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THE ASSESSMENT OF NATURAL RATE OF UNEMPLOYMENT AND CAPACITY UTILISATION IN LATVIA

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CONTENTS

ABBREVIATIONS

CSB – Central Statistical Bureau of Latvia
EMU – Economic and Monetary Union
EU – European Union
EU12 – countries which joined the EU on 1 May 2004 and 1 January 2007
EU15 – EU countries before 1 May 2004
GDP – gross domestic product
NAIRCU – non-accelerating inflation rate of capacity utilisation
NAIRU – non-accelerating inflation rate of unemployment
OECD – Organisation for Economic Co-operation and Development
US – United States of America

ABSTRACT

Inflation and its dynamics are among the most important indicators in the focus of such economic agents as producers, consumers, investors, and monetary and fiscal policy makers. Risks of high inflation or deflation enhance the need to profoundly investigate factors and causes that could underpin materialisation of such risks in the economy and to seek for steps to avert adverse effects of unwelcome inflationary dynamics. Optimal capacity utilisation is one of the ways to escape endogenous pressures that increase inflation or cause deflation.

The study pursues the aim to assess short-term relationships between the capacity utilisation rate and inflation. The authors have set a target to determine the capacity utilisation rate at which no pressure is exerted upon inflation and to show whether the capacity utilisation rate of the Latvian economy was an underlying factor that caused a rise in inflation after the EU accession.

Keywords: NAIRU, NAIRCU, Kalman filter

JEL classification: C51, E31, D24

INTRODUCTION

Inflation and its dynamics are among the most important indicators in the focus of such economic agents as producers, consumers, investors, and monetary and fiscal policy makers. Risks of high inflation or deflation enhance the need to profoundly investigate factors and causes that could underpin materialisation of such risks in the economy and to seek for steps to avert adverse effects of unwelcome inflationary dynamics. Optimal capacity utilisation is one of the ways to escape endogenous pressures that increase inflation or cause deflation.

The study pursues the aim to assess short-term relationships between the capacity utilisation rate and inflation. The authors have set a target to determine the capacity utilisation rate at which no pressure is exerted on inflation and to show whether the capacity utilisation rate of the Latvian economy was an underlying factor that caused a rise in inflation after the EU accession.

For the purpose of this study, unemployment rate and capacity utilisation rate in manufacturing are indicators that characterise overall capacity utilisation in the economy. The rates of unemployment and capacity utilisation that do not accelerate inflation are the NAIRU and NAIRCU respectively. In the estimation of the NAIRU and NAIRCU, this study relies on two assumptions: 1) the NAIRU and NAIRCU are constant; 2) the NAIRU and NAIRCU are time-varying. As far as the authors are informed, the assessment of Latvia's NAIRU and NAIRCU has not been conducted as yet.

Data from Latvia's labour surveys published by the CSB on unemployment rate (rate of job seekers) and business and consumer survey data on capacity utilisation rate (capacity utilisation in manufacturing) are used in this paper. The authors opted for consumer price index as an inflation measure.

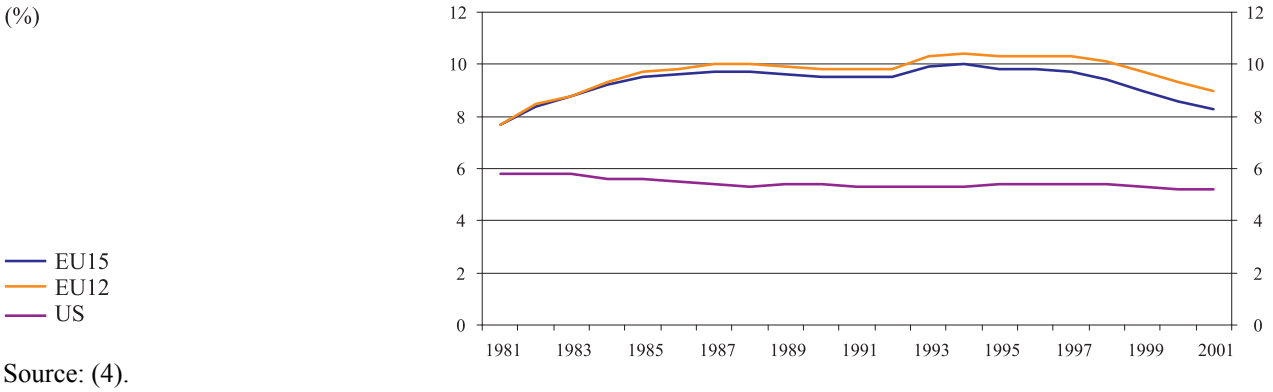
Chapter 1 gives an overview of the NAIRU and NAIRCU global assessment. Methodology and data used are in the focus of Chapter 2. The NAIRU and NAIRCU are estimated in Chapter 3, building on an assumption of their constant nature. Chapter 4 deals with the estimates of NAIRU and NAIRCU using the Kalman filter and basing on an assumption that they are time-varying. The concluding part presents basic inferences.

1. THEORETICAL ASPECTS

Several studies which pursue the aim of exploring inflation causes deal with such capacity utilisation rates that do not exert pressure on prices. A. W. Phillips who assessed wage dependence on the unemployment rate can be considered the founder of this approach.(18) However, it was more than 200 years ago that D. Hume already advanced a hypothesis about interrelation existing among money supply, prices and employment.(9) On the basis of A. W. Phillips' article, P. Samuelson and R. M. Solow coined the term "Phillips curve" (20) and M. Friedman proposed the "natural rate of unemployment" in 1968 (6), later transformed into the NAIRU.

The NAIRU concept became well-known in Europe in the 1990s. One of the first attempts to assess a time-varying NAIRU was made in 1993 when J. Elmeskov estimated the natural rate of unemployment assuming that wage rises are proportional to the unemployment gap, i.e. the difference between the actual and natural rates of unemployment.(5) It was followed by a number of other studies in which the Kalman filter became the most popular approach for the assessment of the NAIRU.(7; 4; 11; 10) The findings by C. Denis, K. Mc Morrow and W. Röger when investigating the EU15 and EU12 countries (4) show that the level of the NAIRU gradually decreased in 1997–2001 (see Chart 1.1). Meanwhile, according to authors' estimates, the US rate of natural unemployment declined from 5.8% to 5.2% in 1981–2001.

