

## **Determinants of Inflation in Case of Pakistan: A TVAR Analysis & Methods of Quran & Hadith**

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### **Abstract**

This study investigated the nonlinear dynamic relationship between inflation and its determinants by adopting threshold co integration and TVECM. It is found that there exists nonlinear long run relationship among variables. The variables used here are inflation, economic growth, money supply growth, government spending percentage of GDP and exchange rate. The time series data at annual frequency ranging from 1960-2015 is collected for all the variables. TVECM shows different speed of adjustment parameter values towards study state level. Nonlinear impulse response function shows different dynamics for high persistent regime as well as for low persistent regime. The nonlinear regression model is also interpreting different magnitude in different regimes.

**Keywords:** Inflation, Nonlinear, Determinants

### **Introduction**

Inflation is accorded as a continuous increase in the general price level. Inflation is highly important to check in the economy, government and central bank main target is to stabilize the inflation for the stability of other variables as well. As due to the fluctuations in price level all real variables are affected thus producing instability in the whole economy. A plenty of papers and discussions have been made to check inflation in case of Pakistan that are cited below, the main purpose of all those papers to model the inflation and its determinants through linearly using

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traditional ordinary least square method (OLS) and traditional Cointegration test like Johansen (1998) in case of Pakistan and ignored the nonlinearity in inflation. Hardly any study used to incorporate the nonlinear model properly because a plenty of studies show threshold level in inflation but still used linear model as well showing a negative relationship [see Naqvi and Khan (1989), Barro (1995), Khan and Gill (2010), Olatunji et al (2010)] and positive relationship [see Lim and Papi (1997), Kuijs (1998), Liu and Adedeji (2000), Laryea and Sumaila (2001), Abdullah and Khalim (2009) and Abidemi and Malik (2010)] between inflation and economic growth. Monetarist and structuralist put stressed over the importance of inflation as a vital component in for growth and related with different other variables such as exchange rate, population and government spending [(Malik and Chowdhry (2001) and Abidemi and Malik (2010)].

In setting of Pakistan, Naqvi and Khan (1989) guaranteed for single digit of expansion (6.5 to 7) for stable monetary development likewise there discovered negative connection amongst swelling and financial development and basically utilized the customary slightest square techniques (OLS). Malik and Chowdhury (2001) for South Asian district researched the connection amongst swelling and monetary development for short-run and long-keep running by applying board co integration test and asserted for positive relationship amongst expansion and financial development for Pakistan. Mubarik (2005) likewise examined an experimental time arrangement ponder and asserted that an edge level of swelling at 9 percent for the day and age 1973-2000 and utilized direct co integration test. Hussain (2005) asserted utilizing time arrangement information covering 1973-2005 in the event of Pakistan a limit level range from 4 to 6 percent. As before this range swelling may be break down the economy and he additionally utilized customary straight co integration procedures and comparative outcomes are accounted for by [see Khan et al (2007), Abdullah and Khalim (2009), Khan and Gill (2010)]. Assist Bashir et al (2011) additionally led an investigation keeping in mind the end goal to see the relationship of swelling and monetary development for time arrangement information for the time of 1972-2010. They utilized Johansen co

integration approach along vector mistake revision model and granger causality test. They guaranteed for the presence of a positive connection amongst expansion and monetary development if there should be an occurrence of Pakistan.

As Engle and Granger (1982) and Granger and Weiss (1983) first presented the idea of co integration for two factors and afterward progressed by Johansen (1991) and Juselius (1990) for more than two factors. The significant suspicion of their test is that disequilibrium advance toward long-run balance in each period. On inverse to it, Balke and Fomby (1997), Enders and Siklos (2001) and Hansen and Soe (2002) contemplated that such developments not really happen to each era but rather after a limit level and they presented the idea of edge cointegration and nonlinearity along edge mistake redress model and edge autoregressive model for the time arrangement information in which nonlinearity confirm.

