SBP Working Paper Series

No. 104 February, 2020

Estimation of Medium Term Inflation Target for Pakistan

Fayyaz Hussain

Dr. Muhammad Rehman

STATE BANK OF PAKISTAN

SBP Working Paper Series

Editor: Sajawal Khan

The objective of the SBP Working Paper Series is to stimulate and generate discussions on different aspects of macroeconomic issues among the staff members of the State Bank of Pakistan. Papers published in this series are subject to intense internal review process. The views expressed in these papers are those of the author(s) not State Bank of Pakistan.

Price per Working Paper (print form)

Pakistan:	Rs 50 (inclusive of postage)
Foreign:	US$ 20 (inclusive of postage)

Purchase orders, accompanied with cheques/drafts drawn in favor of State Bank of Pakistan, should be sent to:

Chief Spokesperson,
External Relations Department,
State Bank of Pakistan,
I.I. Chundrigar Road, P.O. Box No. 4456,
Karachi 74000. Pakistan.

Soft copy is downloadable for free from SBP website: http://www.sbp.org.pk

For all other correspondence:

Postal:
Editor,
SBP Working Paper Series,
Research Department,
State Bank of Pakistan,
I.I. Chundrigar Road, P.O. Box No. 4456,
Karachi 74000. Pakistan.

Email: wps@sbp.org.pk

ISSN 1997-3802 (Print)
ISSN 1997-3810 (Online)

Published by State Bank of Pakistan, Karachi, Pakistan.
Printed at the SBP BSC (Bank) – Printing Press, Karachi, Pakistan

Estimation of Medium Term Inflation Target for Pakistan

Fayyaz Hussain [1] & Dr. Muhammad Rehman [2]

Abstract

As a part of its strategic goal, State Bank of Pakistan (SBP) plans to switch to flexible inflation targeting regime. In this regard, the first and most important question is about setting appropriate medium term inflation target. This study aims to search for the medium term inflation target that is conducive for socioeconomic welfare. Seeking guidance from the international best practices, we have used broadly two procedures to search for appropriate inflation target and its band for Pakistan. First, we have analyzed the target setting practices of advanced and emerging inflation targeting economies. Second, we used a variety of technical methods. Results show that inflation level above 8 to 9 percent is harmful for the society. On the lower bound inflation below 4.0 percent is also undesirable. Keeping in mind these findings, inflation target range in the similar emerging economies, history of inflation volatility in Pakistan and importance of exchange rate, we recommend inflation target to be set at 5.5 percent with a band of +/- 1.5

JEL Classification: E310, E520, E580
Key Words: Price Level; Inflation, Monetary Policy, Central Banks and Their Policies

Acknowledgments

Authors would like to thank Waqas Ahmed, Omar Farooq Saqib, Mahmood ul Hasan Khan, and anonymous reviewer for the thoughtful comments on an earlier version of this paper.

Contact for correspondence:
Fayyaz Hussain
Joint Director,
Monetary Policy Department
State Bank of Pakistan
I.I. Chundrigar Road
Karachi 74000.
Email: Fayyaz.Hussain@sbp.org.pk

[1] Joint Director, Monetary Policy Department, State Bank of Pakistan, Karachi (Fayyaz.Hussain@sbp.org.pk)
[2] Joint Director, Monetary Policy Department, State Bank of Pakistan, Karachi (Muhammad.Rehman@sbp.org.pk)

Non-technical Summary

As a part of its strategic goal, State Bank of Pakistan (SBP) plans to switch to flexible inflation targeting regime. In this regard, the first and most important question is about setting appropriate medium term inflation target. Government's annual CPI inflation target is largely based on recent price trends and keeps on changing both up and down and sometimes by big margins. Such frequent changes in inflation targets are not conducive for anchoring inflation expectations.

This study aims to search for the medium term inflation target that is conducive for socioeconomic welfare. Seeking guidance from the international best practices, we have used broadly two procedures to search for appropriate inflation target and its band for Pakistan. First, we have analyzed the target setting practices of advanced and emerging inflation targeting economies. Second, we used a variety of technical methods.

Global practice shows that most of the inflation targeting central banks of emerging economies are targeting inflation in the range of 2 to 6 percent. Advanced economies set inflation targets in the range of 1 to 3 percent.

Analysis of inflation growth nexus shows that inflation band of 5.7 to 10.4 percent is conducive for economic growth.

Conduct of monetary policy in Pakistan as measured by Taylor rule indicates implicit inflation target of 8.9 percent.

Analysis of impact of inflation on price dispersion shows that inflation band of 4.3 to 9.1 percent corresponds to price stability.

When economy operates close to its potential (zero output gap), inflation averages around 7 to 8 percent.

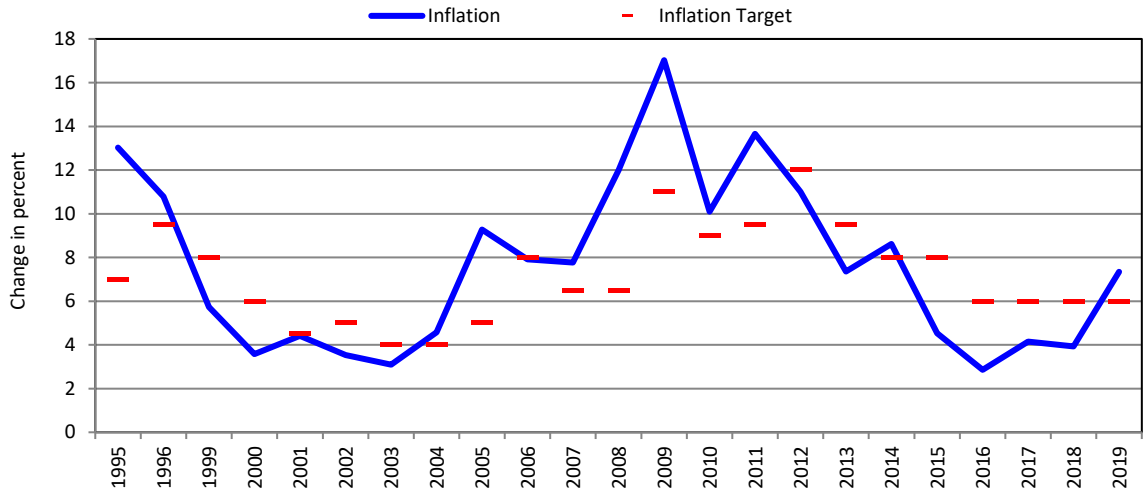
Inflation in the band of 4.0 percent to 5.0 percent corresponds to the lowest wage dispersion in the economy.

Keeping in mind a) these findings, b) inflation target range in the similar emerging economies, c) history of inflation volatility in Pakistan and d) importance of exchange rate, we recommend inflation target to be set at 5.5 percent with a band of +/- 1. 5.

1. Introduction

In line with the general trend across the globe, over the last decade price stability has become one of the most important, if not sole objectives, of monetary policy in Pakistan. Despite this increasing importance, however, there is no consensus on the specific inflation target which is consistent with the definition of price stability[1]. As a result, government's annual CPI inflation target is largely based on recent price trends and keeps on changing both up and down and sometimes by big margins (Figure 1). Such frequent changes in inflation targets are not conducive for anchoring inflation expectations. The importance of price stability consistent inflation targets has become all the more important with the State Bank of Pakistan (SBP) strategic goal of implementing flexible inflation targeting. In this backdrop, this study aims at exploring the inflation target band that is consistent with the definition of price stability and can be used as a starting point for medium term inflation target[2].