Chart 1.1
Assessment of time-varying NAIRU in EU15, EU12 and US



Source: (4).

The paper by D. Turner *et al.* demonstrates that the NAIRU for the US contracted in 1962–1999; however, due to confidence intervals, it can be treated as constant with a certain degree of confidence.(22) The NAIRUs for Japan, Germany and Italy increased, while the NAIRU for Canada had grown by the mid-1980s but thereafter decreased gradually. In the EMU countries, the NAIRU was going up in the 1980s, stabilising at the level of about 9% in the 1990s (see Table A.1).

In 2000, K. Mc Morrow and W. Roeger published a paper (13), in which they estimated constant NAIRUs of different periods, using a hybrid model[1]. This estimation is given in Table A.2. According to the Table, estimations for several

[1] For more detailed model specification see (13).

countries, e.g. Germany, differed substantially from the findings published in the paper by D. Turner *et al.*(22) In addition, NAIRU estimates by K. Mc Morrow and W. Roeger excel in large standard errors; accounting for these errors leads to a conclusion that in a number of countries NAIRUs did not change notably and were constant in the sample period.

When analysing the NAIRU of the EMU countries, C. Logeay and S. Tober calculated that in 1975–1990 it increased, thereafter in the early 1990s decreased, to rise rapidly again in 1994 and 1995.(11) In this study, estimations are based on the NAIRU with and without exogenous variables and the outcomes in both cases are very similar. According to this study, the NAIRU for the EMU countries in 2001 was 8.5% (3% in 1975).

In 2005, NAIRUs of 19 OECD countries were estimated by R. Llaudes.(10) The estimated NAIRUs for Austria, Canada, Denmark, and Portugal can be viewed as constant for the period from the 1980s to 2002; meanwhile, the NAIRUs for Belgium, France, Germany, and Greece increased. The estimated NAIRU for EMU countries was around 9% in 2002 (around 5% in 1979).

For the first time in 1978, R. McEelhattan estimated the dependence of inflation on capacity utilisation and the rate of capacity utilisation, which corresponds to stable inflation, i.e. the NAIRCU, which can be considered an alternative to the traditional Phillips curve.(14) The studies of this indicator for European countries were undertaken by N. J. Nahuis who held that the NAIRCU of the countries in Europe is a better indicator of capacity utilisation given the weak labour market elasticity and hysteresis typical for the unemployment rate.(17)

For the US, the NAIRCU estimate is 82%, while its 95% confidence interval ranges within the 78.5%–83.5% margin.(15) The full sample NAIRCU for the European countries is from 75.2% (Italy) to 84.4% (Germany; see Table A.3).(17) When assessing the NAIRCU for different sample periods (assuming that it is constant in each of them), N. J. Nahuis came to the conclusion that over time the NAIRCU increased and its confidence intervals widened in all sample countries, which suggests a weakening in the relationship between inflation and capacity utilisation.

Available information suggests that so far studies dedicated to the assessment of NAIRU and NAIRCU have not been conducted in Latvia. M. Bitāns, D. Šļakota and I. Tillers studied the Phillips curve for Latvia using the difference between the actual and potential GDP, or the output gap, as an indicator of capacity utilisation.(2) M. Hansen and R. Pancs captured the negative relationship between inflation and unemployment rate via graphical representation, stressing at the same time the need of a more comprehensive analysis to verify its plausibility.(8) J. Masso and K. Staehr, using panel data in their analysis, concluded that only the deviation of industrial output from its natural level figures as an important factor affecting inflation, while changes in the unemployment rate do not have impact on inflation.(12) In 2007, A. Meļihovs and A. Zasova estimated the Phillips curve for Latvia focusing on inflation expectations.(16)

2. METHODOLOGY AND DATA USED

2.1 NAIRU and NAIRCU: Estimation Approaches

D. Romer advanced a hypothesis that in theory a short-term relationship between inflation and output exists.(19) Building on it, if is not used to the full, a certain downward pressure on prices emerges, and *vice versa*. This study employs the following modification of the triangle Phillips curve model:

$$\Delta\pi_t = \alpha\Delta\pi_{t-1} + \beta(GAP_t) + \Phi Z_t + \varepsilon_t \quad [1]$$

where

Δ is the first order difference of variable $(\Delta x_t = x_t - x_{t-1})$;

π is annual inflation;

GAP is the indicator capturing deviation of capacity from the structural level;

Φ is the coefficient vector;

Z is the vector of variables capturing the supply side shocks;

t is the time period.

This study uses two indicators that capture the capacity utilisation rate in the economy: 1) unemployment rate and 2) capacity utilisation rate in manufacturing. The authors undertook to identify the natural rate of these indicators, i.e. the NAIRU and NAIRCU respectively. As equations include variables representing supply shocks, the estimated NAIRU and NAIRCU will respectively reflect the unemployment rate and capacity utilisation rate associated with a stable inflation rate, provided that short-term supply shocks do not occur.

The NAIRU and NAIRCU are indicators that are unobservable, yet they can be estimated by making assumptions and use of the actual observable indicators. Three approaches can be used in the estimation of NAIRU or NAIRCU: 1) the structural approach, 2) the statistical approach, and 3) the reduced-form approach.

According to the structural approach, not only price inflation but also the NAIRU or NAIRCU are modelled on the basis of theoretically founded relations, i.e. the NAIRU or NAIRCU is assessed as functions of other factors. The statistical approach provides for the application of various statistical instruments to distinguish between the cyclical and trend components of indicators. The trend component is interpreted as the NAIRU or NAIRCU. The third approach is a combination of the two former approaches. Similar to the structural approach, it provides for constructing the inflation behaviour equations on the basis of theoretical aspects but makes use also of statistical methods in modelling the NAIRU or NAIRCU.

