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Estimating NAIRU in Kazakhstan

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1. Introduction

Understanding the nature of the relationship between inflation and unemployment is critical to the formulation of macroeconomic policy in a market economy. The effects of monetary policy, fiscal policies and aggregate demand or supply shocks all depend on this relationship. In classical economic theory money is neutral. Changes in the quantity of money affect the price level, but do not affect relative prices, production or employment. However, in the real world most economists would agree that changes in monetary aggregates do have real effects, pushing inflation and unemployment in opposite directions at least in the short run.[1] Further, in the long run, this relationship may change, effectively shifting the Phillips curve over time. In transition economies real shocks, imperfect information, lack of developed markets, labor market rigidities and inadequate institutional and legal foundations are clear origins of sometimes dramatic business cycle fluctuations that would make the relationship between inflation and unemployment unstable. However, as transition progresses these sources of economic fluctuation diminish and an understanding of the influence of money and monetary policies on the real economy becomes more important. The trade off between inflation and unemployment, and how monetary policy makers can influence real economic outcomes, again, at least in the short run, is best understood in the context of the Phillips curve and the natural rate of unemployment[2] (the long run unemployment rate), or

[1] See the introduction to Ball and Mankiw (2002) for a very brief over view. The real business cycle theorists maintain money neutrality and argue that business cycles originate primarily from technological change.

[2] The natural rate may reflect how well labor markets match workers and jobs. This is certainly changing as the transition from central planning to a market economy takes place.

NAIRU, the non accelerating inflation rate of unemployment[3] (the rate of unemployment at which inflation will be stable). As transition takes place there is some point in time where these concepts provide useful insights to the functioning of the macro-economy and some guidance for policy makers.

Herein we focus on Kazakhstan, an economy in which the transition is well advanced and macroeconomic data may be sufficient to provide insights in the traditional Phillips Curve-NAIRU framework. During transition the "normal" relationship between inflation and unemployment, or the natural rate of unemployment, is dominated by supply shocks, which appear to shift the Phillips Curve. But at some point supply shocks diminish and the monetary regime stabilizes sufficiently to allow estimation of the relationship between inflation and unemployment. Estimating this relationship is the goal of this paper. Then we must ask how confident are we in its measurement, to what extent should we rely on it as an indicator, and how useful is knowledge of NAIRU in anticipating changes in inflation? Further, if NAIRU is useful as an indicator of future inflation are there other leading indicators that may be better, perhaps over a longer horizon? In the next section we provide a brief theoretical overview and a description of

[3] Ball and Mishkin (2002) note that the usefulness of NAIRU depends upon the monetary regime and expectations. If expected inflation is close to zero, the natural rate of unemployment would be associated with stable prices rather than stable inflation. If inflation is close to a random walk and adaptive expectations are close to rational then the natural rate may be considered NAIRU, or is associated with stable inflation. While the natural rate may change over time (due to demographics, institutions, etc.) the relationship between inflation and the natural rate is also subject to supply shocks which are disruptions in the "normal" inflation process. For an economy in transition supply shocks may dominate the relationship. It is our purpose to discover the "normal" relationship in Kazakhstan. It should also be noted that critics of its use, such as Espinoza-Vega and Russell (1997) and Galbraith (1997) may dismiss NAIRU as a useful policy guide, but the weight of research evidence and its persistence in use by policy makers suggests otherwise.

the model to be estimated. In section 3 we provide the empirical results and implications for monetary policy. We close with a brief summary and suggestions for further analysis.

1. Theoretical Background

An informative description of the empirical relationship between inflation and the natural rate of unemployment and NAIRU in the European context may be found in Richardson, et al. (2000). They identify three NAIRU concepts, the unemployment rate consistent with stable inflation, each depending on the time horizon. First, is "the" NAIRU, an equilibrium toward which unemployment converges in the absence of temporary supply shocks (a medium term concept - after which supply shocks have fully dissipated). Second is a short term NAIRU, a rate consistent with stabilizing the inflation rate at its current level in the next period. This rate depends on "the" NAIRU above, but is more volatile because it is affected by all, even temporary, supply influences, expectations or inertia, and persistence effects including the actual level of unemployment. And third, a long term unemployment rate, the natural rate, corresponding to a long run steady state once NAIRU has adjusted to all supply and policy shocks. Estimates of the relationship between inflation and each of the first two concepts via reduced form Phillips Curve equations are generally fairly robust within a framework allowing basic hypothesis tests of parameters, but neglecting the underlying structural and policy variables which effect unemployment over time or across countries. The relationship between inflation and the third unemployment concept may be estimated

in a structural equation framework, but the results are highly sensitive to specification and identification issues.

