Trade-off between Inflation, Interest and Unemployment Rate of Pakistan: A Cointegration Analysis

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Abstract

Pakistan is one of the developing countries in Asia. Destabilized economy is one of the major hurdles in the progress of Pakistan while inflation, interest and unemployment rates are three major indicators for destabilization. Purpose of the study is to investigate the link between these major economic variables that have great affect on the economic structure. Johansen's Cointegration test and Vector Error Correction Model (VECM) have been employed to find out the long run relationship between variables. Furthermore, Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) have been estimated. The results of the study indicate that inflation, interest and unemployment rates are cointegrated. It is found that interest and unemployment rates are both negatively related to the rate of inflation in the economy. But the rate of unemployment does not depend on inflation rate and interest rate.

Keywords: Cointegration; Vector Error Correction Model (VECM); Impulse Response Function (IRF); Forecast Error Variance Decomposition (FEVD).

1. Introduction

Inflation, interest and unemployment rates are important meters of an economy. Inflation is a situation in an economy where the demand of money is fewer than its supply. Inflation reduces the value of money and other monetary items. Inflation is a situation when due to high prices, power of common men to purchase something decreases with the lowering value of currency. People then purchase fewer goods or in other word, inflation reduces the purchasing power of an individual. Low purchasing power can also be thought as an individual has low income for his expenditures. So whenever there is high rate of unemployment in an economy, people will have less money to spend. When

goods in the market remain unsold then producer will try to sale his goods at low prices. Hence, reduction in the price level due to high rate of unemployment will consequently reduces the rate of inflation in the economy. Economic theories like Philips curve suggest negative relation between inflation and unemployment rates. Inflation is important in an economy because it allows adjustment in interest rate and encourages investors to invest on capital projects. Interest rate is the amount which a borrower has to pay to the lender for using his asset or bank pay on the saving certificates etc. Interest rate plays an important function in the economy. It directly influences the consumer's behavior. It means that interest rate can affect the savings and consumption. Economist used interest rate to control the rate of inflation. In case of high interest rates the consumer will try to save more money so that they can get heavy returns rather than purchasing goods and services. Hence high interest rates cause lowering the price levels (inflation). Interest rate may be a cause to induce or reduce the rate of unemployment. It also affects the investment in the economy and capability to provide loans so that unemployed persons in economy are able to run their own businesses.

Investigation of the relationship between aforementioned time series variables has been carried out. Johansen's approach to vector auto regression also known as VECM is employed. Johansen cointegration approach is used to estimate vector error correction model when there are more than two endogenous variables. It is a system of VAR models with more than two cointegrated variables.

2. Review of Related Literature

Khan and Qasim (1996) estimate error correction model for three types of inflation (overall, food and non-food) and provides that money supply and gross domestic product (GDP) are important factors for inflation rate. Stock and Watson (2001) fit VAR model using inflation, interest and unemployment rate of US. They suggest that there is one-way causality between inflation and interest rate while inflation is only predicted by unemployment and unemployment is caused by interest rate. Malik and Chowdhury (2001) build error correction model to determine the relationship between inflation and growth rate. Study reports that there is positive relationship between inflation and growth rate of Pakistan. Chaudhry and Choudhary (2005) examine the determinants of price levels and growth production for Pakistan and find that monetary factors don't affect price level but the import prices. Hondroyiannis (2006) study the determinants of aggregative private savings in European countries. Khan and Schimmelpfennig (2006) build a vector error correction model to investigate whether inflation in Pakistan is due to wheat prices or by monetary factors. Results suggest that wheat prices have short term effects on inflation while monetary factors have long term effects on inflation rate of Pakistan. Ribba (2006) interprets minute co-movements between inflation and unemployment of the US economy. Benati and Vitale (2007) estimate natural interest and unemployment rate potential output and likely inflation rate for the European countries. Rafiq et al. (2008) find that inflation is inversely related with the unemployment rate of Pakistan. Subhan and Hayat (2009) determine the impact of instable prices on unemployment and economic growth of Pakistan. They found that instable prices negatively influence unemployment and growth rate of Pakistan. Hussain (2009) estimates VECM to study the effect of monetary policy channels on the real GDP and inflation rate of Pakistan. He observes that exchange rate channel is the most powerful channel. Al-Fayoumi (2009) applies VECM to study the long term relationship. Chen et