This study uses two approaches in the estimation of the NAIRU and NAIRCU: 1) the structural approach, assuming that the NAIRU and NAIRCU are constant in the sample period, and 2) the reduced-form approach using the Kalman filter in the estimation of NAIRU and NAIRCU, assuming that they are varying over time.

2.2 Data Used

Data used in the analysis refer to the period from the first quarter of 1995 to the fourth quarter of 2008. Unemployment is measured by the rate of job seekers to economically active population taken from Latvia's labour surveys conducted by the CSB. These data are in line with standards and requirements of the International Labour Organization (ILO). Compared with the registered unemployment rate, this indicator has one weakness: up to 2002, labour surveys in Latvia were conducted on a semi-annual basis and quarterly data of this indicator are not available. Meanwhile, data on registered unemployment are available in the breakdown by month, as are those on inflation; hence, for the purpose of econometric estimation, the number of observations can be expanded.

Despite the above referred weakness, the rate of jobseekers has an essential advantage: this indicator includes not only the number of jobseekers registered with the State Employment Agency but also those who go job-hunting on their own initiative. Consequently, it is a more accurate measure to capture the labour market situation objectively. In order to cope with the problem of data shortages, the employment series up to 2002 was interpolated taking into account short-term employment data.[2]

The source of data on capacity utilisation in manufacturing is business condition and consumer surveys published by the CSB and comprising managers' answers about capacity utilisation in each respective enterprise (in % of total capacity). These indicators are available in the breakdown by quarter for the entire sample period.

Quarter-on-quarter changes in annual inflation are calculated as

$$\Delta\pi_t^{cpi} = 100 * \Delta\left(CPI_t \Big/ CPI_{t-4} \right) \qquad [2]$$

where

$\Delta\pi_t^{cpi}$ is quarter-on-quarter changes in annual inflation (in percentage points);

CPI_t is the quarterly index of inflation (2000 as the base period).

The supply side shocks in the models are represented by such variables as oil prices and import prices, used also in the NAIRU and NAIRCU estimation models.

Chart 2.1 shows the series of unemployment and capacity utilisation rates which are correlated with quarterly changes in annual inflation in this analysis.

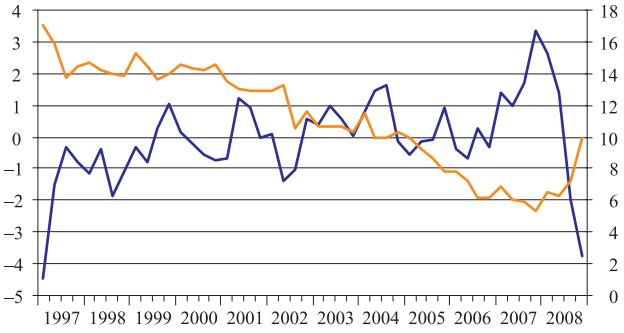
[2] More detailed information about assumptions underlying data interpolation can be requested from the authors of this paper.

Chart 2.1

Correlation of quarterly changes in annual inflation with unemployment rate and capacity utilisation rate

Chart 2.1.a

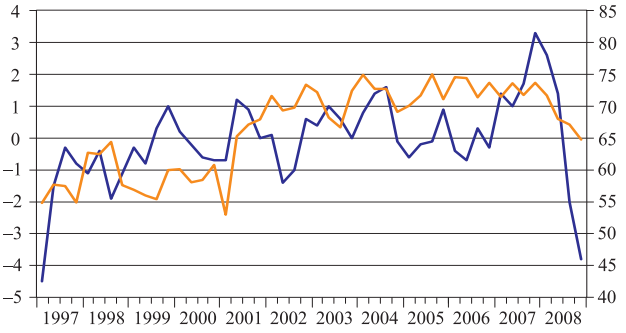
$\rho = -0.483$



Quarterly changes of annual inflation (in percentage points)
Unemployment rate (%; right-hand scale)

Chart 2.1.b

$\rho = 0.457$



Quarterly changes of annual inflation (in percentage points)
Capacity utilisation rate (%; right-hand scale)

ρ is the correlation coefficient

Sources: CSB and authors' calculations.

The visual analysis of time series and obtained correlation coefficients suggest a likely relationship between the rate of inflation and economic indicators in Latvia, which is in line with the theory: decelerating inflation corresponds to higher rate of unemployment and lower capacity utilisation.

3. ESTIMATION OF CONSTANT NAIRU AND NAIRCU

In order to estimate the relationship between inflation and rates of unemployment or capacity utilisation, annual data of the respective indicators are more useful, for they rule out random shifts and provide stable indicator relationships. However, as the available time series are short, econometric estimation of relationships is not possible on the basis of annual data; that is why quarterly data are used when constructing econometric models in the paper.

In order to get an initial idea about the dependence of inflation on unemployment and capacity utilisation rates, Chart 3.1.a presents annual inflation changes on the vertical scale and the average annual unemployment rate of capacity utilisation on the horizontal one. Chart 3.1.b shows the annual average rate of capacity utilisation on the horizontal scale.

