags on a vector of n variables $\mathbf{x}_t$ with n_0 deterministic variables $\mathbf{q}_t$, the corresponding VAR is:

$$\mathbf{x}_t = \sum_{j=1}^{k} \mathbf{A}_j \mathbf{x}_{t-j} + \mathbf{K}\mathbf{q}_t + \boldsymbol{\epsilon}_t \text{ with } \boldsymbol{\epsilon}_t \sim \mathsf{IN}_n\left(\mathbf{0}, \boldsymbol{\Sigma}\right), \tag{5}$$

where $\mathbf{A}_j$ is an $n \times n$ matrix of autoregressive coefficients, $\mathbf{K}$ is an $n \times n_0$ matrix of coefficients of the n_0 deterministic variables, and $\boldsymbol{\epsilon}_t$ is a vector of n unobserved errors which have a zero mean and constant covariance matrix $\boldsymbol{\Sigma}$. When the variables being modelled $\mathbf{x}_t$ are $\mathsf{I}(1)$ but satisfy $r < n$ long run equilibrium relationships $\boldsymbol{\beta}'\mathbf{x}_t$ which are $\mathsf{I}(0)$ the VAR (5) can be written as a vector equilibrium-correction mechanism (VEqCM: see Johansen, 1988, 1992, and Hendry, 1995):

$$\Delta\mathbf{x}_t = \sum_{j=1}^{k-1} \boldsymbol{\Gamma}_j \Delta\mathbf{x}_{t-j} + \boldsymbol{\alpha}\left(\boldsymbol{\beta}'\mathbf{x}_{t-1}\right) + \boldsymbol{\delta} + \boldsymbol{\alpha}\boldsymbol{\lambda}t + \mathbf{K}^*\mathbf{d}_t + \boldsymbol{\epsilon}_t, \tag{6}$$

where Δ is the first difference operator, $\boldsymbol{\Gamma}_j = -\sum_{i=j+1}^{k} \mathbf{A}_i$, $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are $n \times r$ matrices of rank r such that $\boldsymbol{\alpha}\boldsymbol{\beta}' = -\left(\mathbf{I}_N - \sum_{i=1}^{k} \mathbf{A}_i\right)$, and $\mathbf{K}\mathbf{q}_t = \boldsymbol{\delta} + \boldsymbol{\alpha}\boldsymbol{\lambda}t + \mathbf{K}^*\mathbf{d}_t$ so that the deterministic variables include an intercept $\boldsymbol{\delta}$, a linear trend restricted to the cointegration space $\boldsymbol{\alpha}\boldsymbol{\lambda}t$ (trend is so restricted since none of the variables to be modelled exhibit quadratic trend behaviour), and some event specific dummy variables $\mathbf{d}_t$. Identification restrictions are required to ensure uniqueness of $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$. The model in (6) is in $\mathsf{I}(0)$ space when correctly formulated, thus inference concerning its parameters $\boldsymbol{\Gamma}_1, \boldsymbol{\Gamma}_2, ...\boldsymbol{\Gamma}_{k-1}, \boldsymbol{\alpha}, \boldsymbol{\delta}, \boldsymbol{\lambda}, \mathbf{K}^*$ and $\boldsymbol{\Sigma}$ can be conducted using conventional procedures. Since r is not known *a priori* its value has to be determined empirically, and the procedure adopted in the next section is the maximum likelihood one developed by Johansen (1988) as implemented in PcFiml 9.10 which was used for all the empirical results (see Doornik and Hendry, 1997).

If in steady state $\mathsf{E}(\Delta\mathbf{x}_t) = \boldsymbol{\gamma}$ and $\mathsf{E}(\boldsymbol{\beta}'\mathbf{x}_t) = \boldsymbol{\mu} + \boldsymbol{\lambda}t \;\forall t$ then (6) can be re-written as:

$$\left(\Delta\mathbf{x}_t - \boldsymbol{\gamma}\right) = \sum_{j=1}^{k-1} \boldsymbol{\Gamma}_j \left(\Delta\mathbf{x}_{t-i} - \boldsymbol{\gamma}\right) + \boldsymbol{\alpha}\left(\boldsymbol{\beta}'\mathbf{x}_{t-1} - \boldsymbol{\mu} - \boldsymbol{\lambda}(t-1)\right) + \mathbf{K}^*\mathbf{d}_t + \boldsymbol{\epsilon}_t \tag{7}$$

so that each of $(\Delta\mathbf{x}_{t-i} - \boldsymbol{\gamma})$ and $(\boldsymbol{\beta}'\mathbf{x}_{t-1} - \boldsymbol{\mu} - \boldsymbol{\lambda}(t-1))$ is $\mathsf{I}(0)$ and has a zero mean. This formulation makes clear the sources of growth, namely drift in $\mathbf{x}_t$ via $\boldsymbol{\gamma}$ and deterministic trend $\boldsymbol{\lambda}$ for equilibrium mean $\mathsf{E}(\boldsymbol{\beta}'\mathbf{x}_t)$. Depending on their nature (impulse or step change) the event specific dummies induce step or trend change behaviour in $\mathbf{x}_t$.

4 Results

We now present the estimated VEqCM's as defined in (7) for UK, Italy, and Poland, splitting the sample periods into two sub-samples, as suggested from the descriptive analysis in Section 2. This enables us both to evaluate directly whether there have been important changes in the structure of the economy, and to make a comparison of the equilibria and dynamic relationships among the variables in these countries. We also considered full sample analysis of a VAR with $k = 6$ and several dummy variables included to capture the effects of the institutional changes described in Section 2, but failed to obtain a congruent representation for any of the countries - the diagnostic test statistics indicating the presence of residual autocorrelation, heteroscedasticity, and non-normality.

4.1 UK

4.1.1 1965(1)-1979(2)

The specification of the deterministic component of the VAR includes: a constant; a linear trend restricted to lie in the cointegration space, and a set of dummy variables which capture the effects of some of the events recalled in section 2. Starting with $k = 5$, sequential likelihood ratio tests for the significance of the longest lag indicate that a VAR(4) cannot be rejected. The dummies (see section 2.1, Clements and Mizon (1991) and Mizon (1995) for explanations) which are significant in at least one equation according to a t-test are: impulse dummies for 1974(3) ($D743$), 1975(1) ($D751$), and 1979(2) ($D792$); a dummy whose value is -1 in 1971(1), 1 in 1971(2) and zero otherwise ($D71$); a dummy whose value is 1 in 1966(3), 1966(4), 1965(1), and zero otherwise ($D66$); and a dummy whose value is 1 in 1972(3), 0.5 in 1973(1) and zero otherwise ($D72$). The estimated VAR was subjected to diagnostic checking: first single equation statistics - residual standard deviations, serial correlation, normality, and autoregressive heteroscedasticity; and second system test statistics for vector autoregressive residuals, and vector normality (see Doornik and Hendry (1997) for more details of these test statistics). These statistics provided no evidence of misspecification. We therefore concluded that the model provided an acceptable basis for the analysis of the equilibrium and dynamic relationships among the variables.[1]

Table 4 reports the results for Johansen's test statistics, together with the values of the eigenvalues, μ_i, and the value of the maximized likelihood function apart from a constant (which is defined as $l = -T/2\sum_{i=1}^{r}\ln(1-\mu_i)$) (see Johansen, 1988 or Banerjee, Dolado, Galbraith and Hendry, 1993 for details) for both sub-samples. The Max and $Trace$ test statistics are not adjusted for degrees of freedom, and the critical values used are given in Osterwald-Lenum (1992); * and ** indicate rejection at the 5% and 1% level of the hypothesis that the rank is $\leq (r-1)$. We note that Doornik, Nielsen and Hendry (1998) recommend use of the $Trace$ statistic without degrees of freedom adjustment.

