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Estimating Pakistan's Time Varying Non-Accelerating Inflation Rate of Unemployment: An Unobserved Component Approach

Farzana Shaheen
School of Social Sciences
Federal Urdu University of Arts, Sciences and Technology
Islamabad, Pakistan. Email: fshaheen80@hotmail.com

Azad Haider, Corresponding author
School of Economics, Quaid-e-Azam University,
Islamabad, Pakistan. Email: azadhaider@gmail.com

Sajid Amin Javed
School of Economics, International Islamic University,
Islamabad, Pakistan. Email: sajidamin78@gmail.com

ABSTRACT: This paper envisages estimating the Time-Varying Non-Accelerating Inflation Rate of Unemployment (TV-NAIRU) as an unobserved stochastic variable for Pakistan over the time period 1973-74 to 2007-08 using Kalman filter. Results of the study are evident that TV-NAIRU increased from 5.3 percent (1990-91) to 8.12 percent (2004-05) and falls to 6.17 percent again in 2007-08 which is above the actual unemployment rate. The results also indicate that the NAIRU is a relevant concept and the unemployment gap should be one of the factors considered when assessing inflationary pressure in Pakistan.

Key Words: Pakistan, Unemployment, Inflation, NAIRU, Phillips Curve
JEL Classification: E0, E23, E31

1. Introduction

The idea of a "natural" rate of unemployment was first proposed by Friedman in 1968 wherein it is roughly equivalent to the amount of frictional and structural unemployment persisting even when the labor market is in equilibrium.[1] The term NAIRU was first coined by Modigliani and Papademos in 1975. According to Friedman (1968) and Phelps (1968) *"there is not a long-term trade-off between inflation and unemployment: in the long run, unemployment depends on structural variables, whereas inflation is a monetary phenomenon"*. A trade-off exists between unemployment and inflation in the short-run indicating that if unemployment falls below the NAIRU, inflation will rise until unemployment rate returns to the NAIRU. The existence of a NAIRU, therefore, has immediate implications for the conduct of economic analysis and policies.

The issue has been extensively analyzed both at the regional as well as country level but remains unexplored in case of Pakistan. Available studies estimate constant NAIRU.[2] This study tries to fill the void and estimates the TV-NAIRU for Pakistan over the time period 1973-74 to 2007-08 using annual data to guide its anti-inflation and anti-unemployment policies.

"The Time-Varying NAIRU (TV-NAIRU) approach attempts to provide an indication of the path the NAIRU has taken over a particular period by including variables which capture the impact of significant supply side shocks, over the period in question, and which could be expected to influence the NAIRU" [McMorrow and Roeger (2000) p.4]. The accurate measurement of the TV-NAIRU is very difficult due to uncertainty, which flows from the fact that it is an unobservable variable and has

[1] McMorrow and Roeger (2000)
[2] Iqbal (1995) estimates constant NAIRU for Pakistan over the period 1978-1993

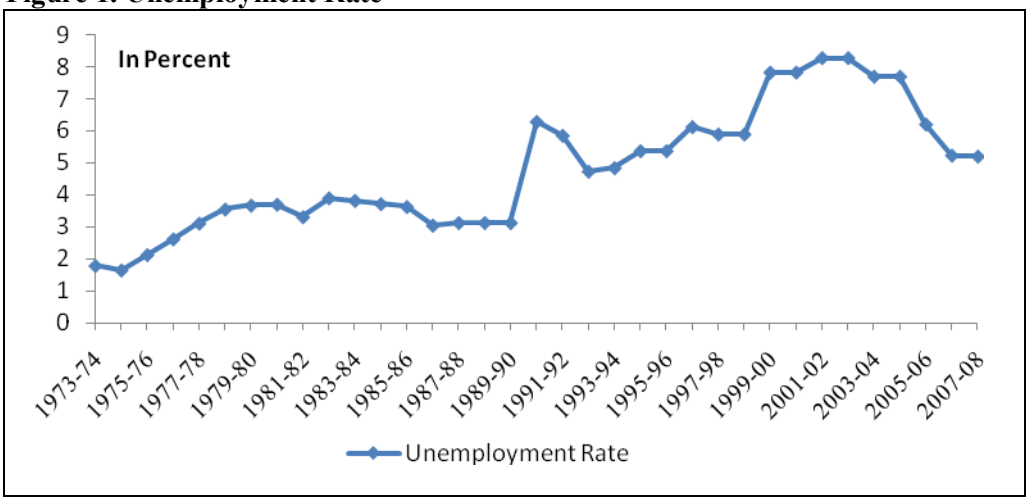
to be estimated using different specifications and different modeling approaches. The problem is that all these approaches give different results. The uncertainty also comes from point estimates of NAIRU.

