Monetary Policy and the Natural Rate of Unemployment*

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Abstract

This paper develops and tests a model in which the natural rate of unemployment depends on the objectives of monetary policymakers. Using UK quarterly data for 1965-2001, we find evidence that the priority given to stabilising the price level in the 1979-1987 and especially the post-1992 period led to a lower natural rate of unemployment

Keywords: natural rate of unemployment; monetary policy; inflation targets

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1) introduction

Explaining differences in unemployment rates, over time and between countries, is a central problem in Economics. The importance of the issue is reflected in a very large literature, much of which focuses on movements in the underlying equilibrium or natural rate of unemployment (Layard and Nickell, 1997, Machin and Manning, 1999). The great majority of studies attribute changes in the natural rate to structural features of the labour and goods markets, reflecting factors affecting wage determination, job search and price formation. This work suggests policymakers can affect the natural rate, but only through supply-side policies that affect wage and price formation. Monetary and fiscal policy can move unemployment away from the natural rate in the short-run but cannot affect the natural rate itself.

In this paper we investigate whether monetary policy can in fact affect the natural rate of unemployment. We assume that policymakers use a Taylor (1993)-like policy rule in which the money supply responds to deviations of employment and the price level from their target or desired levels. The relative importance of the employment or price level objectives is reflected in the relative weight attached to these variables in the policy rule, so a policymaker who regards the price level as more important will respond more vigorously to deviations of prices from target.

We argue that the natural rate of unemployment is lower when policymakers regard the price level as more important and is higher when policymakers regard employment as more important (see also Bratsiotis and Martin, 1999, Cukierman and Lippi, 1999 and Soskice and Iversen, 2000). The intuition for this is quite simple. The natural rate is lower when real wages are more sensitive to unemployment, which occurs, in part, when the demand for labour is more elastic. The link between wages and employment is partly macroeconomic. Higher wages feed through into higher prices, which reduce aggregate demand and lead to lower employment. But this

process is affected by the objectives of monetary policy. If policymakers give priority to employment, any price increases are matched by accommodating increases in the nominal money supply, so higher prices do not reduce aggregate demand. Policymakers that prioritise the price level, by contrast, will respond to higher prices by reducing the nominal money supply, leading to steeper falls in the real money supply and employment. As a result, the elasticity of demand for labour is higher and the natural rate of unemployment is lower, when policymakers give greater priority to the price level.

The apparent fall in the natural rate in the 1990s has been analysed by a number of commentators and policymakers, such as Wadhwani (1999) and Nickell (2001). These papers look to changes in product and labour markets to explain the fall in the natural rate. Pissarides (2003) argues that the "key reason" for the fall in the natural rate in the 1990s was the "reform in monetary policy" associated with the introduction of a credible inflation target in October 1992 and the granting of independence to the Bank of England in May 1997. His evidence of favorable shifts in the Beveridge and Phillips curves at these times is consistent with the evidence presented in this paper.

Our analysis implies that the natural rate is a linear function of the structural features of labour and goods markets that have been identified in previous work, but where the parameters vary over time as the objectives of policymakers change. We therefore estimate a series of models of the natural rate of unemployment using UK quarterly data for 1965-2001 where we allow the parameters to differ between eight sub-periods corresponding to differing monetary policy regimes: (i) 1965Q1- 1972Q2; (ii) 1972Q3-1976Q23; (iii) 1976Q3-1979Q1; (iv) 1979Q2-1987Q1; (v) 1987Q2-1990Q3; (vi) 1990Q4-1992Q3; (vii) 1992Q4-1997Q1 and (viii) 1997Q2-2001Q4 (the choice of these periods is explained in more detail below; see Nelson, 2000 and Cobham, 2002, for discussions of UK monetary pollicy over this period).