Table 4: UK: Cointegration Statistics

	1966(3)-1979(2)				**1980(2)-1993(1)**			
r	1	2	3	4	1	2	3	4
l	931	948	955	960	1047	1062	1075	1180
μ	0.59	0.47	0.25	0.16	0.58	0.44	0.40	0.15
Max	45.79**	32.89**	15.12	9.18	44.46**	30.21*	26.26**	8.72
$Trace$	103.0**	57.19**	24.3	9.18	109.7**	65.2*	34.98**	8.72

For the first sub-sample the evidence suggests that $r = 2$ is appropriate. The first two eigenvalues are substantial, and both the Max and $Trace$ statistics accept the hypothesis $r = 2$. The two largest eigenvalues of the companion matrix for the system are the complex pair $0.93 \pm i0.03$, with all other eigenvalues below unity. Further, the two identified equilibria selected are significant in several equations of the VEqCM. Table 5 shows the equilibria resulting after imposing non-rejected over-identifying restrictions that were tested using a LR statistic ($\chi^2(5) = 1.73 \quad [0.89]$), and their related adjustment coefficients (standard errors are in parentheses).

[1] These results, as well as those for all other VAR models in the paper, are not reported to save space, but are available on request from the authors.

Table 5: UK, Equilibria and Adjustment Coefficients

1966(3)-1979(2) $(r = 2)$

$$eqm_{1,t} = \Delta e_t + \underset{(0.008)}{0.044}\, u_t - \underset{(0.00014)}{0.0011}\, t - 0.039$$

$$eqm_{2,t} = (e-p)_t + \underset{(0.025)}{0.148}\, u_t - \underset{(0.069)}{1.334}\, prod_t - 5.26$$

$$\chi^2(5) = 1.73 \quad [0.89]$$

$\hat{\alpha}_i$	$i = 1$	$i = 2$
$(e-p)$	$-$	$\underset{(0.08)}{-0.30}$
u	$\underset{(0.74)}{2.92}$	$\underset{(0.25)}{-0.62}$
$prod$	$-$	$\underset{(0.08)}{0.22}$
Δe	$\underset{(0.20)}{-1.21}$	$-$

1980(2)-1993(1) $(r = 2)$

$$eqm_{1,t} = \Delta e_t + \underset{(0.003)}{0.025}\, u_t + \underset{(0.01)}{0.08}\, prod_t + 0.77$$

$$eqm_{2,t} = (e-p)_t - \underset{(0.33)}{0.83}\, prod_t - \underset{(0.54)}{4.87}\, \Delta e_t + \underset{(0.001)}{0.0034}\, t + 0.53$$

$$\chi^2(5) = 3.30 \quad [0.66]$$

$\hat{\alpha}_i$	$i = 1$	$i = 2$
$(e-p)$	$-$	$\underset{(0.04)}{-0.09}$
u	$-\underset{(1.06)}{3.65}$	$-\underset{(0.13)}{0.85}$
$prod$	$-$	$-$
Δe	$\underset{(0.21)}{-0.76}$	$-$

The first equilibrium indicates a negative relationship between (de-trended) inflation and unemployment, which can be interpreted as a very steep Phillips curve (4). Both unemployment and inflation respond to deviations from this equilibrium, and though the response of unemployment to this disequilibrium is perverse it does also react to the second disequilibrium. In the second equilibrium real wages respond positively to productivity and negatively to unemployment, which is coherent with the economic hypotheses associated with (1). Real earnings, productivity, and inflation have normal adjustment coefficients to the two disequilibria.

Conditional on $r = 2$ a VEqCM as in (7) with $(\boldsymbol{\beta}'\mathbf{x}_{t-1} - \boldsymbol{\mu} - \boldsymbol{\lambda}(t-1))$ consisting of $eqm_{1,t-1}$ and $eqm_{2,t-1}$ from Table 5, was estimated and found to be congruent. This VEqCM was therefore used as a basis to derive simplified models for the rates of growth of each of the 4 variables using FIML estimation. No contemporaneous variables were significant in the equations, which is coherent with sluggish adjustment. The model reported in Table 6, which parsimoniously encompasses the VEqCM $(\chi^2(45) = 36.50 \quad [0.81])$, results from deletion of non-significant regressors subject to the outcome being interpretable and congruent. In addition to the single equation diagnostics:

	$\hat{\sigma}$	$AR(4,27)$		$ARCH(4,23)$		$N(2)$	
$\Delta(e-p)_t$	1.5%	3.33^*	$[0.02]$	0.23	$[0.92]$	0.46	$[0.79]$
Δu_t	2.5%	1.32	$[0.29]$	0.65	$[0.64]$	6.74	$[0.03]$
$\Delta prod_t$	1.1%	1.82	$[0.15]$	0.63	$[0.65]$	1.55	$[0.46]$
$\Delta^2 e_t$	1.3%	2.65	$[0.06]$	0.29	$[0.88]$	0.27	$[0.87]$

there was no evidence of vector autoregression up to 4^{th} order in the residuals ($F(64,96) = 1.22 \quad [0.19]$), nor of the system residuals being non-normal ($\chi^2(8) = 5.93 \quad [0.66]$).

Table 6: UK reduced model - 1966(3)-1979(2)

$$\Delta(e-p)_t = -\underset{(0.06)}{0.26}\, eqm_{2,t-1} - \underset{(0.15)}{0.43}\,\Delta(e-p)_{t-1} - \underset{(0.15)}{0.52}\,\Delta^2 e_{t-1} - \underset{(0.09)}{0.20}\,\Delta^2 e_{t-2}$$
$$+\underset{(0.11)}{0.31}\,\Delta prod_{t-2} + \underset{(0.02)}{0.04}\,\Delta u_{t-3} + \underset{(0.01)}{0.05}\, D751 + \underset{(0.01)}{0.01}\, D72 + \underset{(0.02)}{0.05}\, D743$$

$$\Delta u_t = \underset{(0.01)}{0.04} + \underset{(0.42)}{2.56}\, eqm_{1,t-1} - \underset{(0.16)}{0.62}\, eqm_{2,t-1} - \underset{(0.25)}{0.60}\,\Delta^2 e_{t-3}$$
$$-\underset{(0.32)}{1.37}\,\Delta(e-p)_{t-1} + \underset{(0.30)}{0.85}\,\Delta(e-p)_{t-3} + \underset{(0.06)}{0.46}\,\Delta u_{t-1} + \underset{(0.06)}{0.15}\,\Delta u_{t-2}$$
$$-\underset{(0.37)}{1.14}\,\Delta prod_{t-1} - \underset{(0.38)}{1.97}\,\Delta prod_{t-2} - \underset{(0.40)}{1.15}\,\Delta prod_{t-3}$$
$$+\underset{(0.03)}{0.06}\, D751 + \underset{(0.02)}{0.14}\, D66 + \underset{(0.02)}{0.20}\, D71 - \underset{(0.02)}{0.17}\, D72 - \underset{(0.03)}{0.12}\, D743$$

