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Stability of Phillips Curve: Rolling Window Analysis in the Case of Pakistan

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Abstract: This study employs JJ cointegration approach, vector error correction model and rolling window regression method to analysize the Phillip's curve hypothesis in the case of Pakistan. The estimation results confirm cointegration between inflation rate and unemployment rate. But the rolling window regression result guides further in the period of 1981 to 1983, 1987, 1991 to 1996 and 2009 the Phillips curve hypothesis unstable in the case of Pakistan.

JEL Codes: E_{31} · E_{24}
Key words: Inflation · Unemployment rate

INTRODUCTION

Fisher [1] suggested that inflation causes to unemployment and also inflation related to the low level of unemployment. Phillip's [2] empirically found reverse causation in the fisher [1] estimation from unemployment to inflation. With the help of these findings the economists modified the theory of tradeoff between inflation and unemployment which is famous in the name of Phillips curve theory. This theory has widely criticized by the researcher. Lucas [3] confirmed the instability of Phillips hypothesis because the government policies have changing with time according to the economic condition. So the forecasted inflation from Phillips curve is use less. While Phillips curve theory criticizes in the literature on the basis of assumptions but it remains as a most important theory of macroeconomics. Moreover with theoretical significance it works as a vital tool for policy makers in the formation of monetary policy (see, Furuoka, [4]). Thus this study aims to explore the stability of Phillips curve by using the JJ cointegration approach, vector error correction model and rolling window estimation method. Remaining part of paper is organized as follows; section- B briefly discusses review of literature. Section-C explains estimation tools; section-D presents estimation results and final section-E summary of results.

Literature Review: Empirical literature shows ambiguous explanation between the association of inflation and unemployment. In literature two sets of study are available, first those who confirmed the stability of Phillips curve hypothesis and other proved un-stability of Phillips curve hypothesis.

Inverse relationship between the unemployment rate and wage inflation was reported by the Lipsey [5] and also suggested this relationship never holds in the period of after War (1914-1918). Samuelson and Solow [6] observed the tradeoff between inflation and unemployment in the case of USA. They found inverse relationship between inflation and unemployment. Atkeson and Ohanian [7] suggested tradeoff between inflation and unemployment exists only in the short run. The Phillips curve tradeoff hypothesis is rejected by Niskanen [8]. He concluded positively sloped Phillips curve and provided following reason, "*inflation will increase the effective tax rate, particularity on the income from capital and eventually reduced the output and increased the unemployment rate*". In the industrial economies tradeoff hypothesis was tested by Reichel [9] and concluded that cointegration relationship exists in the case of Japan and USA. But tradeoff between inflation and unemployment exist only in the case of USA.

Conversely stability of Phillips curve hypothesis confirmed by the Furher [10] in the case of USA. Malinov and Sommers [11] used the data of nineteen OECD to investigate the Phillips hypothesis and concluded stability of Phillips curve hypothesis in the case of seventeen OECD countries. Further in the case of USA, stability of Phillips curve confirmed by Ewing and

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Seyfried [12]. They concluded on the basis of CUSUM squares test. Bhanthumnavin [13] confirmed Phillips curve stability at the time of Asian Financial Crisis by using output gaps and imported price inflation in the case of Thailand. Tang and Lean [14] investigated the Phillips curve hypothesis in the case of Malaysia by using the data 1971-2004. They suggested the tradeoff between inflation and unemployment both in the short run and long run.

Data and Estimation Tools: This study is used JJ-cointegration approach, vector error correction model and rolling window regression method to investigate the stability of Phillip curve hypothesis in the case of Pakistan by using the data 1971-2009. The Phillips curve hypothesis is estimated by using following equation.

$$LIN = \beta_0 + \beta_1 LU + \mu_t \quad (1)$$

We can rewrite eq-1 as

$$LU = \alpha_0 + \alpha_1 LIN + \quad (2)$$

Where:

β_0, α_0, β_1 and α_1 confer respectively constant and slope coefficients. IN is representing the inflation rate and U is representing the unemployment rate. L is representing the sign of natural logarithms. Data of both variables inflation rate and unemployment rate has taken from State Bank of Pakistan.

In order to investigate the order of integration this study employs relatively new unit root test i.e. Ng-Perron [15] unit root test. This unit root test provides us reliable results in the case of small samples. This is based on four test statistics i.e. modified forms of Phillips and Perron Z_α and Z_t statistics, the Bhargava [16] R_1 statistic and the ERS point optimal statistic.