Our estimates support the hypothesis that the natural rate depends on the objectives of monetary policy. Two main periods stand out. The largest impact of monetary policy occurs in the inflation targeting period that began in late 1992. There was a sharp fall in the natural rate of unemployment in this period. Our estimates suggest that part of this fall would have occurred if monetary policy had not changed, but that the setting of an explicit target of

2.5% inflation, with the clarification that this should have priority over other objectives, led to a steeper fall than would have otherwise have occurred. We also find a substantial, albeit smaller effect for the 1979Q2-1987Q1 periods, covering most of the first two Thatcher administrations. Our estimates suggest that the rise in the natural rate in the first part of this period would have been more marked and the subsequent fall more muted if monetary policy had given less priority to stabilising prices. We also find significant but smaller effects for the Callaghan era of 1976Q3-1979Q1 and for the ERM period of 1990Q4-1992Q3.

The remainder of the paper is structured as follows. Section 2) develops a model of the interactions between monetary policy and the natural rate. This model is essentially a simplified version of the model in Bratsiotis and Martin (1999). Section 3) discusses our empirical methodology, explaining the transition from theoretical to empirical models and considering the measurement of the natural rate and the specification of explanatory variables reflecting structural characteristics of the labour and goods markets. Section 4) then presents our estimates, discussing whether the evidence tends to support our main hypothesis. Section 5) concludes the paper, discussing possible extensions to our work.

2) a model of interactions between monetary policy and the natural rate of unemployment

In this section we present a simplified version of the model of Bratsiotis and Martin (1999) to illustrate how the natural rate of unemployment may be affected by the stance of monetary policy.

Monetary policy

The demand for the output of firm i is

(1) $$y_i = y - \eta(p_i - p)$$

where y is aggregate demand, p_i is the price of firm i and p is the aggregate price level (all variables are expressed as logs). Aggregate demand is

(2) $$y = \bar{y} + \alpha(m - p)$$

where m is the nominal money supply and $\bar{y}$ is exogenous. Monetary policymakers use the policy rule

(3) $$m = \bar{m} - \phi(p - p^T) - \psi(y - y^T)$$

where $\bar{m}$ is exogenous, p^T is the target price level and y^T is the target level of output. The parameters ϕ and ψ measure the weight given by monetary policy to attaining the targets for prices and output. The stance of monetary policy is captured by the rate of accommodation, defined as

(4) $$\rho = \frac{\partial m}{\partial p} = -\psi\frac{\partial y}{\partial p} - \phi = \frac{\alpha\psi - \phi}{1 + \alpha\psi}$$

Adoption of an inflation target, or other policy that gives priority to the price level, will increase ϕ relative to ψ and thus will lower the rate of accommodation in monetary policy.

Price-setting

We assume there are a large number (n) of identical monopolistically competitive firms each of whom has the constant retuns to scale production function

(5) $$y_i = \tau + l_i$$

where y is output, l is employment and τ captures other factors that affect output. Assuming that labour is the only variable factor in the short-run and aggregating over identical firms,

(6) $$p = \mu + w - \tau$$

where w is the nominal wage and $\mu = (1 - \frac{1}{\varepsilon})^{-1}$ is the mark-up of price over marginal cost.

Wage setting

We use the monopoly union model. Unions choose nominal wages treating the wages chosen by other unions as given. Workers are organised into k identical unions, where we use $\sigma = 1/k$ as a simple measure of centralization. If there is a single union, then wage-setting is completely centralized and $\sigma = 1$. If each firm has its own union, then wage-setting is decentralized and $\sigma \to 0$.

We assume that the objective function of each union is

(7) $$\Omega_j = \frac{1}{2}(w_j - p - w*_j)^2 + \frac{\theta}{2}(l_j - l^*_j)^2$$

where j indexes the union, $w*$ and l^* are the union's targets for real wages and employment and θ is the unions' relative preference for employment. The first-order condition for the maximization of (7) is

(8) $$\frac{\partial \Omega_j}{\partial w_j} = (w_j - p - w*_j)(1 - \frac{\partial p}{\partial w_j}) + \theta(l_j - l*_j)\frac{\partial l_j}{\partial w_j} = 0$$

Using the production and demand functions to express employment in firms covered by union j as