$$\Delta prod_t = \underset{(0.001)}{0.007} + \underset{(0.05)}{0.18}\, eqm_{2,t-1} - \underset{(0.02)}{0.07}\,\Delta u_{t-2} + \underset{(0.006)}{0.01}\, D66 + \underset{(0.007)}{0.01}\, D71$$
$$+\underset{(0.01)}{0.02}\, D743 + \underset{(0.01)}{0.03}\, D792$$

$$\Delta^2 e_t = -\underset{(0.12)}{0.92}\, eqm_{1,t-1} - \underset{(0.10)}{0.27}\,\Delta^2 e_{t-1} + \underset{(0.06)}{0.07}\,\Delta^2 e_{t-3} + \underset{(0.13)}{0.16}\,\Delta(e-p)_{t-1}$$
$$-\underset{(0.01)}{0.02}\, D66 + \underset{(0.01)}{0.04}\, D743 + \underset{(0.01)}{0.06}\, D751$$

Apart from deterministic variables, the growth of real earnings depends on $eqm_{2,t-1}$ and lags of the growth rates of the variables included in it, plus lags of the acceleration in earnings. Note that there is not a significant constant term in the real earnings growth equation which is reassuring since real earnings cannot be expected to exhibit drift independently of productivity increases. The growth of unemployment is much more difficult to model, but a combination of the two disequilibria, lags of the growth rates of all variables, plus all but one of the dummy variables does provide a reasonable characterization. There is a positive drift in the unemployment equation which is consistent with its increase over the sample. The growth in productivity reacts appropriately to disequilibrium in the labour market $eqm_{2,t-1}$, increases with growth in unemployment, and has a positive drift. Earnings inflation appropriately exhibits no drift, and responds as expected to disequilibrium in the Phillips curve $eqm_{1,t-1}$, as well as increasing with growth in real earnings.

4.1.2 1979(3)-1993(1)

Several important changes took place in late 1979 and early 1980, some of which are documented in Section 2, so that it was very difficult to model this period. However, a congruent model for this sub-sample was obtained with a VAR(3) including a constant, a restricted trend, centered seasonal dummies, and the following impulse dummy variables1984(2) ($D842$), 1986(2) ($D862$), 1989(1) ($D891$), and 1992(1) ($D921$).

Both the $Trace$ and Max statistics indicate $r = 3$ (see Table 4), but the largest roots of the companion matrix are given by two complex pairs with moduli 0.94 and 0.82 respectively. It was therefore decided to proceed with $r = 2$, particularly after some experimentation with $r = 3$ did not produce satisfactory results.

The restricted cointegrating vectors and their loadings are reported in Table 5. The second equilibrium is a real wage equation consistent with the insider-outsider model - equation (1) with $\beta_{11} = 0$. $prod_t$ is weakly exogenous for the parameters of both equilibria, perhaps reflecting the marked changes that took place in the UK labour market in this period. u_t reacts appropriately to disequilibrium in $eqm_{1,t}$, but surprisingly decreases with negative disequilibrium in $eqm_{2,t}$. However, the first equilibrium is a productivity-augmented Phillips curve, with Δe_t decreasing with increases in both u_t and $prod_t$. This reflects the successful anti-inflationary policies resulting in much higher unemployment and increased labour productivity. Finally, $(e-p)_t$ and Δe_t react appropriately to $eqm_{2,t}$ and $eqm_{1,t}$ respectively.

Evidence of the change in the equilibrium relationships is provided in Figure 4 which contains the full sample graphs of the two equilibrium errors $(eqm_{1,t}$ and $eqm_{2,t})$ estimated separately for each of the two regimes (1966(3)-1979(2) and 1980(2)-1993(1)), after imposing their different over-identifying restrictions but without partialling out the effect of dummy variables and short run dynamics. They are denoted $eqm701$, $eqm702$, $eqm801$ and $eqm802$ in the graphs. The difference between the two regimes is dramatically revealed in the graph of $eqm701$ which is essentially stationary before 1980, but clearly non-stationary afterwards, and those of $eqm801$ and $eqm802$ which are clearly non-stationary before 1980 but essentially stationary thereafter. It appears that the first sub-sample restrictions do not generate stationary errors over the whole sample, and the same is true for the second sample restrictions. The first sub-sample restrictions were rejected ($\chi^2(5) = 32.83 \quad [0.00]$) when tested with the second regime data, and the second sample restrictions were rejected ($\chi^2(5) = 17.02 \quad [0.01]$) when tested with the first regime data.

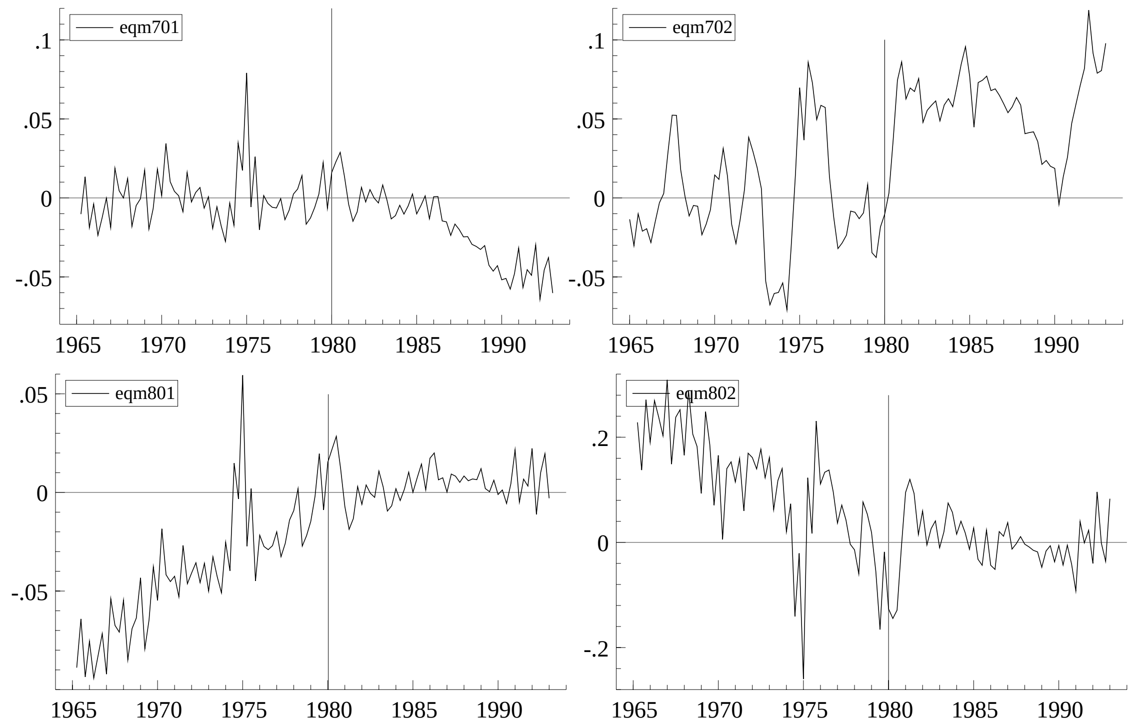

Figure 4 Restricted Equilibrium Correction Terms, UK.