The rest of this paper is organized as follows. Section 2 highlights shortly the development of unemployment rates in Pakistan. Some empirical literature review is briefly discussed in Section 3 and the model is specified in Section 4. Estimation results of time-varying NAIRU are presented in Section 5 and finally Section 6 concludes the study.

2. The Behavior of Unemployment in Pakistan

The unemployment rate, an important macroeconomic indicator, is the unemployed population expressed as a percentage of the currently active population.[3] In all five year plans of Pakistan policies to reduce unemployment were proposed however most of them proved ineffective. Figure 1 depicts the unemployment rate for Pakistan exhibiting an increasing trend over the period 1973-74 to 1980-81 while a decline is registered in 1981-82 and then it started increasing again. It decreased again from 1983-84 to 1986-87; but remained constant during 1987-88 to 1988-89. The unemployment rate in 1990-91 jumped to 6.28 from the previous year's 3.1 per cent.[4] The figure also shows that the overall unemployment rate is on a decline from 2005-06. A plausible explanation can be a steeper decline in unemployment in the rural regions. Further, this decline can safely be attributed to numerous reasons, a flourishing economy being one of them. This declining trend in unemployment rate continued in 2006-07 and 2007-08.

Figure 1. Unemployment Rate



Source: Various Issues of Pakistan Labor Force Survey and Economic Survey of Pakistan from1973 to 2008.

3. Empirical Literature: A Brief Description

The expectations-augmented Phillips curve is the simplest theoretical framework that incorporates the NAIRU concept in a transparent way, which Gordon (1997) has summarized in the form of the so-called "triangle model". In this model, inflation is determined by three factors: inertia, the demand shock as proxied by unemployment gap and supply shocks. Below review of some of the empirical studies on NAIRU is briefly discussed.

Gordon (1997) estimates time-varying NAIRU using different inflation indices for U.S economy. The results show that the sum of coefficients on the inflation inertia variable are close to unity and the coefficient on the unemployment gap are always highly significant and of the correct sign. Richardson, et al. (2000) used the Kalman filter and Hodrick Prescott Multivariate (HPMV) approaches to estimate the TV-NAIRU for 21 OECD countries using data from 1962 to 1999. The results of the study illustrate that the Phillips curve explains the inflationary development for past

[3] Economic Surveys of Pakistan (Various Issues)

[4] The jump might be attributed to conceptual dimensions of unemployment as Labor force survey (LFS) 1990-91 adopted the new definition of unemployment (Majid,2000).

three to four decades in all countries and unemployment gap is significant in explaining the inflation. The results of Kalman filter and HPMV filter are highly correlated with each other and also these unemployment gaps consistent with the earlier studies on OECD countries in (2000).

Hirose and Kamada (2002) estimates time-varying NAIRU and potential growth using Kalman filter from 1983:Q2 to 2002:Q2 for Japan. The TV-NAIRU was about –4 percent in the 1980s and there has been a downward trend between 1992 and 2002. The parameters of the Phillips curve are unstable since 2000. The study suggests that there should be considerable caution to use NAIRU estimates as a guide for macroeconomic policy. In another study, Greenslade, et al. (2003) estimates TV-NAIRU for the UK over 1973 to 2000 by applying the Kalman filter. The results from different models show that NAIRU reached a peak in the mid-1980s and thereafter tend to fall and that actual unemployment was below the NAIRU in the second half of the 1990s.[5] In the period of economic expansion unemployment falls below the NAIRU and this negative unemployment gap puts upward pressure on inflation.