Figure 1: CPI Inflation and Government's Inflation Target



Rest of the study is planned as follow. Section two briefly describes the theoretical debate on the meaning of price stability and global practices on setting inflation target. Section three discusses the empirical approaches of estimating inflation target band and replication of those approaches for Pakistan's case. Section four recommends an appropriate inflation target along with tolerance band and time horizon for Pakistan and the last section concludes the study.

[1] European Central Bank (ECB) defines price stability as "a year on year inflation in the Harmonized Index of Consumer Prices for the Euro Area of below 2 percent". Similarly, an inflation rate of 1 to 3 percent corresponds to price stability in Advance economies while in transition economies inflation in the range of 4 to 5 percent would correspond to price stability (Jonas. J and F.S. Mishkin, 2003).

[2] Though there are different measures of price indices such as Consumer price index (CPI), wholesale price index (WPI), sensitive price index (SPI) and GDP deflator, we opted for CPI based measure of inflation for many reasons. First, all the inflation targeting countries are using this index for setting their inflation targets. Second, Government of Pakistan has already been setting inflation targets based on this index. Third, shortcomings of competing price indices also make CPI index the most suitable candidate for analysis. For instance, WPI does not include prices of services that constitute more than one half of the economy. Likewise, data on GDP deflator is available on annual basis only and SPI covers prices of only kitchen items.

2. Background

2.1. Theoretical Debate

Over the last six decades, Phillips curve has been used as a guiding principal in the monetary policy thinking for setting inflation targets. In the late 1950s and early 1960s, negative trade-off between inflation and unemployment was treated as menu for policy makers to choose from long run objective of price stability and unemployment. Empirical evidence showed that inflation can be reduced by tolerating higher unemployment rate or unemployment rate can be reduced by tolerating higher inflation[3]. Major blow to this paradigm came from higher inflation decades of the 1970s and 1980s.

In 1970s and 1980s, monetary policy formulation remained under the influence of Milton Friedman's work (1968) showing no trade-off between inflation and unemployment in the long run (vertical Phillips curve), though short run trade-offs remained. In this framework, central bank can choose the low and stable rate of inflation along the vertical line but it has no impact on the permanent rate of unemployment. With little control on NAIRU[4], price stability or very low inflation became the overriding objective of monetary policy in this regime.

In 1990s despite very low and stable inflation in United States and Canada, annual unemployment rate moved in a wide range raising questions about vertical Phillips curve in the long run. This inflation puzzle was solved by Akerlof et al (2002). They found that at higher level of inflation Phillips curve is vertical while as inflation falls below certain threshold it increases unemployment. Between these two thresholds, Phillips curve is negatively sloped. They attribute this increase in unemployment to downward nominal wage rigidity and near rational neglect of low inflation. Their findings implied that price stability corresponds to some positive inflation level.

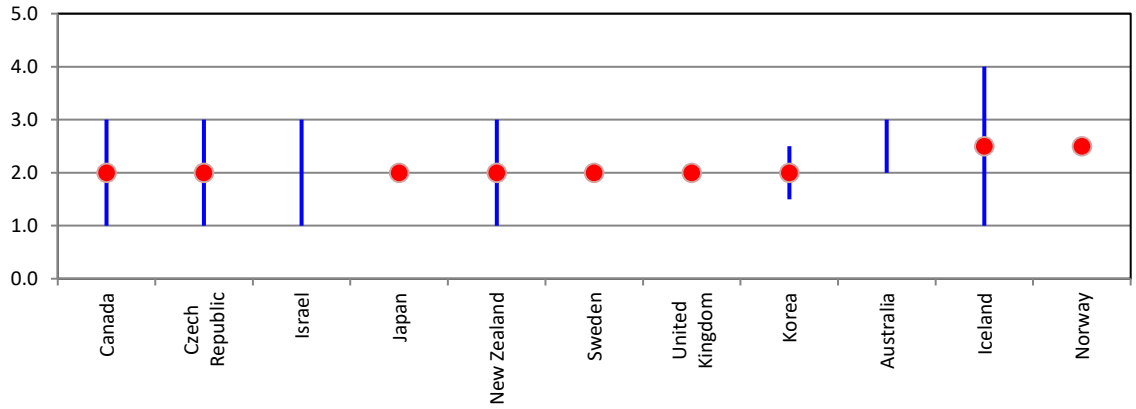
2.2 Global practices on setting Inflation target

Inflation rates above and below the certain ranges does not bode well for economies. There is plenty of literature on the costs of high inflation (for detail see O,Reilly 1998). Most prominent among these costs of high inflation include financial disintermediation (into Real Estate and Gold) and consequent decline in financial savings and investment contributing to lower growth. The literature on adverse impact of very low inflation, however, is relatively scarce. Frequently cited detrimental impact of very low inflation includes: (a) risks of growing deflationary concerns; (b) at very low inflation, downward nominal wage rigidity makes it difficult to cut real wage rate (in case of adverse demand shock) that adds to unemployment and hurts economic growth; and (c) limited room to cut real rate below zero in case of adverse shock. Keeping theses costs of very high and very low inflation in view, central banks across the globe target positive inflation rate.

As per Jonas and Mishkin (2003), there is a general consensus in the literature that inflation rate in the range of 1 to 3 percent corresponds to price stability in the advanced economies. This is also evident from inflation targets of advanced inflation targeting countries (Figure 2).

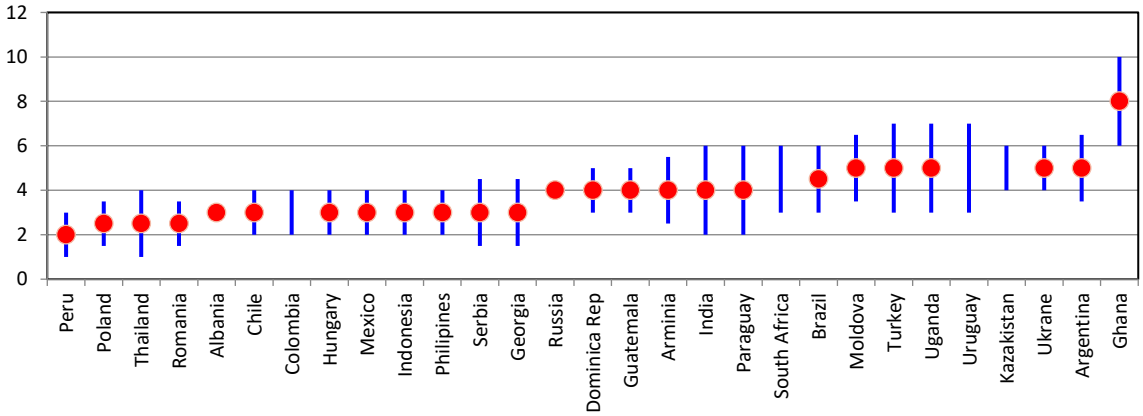
[3] Phillips (1958), Samuelson and Solow (1960), Lipsey (1960), Eckstein and Wilson (1962), Perry (1964) and Kaliski (1964).
[4] Estimates of NAIRU differed across countries and time periods and so did the optimal inflation.

Figure 2: Inflation Targets Levels and Bands in Advanved Economies as of June 2018



In case of emerging economies, analysts argue that emerging economies should target somewhat higher inflation than their developed counterparts because of Harrod-Belassa-Samuelson effect[5], measurement error in inflation, price level convergence, low credibility and low independence.[6] For instance, Škreb (1998) argues that owing to measurement error, inflation in the range of 4- 5 percent would correspond to price stability in transition economies. The hypothesis of price convergence suggests that emerging economies with lower price level set a higher inflation target to reflect the expected price convergence toward their developed counterpart. Likewise, with the less credible central bank, emerging economies can manage inflation expectations less effectively than developed countries. This makes them set inflation targets above the targets set for developed economies. Lastly, in emerging economies central banks are more prone to government influence. This limits their ability to keep inflation at a lower level and they choose a relatively higher inflation target than that of developed countries.