They note that an expectations augmented Phillips Curve may be derived in a structural model and, in their notation (approximately), may be written in a two equation system as:

$$\Delta\Pi_t = \alpha(L)\Delta\Pi_{t-1} - \beta(u_t - u^N_t) - \theta(L)\Delta u_t + \lambda(L)\, ZT_t + \varepsilon_t \qquad (1)$$

$$u^N_t = [K_t + \rho(L)ZL_t]/\beta \quad , \qquad (2)$$

where Δ is the first difference operator, Π_t is inflation, u_t is the observed unemployment rate, ZL_t and ZT_t are vectors of long term and temporary shocks, $\alpha(L)$, $\theta(L)$, $\rho(L)$, and $\lambda(L)$ are polynomials in the lag operator, K_t is a parameter capturing all other unspecified influences on NAIRU, u^N_t, and ε_t is a white noise error term. While this specification is quite comprehensive, data requirements limit its utilization as written. With appropriate assumptions a simpler, but essentially equivalent expression (similar to Staiger, Stock and Watson (2005)), is:

$$\Delta\Pi_t = \beta_1(u_{t-1} - u^N) + \beta_2(u_{t-2} - u^N) + \gamma X_t + \upsilon_t \qquad (3)$$

where Π_t is the rate of inflation, u_t is the unemployment rate, X_t is a vector of control variables and u^N is NAIRU, again an unknown parameter.[4] The number of lags here is set to two, but ultimately this is an empirical question with the number of lags typically

[4] Note that if we place the inflation rate as the endogenous variable and lagged inflation explicitly on the right hand side this equation is then simply an expectations augmented Phillips curve. See Ball and Mankiw (2002), 117-119.

determined by the last statistically significant lag. To estimate this equation more easily it can be rewritten as:

$$\Delta\Pi_t = \mu + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \gamma X_t + \upsilon_t \quad , \qquad (4)$$

where μ, β_1, β_2 , and γ can be estimated via ordinary least squares.[5] Then we can write NAIRU as:

$$\text{NAIRU} = u^N = -\mu/(\beta_1 + \beta_2) \quad , \qquad (5)$$

which implies NAIRU is constant during the estimation period. However, if we believe NAIRU is changing over time we can write

$$u^N - (\upsilon_t + \gamma X_t)/(\beta_1 + \beta_2) = -\Delta\Pi_t/(\beta_1 + \beta_2) + \beta_1/(\beta_1 + \beta_2)\, u_{t-1} + \beta_2/(\beta_1 + \beta_2) u_{t-2} \qquad (6)$$

Again, the parameters may be estimated from equation (4) and u^N may be isolated in equation (6) via a standard filtering technique such as the Hodrick Prescott filter.

In a transition economy NAIRU is certainly changing over time as the structure of the economy evolves -- labor markets in particular. In addition many of the transition economies have been subjected to significant structural breaks which may be captured by the control variables in X. Thus, we estimate an equation like (4), calculate the right hand side of equation (6), then apply the Hodrick Prescott filter to determine u^N.

[5] Note though that in many cases maximum likelihood estimation and Kalman filter techniques are also employed. An example is Laubach (2001) for the G7 economies.