al. (2010) shows that interest rate plays important role in explaining the relationship between inflation and unemployment rate. Chaudhery et al. (2011) fit auto regressive distributed lag model using GDP deflator (inflation) and foreign exchange reserves of Pakistan. They suggest that foreign exchange reserves negatively influence the GDP deflator even if the change is very small. Aurangzeb and Haq (2012) study determinants of inflation in Pakistan taking many other economic variables. They suggest that GDP has negative impact on inflation and government borrowing is a major cause of high price levels. Shahbaz (2012) focuses on the issue of multivariate granger causality between CO_2 emission, energy intensity and economic growth in Portugal.

The purpose of this article is to see whether there is any causal relationship between inflation, interest and unemployment rate of Pakistan. If degree of relationship exists then the purpose is to explore the nature of that relationship, forecasting these variables and the co-movement of these three variables especially in economy of Pakistan. The major contribution of this work is that this study is intended to estimate the long run relationship between these three economic indicators of Pakistan with the short term dynamics and their co-movements which is not discussed earlier in any research on the economy of Pakistan. It is also of interest that this study deals with VECM having non-normal residuals.

 The rest of the paper is ordered as the research methodology is revisited in section 3. The data analysis and discussion are reported in section 4. The concluding remarks are given in the last section.

3. Research Methodology

Every research is intended to meet some goals and based on some hypothesis to be verified so that one may conclude the real existence of that particular hypothesis. This research is also conducted to verify some hypothesis.

Objectives and hypotheses of this research article are illustrated below:

1. Investigating the causal relationship between inflation, interest and unemployment rate of Pakistan
2. Capturing and investigating the nature of relationship
3. Testing the variables for possible cointegration
4. Fitting and forecasting the above mentioned variables

Johansen's Cointegration approach is a multivariate approach that can be used when there are more than two endogenous variables in the model. Asteriou (2006) discussed a model with three endogenous variables and one lag of each variable.

$$\begin{pmatrix} \Delta Y_t \\ \Delta X_t \\ \Delta Z_t \end{pmatrix} = \Gamma_1 \begin{pmatrix} \Delta Y_{t-1} \\ \Delta X_{t-1} \\ \Delta Z_{t-1} \end{pmatrix} + \begin{pmatrix} a_{11} & a_{21} \\ a_{21} & a_{22} \\ a_{31} & a_{23} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ Z_{t-1} \end{pmatrix} + e_t$$

Where $\begin{pmatrix} a_{11} & a_{21} \\ a_{21} & a_{22} \\ a_{31} & a_{23} \end{pmatrix}$ is the matrix of coefficients that measures the speed of adjustment

of equilibrium, and $\begin{pmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{pmatrix}$ is the matrix of coefficients that measures the

long-run relationship. So we can rewrite the model as

$$\begin{pmatrix} \Delta Y_t \\ \Delta X_t \\ \Delta Z_t \end{pmatrix} = \Gamma_1 \begin{pmatrix} \Delta Y_{t-1} \\ \Delta X_{t-1} \\ \Delta Z_{t-1} \end{pmatrix} + \Pi \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ Z_{t-1} \end{pmatrix} + e_t$$

Where

$$\Pi = \alpha' \beta \quad \alpha' = \begin{pmatrix} a_{11} & a_{21} \\ a_{21} & a_{22} \\ a_{31} & a_{23} \end{pmatrix}, \quad \beta = \begin{pmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{pmatrix}$$

An important point here is that, if we have 'N' variables then there will be $N-1$ cointegrating vectors. If $N = 2$ then there exists a unique cointegrating vector. If $N > 2$ and even then there exist only one cointegrating relationship (a special case), then we can assume that some of the variables treated as endogenous, are weakly exogenous. In this situation results provided by univariate Cointegration approach are same like multivariate approach [for more details, reader may refer to Asteriou, 2006].