If there should be an occurrence of Pakistan Mubarik (2005) and Hussain (2005) just assessed a limit level of swelling and asserted the nonlinearity presence yet at the same time they utilized straight cointegration and blunder remedy model of longrun and short run relationship along VAR model and half taken every necessary step since it is deceiving to run with direct cointegration in the event that there exist topsy-turvy alteration [see Enders and Siklos (2001) and Hansen and Soe (2002)].

The purpose of this study is to test the uneven change amongst expansion and its determinants if there should be an occurrence of Pakistan for time arrangement information at yearly recurrence extending from 1960-2015. Particularly the inquiries which are endeavoring to address in this examination are: (I) the presence of edge co integration and topsy-turvy modification towards long run balance, (ii) how determinants of expansion overstating towards swelling in various administrations, (ii) a limit autoregressive model and nonlinear drive reaction work.

### **Model Specification, Data and Estimation Techniques**

While formulating methodology the key consideration is

given to incorporate major variables that play their role to cause inflation strongly in an economy on strong theoretical reasoning as mentioned above. The time series data at annual frequency going from 1960-2015 is gathered for every one of the factors and the wellspring of information are different issues of Pakistan Financial Study, Government Department of Insights and Factual Notice of the State bank of Pakistan (different years of SBP). With a specific end goal to look at the relationship for swelling and its determinants the accompanying model as took after by some past investigations [see Khan and Senhadji (2001), Ahmed and Mortaza (2005) and Munir et al (2009)] and figured as:

Where are intercept term, coefficients and error terms respectively. The model given in equation (1) is reduced into two regime model or threshold autoregressive (TAR) model that is one of the main purpose of this study to estimate given as:

And This paper precisely employs threshold cointegration technique of long run relationship advanced by [Enders and Siklos (2001)] to examine the cointegration relationship in the presence of asymmetric adjustment. The threshold cointegration as the assumption, let is denoted as random variables (observable) being integrated of order one (<sup>1</sup>). The long run equilibrium association is termed as:

Where in scenario if the equilibrium longrun relationship [ in equation (2)] is furnished with symmetric adjustment and resulting to accept equation (2). Conversely, traditional frame work of cointegration in (2) is misspecified if there exist asymmetric adjustment, called as threshold autoregressive (TAR) model: Where such as: And The momentum threshold (MTAR) is another substitute adjustment process instead of TAR as follows: The MTAR is applicable in case if the threshold value likely to occur in previous period change of If there happen serial correlation problem in (5) and (3) then these are rewritten as:

Enders and Siklos (2001) advanced two sorts of test to test the threshold cointegration, called the that involves F-statistics procedure for the null hypothesis of. The second test is for the null hypothesis o as between and it involves t-statistic in order to reject

<sup>1</sup> Chan (1993), Balke and Fomby (1997), Applied Econometric Time series, 3<sup>rd</sup> edition. pp. 4

the null hypothesis. In the event that edge level is unidentified, it would be assessed through a technique presented by Chan (1993). In the event that arrangement isn't bounce over limit level then it is deficient to utilize that edge level<sup>1</sup>. To acquire a consistent estimate of threshold levels at first arrange disturbance term the ascending order arrangement as a potential edge level and the genuine edge esteem must lie in residual esteems for this reason we characterize an interim  $\tau$  speaks to the obscure edge esteem and characterize inside the interim of  $\tau \in (\tau_L, \tau_U)$ . Presently by considering and run threshold autoregressive model (TAR) given above [see equation (3), (5)] and obtain sum of squared of residuals (*SSR*), and repeat this process and obtain all the sum of square of residuals by considering each observation in place of threshold. Now, OLS estimate of  $\sigma^2$  is obtained for each  $\tau$  as follows: Presently according to Chan (1993) the minimum square gauge of the threshold level would be at that perception where aggregate of square residuals would be least as follows: And this is because as much closer we touch the true threshold estimate the lower would be sum of square of residuals [see Tong (1983, 1990), Balke and Fomby (1997), Enders and Siklos (2001) and Hansen and Soe (2006)].