2. Data and empirical specification

We estimate equation (4) as above, with contemporaneous unemployment and its lagged values and also with inflation expectations explicit as:

$$\Pi_t = \mu + \beta_0 \Pi_{t-1} + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \gamma X_t + \upsilon_t , \qquad (4')$$

where all variables are defined as before (but the parameters are different due to the inclusion of Π_{t-1} explicitly as a predetermined variable). We use quarterly data from 2001Q1 to 2007Q2. All data are compiled by the National Bank of Kazakhstan. There are several options that we considered. First, what measure of inflation is appropriate? We considered both the CPI and the GDP deflator and settled on the CPI specifications.[6] As future research we will consider other components of the CPI and wages (as in ECMOD the model of the Polish economy constructed by the National Bank of Poland). And second, recent research indicates that the overall unemployment rate may not be the most appropriate and better results are found using unemployment rates for married males, for example. This is an open question worth considering and certainly the specification would be dependent on the institutions, culture and traditions associated with the labor market in the country being considered. For Kazakhstan, at the moment, this data is unavailable. Figure 1 illustrates the movements of CPI inflation and the unemployment rate during the 2000s. From 2001 to 2006 the negative relationship between unemployment and CPI inflation is evident.

(Insert Figure 1 here.)

[6] Staiger, Stock and Watson (1997b) also note that the GDP deflator yields less precise estimates of NAIRU in the US context.

The final specifications are summarized in Table 1. (Appendix 1 presents the original EViews output.) Several specifications with longer lags for unemployment were also estimated, but lagged values were not statistically significant and /or had incorrect signs so those specifications are not reported. Overall the econometric results are comparable to those typically found for market economies, with the correct signs, reasonable statistical significance and reasonable goodness of fit. Specifications 1 and 3 model the change in inflation as a function of unemployment, either contemporaneous or lagged one period. Specification 2 and 4 model inflation as a function of inflation expectations and unemployment, contemporaneous or lagged one period. Specification 2 and 4, with expectations explicit and contemporaneous price adjustment to unemployment or adjustment to unemployment lagged one period, are the best specifications based upon goodness of fit. The coefficient on lagged unemployment is not statistically significant in specification 4, so we will exclude it from further analysis.

(Insert Table 1 here.)

NAIRU for the entire period (assuming a constant value) ranges from 8.53% (specification 1), to 8.68% (specification 3) to 14.59% for specification 2. Of course we do not expect NAIRU to be constant during this period, and if anything it should be falling as transition progresses and labor markets develop and stabilize.

From the estimation results in Table 1 we may calculate time varying NAIRU from (6) for specifications 1 and 3 or from

$$u^N - (\upsilon_t + \gamma X_t)/(\beta_1 + \beta_2) = - \beta_0 \Pi_{t-1}/(\beta_1 + \beta_2) + \beta_1/(\beta_1 + \beta_2)\, u_{t-1} + \beta_2/(\beta_1 + \beta_2) u_{t-2} \quad (6')$$

for specification 2, all with γ and β_2 equal to 0. These are graphed in Figure 2 below.

(Insert Figure 2 here.)

Each specification produces a different estimated value of NAIRU, but the pattern is clear. From late 2002 NAIRU is falling and by early 2007 it reaches about 7.7% regardless of specification. This rate, even the range over the whole period, is within the range of estimated values of NAIRU for market economies. Laubach (2001) reports NAIRU estimates for the G-7 economies that range from 5-18% depending on country and specification. Similarly the change in NAIRU over his estimation period is sometimes as large as those in Figure 2.

The question then is how to interpret both the level and movement of NAIRU for Kazakhstan. It is not clear whether NAIRU has stabilized at a level near that calculated for the last part of the sample or whether it may still continue to fall. The precise value is not as important as the general finding that it can be reasonably estimated, that it is falling over the sample period, and importantly, current unemployment rates are less than all of the estimated values of NAIRU. The later indicates that the labor market may be generating incipient or realized wage and price increases and monetary policy makers should be appropriately aware. The decline in NAIRU itself likely reflects changes in the