There are six steps in Johansen's Cointegration approach. Firstly determine the integrated order, secondly identifying the lag length. Thirdly decision of the deterministic component, fourthly decide the rank of Π matrix and then deciding the number of Cointegration equations using Maximum Eigen value and Trace test (see for example, Johansen and Juselius (1990)). After identifying the number of equations we check the variables for "weak exogeneity". Lastly, using Johansen's cointegration test we can impose restrictions for policy implications (see for example, Asteriou, 2006).

To interpret the coefficients of VAR model it is recommended to estimate the IRF and FEVD. It is the decomposition of the forecast error variance. The variance decomposition identifies, how much each variable help to determine the other variable in the VAR process. According to Gujarati (2003), "IRF is a function which measures the change in the current and future period of all endogenous variables of VAR due to a small change in the residuals"

Stationarity of residuals, constant variance, residuals should not be serially correlated and normality of residuals are the adequacy checks for the vector error correction model and can be ensured as discussed by Asteriou (2006).

4. Data Analysis and Discussion

To investigate the relationship among inflation, interest and unemployment rate of Pakistan, real time series data have been taken on quarterly basis from Pakistan Bureau of Statistics. Data covered the range from 1992-Q_1 to 2011-Q_3, a total of 79 observations. Results on the basis of ADF test for the null hypothesis that series is not stationary is

presented in table 1. It suggests that all of the aforementioned series are stationary at first difference i.e. $I(1)$.

Table 1: Output of the ADF test

Time series variables	P-values of ADF test	
	Level	First difference
Inflation rate	0.5647	0.000
Interest rate	0.7131	0.000
Unemployment rate	0.5729	0.000

Secondly to check the appropriate lag length; an unrestricted VAR model has been estimated and the optimal lag length provided that 4th lag is optimum as majority criterions supports 4th lag.

Table 2: Optimal lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-88.42654	NA	0.002637	2.575395	2.671002*	2.613415*
1	-88.42600	0.001003	0.003399	2.828902	3.211326	2.980980
2	-88.42547	0.000966	0.004386	3.082408	3.751651	3.348544
3	-88.42483	0.001099	0.005673	3.335911	4.291973	3.716106
4	-44.56393	71.66005*	0.002139*	2.353914*	3.596794	2.848168
5	-44.55920	0.007332	0.002787	2.607301	4.137001	3.215614
6	-44.55436	0.007098	0.003651	2.860686	4.677204	3.583058
7	-44.55062	0.005159	0.004813	3.114102	5.217438	3.950532

*Indicates lag order selected by the criterion
LR: Sequential modified LR test statistic (at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

After selecting appropriate number of lags, Johansen Cointegration test has been applied. Johansen Cointegration test declared that there is only one Cointegration equation (on the basis of p-values 0.0003 and 0.0001 of Maximum Eigen Value and Trace Test) in the model and no trend but an intercept term should be included in Cointegration equation. The estimates of VECM with one Cointegration equation are illustrated here.

$$inf_{t-1} = 5.443317 - 0.090621 int_{t-1} - 0.574127 unemp_{t-1}$$
$$t \quad = -5.7387 \quad 3.0519 \quad 5.4065$$

The coefficients in Cointegration equation of rate of interest, unemployment are significantly different from zero as their t-values are greater than ± 2 hence there is significant Cointegration between inflation, interest and unemployment rate of Pakistan. Furthermore the negative values of the coefficients of interest and unemployment rate of Pakistan indicates that interest and unemployment rate have negative impact on inflation

rate of Pakistan in the long run i.e., a unit change in interest and unemployment rate of Pakistan causes a negative change in rate of inflation. It means that rate of inflation decreases with an increase in unemployment rate. When unemployment increases in an economy, income level of household decreases then ultimately household's strength of buying goods and services will be reduced. Therefore, low purchasing power causes the inflation rate to fall. When interest rate rises, people try to reduce their consumption so that they can earn more profit on their savings; hence the price level of goods and services will fall. Results obtained from $VECM$ are summarized below that contains only significant terms:

$$\Delta inf_t = -0.479979\Delta inf_{t-4} - 0.268892\Delta unemp_{t-4} - 0.1516\hat{e}_{t-1}$$
$$t = \qquad -5.3637 \qquad\qquad -4.0503 \qquad\qquad -2.1271$$
$$\Delta int_t = 1.6397\Delta inf_{t-4} + 0.410576\Delta int_{t-4} + 0.844346\Delta unemp_{t-4}$$
$$- 0.5829\hat{e}_{t-1}$$
$$t = \quad 3.5069 \qquad\qquad 3.5702 \qquad\qquad\qquad 2.4341 \qquad\qquad -1.5655$$