We try to explore the likelihood that the threshold cointegration likely to provide an improved empirical description towards longrun relationship between inflation and its determinants. To reply this question, it is tried to split the linear VAR model as multivariate model into more persistent regime and less persistent regime depending upon the threshold effect in the error correction term. The lag length is chosen 1 by AIC/SIC criteria such as:

### Estimation

It is important to check whether the variables under concern are stationary, prior to go empirical findings. It is tested for stationarity to ensure that the variables used in the regressions are not subject to spurious correlation. The Augmented Dicky-Fuller (ADF) and Zivot-Andrews structural break point test are used to investigate the status of stationarity of each variable. The

estimated results are presented in Table (1) as:

Table (1): Null hypothesis: Series has a unit-root (with Intercept (c)/Trend (T))

Var	Zivot-Andrews			At level				Result
	<sup>a</sup> c, t, l	B-P	<sup>b</sup> t-stat/pv	c, t, l	t-stat/pv	c, t, l	t-stat/pv	
$\pi_t$	t, 1	1974	-4.20/0.39	1	-1.41/0.14	1	-6.06*/0.00	I(1)
$y_t$	t, 1	1983	-2.43/0.24	1	-1.26/0.18	----	-8.39*/0.00	I(1)
$Exc_t$	c, t	1990	-3.77/0.34	----	2.73/0.98	----	-3.32*/0.00	I(1)
$GS_t$	c, t	1988	-3.12/0.35	----	-0.11/0.64	----	-5.10*/0.00	I(1)
$M2_t$	T	1977	-2.09/0.15	----	-1.30/0.17	----	-7.93*/0.00	I(1)
$POP_t$	T	1983	-3.83/0.14	----	-1.33/0.16	----	-3.12**/0.01	I(1)

<sup>a</sup>: c,t,l are intercept, trend and lagged values of the dependent variable respectively.

<sup>b</sup>: t-stat/pv is test-statistic/p-value, and B-P is break point year.

Critical values:

	zivot-Andrews			ADF		
Level:	1%	5%	10%	1%	5%	10%
Drift	-5.34	-4.93	-4.58	-3.56	-2.92	-2.59
Trend	-4.80	-4.42	-4.11			
Both	-5.57	-5.08	-4.82	-4.14	-3.49	-3.17
None				-2.61	-1.95	-1.61

\*, \*\*, and \*\*\*\* are shows the significance at 1%, 5% and 10% level.

In Table (1), Zivot-Andrews unit root test applied on  $\pi_t$  at level with trend and one dependent lag to avoid autocorrelation and test statistic is -4.20 with p-value 0.39. The test statistic does not exceed from the critical values as given in Table (1), also the p-value above 0.05 and does not reject the null hypothesis of unit root at level with structural break point time of 1974. Similarly, Zivot-Andrews test proceeded for all other variable and every time it has been found unit root with a structural break that can be examine from Table (1). The graphical presentation of structural break-point is given at appendix [see Figure: i-vi]. Similarly, ADF test is applied at level of  $\pi_t$  and test statistics is -1.41 with p-value 0.14, thus does not exceed from the critical values at 1%, 5% and 10% [see Table (1)]. Again ADF test run at first difference of  $\pi_t$  and test statistic calculated as -6.06 with p-value 0.00 and rejecting the null hypothesis of unit at first difference. Thus, the order of integration of  $\pi_t$  is I(1). Similarly, the ADF test regressed for rest

of all variables, and almost same results happen to see [see Table (1)], as concluding from unit root tests, all the variables are found to be same order of integration as  $I(1)$ .

Now we go to regress long run model at level as given in equation (1) in order to get the residual terms for further analysis to run threshold cointegration test as explained above in methodology.

The estimated model is as: We obtained the residuals from this long run model and run the TAR and MTAR model in order to test the threshold cointegration [see equation (3), (5)]. The estimated results are formed below in the Table (2) as:

Table (2): *Enders and Siklos (2001) threshold cointegration test:*

Variables	$\pi$ TAR	$\pi$ M-TAR
constant	0.65(0.67)	----
-0.77(-2.26)**		-0.80(-3.30)**
	0.33(0.56)	-0.33(-1.41)
	0.41(1.20)	0.03(0.14)
Threshold	-5.274	2.398
Auto-LM test		
ARCH <sub>1</sub>		
AIC/SIC	5.74/5.88	10.41/10.48

\*Asymmetric tests:

Null hypothesis Test Statistic/p-value

	**	***
6.05	(2,50) /0.02	5.47 (2,50)/0.04
5.84**	(1,50) /0.01	2.99(1,50)/0.09

Parentheses show  $t$  test-statistic. It has been employed  $t$ -Max statistic for TAR and MTAR. The symbolizes tests for null hypothesis:

$F$  test is for asymmetry as. '\*\*', '\*\*' and '\*\*\*' show significance at 1%, 5% and 10% level of significance respectively.