Stephanides (2006) estimated the constant and time varying NAIRU in three countries; USA, Japan and European Union using maximum likelihood, Kalman filter and the non-linear least squares. The main findings of the study suggest that the NAIRU estimates are measured with large uncertainty and have extensive variability across the countries and specifications. Furthermore, Mehihovs and Zasova (2009) estimate NAIRU and Non Accelerating Inflation rate of capacity utilization (NAIRCU) for Latvia using Kalman filter in both structural and the reduced-form. The authors report that TV-NAIRU for Latvia decreased from 14.3 percent at the beginning of 1997 to 7.4 percent 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 labor market situation most likely fuelled a rise in the inflation rate.

We conclude this section by providing findings of Epstein and Macchiarelli (2010). The authors estimate NAIRU for Polish economy using Kalman filter over the period 1995-2008. The results are evident that estimated unemployment gap follows the post-reform business cycle in Poland. The literature on estimating a TV–NAIRU usually uses state space models or Kalman filter [Kalman (1960), Kalman and Bucky (1961)] to capture the dynamics of the NAIRU over time.[6] The overall of different studies suggests that there should be considerable caution to use NAIRU estimates as a guide for macroeconomic policy.

4. Model Specification

This section outlines the data and model specification to be used to estimate TV-NAIRU for Pakistan. Annual data for the variables is drawn from Labour Force Survey and Economic Survey of Pakistan for the period 1973/74-2007/08. We employ a general-to-specific approach (omitting insignificant variables) for estimation. Two lagged terms for price inflation (capturing inertia), unemployment gap (the demand shock), oil prices (supply shock) and a dummy variable that shows change in inflation along with constant term are included in Phillips curve equation. [7] We use oil prices as proxy for supply-side shock in Phillips curve equation. We follow Denis et al. (2002) and Epstein and Macchiarelli (2010) for analysis and estimations. There are two steps used to estimate NAIRU. In the first step, the unemployment is decomposed using Kalman filter. The second step identifies cyclical component according to Phillips curve relationship.

4.1. First Step

In first step unemployment rate is decomposed into a stochastic trend and cyclical component as:

$$u_t = (u_t - u_t^*) + u_t^* \qquad (1)$$

Where trend component follows local linear trend model as given below:

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[5] The results about NAIRU series are influenced by a signal-to-noise ratio which is assumed to be 0.16

[6] See Gordon (1997, 1998) and Staiger et al. (1997a,b) for the seminal contributions, Gerlach and Smets (1999), Apel and Jansson (1999), among many others Laubach (2001), Fabiani and Mestre (2000and 2001), Logeay and Tober (2006), and Fitzenberger et al (2007) and Denis et al (2002,2006).

[7] Greenslade et al. (2003)

$$u_t^* = \mu_t + u_{t-1}^* + \eta_t \quad (2)$$

While the trend component is assumed to follow random walk with drift as follows

$$\mu_t = \mu_{t-1} + \omega_t \quad (3)$$

The drift term, assumed to be stochastic, allows following random walk. Both error terms (η_t) and (ω_t) are Independent and Identically Distribution (IID) normal with zero mean and constant variance and are mutually uncorrelated. According to Danis et al (2002) *"The rationale for choosing such specification is the observed non-stationarity of the unemployment rate. While using Kalman filter the standard deviation innovation can be estimated, but there exists the problem often encountered in the literature that estimated trends are too smooth or too noisy"*. This problem can be overcome by fixing variance of estimated unemployment trend as suggested by Gordon, 1997 and OECD, 2000. Gordon (1997) suggests "smoothness prior", which means that you need to fix the variance of trend innovation. According to him when standard deviation of η_t=0, then this denotes time invariant or constant NAIRU; otherwise NAIRU varies by an amount η_t in each period. In this context we assume "smoothness prior" and fix the variance of trend innovation at lower bound of 0.1 consistent with Gordon (1997).

$$u_t - u_t^* = \theta_1\left(u_t - u_t^*\right)_{t-1} + \theta_2\left(u_t - u_t^*\right)_{t-2} + \upsilon_t \quad (4)$$

The unemployment gap is modeled as an AR(2) process and is assumed to be stationary and requires $\theta_1+\theta_2 < 1$.[8] Kalman filter is employed to estimate these components using equations (2) and (4). The results of the first step are reported in Table 1 set out in the next section.