Since the rate of unemployment does not contain any significant variables except the past values of unemployment at 4th lag, therefore it can be considered that the rate of unemployment is weakly exogenous variable. Therefore it is removed from the left hand side of the system of equations of Vector Error Correction Model.

Significant coefficients of independent variables in a Vector Error Correction Model show that there is short run relationship between the variables where the long run relationship is described by the error correction term i.e. $\hat{e}_{t-1}$ in the model. Hussain (2009) described if the coefficient of $\hat{e}_{t-1}$ is negative it implies that the long run relationship among the variables is stable. It is observed the negative value of coefficient of error correction and it is significant only in one equation (inflation equation). It implies one way causal relationship between inflation and interest rate. The results of $VECM$ declares that inflation causes interest rate but interest rate does not cause inflation rate, which confirm one way causality.

By the ADF test of residuals obtained from VECM it is found that residuals are stationary i.e. $I(0)$, it means that residuals are stationary at level.

Table 3: Output of the Augmented Dickey Fuller test

ADF test statistic	T-statistic	p-value*
	-9.392635	0.0000
Test critical values 1%level	-3.521579	
5% level	-2.901217	
10% level	-2.587981	

*Mackinnon (1996) one-sided p-values

Hence inflation, interest and unemployment rate are cointegrated. Another important assumption for $VECM$ is the residuals should be homoscedastic. To detect the homoscedasticity of residuals, White's General test for heteroscedasticity is applied. The p-value of White test 0.2062 suggested that the residuals of VECM are homoscedastic.

To test whether there is autocorrelation in the residuals or not the autocorrelation test is employed. Results obtained from Q-test provide evidence in the favor of null hypothesis we may conclude that residuals are independent (Table 4).

Table 4: Q-test for Autocorrelation

Lags	Q-stat	P-value	Adj Q-stat	P-value	Df
1	0.876088	NA*	0.88809	NA*	NA*
2	1.966351	NA*	2.008638	NA*	NA*
3	3.402458	NA*	3.505425	NA*	NA*
4	19.61125	NA*	20.64043	NA*	NA*
5	20.34740	0.2050	21.42993	0.1626	16
6	20.94260	0.6958	22.07765	0.6313	25
7	21.43717	0.9537	22.62388	0.9318	34
8	54.56856	0.1111	59.77120	0.0459	43
9	55.22716	0.3537	60.52099	0.1953	52
10	55.86631	0.6619	61.26001	0.4666	61
11	56.5595	0.8782	62.01134	0.7408	70
12	80.64542	0.4274	90.82296	0.1711	79

*The test is valid for lags larger than the VAR lag order

After establishing a statistical model we further have to check whether the residuals are normally distributed or not. Hence to proceed further the normality test of residuals is performed using Jarque-Bera test. P-value (0.000) of Jarque- Bera test declares that residuals are not normally distributed. Silvapulle and Podivinsky (2000) proved that in the Johansen Cointegration approach to VAR model, estimated results are robust for the case in which residuals are not belonging to Gaussian distribution even when the sample size is small.

For the interpretation of the VAR model and how well the model is for forecasting purpose, IRF and FEVD has been used (See Figure-1 and Figure-2). Variance decomposition is the decomposition of forecast error. IRF and FEVD both are the measures of forecasting in VAR. These functions can be used in interpreting VAR models.