Figure 3: Inflation Targets Levels and Bands in Emerging Economies as of June 2018



In line with the above mentioned arguments, most of the inflation targeting central banks of emerging economies are targeting inflation in the range of 2 to 6 percent (Figure 3), higher than range (1 to 3 percent) of the developed economies. It is also worth noting that inflation target bands in the emerging

[5] Countries with high productivity growth also experience high wage growth, which leads to higher real exchange rates. The Balassa-Samuelson effect suggests that an increase in wages in the tradable goods sector of an emerging economy will also lead to higher wages in the non-tradable (service) sector of the economy. The accompanying increase in inflation makes inflation rates higher in faster growing economies than it is in slow growing developed economies.

[6] Clinton (2000), however, argue that rapidly rising labor productivity in emerging economies does not support targeting relatively higher inflation in these countries.

economies are wider than those of the advance economies. This probably reflects the more volatile macroeconomic environment in the emerging economies.

3. Search for medium term price-stability consistent inflation target for Pakistan

Empirical literature on the selection of inflation targets can be broadly categorized into three distinct approaches. First are the macro econometric models. Most prominent among these are studying the impact of inflation on aggregate output,[7] and estimating implicit inflation target from Taylor rule.[8]

Statistical methods such as relative price variability (RPV) and output gap can be categorized as the second approach[9]. The impact of inflation on RPV is considered an important channel for real effects of inflation. The RPV analysis suggests inflation thresholds that have smaller impact on RPV. Output gap analysis search for the level of output where aggregate demand meets aggregate supply and given all else constant, inflation gravitates to its long run value.[10]

Besides macro econometric and statistical approaches, a third type of contribution has been purely microeconomic method.[11] This approach studies the impact of inflation on relative real wage variation and finds that inflation-induced increase in wage variation that is harmful for economic growth.

Seeking guidance from the above international practices, we use macro econometric, statistical and microeconomic methods to search for appropriate inflation target for Pakistan. These methods and their findings are discussed in greater detail below.

3.1 Macro econometric models

3.1.1 Inflation growth nexus

Central banks across the globe are usually mandated with the dual objective of price stability and maximum sustainable level of growth. These two objectives are interlinked. Not only level of economic growth vis-à-vis its potential influences inflation trends but inflation environment also impacts economic growth. A plenty of literature has consensus that high inflation has negative impact on medium to long-term growth.[12] Many researchers have tried to explore the level of inflation above which it is inimical to growth. For instance, Khan and Senhadje (2001) found such inflation thresholds in the range of 1-3 percent for developed economies and 7-11 percent for developing economies.[13] This implies that price stability consistent inflation target should be set below the inflation threshold that hurts economic growth.

Regarding Pakistan, a simple data analysis suggests that inflation rate in the range of 5 to 7 percent appears to be beneficial for economic growth. Specifically, using annual data on inflation and economic growth from 1976 to 2016, we computed average growth rates against different bands of inflation. Maximum economic growth corresponds to the period when inflation remained in the band of 5 to 7 percent (Table 1).

[7] This approach finds the inflation threshold above which it is harmful for real growth. Most influential contribution in this regard is that of Khan and Senhadji (2001) and Rober Barro (1997).
[8] Main contribution in this regard is from Clarida et al. (1998)
[9] Most influential paper is by Park (1978)
[10] Mishkin (2007)
[11] A good example of this approach is the work done Groshen and Schweitzer (1996; 1999).
[12] See for example Barro (1997), Khan and Senhadji ((2001), Fischer (1993) etc
[13] Robert Barro (1997) using a panel of 100 countries found that inflation rate above 15 percent is definitely harmful for growth.

Table 1: Relationship between Inflation and Growth (FY76-FY16)

Inflation range	Average growth
upto 3%	4.7%
3% to 5%	4.9%
5% to 7%	5.9%
7% to 9%	4.9%
9 % above	4.7%

Based on the growth strategy, empirical studies on Pakistan suggest that inflation thresholds lie in the range of 4.0 to 9.0 percent. Specifically, Mubarak (2005), Hussain (2005) and Iqbal and Nawaz (2009) found inflation thresholds at 9.0 percent, 4 to 6 percent and 6.0 percent respectively. In a more recent study, Arby et al (2017) estimated inflation threshold in the range of 6.3 to 8.9 percent.

However, these studies on Pakistan have not addressed important econometric issue of inflation endogeniety identified in the literature. For instance, Barro (1996) mentioned that inflation is endogenous variable that may respond to growth or other variables related to growth. Likewise, Khan and Senhadje (2000) acknowledged the issue of inflation endogeniety and checked the robustness of their results by applying instrumental variable approach. In case of simultaneity problem, the coefficient estimates of above studies on Pakistan would be biased.

This study attempts to address the potential endogeniety of inflation by applying threshold vector autoregressive (TVAR) model. Before estimation of TVAR model, we have applied Likelihood Ratio (LR) test of Hansen (1999) to test linearity against the threshold(s) between inflation and growth along their other control variables. LR test basically compares the co-variances of different regimes:

$$LR_{i,j} = T(\ln(det(\hat{\Sigma}_i) - det(\hat{\Sigma}_j)) \qquad 3.1.1.1$$

Here $\hat{\Sigma}$ is the estimated covariance matrix of the model with i,j=0,1,2 regimes. T denotes the number of observations in the model which in our case is 41. To select the control variables in the model, we have followed Khan and Senhadje (2001) and used annual data of inflation, real GDP growth, investment as percent of GDP and population growth that spans from 1976 to 2016.[14]

Table 2: LR test Results		
Test	Linear VAR versus 1 threshold TVAR	Linear VAR versus 2 thresholds TVAR
Values	72.37	233.49
P-Val	0.70	0.00

The results of $LR_{i,j}$ test reject the Linear VAR versus two thresholds TVAR. After formal rejection of linear VAR against two thresholds model, we have estimated the following two regimes TVAR model:

$$Y_t = \Phi_1(L)Y_{t-1}I.(y_{t-d} \leq \gamma_1) + \Phi_2(L)Y_{t-1}I.(\gamma_1 < y_{t-d} \leq \gamma_2) + \Phi_3(L)Y_{t-1}I.(y_{t-d} > \gamma_2) + \epsilon_t \qquad 3.1.1.2$$

Where

$Y_t = \{\text{constant, inflation, real GDP growth, investment as percent of GDP, population growth}\}$ is a vector of endogenous variables, $\Phi_1(L)$, , $\Phi_2(L)$ and , $\Phi_3(L)$ are lag polynomial matrices, ϵ_t is a k

[14] We have used population as proxy for the skilled labor data of the original paper.

vector of innovations to the non-structural TVAR, and y_{t-d} is the threshold variable (which in our case is inflation), which determines what economic regime the system is in. *I*. is an indicator function.

TVAR estimates inflation thresholds at 5.7 and 10.4 percent. These results are similar to those of Khan and Senhadji (2001) who estimated inflation thresholds for emerging economies in the range of 7 to 11 percent. This is also broadly in line with inflation threshold estimates of 9.0 percent by Mubarak (2005) and 6.3 & 8.9 percent by Arby et al (2017).

3.1.2 Taylor Rule

Taylor rule measures how the central bank has conducted monetary policy. Specifically, it guides policy maker's reaction (through changes in policy rate) against the deviation of inflation and output from their targets. Starting from Clarida et al (1998), researchers have exploited the Taylor rule to compute the implicit inflation target being followed by the corresponding central banks. Seeking guidance from this literature, we have computed the implicit inflation target for Pakistan.