Kazakhstan economy that are also causes for changes in NAIRU in a market economy, except these forces are more extreme: better job matching as the labor market develops, hysteresis, productivity effects, and opening of the domestic economy or "globalization."[7] Casual observation suggests an improvement in the functioning of labor markets and job matching which would lead to a decline in NAIRU. But also the general increase in the demand for labor and the resulting growth in wage rates and incomes associated with the long economic expansion that has been taking place since the early 1990s also generates hysteresis and productivity induced changes in NAIRU. While the unemployment rate for different types of workers varies according to skill level, age, and intensity of job search, the long period of strong economic growth has pushed unemployment rates for all skills and age groups downward and hysteresis, the tendency for an object or outcome to remain in place after a shock or change, then suggests that NAIRU would decrease.[8] In addition, productivity growth has been quite high and real wages grow with productivity increases. If workers wage aspirations are less than the realized higher than expected productivity growth, this leads to lower expected wages and less upward wage pressure on wages and prices than a particular level of unemployment would warrant. Thus, NAIRU would fall. Finally, greater openness to trade and investment has increased competitive pressures on domestic firms so that even as the unemployment rate falls individual firms cannot raise prices as easily. And again, NAIRU would tend to fall. It is clear that all of these factors are at work in Kazakhstan, as in all of the transition economies.

[7] These are also suggested for the US in Ball and Mankiw (2002).
[8] See Ball and Mankiw (2002), p. 119 for a brief discussion of NAIRU and hysteresis.

Unemployment, or unemployment relative to NAIRU, has been shown to be a leading economic indicator of inflation, but not always strong or precise.[9] A changing NAIRU complicates its use as a monetary policy guide. Therefore, monetary policy must be informed by each of the factors that influence NAIRU and the extent to which their effect on NAIRU has been exhausted. In addition, there are other factors that influence both inflation and the appropriateness of the central bank's response to particular inflationary shocks. Capacity constraints, sectoral bottlenecks and external shocks passed through to the domestic economy via exchange rate policies are also potential determinants of inflation. Stock and Watson (1996) consider 71 different inflation forecasting models and find that unemployment, new orders (data based on survey responses) and capacity utilization in manufacturing are the most important indicators of future inflation in the US. Certainly capacity utilization is an important constraint in a fast growing economy like Kazakhstan, but the constraint is most likely in the construction sector rather than manufacturing. This is an open question, however. In addition foreign shocks, ranging to oil price increases generating large dollar inflows to recent food price shocks, may certainly contribute to domestic inflationary pressures. Inflows associated with oil price increases have seemingly been sterilized via management of the National Fund. However, sharp increases in the world price of wheat apparently have not been managed and are often identified as the source of the recent inflation spike in the third and fourth quarters of 2007. We must add, however, that our findings – that current unemployment rates are significantly less than all measures of NAIRU – are an important indicator of incipient inflationary pressures that may be

[9] See Staiger, Stock and Watson (1997a).

realized in the near future if the National Bank of Kazakhstan fails to make appropriate adjustments in monetary policy.[10]

4. Summary and suggestions for future research

In this paper we take a first step toward understanding the relationship between inflation and unemployment in Kazakhstan. Phillips curves were estimated and three measures of the time varying non-accelerating inflation rate of unemployment were calculated. The estimates are within reason and provide some indication of the structural changes taking place in the Kazakhstan economy. Importantly, the current unemployment rate is less than all measures of NAIRU indicating potential inflationary pressures. This serves as a warning to policy makers of the need to make corrections in monetary policy.

While our measures of NAIRU may serve as a guide for monetary policy they should not be taken alone. Other methods of estimating NAIRU, employing alternative price indices and alternative measures of unemployment, and alternative estimation techniques should be explored. Further, the specific determinants f NAIRU and changes in NAIRU as transition is completed should be analyzed. Finally, a more complete picture of the inflation process and the use of capacity utilization and survey based information should be incorporated into any description of the inflation process.

[10] Also note that there is significant anecdotal evidence of labor market shortages being met by legal and illegal workers in the construction sector. These labor flows may have been abated with the collapse of the real estate boom.

The precise value of NAIRU is not so important. Oskar Morgenstern quotes Norbert Wiener (physicist) as saying "Economics is a one or two digit science."

References

Ball, Laurence and N. Gregory Mankiw (2002) "The NAIRU in Theory and Practice," *The Journal of Economic Perspectives* 16,4: 115-136.

Blanchard, O. and L.F. Katz (1997), "What we know and do not know about the natural rate of unemployment", *NBER Working Paper*, No. 5822.