4.2. Second Step

In the second step, we identify cyclical component using Phillips curve as in eq (5) below.

$$\Delta\pi_{t+1} = c + \alpha_1\Delta\pi_t + \alpha_2\Delta\pi_{t-1} + \alpha_3\Delta\pi_{t-2} + \beta\left(u_t - u_t^*\right) + \gamma_1 p_t^{oil} + \gamma_2 p_{t-1}^{oil} + D + \zeta_t \quad (5)$$

Where Δ is the first order of difference of variable while π_{t+1} is the inflation in time period t+1. c denotes constant term and π_t , π_{t-1} and π_{t-2} is inflation in time period t, t-1 and t-2 respectively. Further $u_t - u_t^*$ stands for unemployment gap while p_t^{oil} and p_{t-1}^{oil} denote oil prices in time period t and t-1 respectively. Dummy variable for inflation[9] and error term are denoted by D and ζ_t .

The results against eq (5) are furnished in Table 2 while Figure 2 depicts the estimated TV-NAIRU for Pakistan. For estimation of equation (5) we require a non-linear estimation. For increased precision, the estimation is initialized with an OLS regression where the unemployment gap is first approximated by the cyclical component obtained in the first step. The cyclical component ($u_t - u_t^*$) is consequently treated as unobserved and hence re-estimated within equation (5) under the specification in equation (4). The results are shown in next section.

5. Estimation Results and Discussion

The estimation results of first step of Kalman decomposition are presented below in Table 1 while Table 2 presents results of Kalman filter estimation of TV-NAIRU for Pakistan.

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[8] Denis et al. (2002)

[9] The shift dummy variable is included in order to account for changes in inflation. In particular, by imposing a change in the mean value for inflation, i.e. D=0 when inflation was mostly trending lower or equal to its mean value and D=1 for otherwise; i.e. when inflation trended higher its mean value.

Table 1. First Step Results: Kalman Decomposition

Variables	Coefficient	S.E	z-Statistic
$(u-u^*)_{t-1}$	0.490442*	0.025031	19.59324
$(u-u^*)_{t-2}$	-0.23396*	0.023083	-10.1355
Log	-240.113		

Note: * mean significant at 1 percent level of significance.

As is evident from Table 1, θ_1 and θ_2 are 0.49 and -0.23 respectively and statistically significant at 1 percent level of significance. Sum of both $\theta_1 + \theta_2$ is less than one indicating the stationary process which shows that unemployment gap in Pakistan follow an AR (2) process. Next we turn to second step results.

Table 2. Second Step (Kalman Filter Estimate) Results for NAIRU of Pakistan

Cyclical Component and Phillips Curve Estimates Maximum likelihood and statistics Estimation Periods:1974-2007 (35			
Variables	**Coefficients**	**S.E**	**z-statistics**
Constant	1.826964*	0.288453	6.333668
$\Delta\pi_t$	-0.32334*	0.04603	-7.02468
$\Delta\pi_{t-1}$	0.102784*	0.027172	3.782738
$\Delta\pi_{t-2}$	0.103761*	0.020676	5.01846
(u-u*)	-0.59348*	0.14702	-4.03675
p_t^{oil}	0.038374*	0.004255	9.018277
p_t^{oil} **(-1)**	-0.05171*	0.005164	-10.0133
D	-2.23152*	0.173204	-12.8838
Unemployment Cycle AR(2) Terms			
$(u-u^*)_{t-1}$	0.742401*	0.075767	9.798468
$(u-u^*)_{t-2}$	-0.27438*	0.067754	-4.04966
log likelihood	-236.401		