Chart 3.1
Correlation of changes in annual inflation with average annual unemployment rate and capacity utilisation rate

Chart 3.1.a
NAIRU = 12.0%

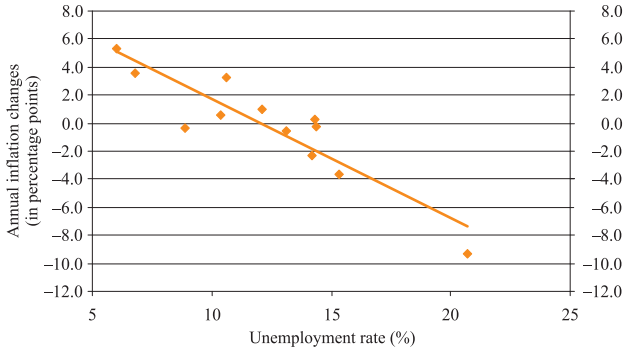
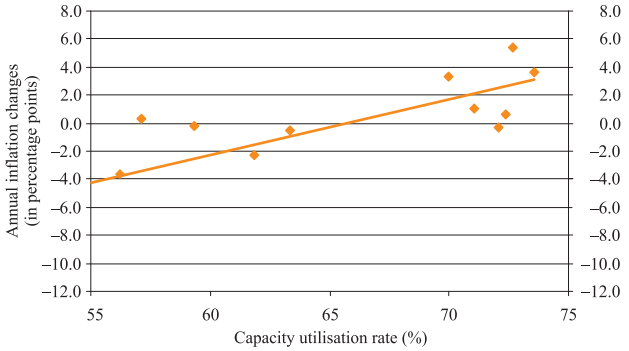


Chart 3.1.b
NAIRCU = 65.7%



Sources: CSB and authors' calculations.

Chart 3.1 also shows the estimated linear relationship between the changes in inflation rate and capacity utilisation or unemployment rates. The values of capacity utilisation and unemployment rates at the points where the straight lines of the linear relationship estimation cross the horizontal axis reflect such unemployment and capacity utilisation rates at which no pressure on annual inflation rate is exerted or the NAIRU and NAIRCU respectively.

This is the simplest method for the estimation of the constant NAIRU and NAIRCU. According to this simplified estimation, the NAIRU is at the level of 12.0%, while the NAIRCU stands at 65.7%. Further on, the NAIRU and NAIRCU are estimated using econometric models which enable the withdrawal of supply shocks from the estimation and the measurement of such unemployment and capacity utilisation rates in manufacturing that are associated with stable inflation, provided that short-term supply shocks are non-existent.

3.1 Estimation of Constant NAIRU

In the estimation of constant NAIRU, model [1] has been used in a more extended form:

$$\Delta\pi_t^{cpi} = \alpha\Delta\pi_{t-1}^{cpi} + \beta\left(u_t - NAIRU\right) + \phi_1\Delta\pi_t^{imp} + \phi_2\Delta\pi_t^{oil} + \varepsilon_t \qquad [3]$$

where
u_t is the actual unemployment rate in period t;
$NAIRU$ is the constant NAIRU;
π_t^{imp} is the annual inflation of import prices;
π_t^{oil} is the annual inflation of oil prices in lats.

As a result of opening brackets in equation [3], $\beta\left(NAIRU\right)$, which is a constant, is obtained and the equation can be rewritten in a simplified form:

$$\Delta\pi_t^{cpi} = c + \alpha\Delta\pi_{t-1}^{cpi} + \beta u_t + \phi_1\Delta\pi_t^{imp} + \phi_2\Delta\pi_t^{oil} + \varepsilon_t \qquad [4]$$

where $c = -\beta\left(NAIRU\right)$.

Table 3.1 sums up the estimation results of end specification in model [4] which are based on Latvia's data.

Table 3.1
Phillips curve for Latvia
(constant NAIRU; quarterly data; Q 3 1996–Q 4 2008)

Variable	Coefficient	*t*-statistic
Dependent variable: $\Delta\pi_t^{cpi}$		
Explanatory variables		
Constant	1.704***	3.124
$\Delta\pi_{t-1}^{cpi}$	0.378***	3.652
u_t	–0.144***	–3.181
$\Delta\pi_t^{imp}$	–0.025	–0.707
$\Delta\pi_t^{oil}$	0.014***	2.360
Adjusted R^2		0.482

*, **, *** denote statistical significance of coefficients at the 10%, 5% and 1% level respectively.

Summing up the results presented in Table 3.1, it can be concluded that a deviation of unemployment rate from the NAIRU is statistically significantly affecting inflation. The estimated coefficient suggests that each percentage point of the difference between unemployment rate and NAIRU increases (decreases) inflation by 0.144 percentage point, provided that actual unemployment is below (above) the NAIRU. The estimated coefficient of $\Delta\pi_{t-1}^{cpi}$ shows that 37.8% of inflation changes are on account of inflation changes of the next period and it is statistically

significant at the 1% level. Changes in import price inflation were not significant, whereas oil price inflation significantly and positively affected the domestic inflation rate.

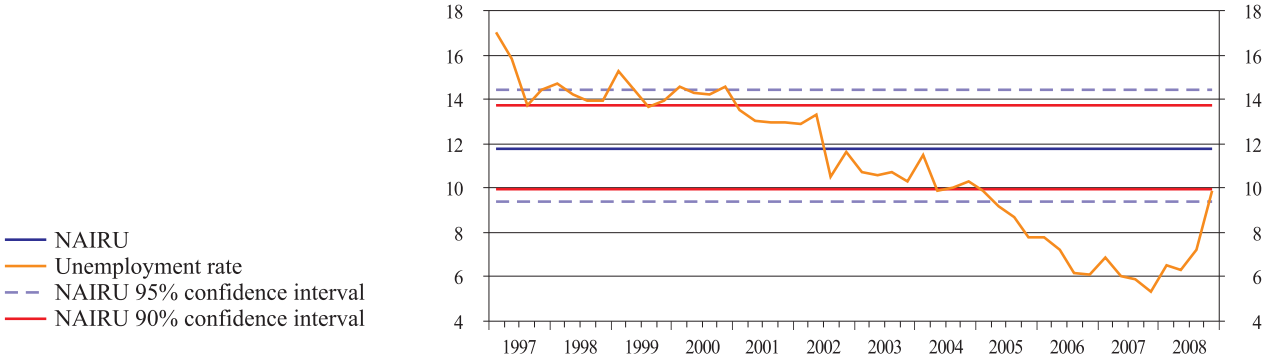
Pursuant to equation [4], $NAIRU = -c/\beta$. According to the findings in Table 3.1, the value of constant NAIRU is 11.8% for Latvia and is associated with a stable inflation rate, provided that no short-term supply shocks are incurred; this value is very close to the NAIRU presented in Chart 3.1.