Following Leigh (2005), we have estimated implicit inflation target by using Taylor Rule with the following specification:

$$R_t = R_n + \pi_t^e + (K_\pi - 1)(\pi_t^e - \pi^*) + K_y y_t + \mu_t \qquad 3.1.2.1$$

Where R_t is the policy rate, $\pi_t$is CPI inflation and y_t is output gap, π^* is inflation target, R_n is natural rate of interest and μ_t is the error term. Both $K_\pi - 1$ and K_y are expected to be positive. The former captures the response of a central bank to deviation of expected inflation from its target while the latter measures the response of a central bank to deviation in output from its potential level.

To avoid abrupt changes in policy rates, central banks gives some weight to interest rate inertia. In this case the Taylor rule specification will be:

$$R_t = (1 - K_r)\left[R_n + \pi_t + (K_\pi - 1)(\pi_t - \pi^*) + K_y y_t\right] + K_r R_{t-1} + \mu_t \qquad 3.1.2.2$$

Assuming natural rate of interest and inflation target as constant the equation becomes:

$$R_t = (1 - K_r)\left[K_0 + K_\pi \pi_t + K_y y_t\right] + K_r R_{t-1} + \mu_t \qquad 3.1.2.3$$

Where intercept term K_0 comprises of both the natural rate of interest $R_n$and inflation target π^*.

$$R_t = (1 - K_r)K_0 + (1 - K_r)K_\pi \pi_t + (1 - K_r)K_y y_t + K_r R_{t-1} + \mu_t \qquad 3.1.2.4$$

$$R_t = c + b\pi_t + dy_t + K_r R_{t-1} + \mu_t$$

By estimating this equation and making an assumption about natural rate of interest, we can compute implicit inflation target in the following way.

$$c = (1 - K_r)K_0 \qquad 3.1.2.5$$

$$c = (1 - K_r)[\rho + (1 - K_\pi)\pi^*] \qquad 3.1.2.6$$

$$\pi^* = \frac{1}{(1 - K_\pi)}\left[\frac{c}{(1 - K_r)} - \rho\right] \qquad 3.1.2.7$$

Also

$$b = (1 - \mathrm{K_r})\mathrm{K_\pi} \quad 3.1.2.8$$

$$\mathrm{K_\pi} = \frac{\mathrm{b}}{(1 - \mathrm{K_r})} \quad 3.1.2.9$$

We have used annual data spanning from 1976 to 2016. Output gap was estimated using modified HP filter while T-Bill rate of 6-months tenure was used as proxy of policy rate changes.

The estimates of Taylor rule as shown in Table 3 suggest that signs of all the coefficients are in line with economic intuition. It also shows that SBP has been caring more about output stability than price stability. The co-efficient of inflation b is also considerably lower than one that is not consistent with Taylor principal. Estimate of $\mathrm{K_r}$. at 0.77 also shows significant interest rate inertia.

Table 3: Taylor Rule Estimation Results	
c	0.43 (0.89)
b	0.14 (.05)
d	0.35 (0.14)
$\mathrm{K_r}$	0.77 (.097)
Standard errors are in parenthesis	

Substituting the estimated coefficients along with equilibrium natural interest rate as the average real interest rate (6-months T-Bill rate –Inflation) from 1976 to 2016 in equation 3.1.2.7, implicit inflation target is computed at 8.9 percent.

This is slightly higher than inflation target computed by Malik and Ahmed (2010). They applied similar technique on annual data from 1991 to 2006 and estimated optimal inflation target at 8.0 percent.[15]

3.2 Statistical Methods

As mentioned earlier, in addition to macro econometric approaches, we have also attempted to estimate the price-stability consistent inflation target by applying two statistical approaches. First links the relative price variability to the headline inflation and the second computes the inflation rate that is consistent with maximum sustainable level of growth or zero output gap. These approaches and their findings are discussed in a greater detail as under.

3.2.1 Relative Price Variability

Inflation impacts the real economy through changes in relative prices. Higher inflation increases the RPV that distorts the information content of nominal prices, thereby incurring social costs by impeding the efficient allocation of resources. This positive relationship between inflation and RPV is substantiated by a plenty of literature.[16]

More importantly, recent literature suggests non-linear relationship between inflation and RPV (see e.g. Fielding and Mizen (2008) and Bick and Nautz (2008)). The marginal impact of inflation on RPV is different for different levels of inflation. Specifically, using price observations from bazaars,

[15] This difference may be because of slight modification of Taylor rule specification. Following Leigh (2005), we have added interest rate smoothing variable in the rule. Further, we have also used longer data sample (1976-2016) compared with their sample of 1991-2006.

[16] Parsley (1996), Debelle and Lamont (1997), Aarstol (1999), Jaramillo (1999), Chang and Cheng (2000), Konieczny and Skrzypacz (2005), and Nautz and Scharff (2005).

convenience stores, and supermarkets in Turkey, Caglayan et al. (2008) found a V-shaped relationship between inflation and RPV. Fielding and Mizen (2008) for USA and Choi (2010) for USA and Japan show evidence of a U-shape profile of the inflation-RPV relationship. This implies that reducing inflation below a certain threshold is also harmful (Bruno and Easterly 1998). The identification of upper and lower inflation thresholds could provide useful information about the appropriate location of band of inflation target.

Following the empirical literature (see e.g. Bick and Nautz (2008),Jaramillo (1999), Parsley (1996), Fielding and Mizen (2000)), we have computed RPV by following formula:

$$RPV_t = \sqrt{\sum \left(\omega^i\left(\pi_t^i - \pi_t\right)\right)^2} \qquad 3.2.1.1$$

Where ω^i is the weight of sub index in the CPI basket, π_t^i is the year on year inflation of *i*th sub index and π_t is year on year head line inflation.

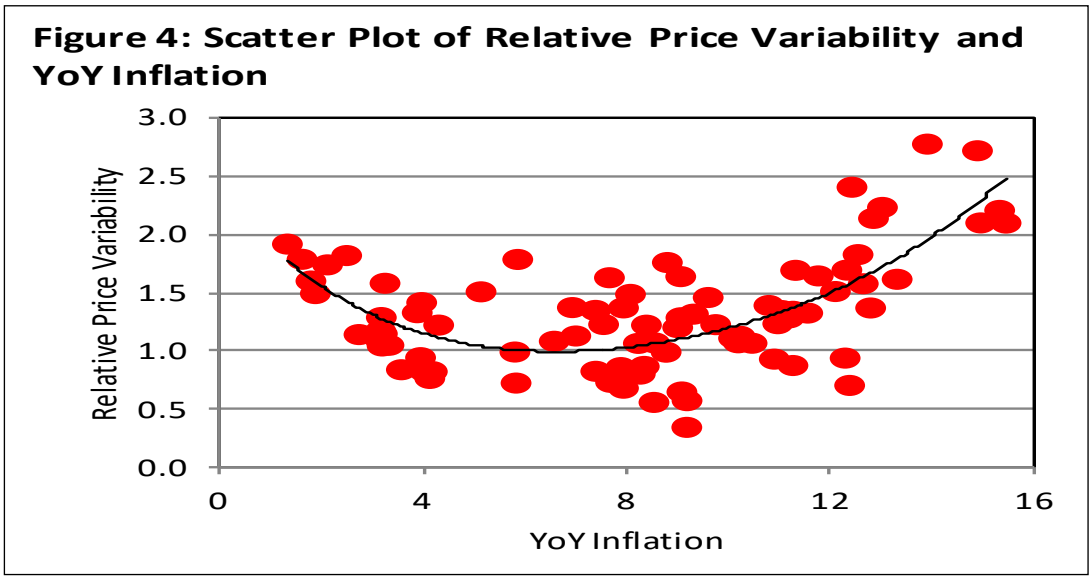
Table 4: Relative Price Variability

2002-2016		2009-2016	
Inflation Range	RPV	Inflation Range	RPV
[2 3)	1.17	[2 3)	1.47
[3,4)	1.16	[3,4)	1.19
[4,5)	1.10	[4,5)	1.06
[5 6)	1.29	[5 6)	1.35
[6,7)	1.29	[6,7)	1.20
[7,8)	1.24	[7,8)	1.08
[8 9)	1.41	[8 9)	1.22
[9 and above	1.86	[9 and above	1.60

We have computed RPV using monthly data on 89 sub-indices of CPI basket from July 2009 to June 2016. Basic data analysis shows that RPV is minimal when inflation is in the band of 4 percent to 5 percent (Table 4). The results are robust to extending data back to July 2002.