Blanchard, Oliver J., and Lawrence H. Summers, "Hysteresis and the European Unemployment Problem," *NBER Macroeconomics Annual,* 1986, 15-77.

Brayton, F., Roberts and J.C. Williams (1999), "What's happened to the Phillips curve?", *Federal Reserve Board Working Paper*, No. 199-49 (September).

Butler, L. (1996), "A semi-structural method to estimate potential output: combining economic theory with a time-series filter", *Bank of Canada Quarterly Projection Model*.

Camarero, M. et al. (2005) "Unemployment dynamics and NAIRU estimates for Accession countries: a univariate approach," Journal of Comp. Econ. 53 584-603.

Cecchetti, Stephen G., "Inflation Indicators and Inflation Policy," *NBER Macroeconomis Annual* 1995, 189-219.

Cromb, R. (1993), "A survey of recent econometric work on the NAIRU", *Journal of Economic Studies*, Vol. 20, No. 1/2pp. 27-51.

Elmeskov, J. (1993), "High and persistent unemployment: assessment of the problem and its causes", OECD Economics Department, *Working Paper*, No. 132.

Englander, A. and C.A. LOS (1983), "Recovery without accelerating inflation?", Federal Reserve Bank, *Quarterly Review*, Vol. 8, No. 2, pp. 19-28.

Fabiani, S., A.L. Locarno, G.P. Oneto and P. Sestito (1997), "NAIRU: incomes, policy and inflation", *OECD Working Paper*, No. 187.

Fortin, P. (1989), "How natural is Canada's high unemployment rate?", *European Economic Review*, Vol. 58, pp. 1-17.

Galbraith, James K. (1997) "Time to Ditch NAIRU," *Journal of Economic Perspectives* 11(1): 93-108.

Giorno, C., P. Richardson, D. Roseveare and P. Van Den Noord (1995), "Estimating potential output, output gaps and structural budget balances", *OECD Working Paper*, No. 152.

Gordon, Robert (1997) "The Time-Varying NAIRU and its Implications for Economic Policy," *Journal of Economic Perspectives* 11 (1997), 11-32.

_____ (1990) "What is New-Keynesian Economics?" Journal of Economic Literature, September 1990, 28, 1115-71.

_____ (1998) "Foundations of the Goldilocks economy: supply shocks and the time-varying NAIRU", *Brookings Papers on Economic Activity*, Vol. 2, pp. 297-346.

_____ (1975) "Alternative Responses of Policy to External Supply Shocks." *BPEA, 1:1975*, 183-206.

_____ (1982) "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment." In *Workers, Jobs, and Inflation,* edited by Martin N. Baily. Brookings.

_____ (1983) "Credibility vs. Mainstream: Two Views of the Inflation Process." In *Inflation: Prospects and Remedies, Alternatives for the 1980s*, edited by William D. Nordhaus. Washington: Center for National Policy.

_____ (1994) "Inflation and Unemployment: Where is the NAIRU?" Paper prepared for the Meeting of Academic Consultants to the Board of Governors of the Federal Reserve System. Washington, December 1.

_____ (1995) "Estimating the NAIRU as a Time-Varying Parameter." Paper prepared for the Panel of Economic Advisors to the Congressional Budget Office. (November 16).

_____ (1998b) "Median Unbiased Estimation of Coefficient Variance in a Time-Varying Parameter Model." *Journal of the American Statistical Association* 93(March): 349-58.

Gordon, Robert J., and Stephen R. King. (1982) "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models." *BPEA*. 1:1982, 205-42.

Grubb, D. (1986), "Topics in the OECD Phillips curve", *Economic Journal*, Vol. 96, pp. 55-79.

Hahn, J. (1996) "The natural rate of unemployment in Korea: estimation and Implications," *Journal of Comparative Economics.*

Hodrick, R.J. and E.C. Prescott (1997), "Post-war U.S. business cycles: an empirical investigation", *Journal of Money*, *Credit and Banking*, Vol. 29, No. 1, pp. 1-16.

King, Robert, and Mark Watson,(1994) "The Post-War U.S. Phillips Curve: A Revisionist Econometric History," *Carnegie-Rochester Conference Series on Public Policy* 41, 157-219.