The VEqCM, with $r = 2$ and using $eqm_{1,t-1}$ and $eqm_{2,t-1}$ for the second regime from Table 5, was estimated and found to be congruent. No contemporaneous variables were significant in the reduced VEqCM equations, which is coherent with sluggish adjustment. This model, which results from deletion of non-significant regressors subject to the outcome being interpretable and congruent, parsimoniously encompasses the VEqCM $(\chi^2(30) = 18.70 \quad [0.95])$, and is reported in Table 7. In addition to the single equation diagnostics:

	$\hat{\sigma}$	$AR(4,30)$		$ARCH(4,26)$		$N(2)$	
$\Delta(e-p)_t$	1.0%	2.48	$[0.07]$	0.03	$[0.99]$	1.96	$[0.38]$
Δu_t	1.6%	2.54	$[0.06]$	1.35	$[0.28]$	0.32	$[0.85]$
$\Delta prod_t$	0.7%	1.72	$[0.17]$	0.35	$[0.84]$	1.54	$[0.46]$
$\Delta^2 e_t$	0.8%	2.55	$[0.06]$	1.65	$[0.19]$	3.13	$[0.21]$

there was no evidence of vector autoregression up to 4^{th} order in the residuals ($F(64,92) = 0.72 \quad [0.92]$), nor of the system residuals being non-normal ($\chi^2(8) = 3.04 \quad [0.93]$).

The growth in real wages reacts appropriately to the lagged second equilibrium errors, and responds to the lagged changes in all variables. In addition to the dummy variables there is a significant drift of 2.5% per annum in the equation for $\Delta(e-p)_t$, which matches the drift in

$prod_t$. The equation for $\Delta prod_t$ confirms the weak exogeneity of $prod_t$ for the parameters of the equilibria, and shows no dependence of $prod_t$ on u_t. Δu_t reacts appropriately to $eqm_{1,t-1}$, but apparently perversely to $eqm_{2,t-1}$ though this is compensated by the positive effect from $\Delta(e-p)_{t-1}$. Though $\Delta^2 e_t$ has an appropriate reaction to $eqm_{1,t-1}$, there is a disturbing drift of 1.5%. However, the latter phenomenon is to be interpreted in the context of $prod_t$ being modelled as an I(1) variable with positive drift. Overall, this second regime reduced model is markedly different from that of the first regime. which provides further evidence of a change in the dynamic relationships among the variables under analysis after 1980.

Table 7: UK reduced model - 1980(2)-1993(1)

$$\begin{aligned}
\Delta(e-p)_t =& \underset{(0.002)}{0.006} - \underset{(0.03)}{0.10}\, eqm_{2,t-1} + \underset{(0.12)}{0.26}\, \Delta(e-p)_{t-1} - \underset{(0.12)}{0.34}\, \Delta(e-p)_{t-2} \\
& - \underset{(0.02)}{0.04}\, \Delta u_{t-2} - \underset{(0.19)}{0.49}\, \Delta^2 e_{t-1} + \underset{(0.19)}{0.18}\, \Delta prod_{t-1} \\
& - \underset{(0.20)}{0.39}\, \Delta prod_{t-2} + \underset{(0.01)}{0.03}\, D86.2 + Seas
\end{aligned}$$

$$\begin{aligned}
\Delta u_t =& \underset{(0.003)}{0.015} - \underset{(0.64)}{3.29}\, eqm_{1,t-1} - \underset{(0.11)}{0.78}\, eqm_{2,t-1} + \underset{(0.25)}{0.49}\, \Delta(e-p)_{t-1} \\
& + \underset{(0.10)}{0.77}\, \Delta u_{t-1} + \underset{(0.11)}{0.17}\, \Delta u_{t-2} - \underset{(0.02)}{0.05}\, D89.1
\end{aligned}$$

$$\begin{aligned}
\Delta prod_t =& \underset{(0.001)}{0.005} + \underset{(0.11)}{0.48}\, \Delta(e-p)_{t-1} - \underset{(0.12)}{0.42}\, \Delta(e-p)_{t-2} - \underset{(0.14)}{0.69}\, \Delta^2 e_{t-1} \\
& + \underset{(0.14)}{0.18}\, \Delta prod_{t-1} - \underset{(0.14)}{0.40}\, \Delta prod_{t-2} - \underset{(0.005)}{0.02}\, D84.2 + \underset{(0.007)}{0.02}\, D86.2 \\
& - \underset{(0.005)}{0.02}\, D92.1 + Seas
\end{aligned}$$

$$\begin{aligned}
\Delta^2 e_t =& \underset{(0.001)}{0.004} - \underset{(0.14)}{0.83}\, eqm_{1,t-1} - \underset{(0.13)}{0.13}\, \Delta^2 e_{t-1} - \underset{(0.02)}{0.08}\, \Delta u_{t-2} \\
& + \underset{(0.15)}{0.23}\, \Delta prod_{t-1} - \underset{(0.16)}{0.36}\, \Delta prod_{t-2} - \underset{(0.004)}{0.008}\, D84.2 \\
& + \underset{(0.008)}{0.02}\, D86.2 + \underset{(0.004)}{0.005}\, D89.1 + \underset{(0.004)}{0.01}\, D92.1 + Seas
\end{aligned}$$

4.2 Italy

4.2.1 1971(2)-1979(4)

The initial specification was a VAR(5) with a constant, a restricted trend, and impulse dummies for 1973(2) ($D732$), and 1973(3) ($D733$) associated with the oil price increase mentioned in Section 2. This congruent VAR(5) simplified to a VAR(4), whilst remaining congruent. The cointegration statistics in Table 8 suggest $r=2$, and this is supported by the largest eigenvalues of the companion matrix being $0.84 \pm 0.34i$ which have modulus equal to 0.91 and the remaining eigenvalues being noticeably smaller.

Table 8: Italy, Cointegration Statistics

	1971(2)-1979(4)				**1980(2)-1994(1)**			
r	1	2	3	4	1	2	3	4
l	633	646	654	656	1121	1135	1140	1145
μ	0.69	0.52	0.40	0.08	0.85	0.36	0.18	0.15
Max	40.84^{**}	25.96^{*}	17.71	3.06	110.3^{**}	26.64^{*}	11.76	9.46
$Trace$	87.57^{**}	46.73^{*}	20.77	3.06	158.2^{**}	47.87^{*}	21.22	9.46

The over-identifying restrictions implied by the restricted equilibria and adjustment coefficients reported in Table 9 were not rejected by the LR test ($\chi^2(6) = 5.58 \quad [0.47]$). The first equilibrium $eqm_{1,t}$ has an efficiency wage interpretation as in (3), noting that $prod$ has a linear trend in sample of exactly 0.006. The second equilibrium $eqm_{2,t}$ has a Phillips curve interpretation similar to the one found for the UK in the first sub-sample. The adjustment coefficients all have the correct signs. An interesting result is that they are equal to zero for Δe, which is therefore weakly exogenous for the equilibrium parameters, and is the natural candidate as a stochastic trend of the system over the 1970s. This is coherent with a rigid labour market, and the defence of employment and earnings as a policy objective independently of general economic conditions.