Further, from Figure 4**,** it appears that relationship between inflation and RPV is nonlinear (U-shaped) in Pakistan. This seems in line with the findings of Fielding and Mizen (2008) and Choi (2010).

Figure 4: Scatter Plot of Relative Price Variability and YoY Inflation



Following Bick and Nautz (2008), we have defined following double thresholds model to estimate non-linear relationship between inflation and RPV.

Table 5: A Double-Threshold Model for the Inflation-RPV Linkage	
$RPV_t = (\alpha_1 + \beta_1 \pi_t)I.(\pi_t \leq \gamma_1) + (\alpha_2 + \beta_2 \pi_t)I.(\gamma_1 < \pi_t \leq \gamma_2) + \beta_3 \pi_t I.(\pi_t > \gamma_2) + \beta_4 RPV_{t-1} + \epsilon_t$	
	20 % Rule
Threshold Estimates	
$\hat{\gamma}_1$	4.3
$\hat{\gamma}_2$	9.1
Regime Dependent Inflation Coefficients:	
$\hat{\beta}_1$	-0.24**
	(0.06)
$\hat{\beta}_2$	-0.018
	(0.59)
$\hat{\beta}_3$	0.18**
	(0.04)
Regime Dependent Intercepts:	
$\hat{\alpha}_1$	1.6
	(0.26)
$\hat{\alpha}_2$	0.89
	(0.49)
Regime Independent Coefficient:	
$\hat{\beta}_4$	0.33**
	(0.11)
R^2	0.60
Observations in Regime 1	21
Observations in Regime 2	28
Observations in Regime 3	36
Note: ** indicates significance at the 1% level. Standard errors are in parentheses. Each regime consists of at least 20% of all observations.	

$$RPV_t = (\alpha_1 + \beta_1 \pi_t)I.(\pi_t \leq \gamma_1) + (\alpha_2 + \beta_2 \pi_t)I.(\gamma_1 < \pi_t \leq \gamma_2) + \beta_3 \pi_t I.(\pi_t > \gamma_2) + \beta_4 RPV_{t-1} + \epsilon_t \quad 3.2.1.2$$

Where I. is an indicator function, γ_1 is the lower threshold of inflation and γ_2 is the upper threshold of inflation. β_1 is the marginal impact of inflation on RPV when inflation is below the lower threshold. $\beta_2$is the marginal impact of inflation on RPV when inflation is between lower and upper thresholds. β_3 is the marginal impact of inflation on RPV when inflation is above upper threshold. α_1, α_2 and α_3 are regimes dependent intercepts.

Upper panel of the Table 5 reports results of two inflation thresholds. The lower threshold is 4.3 percent while the upper threshold is 9.1 percent. The former is more close to crude data analysis reported in Table 4 (where exogenous thresholds were imposed) while the latter is considerably higher.

The middle panel of Table 5 reports the results of regimes specific marginal impact of inflation on RPV. The results reveal that both the sign and magnitudes of the inflation coefficients depend on the level of inflation. In the low inflation environment (inflation below 4.3 percent), the marginal impact of inflation

($ß_1$) is significantly negative. This implies further reduction in inflation will increase price dispersion significantly that does not bode well for future decision making by businesses and households.

In the moderate inflation environment (inflation between 4.3 percent and 9.1 percent), the marginal impact of inflation ($ß_2$) is considerably weaker and insignificant. In the high inflation environment (inflation above 9.1 percent), marginal impact of inflation ($ß_3$) is positive and statistically significant. Thus inflation exceeding upper threshold leads to price uncertainty. Thus inflation below 4.3 percent and above 9.1 percent significantly increases price dispersion that does not bodes well for economic growth and thereby social welfare.

3.2.2 Output Gap

Output gap—the difference between actual and potential output—tells us whether the inflation will tend to move up or down. At its potential when supply and demand in the economy are balanced (zero output gap and unemployment rate corresponding to NAIRU) inflation tends to move to its long run value. This long run inflation level also provides guidance for setting the long run inflation target.

This technique gets inspiration from the vertical version of Phillips curve that followed seminal research of Nobel Prize winners Milton Friedman (1968) and Edmund Phelps (1967). They established that the economy gravitates to some natural rate of unemployment in the long run, irrespective of the inflation rate. Efforts to lower unemployment below this rate will only cause inflation, and unemployment above this rate will lead to a decline in inflation. This unemployment rate is often termed as non- accelerating inflation rate of unemployment (NAIRU).

The potential output[17] is defined as the maximum sustainable level of employment. When economic growth is above its potential level (positive output gap and unemployment rate below NAIRU) inflation will rise, while in case of economic growth below potential (negative output gap and unemployment rate above NAIRU) inflation will decline. At its potential (NAIRU), inflation moves to its long run value.

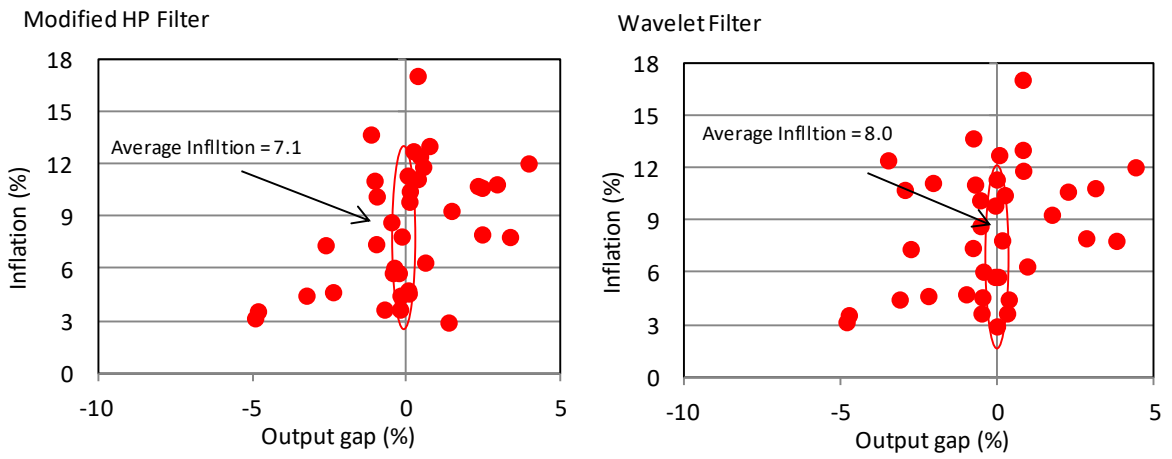
Estimating potential output, however, is very difficult. According to Mishkin (2007), considerable uncertainty surrounds the measures of potential output, derived from any of the well-known approaches. In the literature, three approaches are used to estimate potential output. These are aggregate approaches, production function approach and DSGE approach.