We write modified statistics as follows:

$$Mz_\alpha^d = (T_1 Z_T^d)^2 - f_0)/2k$$

$$Mz_t^d = MZ_\alpha \times MSB$$

$$MSB_d = (k/f_0)^{1/2}$$

$$MP_T^d = (\bar{c}^2 k - \bar{c} T^1)(y^d T)^2 / f_0 \quad \text{if} \quad x_t = \{1\}$$

$$MP_T^d = (\bar{c}^2 k + (1-\bar{c}) T^1)(y^d T)^2 / f_0 \quad \text{if} \quad x_t = \{1\}$$

Where:

$$k = \sum_{t-2}^{T} (y_{t-1}^d)^2 / T^2$$

$$\bar{c} = -7 \quad \text{if} \quad x_t = \{1\}$$

$$\bar{c} = -13.5 \quad \text{if} \quad x_t = \{1, t\}$$

Like other unit root test the null hypothesis of unit root can be rejected if the test statistic is higher than the critical value. When the order of integration confirmed by Ng-Perron unit root test, next we determine long run relationship by using the the Johansen [17,18] cointegration test. This cointegration approach has based on λ_{trace} and λ_{max} statistics. The first 'Trace test' cointegration rank r proposed by Johansen is as follows.

$$\lambda_{trac} = -T \sum_{j=r+1}^{n} In(1 - \hat{\lambda}_j)$$

Second, λ_{max} maximum number of cointegrating vectors against $r+t$ presented in the following way.

$$\lambda_{max}(r, r+1) = -T \ \text{In}(1 - \hat{\lambda}_j)$$

Johansen has recognized λ_{trace} and λ_{max} critical values. If the λ_{trace} and λ_{max} results show the different cointegration vector, then the result of λ_{trace} has robust for inference (see, Johansen [19]). Thus this study is used the λ_{trace} to estimated the long run relationship among the variables.

Estimation Results: Table 2 show the Ng-Perror's unit root test results. The results confirm that both variable i.e. inflation rate and unemployment rate non stationary at level but stationary at first difference. Thus we conclude that both variables are integrated order one or I(1).

Now we further apply the JJ cointegration method to investigate the long run relationship between the inflation rate and unemployment rate. The results (Table 3) demonstrate that there are two cointegrating vector. Thus it means that long run relationship exists and '*both variables are cointegrated in the long run'*.

Table 4 represents the result of vector error correction model. When the inflation rate (LIN) is dependent variable the error correction term is significant and negative sign. This indicates that 54% short run variability in inflation rate due to unemployment rate adjusted every year in the long run. On the other hand when unemployment rate is dependent variable the error correction term (statistically significant) shows 8% short run discrepancy in unemployment rate due to the variability in prices (inflation rate) is adjusted every year.

Table 1: Descriptive Statistic and Correlation Matrix

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. Dev.*	*Correlation Matrix*		*Observations*
LIN	2.05	2.06	3.29	1.07	0.55	1	-0.34	39
LU	1.44	1.37	2.12	0.54	0.48	-0.34	1	39

Table 2: Unit Root Test Results

	MZa	*MZt*	*MSB*	*MPT*
LIN	-10.23	-2.12	0.20	9.51
LU	-10.38	-2.23	0.21	8.96
Δ*LIN*	-19.52**	-3.02	0.16	5.34
Δ*LU*	-19.13**	-3.01	0.15	5.31

Note: **: 5% Level of Significance

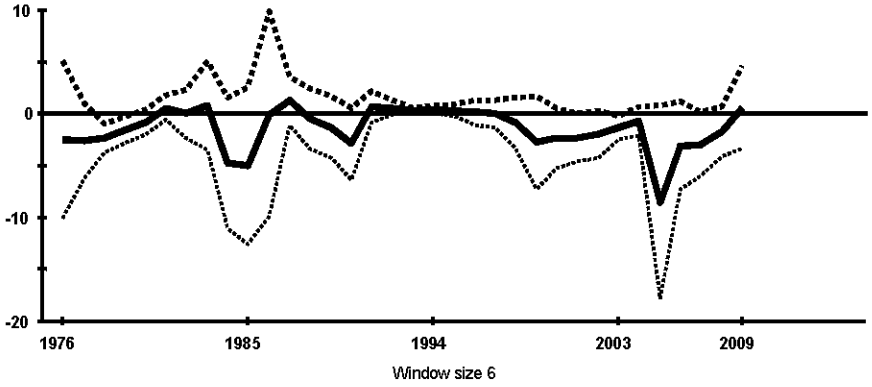

Fig. 1: Coefficient of LU and its two*S.E. bands based on rolling OLS (Dependent Variable: LIN; Total no. of Regressors: 2)