In Table (2), by using critical value both provides a strong indication of cointegration at 1% in TAR and MTAR models accordingly. In TAR model test statistics is 6.05 significant at 5% level and for M-TAR model 5.47 and significant at 10% level of significance. Further, null hypothesis of symmetric adjustment is rejected only for M-TAR model at 5% level test statistics is 2.99 but in case of TAR model it is found significant test statistics is 5.84 significant at 5% level. It shows the adjustment mechanism

toward equilibrium below the estimated threshold is much persistent in TAR. It is evident from Table (2) that the long run equilibrium relationship among inflation and its determinants are asymmetric and comprises onto two regimes such as more persistent regime and less persistent regime. It shows, the speed of adjustment parameter would also differ in the longrun that will be estimated through the TVECM model as:

Table 3: *TVECM model: Inflation as a Dependent variable.*

Var	Linear Model	Threshold VECM model	
Constant	-----	-----	-----
	-0.358** (0.11)	-0.219*** (0.12)	-0.399*** (0.20)
	0.046(0.18)	0.372*** (0.20)	0.468* (0.19)
	5.596(7.122)	-2.438(7.01)	-0.311(7.58)
	0.081(0.172)	-0.033(0.17)	0.074(0.19)
	-0.181** (0.06)	-0.195*** (0.07)	-0.227*** (0.07)
Adj-R <sup>2</sup>	0.28	0.27	0.26
@ Auto-	0.11	1.00	0.88
# Hetero-	0.96	0.81	0.71
Observation	55	32	23

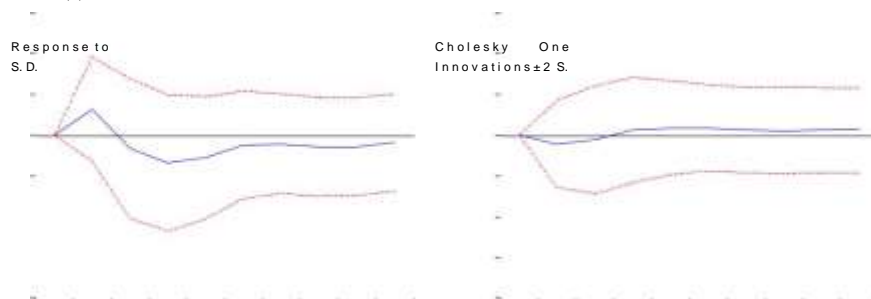
Note: \*\*, \*\*\*, \*\*\*\* and \*\*\*\* shows significance level at 1%, 5% and 10%. Standard error is given in parenthesis. @ shows atuo-correlation chai-square test statistics and # shows heterescedasticity chai-square test statistics.