King, Robert G., James H. Stock, and Mark W. Watson, "Temporal Instability of the Unemployment-Inflation Relationship," *Economic Perspectives,* Federal Reserve Bank of Chicago, May/June 1995, 19, 2-12.

Kuttner, Kenneth N., "Monetary Policy with Uncertain Estimates of Potential Output," *Economic Perspectives,* Federal Reserve Bank of Chicago, January/February 1992, 16, 2-15.

Kuttner, Kenneth, (1994), "Estimating Potential Output as a Latent Variable," *Journal of Business and Economic Statistics* 12, 361-368.

Laubach, Thomas, (2001,"Measuring the NAIRU: Evidence from Seven Economies," *The Review of Economics and Statistics*, 83,2: 218-231.

Layard, Richard, Stephen Nickell, and Richard Jackman, *Unemployment: Macroeconomic Performance and the Labor Market*. New York: Oxford University Press, 1991.

Nishizaki, F (1997), "The NAIRU in Japan: measurement and its implications", *OECD Working Paper*, No. 173.

Phelps, Edmund S. (1978), "Commodity-Supply Shock and Full-Employment Monetary Policy." *Journal of Money, Credit, and Banking* 10,2: 206-21.

Rasi, C.M. and J.M. Viikari (1998), "The time-varying NAIRU and potential output in Finland", *Bank of Finland Working Paper*, No. XX/98.

Richardson, P., et al. (2000) "The concept, policy use and measurement of structural employment: estimating time varying NAIRU across 21 OECD countries, OECD Discussion Paper, Economics Department Working Paper No. 250.

Setterfield, MA., D.V. Gordon, and L. Osberg, "Searching for a Will of the Wisp: An Empirical Study of the NAIRU in Canada," *European Economic Review*, January 1992, 36, 119-36.

Shimer, Robert. Forthcoming. "Why Is the U.S. Unemployment Rate So Much Lower?" In *NBER Macroeconomics Annual 1998*, edited by Ben S. Bernanke and Julio J. Roternberg. (Boston: MIT Press, 1998).

Staiger, D., J.H. Stock and M.W. Watson (1997a), "How Precise are estimates of the Natural Rate of Unemployment?" in C. D. Roover and D.H. Romer (Eds.) *Reducing Inflation, Motivation and Strategy* (Chicago: U of Chicago Press, 1997).

_____ (1997b). "The NAIRU, Unemployment, and Monetary Policy." *Journal of Economic Perspectives* 11(1): 33-49.

Stiglitz, J. (1997), "Reflections on the natural rate hypothesis", *Journal of Economic Perspectives*, Vol. 11, No. 1, pp. 3-10.

Taylor, John, *Macroeconomic Policy in a World Economy: From Econometric Design to Practical Operation*, (NY: Norton, 1993)

Tootell, Geoffrey M.B., "Restructuring, the NAIRU, and the Phillips Curve" *New England Economic Review of the Federal Reserve Bank of Boston*, September/October 1994, 31-44.

Weiner, Stuart E., "New Estimates of the Natural Rate of Unemployment," *Economic Review of the Federal Reserve Bank of Kansas City*, Summer 1994, 79, 5-9.

Wieland, V. (1998), "Monetary policy and uncertainty about the natural unemployment rate," Board of Governors of the Federal Reserve System, Washington, D.C.

Appendix 1: Basic Regression Results

Table 1: Phillips Curve Estimates (Ball and Mankiw specification), contemporaneous price adjustment, expectations not explicit

Dependent Variable: D(CPI_APC)
Method: Least Squares
Date: 08/12/08 Time: 14:01
Sample (adjusted): 2000Q2 2007Q2
Included observations: 29 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	5.112806	1.494906	3.420152	0.0020
UER	-0.599164	0.158014	-3.791844	0.0008

R-squared	0.347481	Mean dependent var	-0.434783
Adjusted R-squared	0.323313	S.D. dependent var	2.010109
S.E. of regression	1.653535	Akaike info criterion	3.910180
Sum squared resid	73.82281	Schwarz criterion	4.004476
Log likelihood	-54.69761	Hannan-Quinn criter.	3.939712
F-statistic	14.37808	Durbin-Watson stat	1.548785
Prob(F-statistic)	0.000766		