Response to Cholesky One S.D. Innovations ± 2 S.E.
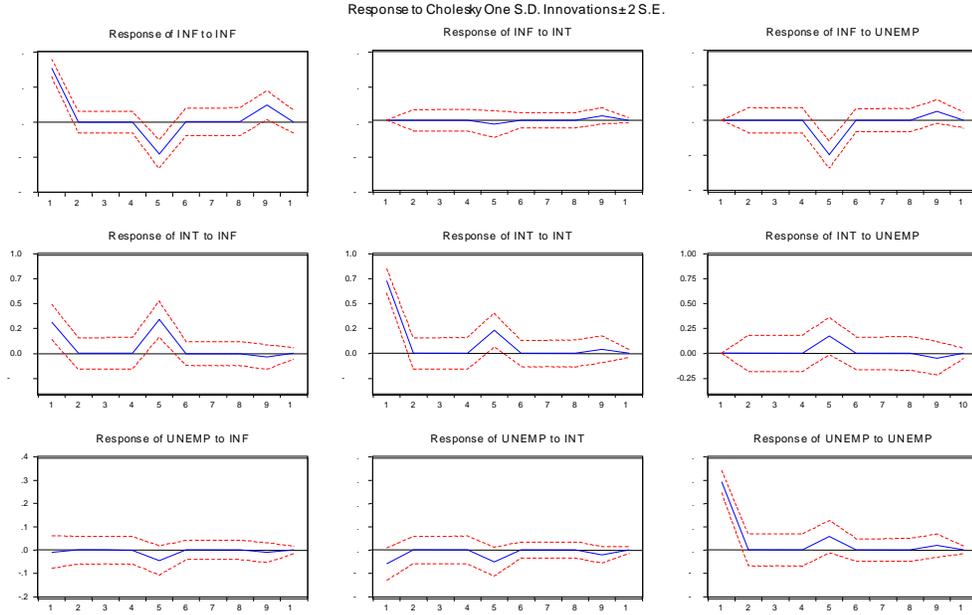
Figure-1: Impulse Response Function

Impulse response function of the estimated VAR model is given below. The response function presents the response of inflation, unemployment and interest to each other. The multiple graphs show that almost all variables are responding to each other. It is actually the response of present value to the future value of one of the endogenous variables in the VAR to the rest of variables. By examining the following figure we can check whether a variable gives response to other variables or not. It can be seen that the inflation to interest rate is very small while the response of inflation to unemployment is considerably good enough. On the other hand, interest rate gives response to both inflation and unemployment. Interest rate shows high response to inflation than to unemployment. Rate of unemployment also gives little response to both inflation and interest rate.

Forecast error variance decomposition also known as variance decomposition illustrates that to what extent percentage of the variance of one variable in VAR is explained by the other variable.

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Variance Decomposition
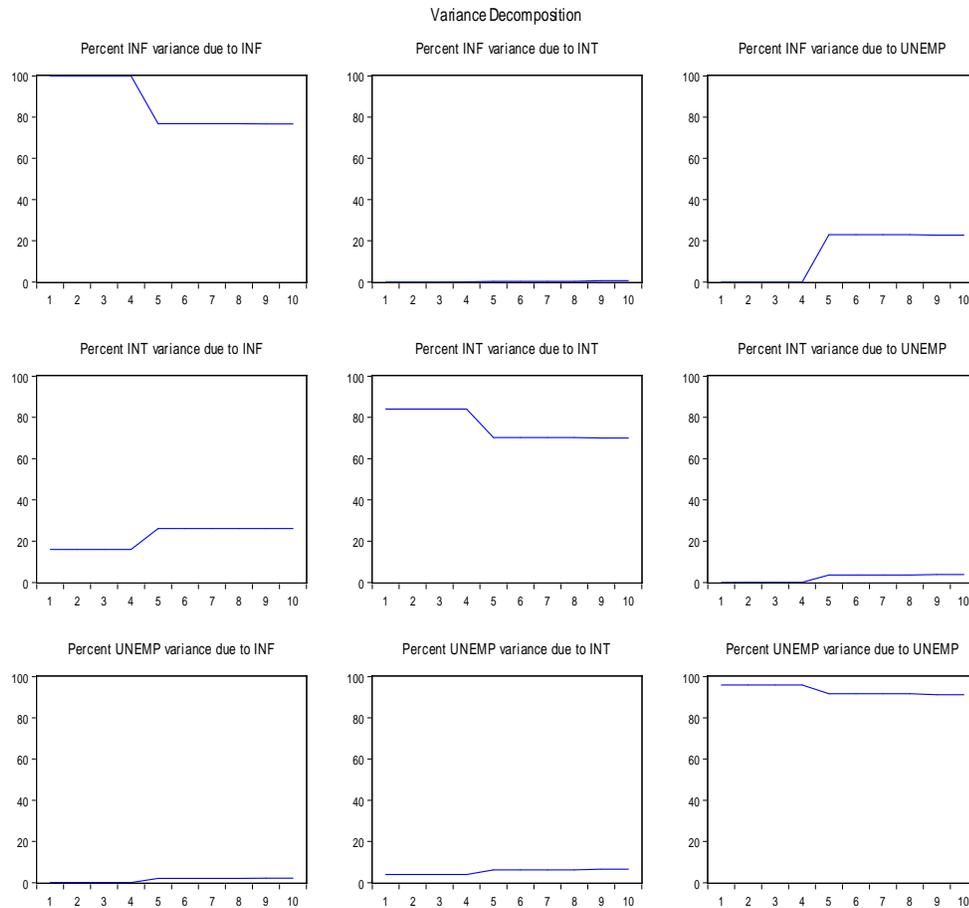
Figure 2: Variance Decomposition