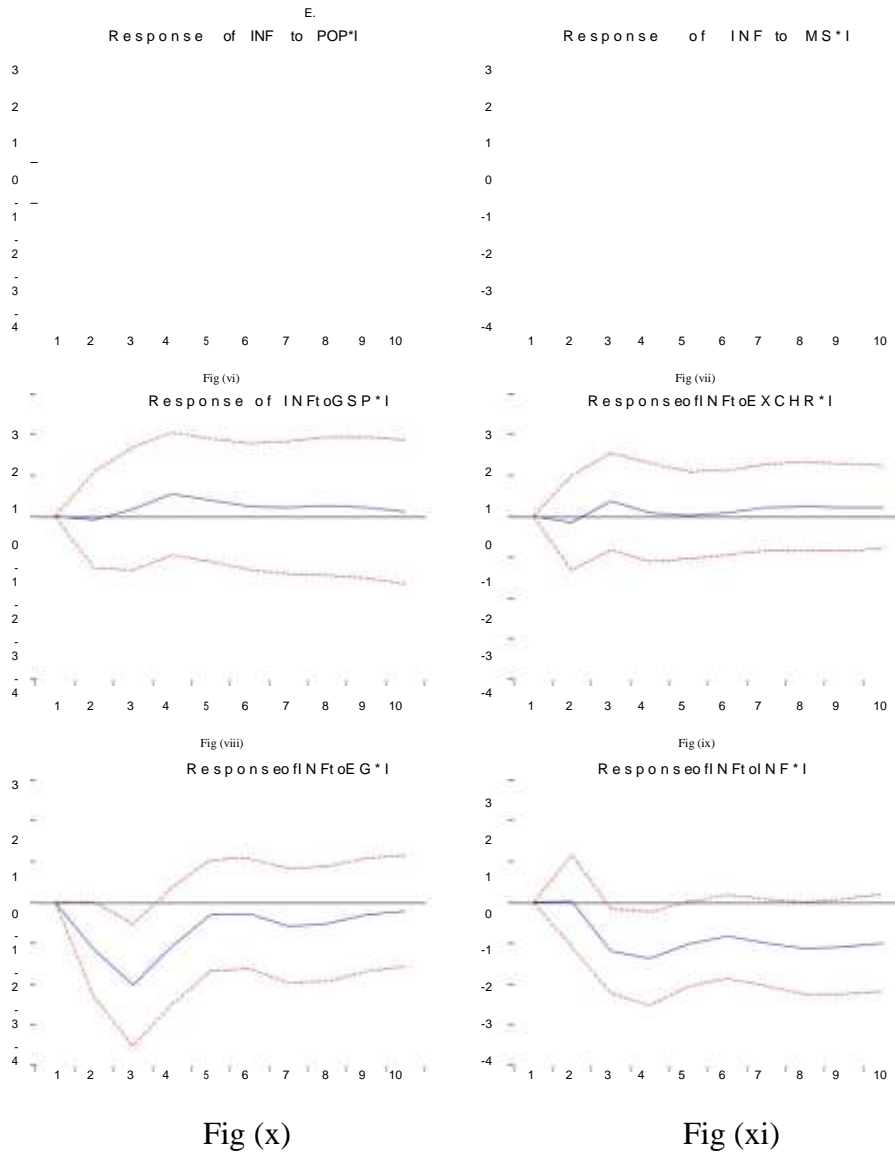
In above Table 3, the linear VECM and nonlinear VECM estimated to sketch a clear picture of the speed of adjustment parameter. In linear VECM model, the speed of adjustment is found - 0.358 significant and fulfilling the statistical properties such as negative sign and below one. It shows the convergence in the long run at 35.8% per year between the dependent and independent variables. It shows the convergence rate 35.8% throughout the whole periods and rejecting the different phases of the economy such as recession and boom. As it found quite illogical that the convergence rate remains same throughout all the phases unchanged. In case of nonlinear VECM, it is quite different. There are different rate of speed of adjustment for more



persistent regime and less persistent regime. In high regime discriminated by threshold value 9.5 in 1992, the speed of adjustment parameter is -0.219 and found significant at 5% level of significance. It is also possessing statistical properties such as negative sign and below one for convergence. It shows, in high regime the speed of convergence is 21.9%. Whereas, in lower regime, speed of adjustment value is -0.399 and found significant, having negative sign and below one showing convergence. There is a clear difference convergence rate produced by high and low persistent regimes for convergence between inflation and its determinants. In high persistent regime, the speed of adjustment is 21% a bit slot from low regime that is 39%. The difference is come from the economic activities in the economy. It shows the effective demand is creating a more distance in high regime than low regime. As economic agents are looking more fruitful in high regime, that is creating more divergence and a slow convergence in the economy. The steady state level is bit difficult to achieve in high regime as compare to the low regime. A threshold autoregressive (TVAR) model run for inflation and its determinants keeping the view of threshold level in inflation estimated above (9.5% for 1992). A traditional VAR is transformed into two regime as more persistent and less persistent regime the only estimation for inflation because on each time being keeping endogenous variable to all the determinants there threshold value have to be calculated to regress TVAR for each other independent variable but we are only interested in inflation in this study. The lag length has been chosen through AIC/SIC criterion given at appendix. The estimation of threshold VAR is to capture the nonlinear response of the variables towards inflation rate as in high and low persistent regimes. The estimated impulse response are given below as:

(i) After threshold level:





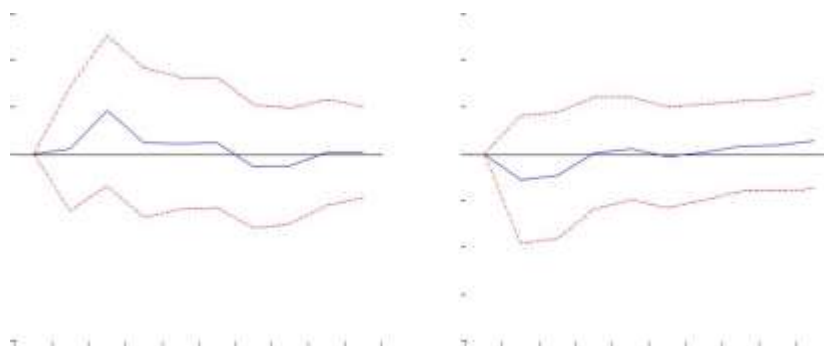
Above in figure (vi) the impulse are generated in pop as after the threshold level to see the inflation response. Where “pop\*I” is dummy variable and showing the after threshold level or high regime else zero. It shows that in high regime shock in population is at first producing positive impact over inflation rate and after the two years it went down to negative and keep

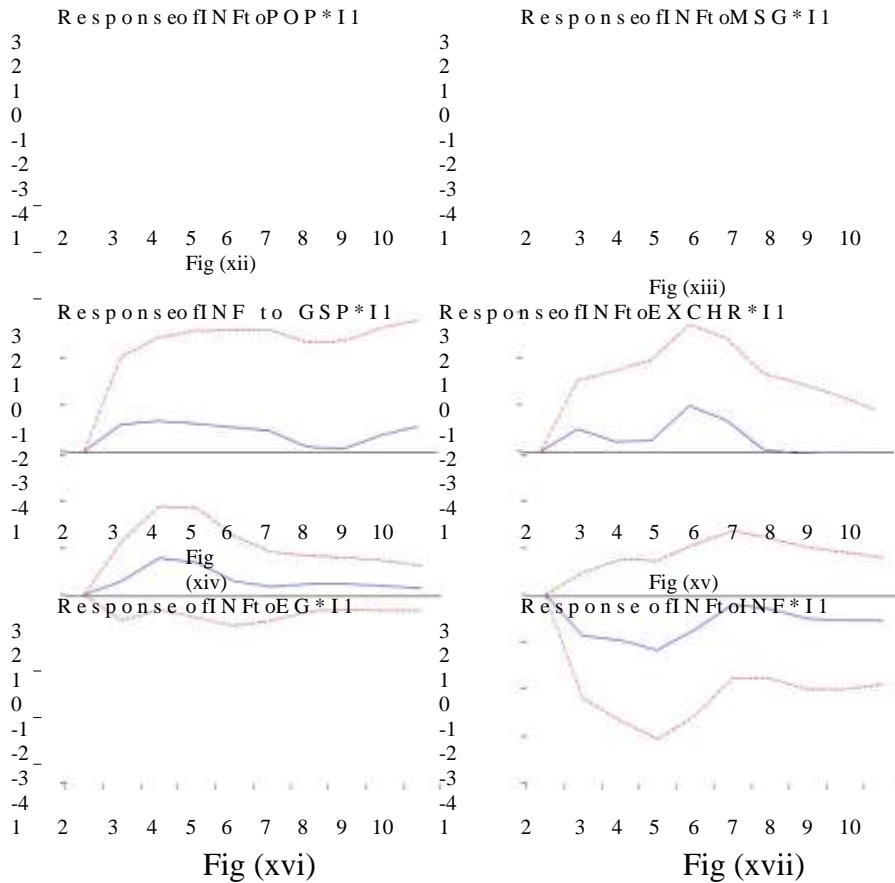
advancing as negatively even for next eight years and do not reach to the steady state level.