(9) $$l_j = \bar{y} + \alpha(m - p) - \eta(p_j - p) - \tau$$

the elasticity of labour demand is

(10) $$\lambda = -\frac{\partial l_j}{\partial w_j} = \alpha \frac{\partial (m - p)}{\partial p} \frac{\partial p}{\partial w} \frac{\partial w}{\partial w_j} + \eta \frac{\partial (p_j - p)}{\partial (w_j - w)} \frac{\partial (w_j - w)}{\partial w_j}$$

Since $\frac{\partial (m - p)}{\partial p} = \rho - 1$, $\frac{\partial w}{\partial w_j} = \sigma$, $\frac{\partial (p_j - p)}{\partial (w_j - w)} = \eta(1 - \sigma)$ and

$\frac{\partial p}{\partial w} = 1$, we find

(11) $$\lambda = \alpha\sigma(1 - \rho) + (1 - \sigma) = \alpha\sigma(\frac{1 + \phi}{1 + \alpha\psi}) + (1 - \sigma)$$

In (11), the elasticity of labour demand is affected by the stance of monetary policy, since $\partial\lambda / \partial\phi > 0$ and $\partial\lambda / \partial\psi < 0$. Aggregating across identical unions and assuming $l^* = l^F$ and $w^* = \tau + \omega^*$, so changes in productivity are reflected in the target real wage, we find

(12) $$w - p = \omega^* + \tau - \theta(1 + \alpha \frac{\sigma}{1 - \sigma} \frac{1 + \phi}{1 + \alpha\psi})u$$

Solving equations (6) and (12), the natural rate of unemployment is

(13) $$u^* = \frac{\omega^* + \mu}{\theta(1 + \alpha \frac{\sigma}{1 - \sigma} \frac{1 + \phi}{1 + \alpha\psi})}$$

The natural rate of unemployment is a function of the parameters of the monetary policy rule. A larger weight on inflation in the policy rule implies a lower natural rate while a larger weight on output leads to higher unemployment. The intuition for this result is quite simple. Higher wages lead to less employment. In this model this occurs because higher wages feed through into higher prices, which reduces the real money supply. This

reduces aggregate demand and leads to lower employment. This process if affected by the stance of monetary policy. If the rate of accommodation is higher, the reduction in aggregate demand due to higher prices is offset by an increase in the nominal money supply. As a result the elasticity of demand for labour is lower and therefore the natural rate of unemployment is higher when the rate of accommodation is higher. Since the rate of accommodation is lower when policymakers give greater priority given to stabilizing prices rather than output or employment, we conclude that the natural rate is lower when policymakers seek to stabilize the price level.

3) empirical methodology

Introducing explicit time subscripts, our model of the natural rate is

(14) $$u^*_t = \frac{\omega^*_t + \mu_t}{\theta(1 + \alpha \frac{\sigma}{1-\sigma} \frac{1+\phi_t}{1+\alpha\psi_t})}$$

Since we are concerned with the effects of the monetary policy rule, it is convenient to use the following first-order approximation to (14)

(15) $$u^*_t = (\frac{\omega^*_t + \mu_t}{\theta})(1 - \alpha \frac{\sigma}{1-\sigma} \frac{1+\phi_t}{1+\alpha\psi_t})$$

We next assume that

(16) $$\frac{\omega^*_t + \mu_t}{\theta} = \alpha_1 Z_{1t} + \alpha_2 Z_{2t} + \alpha_3 Z_{3t} + ...\alpha_m Z_{mt} = Z_t \alpha$$

where $Z_t = [Z_{1t}, Z_{2t}, .., Z_{mt}]$ is a (1xm) vector containing observations on each of m explanatory variables, $\alpha = [\alpha_1, \alpha_2, ..., \alpha_m]$ is a (mx1) vector of parameters and ε_t is a white noise error term.