Table 9: Italy, Equilibria and Adjustment Coefficients

1970(1)-1979(4) $(r = 2)$

$$eqm_{1,t} = prod_t - \underset{(0.33)}{1.42}\,(e-p)_t + \underset{(0.47)}{1.79}\,\Delta e_t + \underset{(0.003)}{0.006}\,t + 0.99$$

$$eqm_{2,t} = \Delta e_t + \underset{(0.03)}{0.22}\,u_t - \underset{(0.0004)}{0.0023}\,t - 0.4$$

$$\chi^2(6) = 5.58 \quad [0.47]$$

$\hat{\boldsymbol{\alpha}}_i$	$i=1$	$i=2$
$(e-p)$	$\underset{(0.12)}{0.33}$	–
u	–	$-\underset{(0.58)}{3.29}$
$prod$	$-\underset{(0.09)}{0.30}$	–
Δe	–	–

1980(2)-1994(4) $(r = 2)$

$$eqm_{1,t} = \Delta e_t + \underset{(0.0001)}{0.0004}\,t - 0.05$$

$$eqm_{2,t} = prod_t + \underset{(0.25)}{1.13}\,(e-p)_t - \underset{(0.06)}{0.17}\,u_t - \underset{(0.002)}{0.011}\,t - 6.51$$

$$\chi^2(6) = 2.86 \quad [0.83]$$

$\hat{\boldsymbol{\alpha}}_i$	$i=1$	$i=2$
$(e-p)$	$-\underset{(0.12)}{0.31}$	–
u	–	–
$prod$	–	$-\underset{(0.02)}{0.10}$
Δe	$-\underset{(0.12)}{1.29}$	$\underset{(0.02)}{0.13}$

The VEqCM with $r = 2$ using $eqm_{1,t-1}$ and $eqm_{2,t-1}$ from Table 9 passes all diagnostic tests and the constancy of its parameters cannot be rejected, so it was used as a framework for the derivation of simplified models. A reduced model which parsimoniously encompasses the VEqCM $\left(\chi^2(40) = 37.40 \quad [0.59]\right)$ is reported in Table 10, and there is little evidence of mis-specification as seen from the following single equation diagnostic statistics:

	$\hat{\sigma}$	$AR(3,15)$		$ARCH(3,12)$		$N(2)$	
$\Delta(e-p)_t$	1.8%	3.74^*	$[0.04]$	0.95	$[0.45]$	0.39	$[0.82]$
Δu_t	3.2%	2.54	$[0.10]$	0.71	$[0.57]$	0.49	$[0.78]$
$\Delta prod_t$	0.8%	3.33^*	$[0.05]$	0.14	$[0.93]$	4.81	$[0.09]$
$\Delta^2 e_t$	0.9%	3.03	$[0.06]$	0.37	$[0.77]$	2.16	$[0.34]$

and the system diagnostics provide no evidence of vector autoregression up to 3^{rd} order in the residuals ($F(48,52) = 1.01 \quad [0.49]$), or of the system residuals being non-normal ($\chi^2(8) = 9.89 \quad [0.27]$).

Table 10: Italy reduced model 1971(2) - 1979(4)

$$\Delta(e-p)_t = \underset{(0.12)}{0.29}\, eqm_{1,t-1} + \underset{(0.13)}{0.46}\, \Delta(e-p)_{t-3} - \underset{(0.15)}{0.32}\, \Delta^2 e_{t-1} + \underset{(0.04)}{0.14}\, \Delta u_{t-1} + \underset{(0.04)}{0.16}\, \Delta u_{t-2} + \underset{(0.02)}{0.04}\, D732$$

$$\Delta u_t = -\underset{(0.34)}{3.30}\, eqm_{2,t-1} + \underset{(0.53)}{1.91}\, \Delta prod_{t-2} + \underset{(0.59)}{1.53}\, \Delta prod_{t-3} + \underset{(0.10)}{0.33}\, \Delta u_{t-2} + \underset{(0.08)}{0.50}\, \Delta u_{t-3} + \underset{(0.38)}{1.65}\, \Delta(e-p)_{t-1} - \underset{(0.45)}{1.99}\, \Delta(e-p)_{t-3} - \underset{(0.31)}{1.62}\, \Delta^2 e_{t-2} + \underset{(0.03)}{0.18}\, D732 - \underset{(0.01)}{0.02}$$

$$\Delta prod_t = -\underset{(0.06)}{0.27}\, eqm_{1,t-1} + \underset{((0.10)}{0.371}\, \Delta prod_{t-1} + \underset{(0.08)}{0.38}\, \Delta^2 e_{t-1} + \underset{(0.07)}{0.26}\, \Delta^2 e_{t-2} + \underset{(0.05)}{0.24}\, \Delta^2 e_{t-3} + \underset{(0.008)}{0.02}\, D732$$

$$\Delta^2 e_t = \underset{(0.10)}{0.75}\, \Delta(e-p)_t - \underset{(0.12)}{0.45}\, \Delta(e-p)_{t-1} - \underset{(0.14)}{0.66}\, \Delta(e-p)_{t-2} + \underset{(0.16)}{0.44}\, \Delta prod_{t-1} + \underset{(0.16)}{0.34}\, \Delta prod_{t-2} - \underset{(0.13)}{0.75}\, \Delta^2 e_{t-1}$$

The growth in real earnings adjusts normally to the efficiency wage disequilibrium $eqm_{1,t-1}$, falls with acceleration in nominal earnings as might be expected, and increases with growth in unemployment as predicted by the insider-outsider model. The constant is not significant in this equation and so there is no autonomous drift in real earnings. The growth in unemployment on the other hand is both more difficult to model, and has autonomous drift. The latter may be no more than a reflection of this sub-sample's growth rates in unemployment, productivity, real earnings, and earnings inflation, rather than a long run feature of the Italian economy.

Growth in unemployment has a normal response to disequilibrium in the Phillips curve relationship $eqm_{2,t-1}$, and unemployment is weakly exogenous for the parameters of the efficiency wage relationship $eqm_{1,t}$. Productivity growth adjusts appropriately to $eqm_{1,t-1}$, has no drift, and is otherwise an autoregressive-distributed lag of the acceleration in nominal earnings. The acceleration in nominal earnings and the growth in real earnings are contemporaneously related, which is unlike the UK for which no contemporaneous relationships were found. Another feature of this latter equation is the absence of both $eqm_{1,t-1}$ and $eqm_{2,t-1}$, so that earnings inflation Δe_t is weakly exogenous for the parameters of the two equilibria, confirming the results found in the unrestricted cointegration analysis reported in Table 9.