Table 2: Expectations augmented Phillips Curve, contemporaneous price adjustment

Dependent Variable: CPI_APC
Method: Least Squares
Date: 08/12/08 Time: 13:54
Sample: 2001Q2 2007Q2
Included observations: 25

	Coefficient	Std. Error	t-Statistic	Prob.
C	6.270931	1.588142	3.948595	0.0007
CPI_APC(-1)	0.638412	0.109492	5.830687	0.0000
UER	-0.429687	0.145077	-2.961781	0.0072

R-squared	0.692021	Mean dependent var	7.287348
Adjusted R-squared	0.664022	S.D. dependent var	1.072625
S.E. of regression	0.621732	Akaike info criterion	1.999551
Sum squared resid	8.504113	Schwarz criterion	2.145816
Log likelihood	-21.99439	Hannan-Quinn criter.	2.040119
F-statistic	24.71667	Durbin-Watson stat	2.169223
Prob(F-statistic)	0.000002		

Table 3: Phillips Curve Estimates lagged price adjustment

Dependent Variable: D(CPI_APC)
Method: Least Squares
Date: 08/12/08 Time: 14:03
Sample (adjusted): 2000Q2 2007Q2
Included observations: 29 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	4.288656	1.365346	3.141076	0.0041
UER(-1)	-0.494262	0.139047	-3.554632	0.0014

R-squared	0.318791	Mean dependent var	-0.434783
Adjusted R-squared	0.293561	S.D. dependent var	2.010109
S.E. of regression	1.689495	Akaike info criterion	3.953209
Sum squared resid	77.06863	Schwarz criterion	4.047505
Log likelihood	-55.32152	Hannan-Quinn criter.	3.982741
F-statistic	12.63541	Durbin-Watson stat	1.538901
Prob(F-statistic)	0.001419		

Table 4: Expectations augmented Phillips Curve, lagged price adjustment

Dependent Variable: CPI_APC
Method: Least Squares
Date: 08/12/08 Time: 14:11
Sample: 2001Q2 2007Q2
Included observations: 25

	Coefficient	Std. Error	t-Statistic	Prob.
C	3.783517	1.400843	2.700886	0.0131
CPI_APC(-1)	0.690856	0.122030	5.661336	0.0000
UER(-1)	-0.179730	0.122279	-1.469840	0.1558

R-squared	0.607739	Mean dependent var	7.287348
Adjusted R-squared	0.572079	S.D. dependent var	1.072625
S.E. of regression	0.701665	Akaike info criterion	2.241445
Sum squared resid	10.83134	Schwarz criterion	2.387710
Log likelihood	-25.01806	Hannan-Quinn criter.	2.282013
F-statistic	17.04258	Durbin-Watson stat	1.944387
Prob(F-statistic)	0.000034		

Tables and Figures to be inserted in text.

Table 1: Phillips Curve Estimates
(p-values in parentheses)

	Specification 1	Specification 2	Specification 3	Specification 4
	$\Delta\Pi_t$	Π_t	$\Delta\Pi_t$	Π_t
C	2.965415	6.270931	4.288656	3.78357
	(0.0562)	(0.0007)	(0.0041)	(0.0131)
Π_{t-1}	-	0.638417	-	0.690856
	-	(0.000)	-	(0.000)
μ_t	-0.354245	-0.429687	-	-
	(0.0501)	(0.0072)	-	-
μ_{t-1}	-	-	-0.494262	-0.79730
	-	-	(0.0014)	(0.1558)
R^2	0.157	0.692	0.318791	0.6077
DW	2.0299	2.1692	1.5389	1.9444
Sample Period	2000Q2-2007Q2	2001Q2-2007Q2	2000Q2-2007Q2	2001Q2-2007Q2
NAIRU	8.37%	14.59%	8.68%	21.05%