In modeling variations in monetary policy over time, we follow Nelson (2000) in distinguishing seven periods for the 1965-1997 period: (i) 1965Q1-1972:2: this was a period of fixed exchange rates, where the need to defend the exchange rate peg led to a low rate of accommodation (see Alogoskoufis, 1991 for an analysis of the links between exchange rate regimes and accommodation in monetary policy); (ii) 1972Q3-1976Q23: a period of flexible exchange rates, suggesting a higher rate of accommodation; (iii) 1976Q3-1979Q1: emphasis shifted to controlling the nominal money supply in this period; (iv) 1979Q2-1987Q1: in this period the Thatcher government intensified the policy of money supply targeting, and emphasised the goal of stabilising prices; (v) 1987Q2-1990Q3: a period in which the aim of monetary policy was to ensure the exchange rate shadowed the Deutschemark, reintroducing some elements of a fixed exchange rate; (vi) 1990Q4-1992Q3: the period of membership of the ERM; (vii) 1992Q4-1997Q1: the initial inflation targeting period, where the target was eventually set at 2.5% but with fluctuations between 1%-4%. We also consider an eighth period, (viii) 1997Q2-2001Q4: in May 1997, the Bank of England was given operational independence and the inflation target was confirmed as 2.5%, but with tolerance bands of +/- 1%. We use a series of time dummies to capture the effects of these variations in monetary policy, assuming

$$1-\alpha\frac{\sigma}{1-\sigma}\frac{1+\phi_t}{1+\alpha\psi_t}=\delta_0+\delta_1 D_{72-76}+\delta_2 D_{76-79} \tag{17}$$
$$+\delta_3 D_{79-87}+\delta_4 D_{87-90}+\delta_5 D_{90-92}+\delta_6 D_{92-97}+\delta_5 D_{97-2001}$$

The parameter δ_0 captures the stance of monetary policy in 1965-72, D_{72-76}, D_{76-79}, etc are a series of dummy variable for the policy periods identified above and so the parameters δ_1, δ_2, etc, capture the effects of variations in monetary policy compared to the1965-72 period.

Combining these assumptions, the model becomes

$$u^*_t = Z_t\alpha(\delta_0+\delta_1 D_{72-76}+\delta_2 D_{76-79} \tag{18}$$
$$+\delta_3 D_{79-87}+\delta_4 D_{87-90}+\delta_5 D_{90-92}+\delta_6 D_{92-97}+\delta_5 D_{97-2001})$$

Since the parameters of (18) are not identified, we further write the model as

(19)
$$u^*_t = (\bar{\alpha}_1 Z_{1t} + \bar{\alpha}_2 Z_{2t} + \bar{\alpha}_3 Z_{3t} + ... + \bar{\alpha}_m Z_{mt})(1 + \beta_1 D_{72-76} + \beta_2 D_{76-79} + \beta_3 D_{79-87} + \beta_4 D_{87-90} + \beta_5 D_{90-92} + \beta_6 D_{92-97} + \beta_7 D_{97-2001}) + \varepsilon_t$$

where $\beta_i = \frac{\delta_i}{\delta_0}$ and $\bar{\alpha}_i = \delta_0 \alpha_i$ and all the parameters in (19) are identified. If $\beta_i = 0$, for $\beta_i = 1,..,7$, the model simplifies to a linear model, similar to others estimated in the literature. Since the parameter δ_0 is not identified, we cannot estimate the impact of monetary policy on unemployment. But we can use estimates of the beta parameters to assess the impact of changes in monetary policy on unemployment.

Since the natural rate is not observed, equation (19) cannot be estimated directly. The actual unemployment rate differs from the underlying natural rate because wage- and price-setting are affected by persistence and forward-looking effects. We could augment our model with wage and price dynamics and estimate the model

(20)
$$u_t = (\bar{\alpha}_1 Z_{1t} + \bar{\alpha}_2 Z_{2t} + \bar{\alpha}_3 Z_{3t} + ... + \bar{\alpha}_m Z_{mt})(1 + \beta_1 D_{72-76} + \beta_2 D_{76-79} + \beta_3 D_{79-87} + \beta_4 D_{87-90} + \beta_5 D_{90-92} + \beta_6 D_{92-97} + \beta_7 D_{97-2001}) + \beta_p{}^+(F)\Delta p^e{}_{t+1} + \beta_w{}^+(F)\Delta w^e{}_{t+1} + \beta_p{}^-(L)\Delta p_{t-1} + \beta_w{}^-(L)\Delta w_{t-1} + \varepsilon_t$$