Here we can see that the graph shown in figure 2 indicates that almost 80% variance of inflation is explained by the inflation and rest of the 20% is divided between interest and unemployment. Interest rate does not help to explain the variance of inflation rate but 20% variance of inflation is explained by unemployment. 18% to 20 % forecast error variance of interest rate is explained by inflation rate and 5% to 8% by rate of unemployment. Rest of the variance i.e. 70% to 80 % is explained by the past values of interest rate. 1% to 2% variation in forecast error variance of unemployment is explained by inflation rate and hardly 8% to 10% variance of unemployment is explained by interest rate. A large fraction of forecast variance is explained by the rate of unemployment i.e. 85% to 90%.

5. Conclusion

In Cointegration equation, Inflation is the function of interest and unemployment rate. Both of the variables in the equation are significantly different from zero. Interest and unemployment rate both are negatively associated with inflation. Coefficient of the interest rate in the Cointegration equation is -0.10. It indicates that one unit change in interest rate will cause an inverse change in the value of inflation rate. If interest rate

increases by one unit, then value of inflation will decrease by 0.10 units. Similarly, if interest decreases by one unit, it will increase the value of Inflation by 0.10 units. The unemployment rate in the Cointegration equation has a coefficient of -0.56. It shows that one unit increase in unemployment will result in decreasing the value of inflation by 0.56 units. Likewise, a one unit decrease in unemployment rate will cause to increase the value of inflation rate by 0.56 units. In the estimated $VECM$, equation for unemployment rate has only one significant variable, i.e. the fourth lag of unemployment. It means that unemployment in this study is the function of its past values only. Hence it can be considered that unemployment rate is weakly exogenous variable.

It can also be concluded from the equation of unemployment that in our study interest rate and inflation rate do not significantly influence the unemployment rate in Pakistan. Hence there may be other important variables like education and economic growth etc. that cause the rate of unemployment in Pakistan. Furthermore, inflation rate is determined by the past values of inflation and unemployment. While the interest rate is caused by the past values of interest rate, inflation rate and unemployment rate as well. In short, results of our study indicate that inflation rate is caused by its own past values and by rate of unemployment. On the hand, interest rate is caused by the past values of interest as well as by inflation rate and unemployment rate. Hence there is causality (one way) that runs from inflation to interest and from unemployment to interest and inflation as well. Hence, we can conclude that there is a significant tradeoff between Inflation, Interest and Unemployment rate of Pakistan in the long run.

Here are some suggestions from the conclusions of the research.

1. To control the shakiness of the Pakistan's economy, experts should try to maintain an equilibrium point between Inflation, Unemployment and Interest rate of Pakistan. Lack of concentration in determining any one of these variable can severely react to the economy.
2. Another suggestion is for the future researchers. One can investigate the long run impact of these variables along with the national population, literacy rate, economic growth rate and foreign exchange reserves with Inflation, Interest and Unemployment rate of Pakistan.

Results of this study are restricted, and can be implemented only for the economy of Pakistan.

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