The impact of shock in population over inflation in high regime is lasting long period responses. In next figure (vii), the shock in money supply growth puts a negative impact over inflation rate and it down to steady state level but after two periods it comes up above steady state level and showing the positive increase in inflation rate at a constant level for next eight periods and do not return to the steady state level. In fig (viii), the shock in government spending is interesting, the response of inflation starts from the next periods, it means it takes time of active fiscal policy to response over the inflation. At first there is a slight increase in inflation for two periods than suddenly it went down but not as much to reach at steady state level. In fig (ix), a shock in exchange rate in high regime, alter the behavior of inflation many a time as at first it has a negative impact over inflation but suddenly after one period inflation reach at steady state level and next it starts increasing but after next four periods it again reach to the steady state level and then starts fluctuating above steady state level so it shows a cobweb phenomenon type relationship between inflation are exchange rate responses in high regime. In fig (x), in high regime a shock is generating huge negative gap for inflation rate, from its beginning it fluctuating negatively below steady state level sharply and never reach to the steady state level. This is also one of the reasons as shown in TVECM that in high regime the speed of adjustment is 21% showing a bit slow convergence as compare to the low persistent regime. The pulses in economic growth generating a bit lower impact after seven periods in inflation. In fig (xi), a shock in inflation in high regime creating negative impact over inflation itself, and it fluctuates below the steady state level throughout.

## (ii) Before Threshold level

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.





Above in figure (xii), in “pop\*I1” I1 is a dummy variable and shows low persistent regime. As after threshold level, the shock in the population producing positive response in inflation and is different to the high regime response in inflation. Throughout inflation fluctuate positively, above the steady state level in all periods. It is as, in low regime, to enhance the affective demand more of the population increased that would lead to increase the inflation positively. In figure (xiii), a shock in government spending impacting over inflation positively at first for first seven periods, and then it fluctuate below from steady state level. These results are totally different from the high regime, as at first in high regime inflation remain below from steady state level and after four periods it reach to the steady state level and then fluctuate positively. It is as, in low regime there is lower

aggregate demand in the economy, and due to the increase in government spending there is increase in the income of the economic agents and laboring class that advances the consumption level up and ultimately responsible for a positive increase in the inflation. In figure (xv), a shock in exchange rate generates a negative impact over inflation at first in the economy. For first four periods, it remains negative, and then reach to the steady state level after it fluctuates a slightly positively a bit higher than the steady state level. There is not a big difference for exchange rate shock over inflation in high and low regime, excepts in low regime the duration of inflation being negative associated remains more longer than the high regime. In Figure (xvi), a shock in economic growth, producing positive impact over inflation and it fluctuates above from the steady state level for all the periods. This is the reason that the speed of adjustment parameter in low persistent regime is higher in TVECM as shown in above Table 3. The increase in economic growth in lower regime, would also generate the effective demand in the economy that results into increase in the price level at first slowly and then steadily. In figure (xvii), a shock in inflation in lower regime would generate as similar response in the inflation as in high regime.

Main inflation determinants model (1) is estimated as:

Table 4: *Nonlinear Model (Inflation as dependent variable)*

Variables	Threshold Model	
Constant	0.047(0.43)	0.403(0.416)
$\Delta y_t$	-0.029(0.126)	-0.409** (0.091)
$\Delta Exc_t$	-0.298(0.536)	-0.421* (0.001)
$\Delta GS_t$	0.830*** (0.447)	-1.005*** (0.166)
$\Delta M_{2t}$	-0.139*** (0.049)	0.114*** (0.011)
$\Delta POP_t$	-5.834(6.681)	-0.164(7.260)
<b>D73</b>	18.583* (2.877)	17.496* (2.671)
<b>D76</b>	-11.850* (2.835)	-14.103* (2.671)
<b>D2008</b>	12.652* (2.741)	16.586* (3.366)
Adj-R <sup>2</sup>	0.63	0.64
Observations	34	20
@ Auto-	0.90	0.08
# Hetero-	0.18	0.47

@: shows aturo-correlation, and # shows heteroscedasticity test statistics. In braces standard errors are given.