where $\beta_p{}^-(L)$ and $\beta_w{}^-(L)$ are polynomials in the lag operator, L and $\beta_p{}^+(F)$ and $\beta_w{}^+(F)$ are polynomials in the forward operator, F. This, however, is a complex task that is beyond the scope of this paper. We will therefore follow much recent literature (eg Ball and Mankiw, 2002) in using a more pragmatic approach. The natural rate of unemployment is the equilibrium underlying the observed unemployment rate. Assuming that the actual unemployment rate is more volatile than the underlying equilibrium, the natural rate can be identified with the low frequency components of the unemployment rate. We can therefore construct a measure of the natural rate

by extracting the low frequency components of the observed unemployment rate. We can then write our model as

$$u^T{}_t = (\bar{\alpha}_1 Z_{1t} + \bar{\alpha}_2 Z_{2t} + \bar{\alpha}_3 Z_{3t} + ... + \bar{\alpha}_m Z_{mt})(1 + \beta_1 D_{72-76} + \beta_2 D_{76-79} + \beta_3 D_{79-87} + \beta_4 D_{87-90} + \beta_5 D_{90-92} + \beta_6 D_{92-97} + \beta_7 D_{97-2001}) + \varepsilon_t \quad (21)$$

where u^T is a measure of the low frequency movements in the observed unemployment rate.

We use an eclectic set of explanatory variables. The price-setting relationship is affected by the mark-up of price over marginal cost. There is no consistent measure of the mark-up over this period, so we follow the literature in using proxies. We use the ratio of imports to GDP and the proportion of total employment that is in the private sector. We would expect a negative effect from these variables since both imply greater competitiveness and hence a lower mark-up. We also use the real oil price and the real interest rate. Following the arguments of Phelps and Zoega (1998) and Carruth et al (1998), we would expect both variables to be associated with higher unemployment, since they increase the non-labour component of costs and thus increase the mark-up of price over marginal labour cost.

The wage-setting relationship is affected by the wage workers can expect to earn in other employment and by the mark-up of wages over this outside wage. To capture these effects, we use union density to measure union membership and the number of days lost in strikes to measure union militancy. We also use the proportion of households that are owner-occupiers. It has been suggested that greater owner-occupation reduces labour mobility and so increases unemployment (eg Oswald, 1997, Pehkonen, 1999). Following Cassino and Thornton (2002) we also use the proportion of workers that are self-employed; this may be an indicator of labour market flexibility. We use two measures of the operation of the unemployment benefits system. The first is a dummy variable for the period since the introduction of the Restart scheme in July 1986. After this date, the monitoring and enforcement of unemployment benefit regulation became more active

and rigorous. Indeed, Wells (2001) in his recent survey of the structure and impact of the UK benefits system, states that "the year 1986 is rightly famous for the start of a reversal in UK labour market policy". We also use a dummy variable for the period after the introduction of the Job-Seekers allowance in July 1996. This measure reduced entitlement to unemployment benefit from 1 year to 6 months[1]. We allow for demographic effects by including the proportion of young workers (aged 15-24) in the workforce. Young workers are known to have much lower levels of job attachment and consequently higher unemployment rates (Staiger et al (2001) presents evidence from the US, while Barwell (2000) has evidence from the UK).

4) results

We use the Hodrick-Prescott (1997) filter (where we use the recommended smoothing parameter of 1600) to construct our measure of the natural rate of unemployment,. This is depicted in figure 1, alongside the unemployment rate. The natural rate increases from the late 1960s to the early 1980s, before falling somewhat in the mid-late 1980s and then falling markedly throughout the 1990s. This pattern is broadly similar to that obtained by detailed studies (eg Greenslade et al, 2001) of the natural rate and is consistent with most views of the evolution of the natural rate. We also note that all our stochastic variables appear to be I(1) (see Cassino and Thornton (2002) for similar findings for broadly similar data).