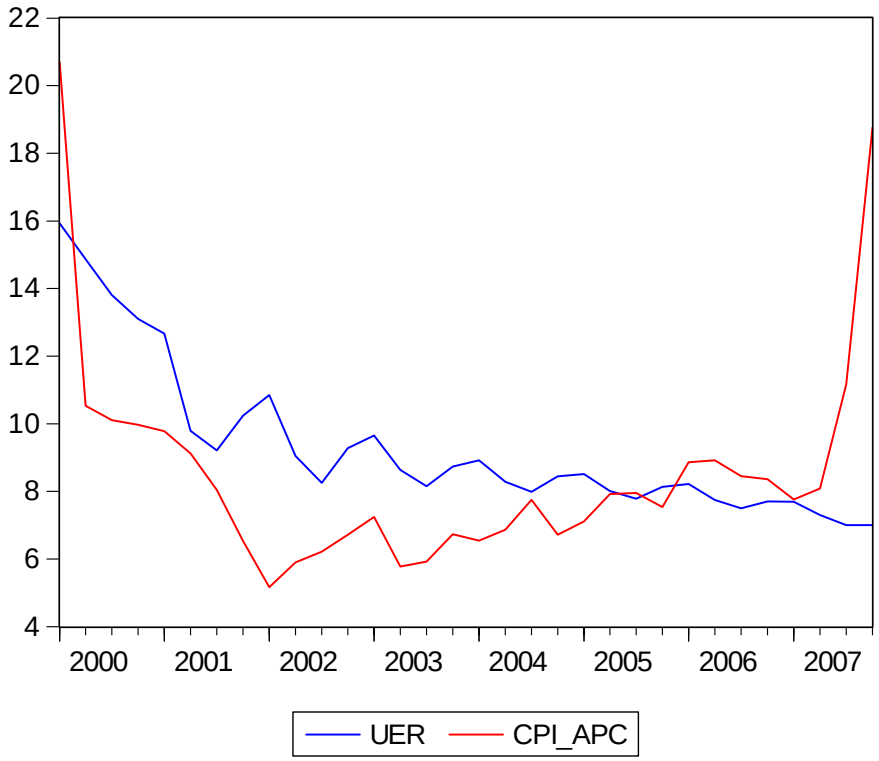

Figure 1: Unemployment and Inflation (CPI, percentage change versus comparable period one year ago)

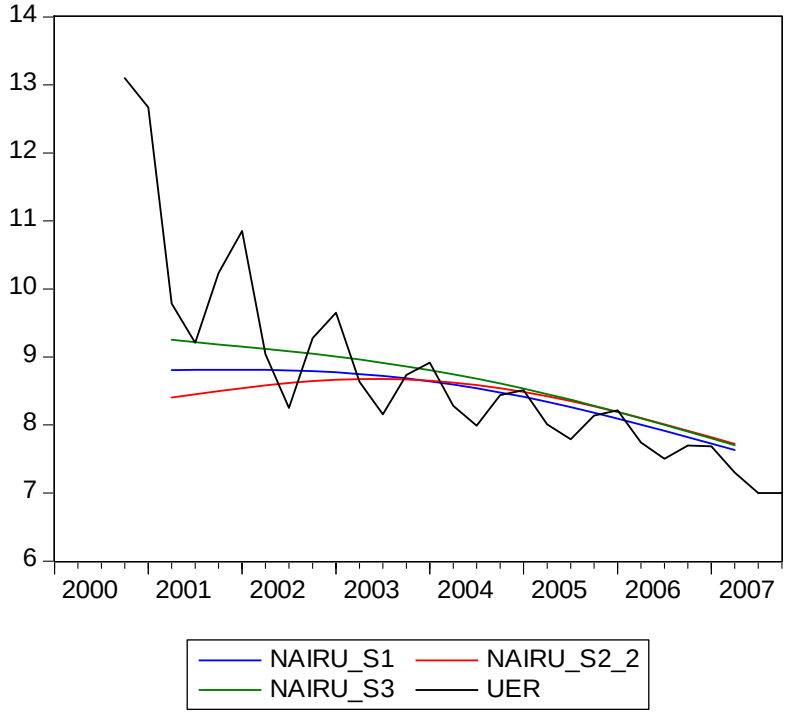

Figure 2: NAIRU Estimates ($\lambda = 1600$)