In order to specify whether the estimated constant NAIRU is statistically significant and to correlate the actual unemployment rate with this estimate of the constant NAIRU, there is a need to find out how precise is the estimate of the constant NAIRU: it can be done by calculating its confidence interval. It is not a simple task, as the constant NAIRU is a non-linear function of estimated coefficients (coefficient β is a denominator). The method used in this study for estimating the constant NAIRU confidence interval is that of D. Staiger, J. H. Stock and M. W. Watson.(21)

In order to measure, for instance, the 95% confidence interval of the constant NAIRU, this method requires that hypotheses about all possible estimates of the constant NAIRU be verified and those estimates of the constant NAIRU, which are not rejected at the 5% statistical significance level, form the 95% confidence interval of the constant NAIRU values. Henceforth, given the estimate of the constant NAIRU (11.8%), the lower margin, e.g. 10%, of confidence interval is selected and equation [4] re-estimated, with u_t being replaced by $(u_t - 10)$ as an indicator explaining inflation changes.

If the selected NAIRU estimate falls within the 95% confidence interval, the real value of the equation constant is zero. Consequently, if the equation constant is not statistically significantly different from zero at the 5% level, the hypothesis about the selected NAIRU estimate being within the 95% confidence interval is not rejected. A similar verification of all possible NAIRU estimates leads to the value of upper margin of the NAIRU 95% confidence interval. Using this method, the NAIRU 90% confidence interval has also been calculated. Chart 3.2 shows the actual unemployment rate, the NAIRU estimate, and its confidence intervals of 95% and 90%.

Chart 3.2
Constant NAIRU, its 95% and 90% confidence intervals and actual unemployment rate



Building on these results, it can be ascertained with 90% confidence that in accordance with the estimation method the unemployment rate hovered below the NAIRU in the period between the second quarter of 2005 and fourth quarter of 2008 and exerted pressure on the rate of inflation in Latvia. The results indicate that the maximum pressure on inflation was observed at the end of 2007, with the situation normalising afterwards and the NAIRU pressure on inflation abating.

3.2 Estimation of Constant NAIRCU

Similar to model [4] where the impact of capacity utilisation in the economy on inflation is approximated by the unemployment rate, the rate of capacity utilisation can be used as a measure of capacity utilisation:

$$\Delta\pi_t^{cpi} = c + \alpha\Delta\pi_{t-1}^{cpi} + \beta\left(CU_t\right) + \phi_1\Delta\pi_t^{imp} + \phi_2\Delta\pi_t^{oil} + \varepsilon_t \qquad [5]$$

where CU_t is the rate of capacity utilisation in period t and $c = -\beta\left(NAIRCU\right)$.

Table 3.2 presents the estimates of model end specification based on Latvia's data.

Table 3.2
Estimation of Phillips curve for Latvia
(constant NAIRCU; quarterly data; Q 3 1996–Q 4 2008)

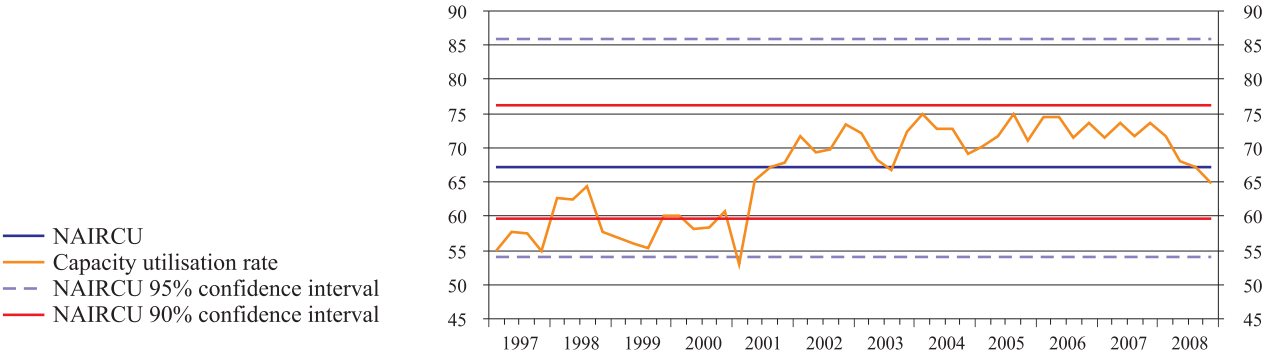
Variable	Coefficient	*t*-statistic
Dependent variable: $\Delta\pi_t^{cpi}$		
Explanatory variables		
Constant	–2.980**	–2.220
$\Delta\pi_{t-1}^{cpi}$	0.496***	3.824
CU_t	0.044**	2.214
$\Delta\pi_t^{imp}$	–0.037	–0.965
$\Delta\pi_t^{oil}$	0.019***	2.768
Adjusted R^2		0.468

*, **, *** denote statistical significance of coefficients at the 10%, 5% and 1% level respectively.

The results summarised in Table 3.2 show that around a half of inflation changes are transmitted into inflation changes of the next period, reflecting inflation inertia in Latvia. The estimated coefficient of variable CU_t suggests that each percentage point of the capacity utilisation and NAIRCU difference increases (decreases) inflation by 0.044 percentage point, provided that the capacity utilisation rate is above (below) the NAIRCU. The effects of import price inflation changes on inflation in Latvia were appraised as insignificant, while the impact of oil price inflation on domestic inflation was significant and positive.

On the basis of the results showed in Table 3.2, the NAIRCU is calculated as $NAIRCU = -c/\beta = 67.2$ and, similar to the NAIRU, its 95% and 90% confidence intervals estimated. The obtained NAIRCU, its 95% and 90% confidence intervals as well as the actual rate of capacity utilisation are represented in Chart 3.3.