Column (i) of table 1 presents estimates of (21). Preliminary estimates revealed that the effect of the proportion of young workers is highly unstable, although significant. We obtained more satisfactory estimates by imposing constraining the estimate on this variable to be unity. Estimates of the $\bar{\alpha}$ parameters are consistent with the hypothesis that monetary policy affects the natural rate of unemployment. The largest effects are found for the two inflation targeting periods, where the estimates are similar and substantial.

[1] There are other possible measures. Nickell et al (2001) measure unemployment benefits in the second and subsequent years of unemployment relative to benefit received in the first year. Since the introduction of the Job-Seekers Allowance reduced benefits in the first year of unemployment but had no affect in subsequent years, this variable rose after 1996 and thus cannot explain the fall in the natural rate of unemployment over this time.

Estimates for the ERM period and the first two parliaments of the Thatcher administration are also negative and significant, although somewhat smaller, while dummies for the Callaghan and late Thatcher periods are smaller yet. The dummy for the post-Bretton Woods period of 1972Q3-1976Q2 is not significant. Of the other explanatory variables, the effects of imports, the proportion in the private sector, the real interest rate, the owner occupation rate and the Restart effect are correctly signed and significant. The effect of the proportion who are self employed and union density are wrongly signed and significant. The oil price is not significant. The fit of the model is quite good and the adf test suggests that this may be a cointegrated relationship.

Column (ii) presents estimates of our preferred specification, obtained by combining the dummies for 1992Q4-1997Q1 and 1997Q2-2001Q2 into a single inflation targeting dummy and dropping insignificant variables. We drop the dummies for 1972Q3-1976Q2, 1987Q2-1990Q3 and (somewhat surprisingly) the ERM period of 1990Q4-1992Q3. The estimates of the other variables are not much changed, although the oil price moves close to significance. Column (iii) presents estimates of a standard linear model obtained by setting the $\bar{\alpha}$ parameters to zero. This model fits the data much less well. The estimates are similar to those of columns (i) and (ii), although the oil price attains significance and the sign of the self employment variables changes sign. CUSUM test reveals a clear structural break in the early 1990s and 1-step ahead Chow tests indicate breaks in the late-1980s and early 1990s. We also estimated the model using data up to 1992Q4 only and used these estimates to forecast the natural rate of unemployment in the 1990s. This model over-predicts unemployment in the 1990s. These findings are consistent with our the estimates in columns (I) and (ii), further suggesting that the introduction of inflation targets tended to produce a lower natural rate of unemployment.

5) conclusions

This paper has developed a model of the impact of monetary policy on the natural rate of unemployment. We have argued that the natural rate is affected by the objectives of monetary policymakers. Adoption of an inflation

target or other policy that gives priority to stabilising the price level will reduce the rate of accommodation in monetary policy. This will affect the behaviour of wage-setters so that real wages to becomes more sensitive to unemployment. This leads to a lower natural rate of unemployment.

We have tested these predictions using UK quarterly data for 1965-2001. We estimate a model in which the natural rate depends on structural characteristics of the goods and labour markets, but where the coefficients are allowed to vary over time in accordance with changes in the objectives of monetary policy. We find clear evidence that the inflation targeting period that began in 1992 and the 1979-87 period were associated with lower natural rates. These findings are consistent with the predictions of our model. These findings are necessarily preliminary. In future work we aim to strengthen these results.