The aggregate approaches estimate potential output by assuming sustainable level of output as permanent. This permanent component of output is estimated by using various univariates statistical methods. Production function approach estimates potential output from underlying factors of production such as labor, capital and total factor productivity. In the New Keynesian DSGE framework, potential output is steady state level of output (zero output gap) where there is complete adjustment in prices and wages.

[17] In the New Keynesian DSGE framework, potential output is defined as the level of output that an economy could attain if wages and prices were fully flexible.

Given the DSGE in infancy stage and relatively greater uncertainty about the estimates and data availability issues of components of production function approach, we focus on aggregate or uni-variate approaches of estimating potential output. Specifically, we estimate the potential output and thereafter output gap by using modified HP filter and Wavelet filter.

Figure 5: Scatter Plot of Output Gap and Inflation (1980-2016)



Estimates of output gap measured by modified HP filter suggest that average inflation was around 7.1 during the period when the output gap was near zero. The result of Wavelet filter shows that average inflation was around 8.0 percent when output gap was in the vicinity of zero.

Further, we have also computed average inflation corresponding to periods when actual unemployment was close to NAIRU. Following Shaheen et al 2011, the NAIRU is estimated by the backward looking Philips curve.

$$\pi_t = c + \sum \gamma_i \pi_{t-i} + \beta(u_t - u_t^*) + \sum_j \mu \, \pi_{t-i}^{imp} + \epsilon_t \qquad (3.2.2.1)$$

Where, π_t is a CPI inflation rate, $(u_t - u_t^*)$ stands for unemployment gap while π_t^{imp} denotes import prices. Unemployment rate (u_t) can be decomposed into cyclic $(u_t - u_t^*)$ and trend component (u_t^*).

$$u_t = (u_t - u_t^*) + u_t^* \qquad (3.2.2.2)$$

Assuming that the trend component is unobservable and follows time varying autoregressive process, therefore,

$$u_t^* = \rho_1 u_{t-1}^* + \omega_t \qquad (3.2.2.3)$$

And cyclic component follows AR(2) process consistent with Gordon (1997).

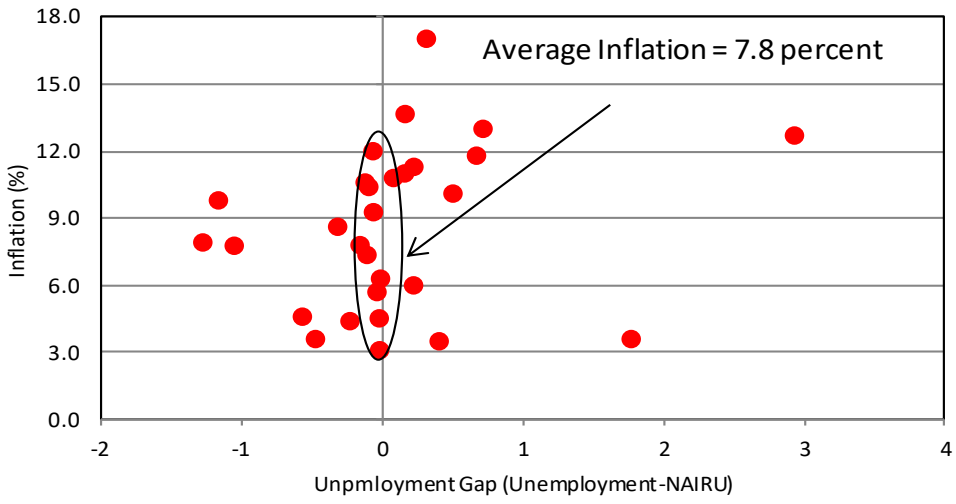
$$(u_t - u_t^*) = \theta_1 (u_t - u_t^*)_{t-1} + \theta_2 (u_t - u_t^*)_{t-2} + \vartheta_t \qquad (3.2.2.4)$$

$$\text{where } \theta_1 + \theta_2 < 1$$

Collectively above equations constitute a state space model. We have estimated this system by Kalman filter under the assumption of multivariate normal distributions of errors. This has given us opportunity to estimate unobservable component: unemployment gap ($(u_t - u_t^*)$ along with unknown parameters.

After the estimation of unemployment gap, we have observed that the average inflation is around 7.8 percent corresponding to close to zero unemployment gap.

Figure 6: Scatter Plot Between Unemployment Gap and Inflation



In short, when economy operates close to its potential, inflation averages around 7 to 8 percent. This can be considered as natural log run rate of inflation that can be used as a guide for setting inflation target.

3.3 Microeconomic

3.3.1 Socioeconomic Planner

This approach estimates inflation target which is socially and economically optimal. For this purpose, we utilize sand and grease effects of inflation on social welfare and economic growth.

The debate of "sand effect" goes back to Milton Friedman (1977);

"[Higher, more variable inflation causes: a] reduction in the capacity of the price system to guide economic activity; distortions in relative prices because of the introduction of greater friction, as it were, in all markets; and very likely, a higher recorded rate of unemployment." Milton Friedman, 'Inflation and Unemployment,' Nobel Lecture (1977).

In an inflationary environment, firms are uncertain about the level of future prices. This uncertainty impairs employers set of information. Since employers use their own weak information set for setting the future wages, this leads to uneven wage changes among firms. Further inability of cash constraints firms to adjust wages also raises variance of real wage distribution in inter and intra markets. These wage mistakes misdirect resources from their most productive uses, and induce suboptimal growth and social disparities.

It is well known that workers not only care about their own pay but also care about their pay relative to other workers of same potential in the market. So wage distortions can affect the utility of the workers. These utility effects could translate into changes in worker effort. They supply fewer efforts and become less productive. Wage distortions create social inequality and undermine social cohesion.

Inflation is not always accused for negative impact but sometimes admire for its positive role– "grease effect". The grease effect argument is first forwarded by Tobin (1972), who states that, in a moderate inflation, firms can adjust to changing labor-market needs by raising some workers' pay in excess of inflation while giving others rises that appear generous but lag behind inflation[18]. This creates inter-market healthy competition among the workers. It also reduces frictional unemployment. In real terms, most of the hired workers are no better off, they just become victim of money illusion. According to this argument, moderate inflation does not raise much of variance of real wage distribution, however it reduces unemployment, increases competition and accelerates growth.

The grease–sand debate discloses positive and negative impacts of inflation on social and economic growth. Literature reveals that different inflation bands produce sand-grease-sand sequence[19]. To attain socially optimal inflation there is a need to identify inflation range that produces grease effects. From above discussion we observe that sand effect raises the variance of the real wage distributions. So, sand effect can *weakly* be identified as periods of high variances of real wage distributions while grease effect is a period of low variance of real wage distribution. We use real wage differentials (between higher wage earners –90th percentile and middle wage –50th percentile earners, and between middle wage earners to low wage earners –10th percentile) as a metric to identify the sequence. To set the socially optimal inflation target, we need to identify the inflation rate for which these wage differentials have minimum values or in other words produces the grease effect.

To obtain inflation target that is socially and economically optimal we set a rule which weigh wage differentials (social welfare) along with the growth (economic welfare):

$$\text{Policy rule} = w_1 * \text{realgdp} - w_2 * \text{real wagedifferential} \qquad 3.3.1.1$$

Where w_1 and w_2 are weights that depends upon the discretion of the policy makers. We try to identify the moderate inflation band for which this policy rule is at maximum. We have used annual data from Labor Force Survey from 1990 to 2011 and real gdp and inflation data from SBP. We have estimated this rule for each year. Result shows that inflation in the band of 4.0 percent to 5.0 percent corresponds to the lowest wage dispersion and maximizes equation 3.3.1.1.