Chart 3.3
Constant NAIRCU, its 95% and 90% confidence intervals and actual capacity utilisation rate



The NAIRCU (67.2%) is close to its counterpart from Chart 3.1.b (65.7%). Nonetheless, as the model gives a comparatively imprecise estimate of the NAIRCU, the actual rate of capacity utilisation is maintained within the 95% confidence interval. In 2001, capacity utilisation rate rose sharply and it may be stated with a 90% confidence that in the period between 2002 and 2007, the actual rate of capacity utilisation was close to the level at which a further build-up in capacity utilisation would trigger an increasing upward pressure of inputs (production costs) on consumer prices. In 2008, the deepening of global financial crisis and a downturn in the Latvian economy resulted in a contracting demand, both external and domestic, which, in turn, caused a decline in capacity.

4. ESTIMATION OF TIME-VARYING NAIRU AND NAIRCU

The assumption about the NAIRU or NAIRCU being constant in developing countries might be too strict a declaration. With the economic restructuring going on, a gradual increase of the NAIRCU might be expected, as old industrial equipment is not as effective in producing competitive output as modern machinery, and, thus, causes a decrease in the NAIRCU. A gradual replacement of old machinery by new equipment and due to more effective production processes, the maximum rate of capacity utilisation accelerates and so does the pace of adjusting new equipment to the changing demand, which, as a consequence, causes an increase in the NAIRCU.

According to data at the disposal of the authors of this paper, the NAIRCU has not been estimated for the developing countries; nevertheless, the authors maintain that the assumption of a constant NAIRCU is more realistic for an economy where structural changes are going on. For instance, the share of manufacturing in Latvia's total value added shrank from 18.2% in 1995 to 9.5% in 2008 (at current prices), and this theoretically can minimise inflation sensitivity to capacity utilisation rate.

The dependence of the NAIRU on structural changes in an economy is not so pronounced, for the NAIRU is essentially affected by other factors as well, e.g. labour legislation, state financing for re-training of the unemployed, labour migration, etc. It can be assumed, however, that, given the economic growth, the NAIRU is likely to decrease, this being supported by a gradual regional aligning, labour force adjustment to new labour market standards, and other factors.

Consequently, the authors estimated the NAIRU and NAIRCU for Latvia assuming that they are time-varying.

4.1 Estimation of Time-Varying NAIRU

The Kalman filter[3] is used in the estimation of time-varying NAIRU. The unemployment rate time series was divided into two, long-term and short-term, components.

$$u_t = T_t^u + C_t^u \qquad [6]$$

where

u_t is the unemployment rate;

T_t^u is the time series trend or long-term component of unemployment rate;

C_t^u is the cyclical time series component, i.e. short-term component of unemployment rate.

The long-term component of unemployment rate's time series deals with such dynamics of structural unemployment rate which does not trigger changes in

[3] For more detailed information on methodology used, see, for instance, *Hamilton, James D. Time Series Analysis. Princeton: Princeton University Press, 1994.*

inflation, i.e. the dynamics of the NAIRU. The short-term component, at the same time, captures deviations of unemployment rate from the NAIRU which facilitate changes in inflation.

If basic principles for component generation are adopted beforehand, both components can be estimated using the Kalman filter. The first measurement equation [6] above determines the components which form the actual unemployment rate; the second measurement equation determines the dependence of inflation changes on the short-term component of unemployment rate:

$$\Delta\pi_t^{cpi} = \beta_1\Delta\pi_{t-1}^{cpi} + \beta_2 C_t^u + \phi_1\Delta\pi_t^{imp} + \phi_2\Delta\pi_t^{oil} + \varepsilon_t \qquad [7]$$

where

π_t^{cpi} is annual inflation of consumer prices;

π_t^{imp} is annual inflation of import prices;

π_t^{oil} is annual inflation of oil prices in lats.

In accordance with the assumption, the short-term component of unemployment rate corresponds to the second order autoregressive process:

$$C_t^u = \alpha_1 C_{t-1}^u + \alpha_2 C_{t-2}^u + \phi_t \qquad [8].$$

It is assumed that the process of long-term component generation evolves in accordance with the random walk process:

$$T_t^u = T_{t-1}^u + \gamma_t \qquad [9].$$

The regression error γ_t captures economic shocks with an impact on the NAIRU. The system of equations [6]–[9] was estimated using data from the third quarter of 1996 to the fourth quarter of 2008. The estimation of the given system is showed in Table 4.1.

Table 4.1

Estimation of Phillips curve for Latvia

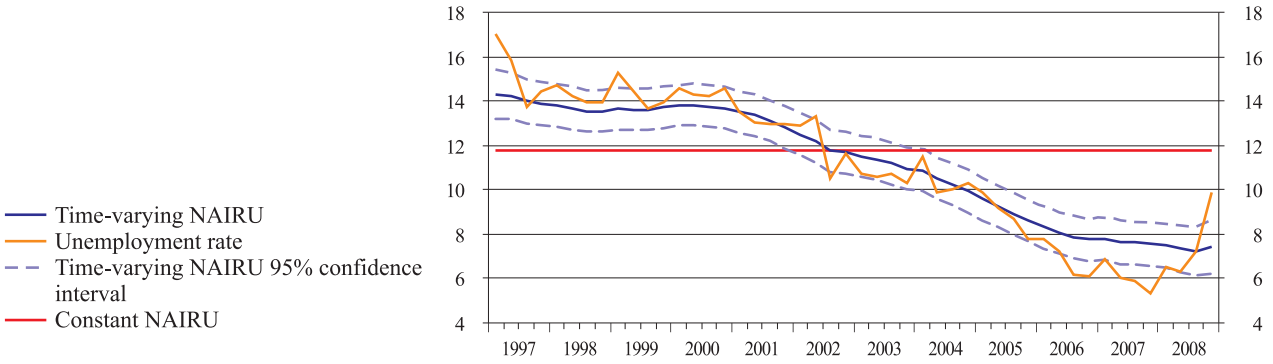
(time-varying NAIRU; quarterly data; Q 3 1996–Q 4 2008)

	Coefficient	*z*-statistic
Phillips curve		
$\Delta\pi_{t-1}^{cpi}$	0.299*	1.804
C_t^u	–0.508***	–4.870
$\Delta\pi_t^{imp}$	–0.046	–0.752
$\Delta\pi_t^{oil}$	0.021***	3.758
Short-term component		
C_{t-1}^u	0.695***	2.632
C_{t-2}^u	–0.002	0.361

*, **, *** denote statistical significance of coefficients at the 10%, 5% and 1% level respectively.

