Non-Accelerating Inflation Rate of Unemployment:
Estimation for the Czech Republic

Osvald Vašícek, Martin Fukac*

Abstract
Quantification of the Non-Accelerating Inflation Rate of Unemployment (NAIRU) is often discussed topic, mainly in the sense of its implementation into the monetary authority decision making. We believe that the NAIRU estimation for the Czech Republic has not been published yet. Identified model for the short-run NAIRU is based on the new classics theoretical approach. The model is treated within state-space framework allowing both time-varying parameters and unobserved variables to be identified using the Kalman filter (with backward smoothing, alternatively). Adaptive identification method provides more robust results in comparison with Kalman filter employed by Estrella, Mishkin (1998), Gordon (1996) or Staiger, Stock, Watson (1996). The KFS application proved its usefulness in modelling economies in transition. Even if the NAIRU does not represent an operative criterion for the monetary policy, it can be a useful information source for its formation. The Czech NAIRU model is estimated on quarterly data.

Keywords
short-run NAIRU, long-run NAIRU, Phillips curve, unemployment gap, extended Kalman filter with backward smoothing, unobserved states, money illusion

1 Short Run NAIRU Conceptual Model

Prior to the conceptual model description, it is necessary to distinguish short-run NAIRU, long-run NAIRU and natural rate of unemployment. The definition of exogenous shocks affecting the NAIRU and the price level is critical issue for this distinction. The short-run NAIRU is defined as a rate of unemployment consistent with inflation rate stabilised at its current level for the next period (month, quarter, semester, year). Its path is affected by shocks with both short run and long lasting impact. The long-run NAIRU is defined as the equilibrium rate towards which unemployment converges in the absence of temporary supply

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influences, ones the dynamic adjustment of inflation is completed. We refer to the short-run NAIRU thereafter.

The conceptual model is based on the new classical economics in what explains fluctuations of unemployment rate around its natural rate, short-run NAIRU respectively. A model of money illusion address to explain the fluctuations in terms of agents’ surprises (unanticipated innovations). The reason for the mistaken expectation is that they cannot distinguish relative from general price movements (recall Lucas’s misperception model). We proceed from following assumption in deriving the theoretical model:\footnote{see Sargent (1987)}:

- agents’ decision depends on relative prices,
- agents’ behavior is rational regarding to a known information set,
- labour suppliers are located in a large number of physically separated competitive markets,
- labour demand is distributed unevenly across markets, so the labour price (wage) varies across the markets,
- labour suppliers are price takers and
- all markets are identical in their behavioral parameters.

We leave the Phillips curve derivation from individual labour demands for a future publication. In this article we only suggest the Phillips curve\footnote{see Gordon (1996)} to be established within the microeconomic framework.

\[
\pi_t - \pi^*_t = \alpha(u_t - u^*_t) + \beta z_t + e_t, \quad \alpha < 0 \quad t = 1,2,...,T, \tag{1}
\]

where \(\pi\) is an inflation rate, \(\pi^*_t\) is an expected inflation rate, \(u\) is an unemployment rate, \(u^*_t\) is a short-run or long-run NAIRU, \(z\) is a term capturing exogenous shocks affecting aggregate price level (in the sense of Gordon(1996), Estrella and Mishkin(1998)) and \(e_t\) is i.i.d. with

\[
E(e_t) = 0 \text{ a } E(e_t e'_t) = 1s^2. \tag{2}
\]
If $\pi_t > \pi_t$ (price level growth is not anticipated in agents’ expectations), then the agents see this disproportion as a change of relative prices, as a change in real purchase power respectively. This leads to a change in labour supply and in unemployment. If $\pi_t = \pi_t$ then the price level change is understood as a change in absolute prices and agents do not react.

NAIRU equation closes the model concept. The NAIRU is determined by lagged unemployment gap and the same exogenous shocks $z_t$ as the price level, or

$$\hat{u}_t = \phi \hat{u}_{t-1} + \delta \Delta r_t + \tilde{z}_t + w_t,$$  \hspace{1cm} (3)

$$\hat{u}_t = u_t - u^*,$$

where $\hat{u}$ is the unemployment gap, $\Delta r$ is a change in interest rate (monetary policy tool), $z_t$ is the exogenous shocks vector and $w_t$ is stochastic component with the same properties as $e_t$.