3.4 Numerical Inflation Target for Pakistan

In view of the above discussion, majority of methods (inflation growth nexus, Taylor rule, RPV and output gap) show that inflation level above which it is harmful for growth is around 9.0 percent. Regarding the lower bound, relative price variability and socioeconomic planner has similar findings that inflation rate below 4.0 percent does not bode well for society. An optimal inflation level (that corresponds to meaning of price stability) lies somewhere between 4.0 to 9.0 percent.

While choosing inflation target band, there are some tradeoffs. On the one hand, too wide a range impairs central bank ability to anchor inflation expectations that may lead to magnify the impact of supply shocks on inflation. On the other hand, it would be difficult to achieve the target with too narrow a range for the economy like Pakistan that is subject to unanticipated supply side shocks such as failure of agriculture crops, global commodity price shocks and sharp exchange rate depreciation.

---

[18] *"Higher prices or faster inflation can diminish involuntary, disequilibrium unemployment...The economy is in perpetual...disequilibrium even when it has settled into a stochastic macro-equilibrium...[When wages are rigid downward] price inflation...is a neutral method of making arbitrary money wage paths conform to the realities of productivity growth."* AEA Presidential Address (1972)

[19] Fagan. G.,and Messina .J.(2009), "Downward wage rigidity and optimal steady state inflation." IMF working paper series No. 1048.

Keeping this in mind, we have also benefitted from the practices of other emerging economies that have weights of food and energy in their CPI basket similar to that of Pakistan. Width of inflation target bands in the selected economies ranges from 200 to 400 basis points, with the mean of 300 basis points **(**Table 6**)**. Broader set of 29 inflation targeting emerging economies also give similar picture. Width of inflation target bands in the latter group ranges from 200 basis points to 400 basis points, with the average of 275 basis points. Of particular interest is the case of India that has a lot of similarities with Pakistan. The two countries have common history, large share of food and energy in CPI basket,[20] similar supply shocks such as floods in the moon-soon season and global commodity prices and almost similar inflation history **(**Figur**e** 8).[21] India has set the upper bound of inflation target at 6.0 percent, with the width of inflation target band of 400 basis points.

Volatility of inflation in Pakistan is the second major consideration for choose the inflation target band. Based on annual data from FY85 to FY18, deviation of CPI inflation from its mean (measured by standard deviation) is 3.7 **(**Figure 7).

Another important factor to decide the band of inflation target is exchange rate consideration. Pakistan has recently adopted market base flexible exchange rate regime. Being a small open economy, Pakistan's exchange rate is vulnerable to various shocks such as global commodity prices and sudden stops or reversal of capital flows that could, in turn lead to significant deviation of inflation from its medium term target. During the last 40 years (FY80 to FY19), exchange rate showed a maximum annual depreciation of 20.3 percent in FY09 (Figure 9). Following ERPT estimate from literature (in the range of 10 to 15 basis points)[22], this much depreciation in future could increase the inflation by 320 basis points.

Keeping in view the above considerations, this study recommends inflation target band of 300 basis points. Estimates of the models suggest that inflation below 4.0 percent is harmful for the society. Adding 300 basis points inflation target band on this lower threshold translates into inflation target of 4.0 to 7.0 percent, with 5.5 percent as the midpoint.

It is worth highlighting that this study may suffer from certain limitations. First, the above estimates are based on the past data. Once we switch to inflation targeting regime, these estimates may not hold for future (Lucas critique). Second, this study contains very few observations where inflation falls below 4.0 percent. Therefore, it would be difficult to estimate the welfare impact of inflation below this point.

4. Conclusion

This study aimed at estimating the inflation target band that would be consistent with the meaning of price stability in Pakistan's context. With the plan to move to flexible inflation targeting, this investigation would help the policy makers in setting the medium term inflation target that would be beneficial for the society.

Global practices suggest that countries target low but positive inflation level. For instance, advanced economies inflation targets are in the range of 1 to 3 percent while in case of emerging economies inflation targets are slightly higher. Following international best practices, we have applied macro

[20] Share of food in CPI basket of Pakistan and India are 37.5 percent and 45.9 percent respectively. Likewise, share of energy in CPI basket of Pakistan and India are 9.0 percent and 6.8 percent respectively.

[21] During 1975 to 2016, average inflation in Pakistan was 7.8 percent with a standard deviation of 5.4 while average inflation in India was 7.5 percent with a standard deviation of 4.9.

[22] Ahmad and Ali (1999), Hyder and Shah (2005)

econometric, statistical and micro econometric approaches to search for the inflation level that is beneficial for the society. In most of the approaches, we have used annual data from 1976 to 2016.[23]

Our results show that inflation level above 8 to 9 percent is harmful for the society. On the lower bound inflation below 4.0 percent is also undesirable. Keeping in mind these findings, inflation target range in the similar emerging economies, history of inflation volatility in Pakistan and importance of exchange rate, we recommend inflation target to be set at 5.5 percent with a band of +/- 1.5.

[23] Due to data availability issues on components of CPI and labor force survey, we have used monthly data on CPI components from July 2009 to June 2016 for Relative Price Variability (RPV) approach and annual data from 1990 to 2011 for socioeconomic planner approach.

References

1. Aarstol, M., 1999. Inflation, inflation uncertainty, and relative price variability. *Southern Economic Journal*, pp.414-423.

2. Ahmad, E. and Ali, S.A., 1999. Exchange rate and inflation dynamics. *Pakistan Development Review*, *38*(3), pp.235-252. 15 basis points

3. Barro, R.J., 1996. *Determinants of economic growth: a cross-country empirical study* (No. w5698). National Bureau of Economic Research.

4. Bick, A. and Nautz, D., 2008. Inflation thresholds and relative price variability: evidence from US cities. *International Journal of Central Banking*, *4*(3), pp.61-76.

5. Bruno, M. and Easterly, W., 1998. Inflation crises and long-run growth. *Journal of Monetary Economics*, *41*(1), pp.3-26.

6. Caglayan, M., Filiztekin, A. and Rauh, M.T., 2008. Inflation, price dispersion, and market structure. *European Economic Review*, *52*(7), pp.1187-1208.

7. Chang, E.C. and Cheng, J.W., 2000. Further evidence on the variability of inflation and relative price variability. *Economics Letters*, *66*(1), pp.71-77.

8. Choi, C.Y., 2010. Reconsidering the relationship between inflation and relative price variability. Journal of Money, Credit and Banking, 42(5), pp.769-798.

9. Clarida, R., Galı, J. and Gertler, M., 1998. Monetary policy rules in practice: some international evidence. *european economic review*, *42*(6), pp.1033-1067.

10. Clinton, K., 2000. Strategic choices for inflation targeting in the Czech Republic. *Inflation targeting in transition economies: The case of the Czech Republic*.

11. Debelle, G. and Lamont, O., 1997. Relative price variability and inflation: evidence from US cities. *Journal of Political Economy*, *105*(1), pp.132-152.

12. Eckstein, O. and Wilson, T.A., 1962. The determination of money wages in American industry. *The Quarterly Journal of Economics*, *76*(3), pp.379-414.

13. Fielding, D. and Mizen, P., 2008. Evidence on the functional relationship between relative price variability and inflation with implications for monetary policy. *Economica*, *75*(300), pp.683-699.

14. Fischer, S., 1993. The role of macroeconomic factors in growth. *Journal of monetary economics*, *32*(3), pp.485-512.