The coefficient of unemployment rate deviations from the NAIRU is statistically significant at the 1% level and indicates that each percentage point of the deviation increases (reduces) inflation of the next period by 0.508 percentage point, provided that the unemployment rate is below (above) the NAIRU. Chart 4.1 shows the assessment of the time-varying NAIRU, its 95% confidence interval, and the actual unemployment rate. For comparison, it shows the estimate of the constant NAIRU as well.

Chart 4.1
Time-varying NAIRU, its 95% confidence interval and actual unemployment rate



In the sample period, the assessment of the NAIRU changed substantially from 14.3% at the beginning of 1997 to 7.2% in the third quarter of 2008; thereafter, the NAIRU grew slightly, reflecting deteriorating economic growth in Latvia and rapidly rising unemployment rate towards the end of 2008. The estimate of the time-varying NAIRU remained broadly unchanged till 2001and was above that of the constant NAIRU. At the same time, the NAIRU estimated since 2004 notably differed from the assessment of the constant NAIRU (see Chapter 3). As of the period from the end-2005 to mid-2008, the estimate of the time-varying NAIRU constantly exceeded the actual unemployment rate. It implies that in this period Latvia's labour market situation most likely had impacted the inflation rate. The estimate for the time-varying NAIRU in the fourth quarter of 2008 is smaller than the actual unemployment rate, which implies that the situation in Latvia's labour market at the end of 2008 underpinned a decrease in the rate of inflation.

4.2 Estimation of Time-Varying NAIRCU

Also, the Kalman filter was used in the estimation of the time-varying NAIRCU. Similar to the unemployment rate, capacity utilisation (CU) was divided into long-term and short-term components:

$$CU_t = T_t^{CU} + C_t^{CU} \qquad [10].$$

The second measurement equation built for the NAIRCU estimation includes inflation changes of the previous period and the current quarter's short-term component of capacity utilisation, both as explanatory variables of inflation changes:

$$\Delta\pi_t^{cpi} = \beta_1 \Delta\pi_{t-1}^{cpi} + \beta_2 C_t^{CU} + \phi_1 \Delta\pi_t^{imp} + \phi_2 \Delta\pi_t^{oil} + \varepsilon_t \qquad [11].$$

Similar to the NAIRU model, it was assumed that the dynamics of capacity utilisation short-term component corresponds to the second order autoregressive process, while the NAIRCU dynamics corresponds to random walk with no bias. The NAIRCU model estimate is given in Table 4.2.

Table 4.2

Estimation of Phillips curve for Latvia

(time-varying NAIRCU; quarterly data; Q 3 1996–Q 4 2008)

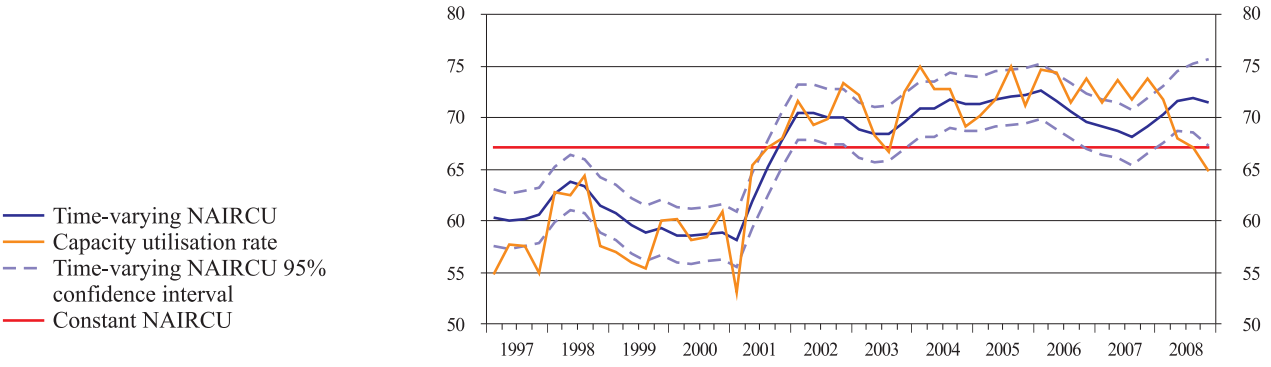
	Coefficient	z-statistic
Phillips curve		
$\Delta\pi_{t-1}^{cpi}$	0.241*	1.847
C_t^{CU}	0.256***	6.911
$\Delta\pi_t^{imp}$	–0.004	–0.136
$\Delta\pi_t^{oil}$	0.022***	5.246
Cyclical component		
C_{t-1}^{CU}	0.597**	2.539
C_{t-2}^{CU}	0.149*	1.749

*, **, *** denote statistical significance of coefficients at the 10%, 5% and 1% level respectively.

The coefficient of capacity utilisation deviations from the NAIRCU is statistically significant at the 1% level and shows that each percentage point of the deviation increases (decreases) inflation of the next period by 0.256 percentage point, provided that the capacity utilisation rate is above (below) the NAIRCU. The time series of both time-varying and constant NAIRCU (the latter given for comparison), their 95% confidence intervals and the actual capacity utilisation rate are given in Chart 4.2.