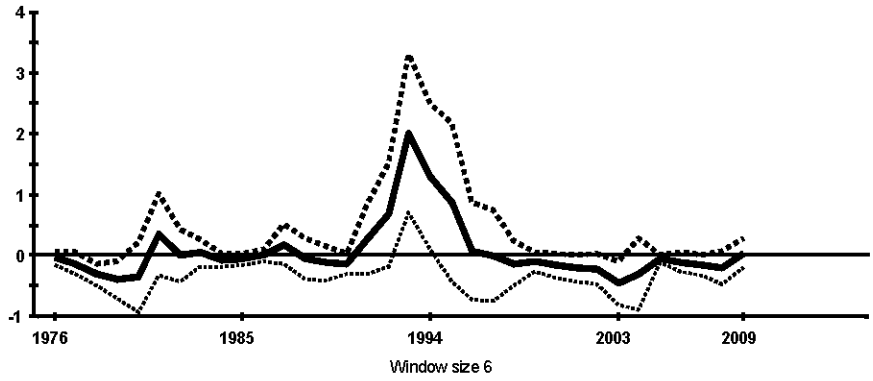

Fig. 2: Coefficient of LIN and its two*S.E. bands based on rolling OLS (Dependent Variable: LU; Total no. of Regressors: 2)

Table 3: Results of JJ Cointegration Method

Hypothesized	Trace Statistic	10% Critical Value	Prob.
None *	21.92	16.17	0.02
At most 1 *	6.99	2.71	0.01

Table 4: Results of Vector Error correction

Error Correction:	D(LIN)	D(LU)
	-0.54	-0.08
	[-3.62]	[-1.64]

Rolling Window Regression Results: This study is also used the rolling window estimation approach in order to determine the tradeoff between the inflation and unemployment in the case of Pakistan. The main advantage of rolling regression approach i.e. we can estimate the coefficient of each observation over the sample. Fig. 1 and Fig. 2 represents the graph of coefficients of unemployment rate (when inflation rate is

dependent variable) and coefficients of inflation rate (when unemployment rate is dependent variable). The graphs of coefficients are suggested that from 1981 to 1983, 1987, 1991 to 1996 and 2009, the inflation rate and unemployment rate are positively correlated. It means that inflation increases unemployment rate and conversely the unemployment rate also increase the inflation rate in the case of Pakistan. Thus we concluded that in these eleven years the Phillips curve hypothesis unstable and in the remaining years Phillips curve hypothesis is stable.

E-SUMMARY

The Phillip curve hypothesis is tested in this study by using the annual data of 1971 to 2009 for Pakistan economy. This study utilizes robust cointegration methods i.e. JJ cointegration, vector error correction model and rolling window regression method for empirical evidence. The results of JJ cointegration suggest long run relationship between inflation rate and unemployment rate and vector error correction model suggests that inflation rate is adjusted more quickly as compare to unemployment rate from short run disequilibrium to long run equilibrium. Further rolling regression results are guided that the period of 1981 to 1983, 1987, 1991 to 1996 and 2009 the Phillips curve hypothesis unstable in the case of Pakistan.

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Appendix: A

	LIN=F(LU)	LU=F(LIN)		LIN=F(LU)	LU=F(LIN)
Year	Coefficient of LU	Coefficient of LIN	Year	Coefficient of LU	Coefficient of LIN
1976	-2.44336	-2.44336	1997	-0.01564	-0.00865
1977	-2.58604	-2.58604	1998	-0.89196	-0.13547
1978	-2.37819	-2.37819	1999	-2.78758	-0.10153
1979	-1.59704	-1.59704	2000	-2.34912	-0.16908
1980	-0.7795	-0.7795	2001	-2.32453	-0.21211
1981	0.59842	0.59842	2002	-2.00391	-0.22099
1982	0.02095	0.02095	2003	-1.35375	-0.44874
1983	0.77788	0.77788	2004	-0.70115	-0.30321
1984	-4.77677	-4.77677	2005	-8.50503	-0.05359
1985	-4.99892	-4.99892	2006	-3.06101	-0.11199
1986	-0.02635	-0.02635	2007	-2.93671	-0.16044
1987	1.29177	1.29177	2008	-1.71623	-0.19771
1988	-0.42913	-0.42913	2009	0.60811	0.03869
1989	-1.31416	-1.31416			
1990	-2.89511	-2.89511			
1991	0.65121	0.65121			
1992	0.57428	0.57428			
1993	0.3504	0.3504			
1994	0.41749	0.41749			
1995	0.3548	0.3548			
1996	0.10616	0.10616			