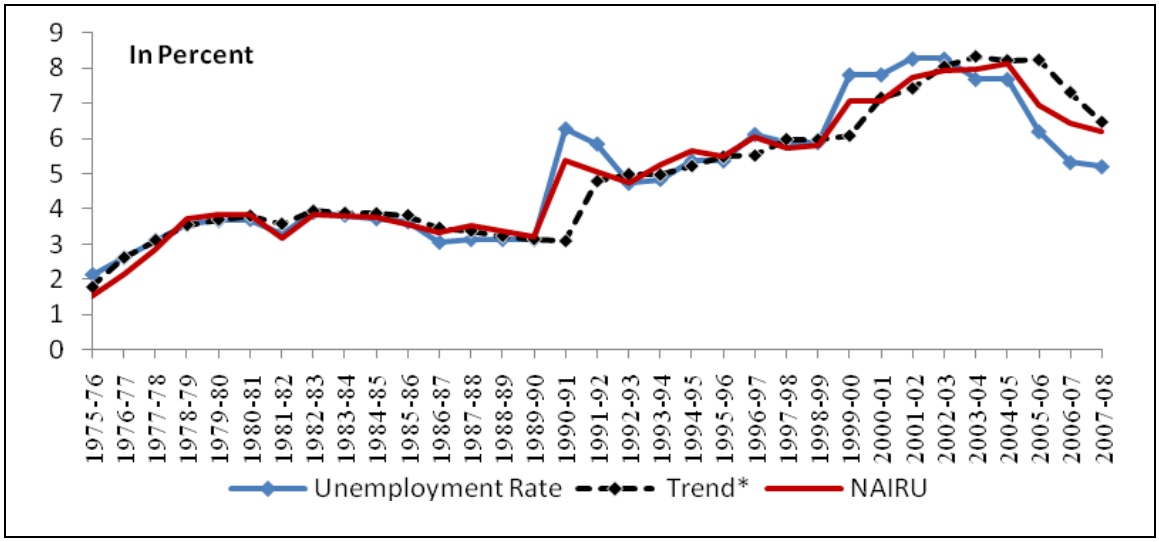
Note: * mean significant at 1 percent level of significance.

Following General to Specific approach, only significant variables and lag lengths are included and reported in this study leaving us with two lags of inflation that are significant. Oil prices turned out to be significant only with one lag. The estimated coefficient on unemployment gap is -0.59 exhibiting that an increase in unemployment gap by 1 percent causes inflation to decrease by 0.59 percent. The relationship between the unemployment gaps and past changes in inflation is statistically significant. Oil prices shock contributes to inflation positively and n increase in oil prices by 1 percent causes inflation to increase by 0.03 percent.

The TV-NAIRU for Pakistan registers mixed trend evident from Figure 2 wherein actual unemployment rate together with the estimated TV-NAIRU is reported. TV-NAIRU increased during 1975-76 to 1979-80 except 1978-79 while a declining trend is documented for 1980s. Again, in 1990-91, it increased from 3.21 percent to 5.37 percent. Actual unemployment rate registered an increase from 3.13 percent to 6.28 percent for the same time period. In 1991-92 and 1992-93 actual unemployment rate decreased to 5.85 and 4.73 percent respectively followed by similar trends for TV-NAIRU. The decrease in unemployment rate can be attributed to the general expansion of the economy and in particular the specific employment generation schemes such as National Self-employment Scheme and Youth Investment Promotion Society (YIPS). Notably TV-NAIRU increased from 5.3 percent in 1990-91 to 8.12 percent in 2003-04. The unemployment rate increased to 8.3 percent in 2001-02 while it declined from 8.3 percent in 2001-02 to 7.7 percent in 2003-04, due to, mainly, to steeper decline in women's unemployment. In recent years there has been a downward trend in the TV-NAIRU from 8.12 percent in the 2004-05 to current estimates of 6.17 percent. The overall unemployment rate is also on the decline from 2005-06 majorly due to a visible decline in unemployment in the rural regions. This decline can also safely be attributed to numerous reasons, a flourishing economy being one of them. The estimate for the TV-NAIRU from the time period 2003-

04 to 2007-08 was above the actual unemployment rate, suggesting that Pakistan's labor market situation most likely fuelled a rise in the inflation rate.