Table 1

	(i)	(ii)	(iii)
	1965Q1-2001Q2	1965Q1-2001Q2	1965Q1-2001Q2
Dependent variable	u^{HP}_t	u^{HP}_t	u^{HP}_t
% imports	-0.354 (0.046)	-0.402 (0.039)	-0.505 (0.046)
% private sector	-0.294 (0.020)	-0.313 (0.014)	-0.375 (0.013)
real oil price	-0.002 (0.001)	0.009 (0.006)	0.017 (0.006)
real interest rate	0.032 (0.012)	0.031 (0.011)	0.051 (0.012)
union density	-0.157 (0.025)	-0.185 (0.022)	-0.322 (0.021)
strikes	0.042 (0.065)	0.075 (0.063)	0.020 (0.008)
% owner occupied	0.356 (0.072)	0.436 (0.061)	0.814 (0.058)
% self employed	0.571 (0.176)	0.494 (0.145)	-0.315 (0.133)
% young	1.000 (*)	1.000 (*)	1.000 (*)
Restart	-0.005 (0.002)	-0.003 (0.002)	-0.013 (0.003)
job seekers allowance	-0.004 (0.002)	-0.006 (0.002)	-0.003 (0.003)
1972Q3-1976Q2	-0.023 (0.018)		
1976Q3-1979Q1	-0.080 (0.027)	-0.056 (0.017)	
1979Q2-1987Q1	-0.179 (0.031)	-0.129 (0.018)	
1987Q2-1990Q3	-0.098 (0.047)		
1990Q4-1992Q2	-0.222 (0.054)	-0.064 (0.026)	
1992Q4-1997Q1	-0.395 (0.046)		
1997Q2-2001Q2	-0.319 (0.060)		
1992Q4-2001Q2		-0.294 (0.026)	
R^2	0.987	0.986	0.968
Standard error	0.0033	0.0034	0.0051
durbin-watson	0.90	1.14	0.63
adf(4)			

Figure 1

Actual and trend rates of unemployment

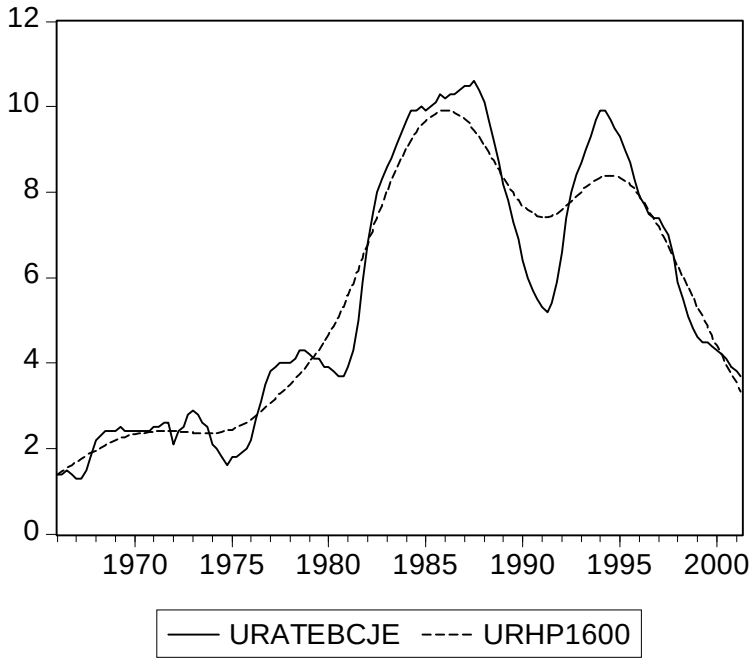
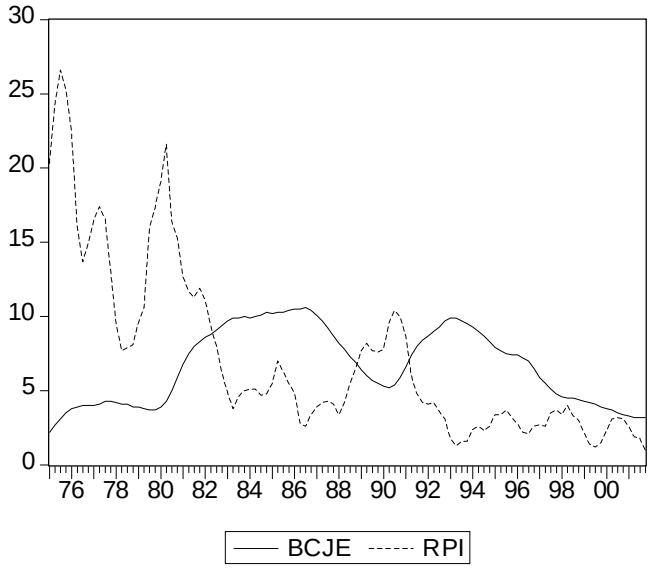


Figure 2

Unemployment and inflation rates



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