4.2.2 1980(1)-1994(4)

During the first 2 to 3 years of this period many sectors of the Italian economy were in transition: a tighter monetary policy was introduced to control inflation, steps were taken to liberalise the labour market, and Banca d'Italia was concerned with the defence of the lira within the ERM. Indeed this period caused considerable difficulty for modelling since the labour sector was undergoing much change that was far from a smooth transition. This is evident from inspection of the second period equilibria in Figure 5, it being noted though that the effects of the dummy variables and short run dynamics have not been partialled out of these graphs. The dummy variables introduced to deal with these problems were: $Deflate$ which is a step dummy for the period 1981(2) to 1981(4) when there was a sharp drop in inflation and increase in unemployment with two realignments of the lira, $Recess$ which is a step dummy for the period 1980(4) to 1982(1) capturing the effects of recession induced by tight monetary policy, ERM which is the difference between impulse dummies for 1982(1) and 1987(2) associated with currency crises. The last 2 years of the sample also posed a problem in that in 1992(4) there was an important change in the measurement of unemployment, and there was a recession induced by the policies associated with the lira leaving the ERM in September 1992. The dummy variables $Unemp$ (which is the difference between impulse dummies for 1992(4) and 1993(2)) and $92Crisis$ (a step dummy for the period 1992(4) to 1994(4)), proved adequate for capturing many of these effects. For the second sub-sample a VAR(1) with a constant, a restricted trend, and these 5 dummy variables, provides a good characterisation of the variables. None of the diagnostic statistics, single equation or vector, was significant for this system, and so we used it as the basis for testing for cointegration. The $Trace$ and Max tests for cointegration indicate $r = 2$ (see Table 8), and the eigenvalues of the companion matrix support $r = 2$, there being a complex pair of roots with modulus 0.91. Hence, we adopt the assumption $r = 2$ and it turns out that the resulting second equilibrium term is significant in several equations.

The equilibria that result after imposing non-rejected ($\chi^2(6) = 2.86 \quad [0.83]$) over-identifying restrictions on the cointegrating vectors and their loadings are reported in Table 9. The first equilibrium represents earnings inflation as stationary around a negative trend in this period, when the reduction of inflation was a major policy objective. The second equilibrium is difficult to interpret in the context of the efficiency wage hypothesis (3) because of the perverse sign for the coefficient on $(e-p)_t$. Indeed it is more like a relationship in which $prod_t$ increases with u_t representing the higher productivity of the marginal worker, who nonetheless receives a lower real wage as result of the threat of unemployment. Though this equilibrium does appear to provide a good characterisation of the Italian labour market in this period, it is a short run, rather than a long run sustainable, equilibrium - see Clements and Mizon (1991) for discussion of a similar relationship for UK data. All the adjustment coefficients are consistent with an equilibrium correction interpretation, with u_t and $prod_t$ being weakly exogenous for the parameters of $eqm_{1,t}$, and $(e-p)_t$ and u_t weakly exogenous for those of $eqm_{2,t}$.

Figure 5 contains the full sample graphs of the two equilibrium errors $(eqm_{1,t}$ and $eqm_{2,t})$ estimated separately for each of the two regimes (1971(2)-1979(4) and 1980(2)-1994(4)), after imposing their different over-identifying restrictions but without partialling out the effect of dummy variables and short run dynamics. They are denoted $eqm701$, $eqm702$, $eqm801$ and $eqm802$ in the graphs. The difference between the two regimes is dramatically revealed in the graphs of $eqm701$ and $eqm702$ which are essentially stationary before 1980, but clearly non-stationary afterwards. The graph of $eqm801,$ which is the deviation of inflation from trend, also illustrates the difference in inflation variability and trend pre- and post-1980. The graph of $eqm802$ again reveals the sharp changes between regimes, and the turbulence in the Italian economy after 1979. Indeed, this latter equilibrium appears non-stationary even after 1979 without the introduction of the dummy variables. The first sub-sample restrictions were rejected ($\chi^2(6) = 87.55 \quad [0.00]$) when tested with the second regime data, and the second sample restrictions were rejected ($\chi^2(6) = 39.21 \quad [0.00]$) when tested with the first regime data.

The VEqCM with $r = 2$ using the second regime $eqm_{1,t-1}$ and $eqm_{2,t-1}$ from Table 9 passes all diagnostic tests and the constancy of its parameters cannot be rejected. A reduced model, which was estimated by FIML and parsimoniously encompasses the VEqCM $(\chi^2(17) = 9.57 \quad [0.92])$, is reported in Table 11. There is no evidence of misspecification as seen from the following single equation diagnostic statistics:

	$\hat{\sigma}$	$AR(4,47)$		$ARCH(4,43)$		$N(2)$	
$\Delta(e-p)_t$	0.7%	0.86	[0.49]	1.86	[0.14]	5.74	[0.06]
Δu_t	3.2%	2.00	[0.11]	0.86	[0.50]	1.99	[0.37]
$\Delta prod_t$	0.5%	1.92	[0.12]	0.93	[0.46]	0.31	[0.86]
$\Delta^2 e_t$	0.6%	2.16	[0.09]	1.28	[0.29]	2.16	[0.34]

and the system diagnostics provide no evidence of vector autoregression up to 4^{th} order in the

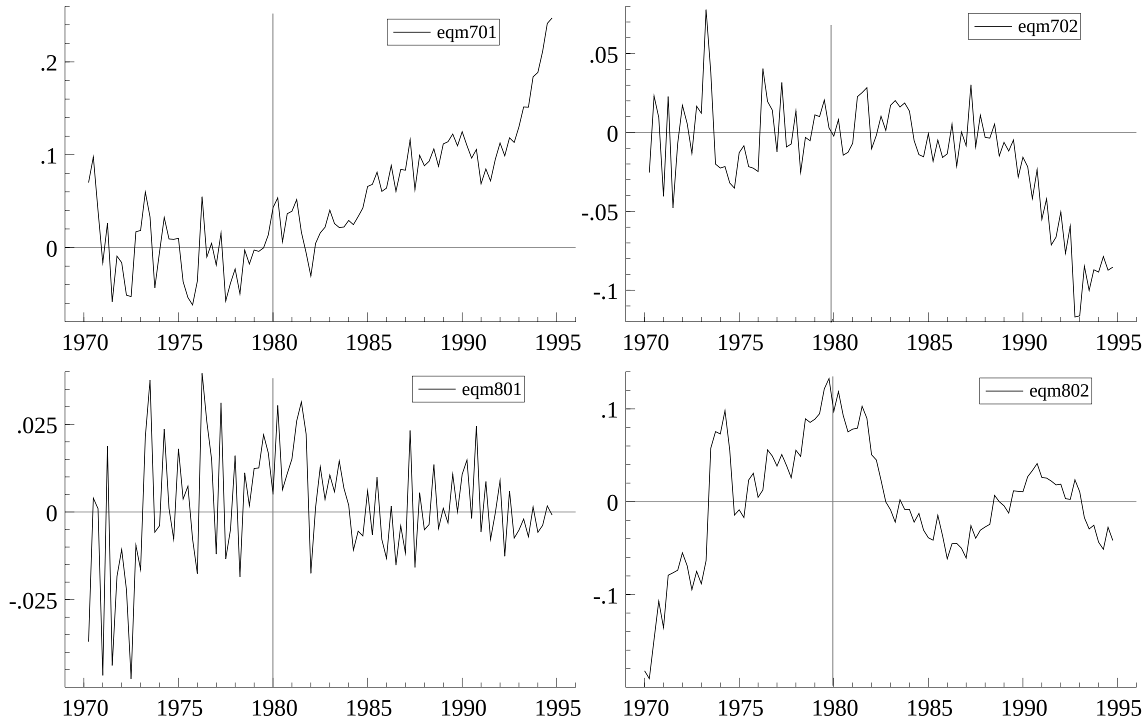

Figure 5 Restricted Equilibrium Correction Terms, Italy.

residuals ($F(64, 147) = 1.12 \quad [0.28]$), or of the system residuals being non-normal ($\chi^2(8) = 7.15 \quad [0.52]$).