Chart 4.2

Time-varying NAIRCU, its 95% confidence interval and actual rate of capacity utilisation



The model findings show that in 2007 the NAIRCU substantially moved away from the actual rate of capacity utilisation. Hence it can be concluded that at the end of 2007, the capacity utilisation rate in manufacturing most likely exerted pressure on inflation rate via rapidly rising production costs (or inputs). The period after the Russian financial crisis of 1998 was similar in terms of duration and opposite in terms of impact on changes in inflation, when the capacity utilisation rate

decelerated steeply and was below the estimated time-varying NAIRCU, with a substantial decreasing effect on inflation growth from the fourth quarter of 1998 to the third quarter of 2008. At the end of 2008, a rapid decline in the capacity utilisation rate resulting from the economic downturn in Latvia and global financial crisis underpinned the situation in which the capacity utilisation in industry started to act as a factor pushing down the inflation rate.

CONCLUSIONS

The study estimates Latvia's NAIRU and NAIRCU in the sample period from the third quarter of 1996 to the fourth quarter of 2008. Two approaches have been used in the estimation: 1) the structural approach, under which the NAIRU and NAIRCU are assumed constant for the sample period, and 2) the Kalman filter, allowing for the NAIRU and NAIRCU to be time-varying.

Upon assuming that the NAIRU is constant, its estimate for the sample period was 11.8% at the 95% confidence interval of 9.4%–14.4%. The applying of the Kalman filter and assumption of a time-varying NAIRU in the given period showed that the NAIRU for Latvia decreased from 14.3% at the beginning of 1997 to 7.4% at the end of 2008. The estimate for the time-varying NAIRU from the end-2005 to mid-2008 was above the actual unemployment rate, suggesting that Latvia's tense labour market situation most likely fuelled a rise in the inflation rate. It can be inferred on the basis of the estimates that the maximum pressure on inflation occurred at the end of 2007; thereafter, the labour market started to return to normal and, consequently, its pressure on inflation abated. As under the impact of the dynamic economic downturn in Latvia in 2008 and the sharp rise in unemployment in the second half of the year the time-varying NAIRU was lower than the actual unemployment rate, Latvia's labour market situation began to support a decrease in inflation.

In the sample period, the estimate for the NAIRCU, under the assumption that it is constant, was 64.4% at the 95% confidence interval of 50.0%–84.3%. The time-varying NAIRCU was estimated by the Kalman filter and displayed a rise from an average of 60.2% in 1997 to an average of 71.8% in 2005. In 2007, the gap between the NAIRCU and actual rate of capacity utilisation expanded notably. This leads to a conclusion that, apparently at the end of 2007, the capacity utilisation rate in manufacturing exerted pressure on inflation via a sharp rise in production costs (inputs). Whereas at the end of 2008, a rapid decline in the capacity utilisation rate resulting from the economic downturn in Latvia and global financial crisis underpinned the situation, in which the capacity utilisation in manufacturing started to act as a factor decelerating the inflation rate.

APPENDICES

Table A.1
Time-varying NAIRU of OECD countries

Country	1980	1985	1990	1995	1999
Australia	5.1	6.0	6.5	7.1	6.8
Austria	1.9	3.2	4.6	5.0	4.9
Belgium	5.5	6.8	8.4	8.0	8.2
Canada	8.9	10.1	9.0	8.8	7.7
Denmark	5.8	5.9	6.9	7.1	6.3
Finland	4.3	3.9	5.6	10.6	9.0
France	5.8	6.5	9.3	10.3	9.5
Germany	3.3	4.4	5.3	6.7	6.9
Greece	4.6	6.5	8.4	8.8	9.5
Ireland	12.8	13.2	14.1	10.8	7.1
Italy	6.8	7.8	9.1	10.0	10.4
Japan	1.9	2.7	2.2	2.9	4.0
Netherlands	4.7	7.5	7.5	6.1	4.7
New Zealand	1.6	5.1	7.0	7.5	6.1
Norway	2.2	2.6	4.6	4.9	3.7
Portugal	6.1	5.4	4.8	4.2	3.9
Spain	7.8	14.4	17.4	16.5	15.1
Sweden	2.4	2.1	3.8	5.8	5.8
Switzerland	2.3	2.9	3.0	3.3	2.4
Great Britain	4.4	8.1	8.6	6.9	7.0
US	6.1	5.6	5.4	5.3	5.2
EMU	5.5	7.1	8.8	9.2	8.8

Source: (22).

Table A.2
Time-varying NAIRU of individual European countries

Country	1990	1993	1996	1999
Belgium	8.6	8.5	8.3	8.0
Denmark	6.6	6.5	6.1	5.6
Germany	5.6	6.2	7.4	8.8
Greece	7.3	8.0	9.1	10.1
Spain	18.5	18.9	18.2	16.6
France	9.6	10.2	10.7	11.3
Ireland	14.1	13.4	11.7	9.3
Italy	9.9	10.4	10.9	11.3
Netherlands	7.0	6.3	5.3	4.0
Austria	3.6	3.7	4.0	4.3
Portugal	4.9	5.5	5.4	4.2
Finland	4.7	17.0	14.6	12.2
Sweden	5.9	7.9	7.4	6.5
Great Britain	9.3	8.7	7.8	6.8

Source: (13).

Table A.3
Constant NAIRCU of individual European countries

Country	Complete sample (1st observation)	1972–1979	1980–1996[2]	1972–1985	1986–1996[2]
Belgium	77.7 (Q 2 of 1972)	77.2	80.1	76.9	78.9
France	84.1 (Q 2 of 1972)	83.3	86.2	83.4	86.4
Germany	84.4 (Q 1 of 1973)	83.0	84.3	83.0	84.9
Greece[1]	77.8 (Q 1 of 1982)	–	–	–	–
Ireland[1]	77.8 (Q 4 of 1984)	–	–	–	–
Italy	75.2 (Q 2 of 1972)	73.0	77.6	73.4	78.1
Netherlands	83.2 (Q 3 of 1972)	81.7	83.4	81.7	83.6
Great Britain[1]	83.3 (Q 2 of 1982)	–	–	–	–

Notes.
1) Due to limited length of the available time series, the NAIRCU estimates are based on full sample.
2) NAIRCU estimates are based on data till the second quarter of 1996.
Source: (17).

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