Equations (1) and (3) are added assumptions on expectation formation (autoregressive process) and on composition of exogenous effects hitting domestic price level. Then the model becomes

$$\Delta \pi_t = a_1 \hat{u}_{t-1} + a_2 \hat{u}_{t-2} + a_3 \Delta s_{t-1} + a_4 \Delta s_{t-2} + a_5 \Delta o_{t-1} + a_6 \Delta o_{t-2} + e_t,$$

$$\hat{u}_t = b_1 \hat{u}_{t-1} + b_2 \hat{u}_{t-2} + b_3 \Delta r_{t-1} + b_4 \Delta r_{t-2} + b_5 \Delta s_{t-1} + b_6 \Delta s_{t-2} + b_7 \Delta o_{t-1} + b_8 \Delta o_{t-2} + w_t,$$  \hspace{1cm} (4)

where $\Delta \pi$ is the first difference of net inflation rate$^3$, $\hat{u}$ is the unemployment gap, $\Delta s$ is the first difference of nominal effective exchange rate logarithm$^4$, $\Delta o$ is the first difference of oil price index logarithm, $\Delta r$ is a change of 3-month interest rate, and $e$ and $w$ are stochastic parts defined above.

As the identification method we use the Kalman filter with backward smoothing arranged to allow simultaneous estimation of both time-varying parameters and unobserved states. Here, state is an unobserved economic variable identified by means of structural assumptions and a set of observed variables (signal extraction problem). We need to transform the model (4) into the state-space representation in order to estimate time varying parameters and the

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$^3$ Price deregulation (under government control) effects are excluded from net inflation.

$^4$ Nominal effective exchange rate is defined as an 65% CZK/DEM -- 35% CZK/USD basket.
unemployment gap simultaneously. We let parameters to be time varying to detect and capture possible structural breaks.

2 Identification Results

Quarterly time series are employed in the model, see Fig.1 for the data. The results of model (4) identification with time-varying parameters are found in Fig.2 and Fig.4. Time-varying parameters trajectories and their confidence intervals are depicted in Fig.3. Time invariant parameter estimates and their standard errors are reported in Tab.1.

Figure 1: Model inputs
Table 1: Time invariant parameter estimates and their standard deviation

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<tr>
<th>Model equation</th>
<th>Parameter</th>
<th>Parameter estimate (standard error in parenthesis)</th>
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Innovation variance

| var(\( e_t \)) | 0.0234 |
| var(\( w_t \)) | 0.2514 |

Figure 2: Estimation of NAIRU model (4)
Figure 3: Estimated time varying parameters paths and their confidence intervals

\[ dp^n_t = a_1 s_{u_t} + a_2 s_{u_{t-1}} + a_3 d_{s_{t-1}} + a_4 d_{s_{t-2}} + a_5 d_{o_{t-1}} + a_6 d_{o_{t-2}} + e_t \]

Figure 4: Short-run NAIRU, long-run NAIRU and net inflation estimates

![Diagram showing estimates of short-run and long-run NAIRU and net inflation in the Czech Republic from 1994 to 2000.](image-url)
Path of time varying parameters seems to be stable (see Fig.3). Their filtered estimates vary only marginally around the smoothed constant path. In this sense we can describe the model with time invariant parameters without any loss in informational content (see Tab.1).

We can say about the development of unemployment rate and NAIRU in 1994:I.Q-1996: IV.Q (Fig.4) that it is in part approximately steady because the net inflation is “stable” at that time period. First well-marked break in this trend is in 1997 when the unemployment growth begins overtaking the NAIRU growth and this tendency continues till 1999. The higher level of estimated NAIRU in 1997 is caused by growth of 3-month interest rate and by a significant effective exchange rate depreciation. The end of 1999 and beginning of 2000 stands for follow-up in being NAIRU and unemployment rate at the same level. However, we can hardly assess its stability, because even if the interest rate path and effective exchange rate path seems to be stabilized, the oil price shock occurs.

Averaging of unemployment rate on annual intervals approximates long-run NAIRU in Fig.4. Even if we cannot educe strict conclusions about real long-run NAIRU from this, we can use it for hypothesis (1) testing. It is evident from Fig.4 that the relationship between $\pi$, $u$ and $u^*$ is in accordance with (1). If $u < u^*$, the inflation rate accelerates (1994-1996). If $u > u^*$, the inflation rate decelerates (1997-2000).

3 Conclusion

This early attempt to estimate the short-run NAIRU for the Czech economy is performed on the basis of a simple two-equation model. The Kalman filter with backward smoothing is applied as identification method. The NAIRU model was estimated with time varying parameters. This is convenient for transitive economy conditions. The NAIRU concept is unusable as an operative criterion for monetary authority decision making, but we believe that it can be an useful information source after augmentation of the basic model and its set in wider macroeconomic framework

References