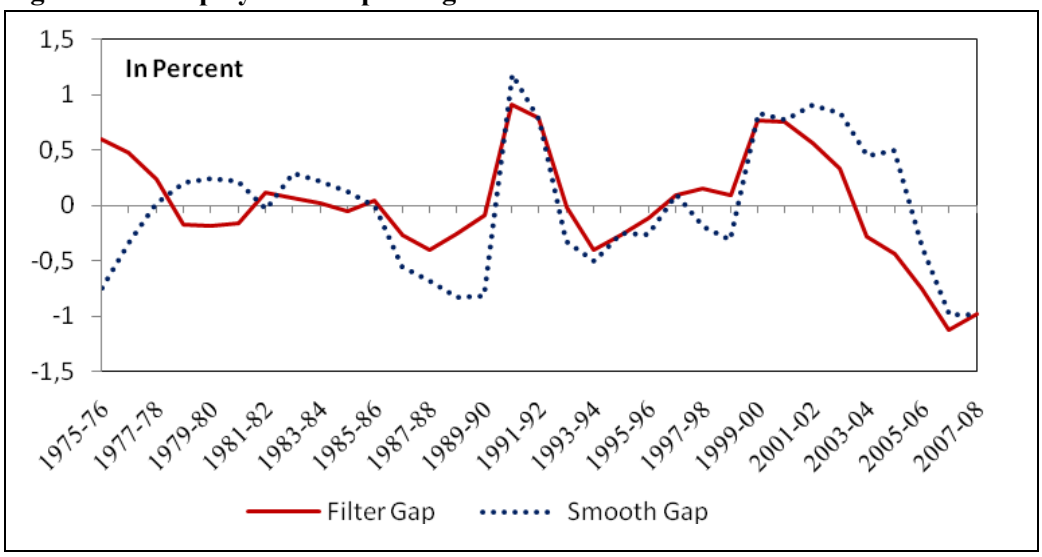
Figure 2. Actual Unemployment Rate and NAIRU Using Kalman Filter



1/ Trend* is a first step Kalman decomposition results.

Figure 3 (below) shows that the unemployment gap estimates obtained in the second step was positive between 1975-76 and 1977-78, in 1981-82 and 1983-84, in 1985-86 respectively. It is also positive between 1984-85 and 1988-89, 1990-91 and 1991-92, 1996-97 and 2002-03. The negative unemployment gap is documented for 1978-79, 1980-81, and 1984-85. Similar results are found for recent times as is evident from estimates between 2003-04 and 2007-08. Time periods 1990-91, 1999-00, 2006-07 and 2007-08 put evidence for the wider unemployment gaps of 0.9, 0.77, -1.1 and -0.97 percent respectively. In 1990-91, the Labor Force Survey revised definition of unemployment as mentioned earlier. Partly because of this and also due to global recession, the unemployment gap increased in 2000-01. The gap appears to have hit a bottom during current downturn driven by global financial crises.

Figure 3. Unemployment Gap Using Kalman Filter



6. Concluding Remarks

The study estimates Pakistan's time varying NAIRU for period ranging from 1973-74 to 2007-08. By any measure the NAIRU is very hard to determine because it is an unobservable variable. We provide estimates of a time–varying NAIRU based on the Kalman Filter. The application of the Kalman filter for the assumption of a time-varying NAIRU the unemployment rate is first assumed to be described by the sum of a trend and a cyclical component [Denis et al. (2002), Horn et al. (2007), Epstein and Macchiarelli (2010)]. The trend component is regarded as a benchmark for the equilibrium unemployment rate, while the cyclical component as a reference for the unemployment gap. In the second step, a standard Philips curve relationship is applied to help model the cyclical component. The estimates presented in this study suggest that the TV-NAIRU in Pakistan is currently around 6.7 percent. According to these estimates, it reached to a peak in 2004-05 gaining a value as high as 8.12 percent and tends to decline through the 2007-08. The estimate for the TV-NAIRU from the time period 2004-05 to 2007-08 is above the actual unemployment rate, suggesting that Pakistan's labor market situation most likely fuelled a rise in the inflation rate and the findings are in concurrence with Mehihovs and Zasova (2009). The results of this study indicate that the TV-NAIRU is a relevant concept and the unemployment gap should be one of the factors considered when assessing inflationary pressure [Szeto and Guy (2004)]. One would further need to look TV-NAIRU for other price indices and the economic determinants of the NAIRU.

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