Table 11: Italy reduced model 1980(2) - 1994(4)

$$\Delta(e-p)_t = \underset{(0.001)}{0.005} + \underset{(0.08)}{0.23}\,\Delta^2 e_t + \underset{(0.004)}{0.01}\,Deflate - \underset{(0.006)}{0.02}\,ERM - \underset{(0.002)}{0.006}\,92Crisis$$

$$\Delta u_t = \underset{(0.02)}{0.06}\,Deflate - \underset{(0.02)}{0.16}\,Unemp$$

$$\Delta prod_t = \underset{(0.001)}{0.004} - \underset{(0.02)}{0.11}\,eqm_{2,t-1} + \underset{(0.003)}{0.008}\,Recess$$

$$\Delta^2 e_t = \underset{(0.16)}{0.38}\,\Delta(e-p)_t - \underset{(0.09)}{1.16}\,eqm_{1,t-1} + \underset{(0.02)}{0.15}\,eqm_{2,t-1} + \underset{(0.005)}{0.01}\,Deflate - \underset{(0.007)}{0.02}\,ERM$$

The difficulty in modelling u_t is still evident: the equation standard error is exactly the same as for the first regime at 3.2%, it is modelled as a random walk without drift, and there are important effects from the $Unemp$ and $Deflate$ variables. The model characterises $(e-p)_t$ and

Δe_t as being simultaneously determined. However, although Δe_t reacts to both equilibria with appropriate adjustment coefficients and has no autonomous growth, $(e-p)_t$ has autonomous growth of 1.8% per year, and only responds to the equilibria via Δe_t. Both these variables are affected by $Deflate$ and ERM, and the $92Crisis$ variable also affects $(e-p)_t$. Interestingly in this second regime for Italy there is no Phillips curve, despite Δe_t and u_t having a strong negative correlation. Productivity responds appropriately to the efficiency wage equilibria $eqm_{2,t}$, and has autonomous growth of 1.5% per year which could reflect the dramatic increase in unemployment in this period, or genuine autonomous growth.

4.3 Poland

The results for Poland should be interpreted with care both because the sample (1961-1979) is short, and since decisions on wages, prices, and unemployment were mainly taken by the central government in this period. Our main goal was to illustrate the change in equilibrium relationships after 1980, even though we could not estimate the new equilibria with only 10 observations available. With this preliminary warning, a VAR(1) with a constant, a restricted trend, and two impulse dummies for 1975 and 1976 provides a reasonable representation for the variables. All the statistics in Table 12 accept their null hypotheses (tests for homoscedasticity cannot be calculated because of the small sample size).

Table 12. Poland System Diagnostic Statistics

1962-1979

	$(e-p)$		ex		$prod$		Δe	
$\hat{\sigma}$	1.8%		0.3%		1.9%		1.7%	
$AR(1,9)$	0.006	[0.94]	0.005	[0.94]	1.75	[0.22]	0.15	[0.70]
$N(2)$	1.11	[0.57]	4.06	[0.13]	2.68	[0.26]	2.21	[0.33]
$ARCH(1,8)$	0.63	[0.45]	0.23	[0.64]	0.07	[0.79]	0.74	[0.41]

$vecAR(16,9)$	0.67	[0.77]
$vecN(8)$	14.35	[0.07]

The Max and $Trace$ test statistics given in Table 13 indicate a cointegrating rank of unity, and yet all the eigenvalues are substantial - the smallest one being 0.34. The highest real eigenvalue of the companion matrix is 0.79, and there is a complex pair with modulus 0.88. Thus we selected $r = 3$, a choice which was confirmed by the significance of each of the equilibrium correction terms in at least one equation, and is in agreement with the choice of $r = 3$ in Welfe (1996) when analysing a similar system for the full sample 1961-1989. We note that both the number and the composition of the equilibrium terms is unaffected by the choice of the sample frequency, even if the small sample properties of the tests can be modified, see Marcellino (1999) for details.

Table 13: Poland, Cointegration Statistics

r	1	2	3	4
l	346	357	362	366
μ	0.87	0.68	0.47	0.34
Max	36.46*	20.71	11.28	7.57
$Trace$	76.03**	39.57	18.86	7.58

Table 14 gives the resulting equilibria and adjustment coefficients when non-rejected over-identifying restrictions ($\chi^2(3) = 0.89 \quad [0.83]$) were imposed. The first equilibrium indicates that productivity, a variable not directly controllable, reacts positively to real wages and negatively to wage inflation, which has an efficiency wage interpretation like $eqm_{1,t}$ for Italy in the first period, and might reflect workers preferences. The second equilibrium relates positively the excess demand for labour and inflation. This can be interpreted as the existence of a Phillips curve, because if increases in inflation determine a decrease in unemployment, this also leads to an increase in the excess demand for labour variable (which we recall has unemployment in the denominator). The existence of rational expectations is not incoherent with the presence of a Phillips curve in a world where nominal wages are fixed by the central government. In the third equilibrium relationship deviations of real wages from a positive trend are influenced by the excess demand for labour. This is to be expected in a market economy, but is more surprising in a centrally planned economy, even if the sometimes high excess demand for labour over this sample might have persuaded the government to implement such a policy. The equilibrium errors influence all variables in the system, so that none of them can be considered as weakly exogenous.

Table 14: Poland, Equilibria and Adjustment Coefficients

$1962 - 1979$

$$eqm_{1t} = prod_t - \underset{(0.03)}{1.72}\,(e-p)_t + \underset{(0.15)}{4.14}\,\Delta e_t + 3.6$$

$$eqm_{2t} = \Delta e_t - \underset{(0.69)}{5.12}\,ex_t - 0.05$$

$$eqm_{3t} = (e-p)_t - \underset{(2.76)}{18.46}\,ex_t - \underset{(0.001)}{0.024}\,t - 6.66$$

$\hat{\boldsymbol{\alpha}}_i$	$i=1$	$i=2$	$i=3$
$(e-p)$	$-$	$\underset{(0.34)}{0.70}$	$\underset{(0.07)}{-0.25}$
ex	$\underset{(0.07)}{-0.19}$	$\underset{(0.27)}{0.73}$	$\underset{(0.07)}{-0.18}$
$prod$	$\underset{(0.47)}{-1.59}$	$\underset{(1.81)}{6.93}$	$\underset{(0.50)}{-1.85}$
Δe	$\underset{(0.07)}{0.10}$	$\underset{(0.35)}{-0.65}$	$-$

Figure 6 graphs the restricted equilibrium errors (eqm_{1t}, eqm_{2t}, and eqm_{3t}) over the whole sample, which highlights their dramatically different behaviour after 1980. The fourth graph in this figure shows the close resemblance of eqm_{1t} to Δe_t (when they are adjusted to match in range and mean), which is also true of eqm_{2t}. This suggest that the first two equilibria are dominated by Δe_t so that modelling conditional on $r = 2$ might be appropriate. However, experimentation with $r = 2$ proved unsuccessful.