In above Table 4, the basic model is comprises into two

parts, as before threshold level and after threshold level. The results indicate different picture in both regime as per above impulse response functions and TVECM. In first regime, economic growth is found insignificant (-0.029) having negative sign. Exchange rate is also insignificant (-0.298) and showing negative relationship with inflation. Government spending is significant (0.830) at 10% level of significance and associated positively to inflation. It shows with one unit increase in government

spending there would be 0.83% increase in inflation in high regime. Next, money supply is also found significant (-0.139) at 10% level of significance. It shows that one unit increase in money supply, inflation rate decreases by 0.13%. Population is insignificant (-5.834) and showing negative relationship with inflation. In this model, dummies are incorporated to capture the shock in order to reduce the error and all the dummies are found significant and making model more stable. The stability test of CUSUM and CUSUMQ are given at appendix. In lower regime, economic growth is significant (-0.403) at 10% level of significance having negative relationship with inflation. It shows that one unit increase in the economic growth would reduce the 0.40% inflation rate in lower regime. Exchange rate is also significant (-0.421) at 10% level of significance and negatively associated with inflation in lower regime. It shows that one unit increase in the exchange rate inflation decrease 0.42%. It shows that appreciation in the economy in lower regime is decreasing inflation. Government spending is also significant (-1.005) and showing negative relationship with inflation in lower regime. It shows that one unit increase in government spending would lead to decrease the inflation by -1.00%. The money supply is also significant (0.114) having positive sign. It shows that one unit increase in the money supply in low regime would result into increase in the inflation by 0.14%. Population is found insignificant (-0.164) having negative relationship with inflation in the lower regime. The dummies are also incorporated in this model to check the error for stability and all dummies are also found significant in the lower regime. All the test diagnostics are clear rejecting the null hypothesis of auto correlation and heteroscedasticity in both models. The CUSUM and CUSUMQ

model for low regime is given at appendix.

### Conclusion and Policy Recommendation

The purpose of the paper is to estimate the nonlinear dynamics for inflation determinants using TVAR modeling of time series data ranging between 1960-2015 for the variables inflation rate, population growth rate, exchange rate, economic growth and government spending. All the variables are found to be stationary at first difference; means showing same order of integration as  $I(1)$ . The threshold co integration method is applied and threshold error correction model along nonlinear impulse response functions are brought under estimation technique, completely ignored in previous literature in case of Pakistan.

The estimations conclude that there is nonlinear long run relationship among variables. The speed of adjustment parameters are characterized into two regime, as high persistent regime and low persistent regime. It shows different speed for different regime as high adjustment toward long run equilibrium in lower regime and low speed of adjustment towards long run equilibrium in high persistent regime. The nonlinear impulse response function shows a different picture, for high persistent regime as well as for low persistent regime respectively. It shows that in high persistent regime, inflation shows different behavior as compare to the lower regime. The dynamic behavior of inflation mostly remains positive, when there is a shock in determinants in case of high persistent regime and vice versa. Next, nonlinear regression model is estimated and dummy variables are included to stable the model and found significant. The impact of determinants is different in different regimes. The stability of the nonlinear model is checked through CUSUM and CUSUMQ model found significant.

This study shows that by incorporating nonlinear properties of the time series data, the variations are different. There is different impact of determinants in different regime. While in high persistent regime when inflation is moving upward, the trade of among variable is higher as compare to the lower regime when inflation is moving downward and that is the reason it shows different speed of adjustment parameter towards study state level

in long run. In case of high regime, the policy makers should change the determinants more as compare to the low regime. There is more need to take care of in high regime a sudden increase in taxes, decrease in government spending, decrease in money supply and controlling exchange rate. It all presents the glimpses and methods of calculating in all fields of economics that are used in the Holy Quran and Hadith.

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