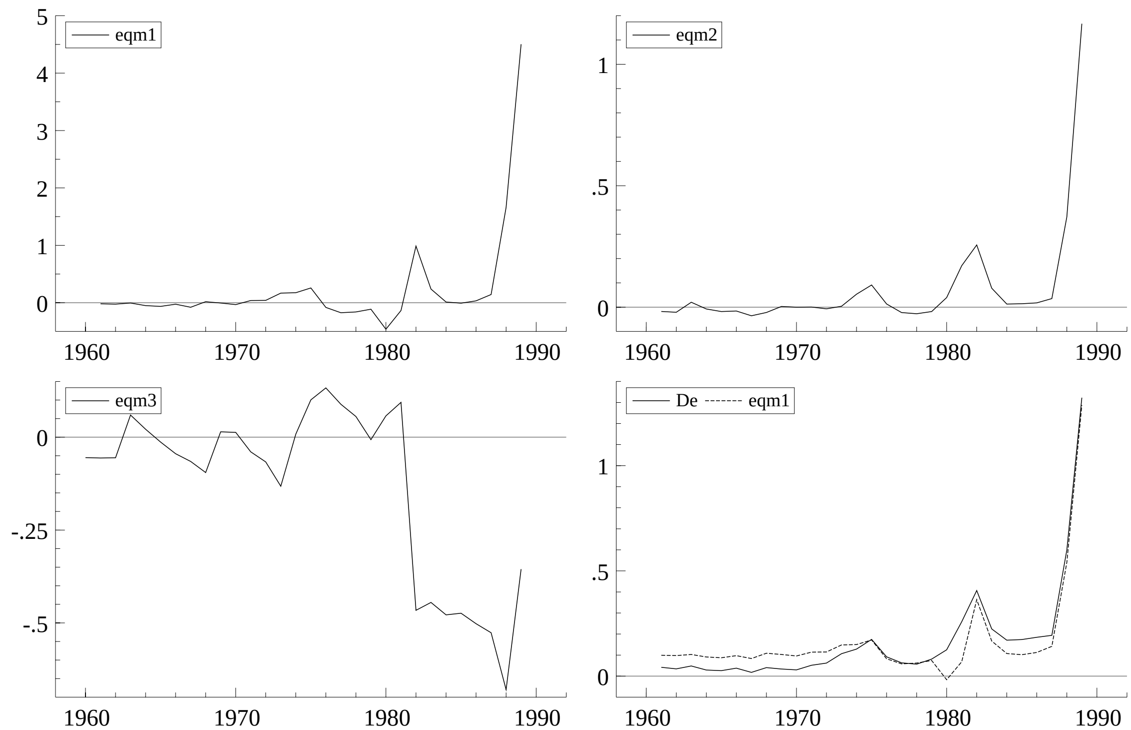

Figure 6 Restricted Equilibrium Correction Terms, Poland.

Another indication of the degree of the change that took place in 1980 is given by noting that when the same VAR was estimated over the full sample it was highly non-congruent. However, it could be argued that there is ample evidence of a substantial change having taken place in Poland in 1980 from the descriptive graphs in Figure 3. On the other hand, the restricted VEqCM estimated over the sub-sample passes all diagnostic controls and its parameters are stable according to the tests of Hansen (1992). A reduced model was then developed which is essentially congruent as the following single equation diagnostic statistics indicate:

	$\hat{\sigma}$	$AR(1,11)$		$ARCH(1,10)$		$N(2)$	
$\Delta(e-p)_t$	1.9%	0.98	[0.34]	0.02	[0.88]	1.66	[0.44]
Δex_t	0.3%	2.25	[0.16]	0.00	[0.97]	6.62*	[0.04]
$\Delta prod_t$	1.6%	0.74	[0.41]	0.05	[0.83]	2.85	[0.24]
$\Delta^2 e_t$	1.8%	0.57	[0.47]	1.32	[0.28]	1.85	[0.40]

The estimates, presented in Table 15, indicate that a simplified model based on equilibrium errors and the two dummy variables provides a reasonable characterisation of the variables. Note that there is significant autonomous growth in the equations for $(e-p)_t$ and $prod_t$. Overall though these results suggest that phenomena resembling market forces were at work even during the central planning period.

Table 15: Poland reduced model

1962-1979

$$\Delta\,(e-p)_t = \underset{(0.002)}{0.03} + \underset{(0.17)}{0.45}\; eqm_{2,t-1} - \underset{(0.07)}{0.24}\; eqm_{3,t-1} + \underset{(0.02)}{0.10}\; D75$$

$$\Delta ex_t = -\underset{(0.05)}{0.15}\; eqm_{1,t-1} + \underset{(0.20)}{0.56}\; eqm_{2,t-1} - \underset{(0.05)}{0.14}\; eqm_{3,t-1}$$

$$\Delta prod_t = \underset{(0.004)}{0.04} - \underset{(0.37)}{1.39}\; eqm_{1,t-1} + \underset{(1.46)}{6.06}\; eqm_{2,t-1} - \underset{(0.390)}{1.61}\; eqm_{3,t-1} + \underset{(0.02)}{0.04}\; D75$$

$$\Delta^2 e_t = \underset{(0.06)}{0.09}\; eqm_{1,t-1} - \underset{(0.23)}{0.83}\; eqm_{2,t-1} + \underset{(0.02)}{0.08}\; D75 - \underset{(0.01)}{0.03}\; D76$$

5 Conclusions

Within the context of linear vector autoregressive models clear evidence has been found for there having been a substantial shift in the structure of the aggregate labour sectors of Italy, Poland, and the UK. Since there have been well documented changes around 1979/80 in the economic policies adopted by the governments in these countries this is not surprising. Although there are a priori grounds for believing that the labour sectors of these economies are very different, the general tenor of many of the changes made has been to establish, amongst other things, more labour market flexibility. It has been interesting therefore to assess to what extent these objectives have been achieved, and to what extent there are commonalities in the structure of the labour sectors of these economies. Table 16 provides the likelihood ratio test statistics for the hypothesis that Italy and the UK have common equilibria in each of the two regimes, with all four possibilities being rejected. For example, testing that the first regime restrictions for Italy hold for the UK as well yields a value of 37.19 for the likelihood ratio statistic which has a limiting $\chi^2(6)$ null distribution.

Table 16: Cross Country Comparison of Equilibria

UK		**Italy**	
It 1	It 2	UK 1	UK 2
$\chi^2(6) = 37.19$	$\chi^2(6) = 43.62$	$\chi^2(5) = 12.16$	$\chi^2(5) = 33.94$
[0.00]	[0.00]	[0.03]	[0.00]

Hence though we have found evidence for there having been substantial changes in each country's labour market (perhaps a move towards more flexibility), there is no evidence of a common underlying structure. Noting the very different economic and political starting points for these three countries, and the different economic policies adopted by their governments, the lack of commonality does not present a surprise.

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