15. Fortin, P., Akerlof, G.A., Dickens, W.T. and Perry, G.L., 2002. *Inflation and Unemployment in the US and Canada: A Common Framework* (No. 20-16). Université du Québec à Montréal, Département des sciences économiques.

16. Friedman, M., 1968. The role of monetary policy. American Economic Review, 58 pp.1-17

17. Friedman, M., 1977. Nobel lecture: inflation and unemployment. *Journal of political economy*, *85*(3), pp.451-472.

18. Groshen, E. and Schweitzer, M., 1999. Identifying inflation's grease and sand effects in the labor market. In *The costs and benefits of price stability* (pp. 273-314). University of Chicago Press.

19. Hansen, B.E., 1999. Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of econometrics*, *93*(2), pp.345-368.

20. Hussain, M., 2005. Inflation and growth: Estimation of threshold point for Pakistan. *Economic Policy Department, State Bank of Pakistan, October*.

21. Hyder, Z. and Shah, S., 2005. *Exchange rate pass-through to domestic prices in Pakistan* (No. 0510020). University Library of Munich, Germany.

22. Iqbal, N. and Nawaz, S., 2009. Investment, inflation and economic growth nexus. *The Pakistan Development Review*, pp.863-874.

23. Jaramillo, C.F., 1999. Inflation and relative price variability: reinstating Parks' results. *Journal of Money, Credit and Banking*, pp.375-385.

24. Jonas, J. and Mishkin, F.S., 2003. *Inflation targeting in transition countries: Experience and prospects* (No. w9667). National Bureau of Economic Research.

25. Kaliski, S.F., 1964. The relation between unemployment and the rate of change of money wages in Canada. *International Economic Review*, *5*(1), pp.1-33.

26. Khan, M.S. and Ssnhadji, A.S., 2001. Threshold effects in the relationship between inflation and growth. *IMF Staff papers*, *48*(1), pp.1-21.

27. Konieczny, J.D. and Skrzypacz, A., 2005. Inflation and price setting in a natural experiment. *Journal of Monetary Economics*, *52*(3), pp.621-632.

28. Leigh, D., 2005. Estimating the implicit inflation target: An application to US monetary policy, *IMF Working papers*, 77, pp.1-25..

29. Lipsey, R.G., 1960. The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1862-1957: a further analysis. *Economica*, pp.1-31.

30. Malik, W.S. and Ahmed, A.M., 2010. Taylor rule and the macroeconomic performance in Pakistan. *The Pakistan Development Review*, pp.37-56.

31. Mishkin, F.S., 2007. *Estimating potential output: a speech at the Conference on Price Measurement for Monetary Policy, Federal Reserve Bank of Dallas, Dallas, Texas, May 24, 2007* (No. 299).

32. Mubarik, Y.A. and Riazuddin, R., 2005. *Inflation and growth: An estimate of the threshold level of inflation in Pakistan*. State Bank of Pakistan.

33. Nautz, D. and Scharff, J., 2005. Inflation and relative price variability in a low inflation country: empirical evidence for Germany. *German Economic Review*, *6*(4), pp.507-523.

34. O'Reilly, B., 1998. *The benefits of low inflation: taking stock* (No. 83). Bank of Canada.

35. Parks, R.W., 1978. Inflation and relative price variability. *Journal of Political Economy*, *86*(1), pp.79-95.

36. Parsley, D.C., 1996. Inflation and relative price variability in the short and long run: new evidence from the United States. *Journal of Money, Credit and Banking*, *28*(3), pp.323-341.

37. Perry, G.L., 1964. The determinants of wage rate changes and the inflation-unemployment trade-off for the United States. *The Review of Economic Studies*, *31*(4), pp.287-308.

38. Phelps, E.S., 1967. Phillips curves, expectations of inflation and optimal unemployment over time. *Economica*, pp.254-281.

39. Phillips, A.W., 1958. The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861–19571. *economica*, *25*(100), pp.283-299.

40. Samuelson, P.A. and Solow, R.M., 1960. Analytical aspects of anti-inflation policy. *The American Economic Review*, *50*(2), pp.177-194.

41. Shaheen, F., Haider, A. and Javed, S.A., 2011. Estimating Pakistan's Time Varying Non-Accelerating Inflation Rate of Unemployment: An Unobserved Component Approach. *International Journal of Economics and Financial Issues*, *1*(4), p.172.

42. Skreb, M., 1998. A note on inflation. *Cottarelli, Carlo and György Szapáry (eds.),Moderate Inflation.* International Monetary Fund and National Bank of Hungary, pp.179-184.

43. Tobin, J., 1972. Inflation and unemployment, in "American Economic Review", n. 1.

Appendix-A

Table 6: Inflation target bands of countries with similar CPI basket				
Country	Food and beverage	Energy	Inflation Target	Target Band
Pakistan	37.5	9.0	4-7	300
Turkey	21.8	11.0	3-7	400
India	45.9	6.8	2-6	400
Thailand	39.0	11.8	1-4	300
Indonesia	35.0		2-4	200
Philippines	36.1		2-4	200

Figure 7: Pakistan's Inflation History

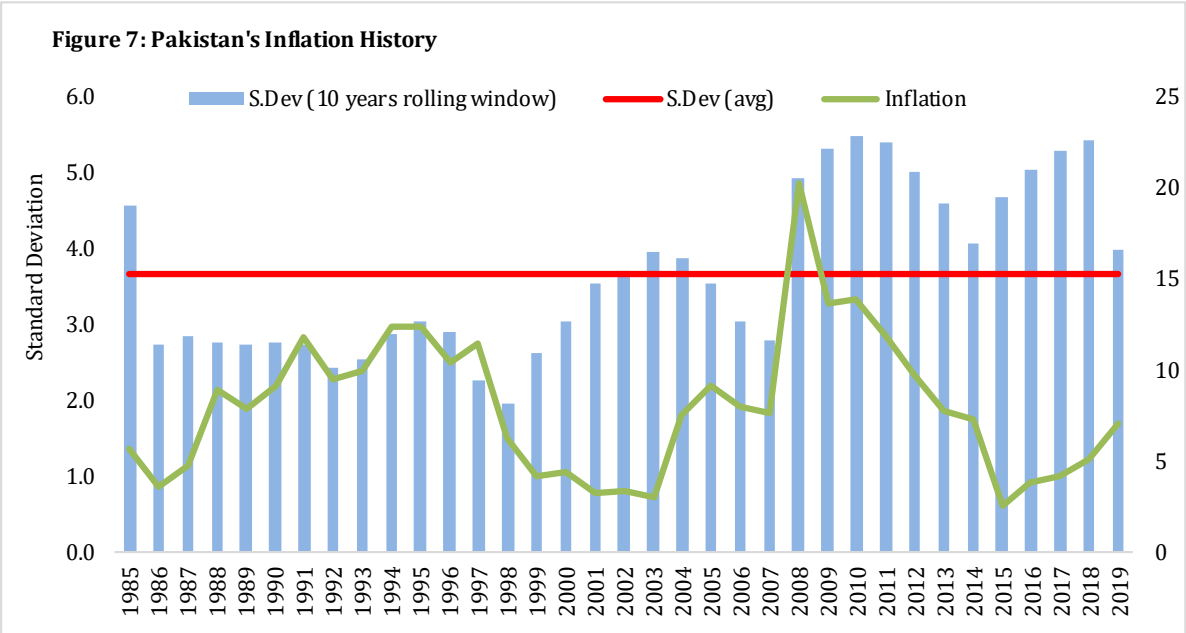


Figure 9: Pakistan's Exchange Rate History

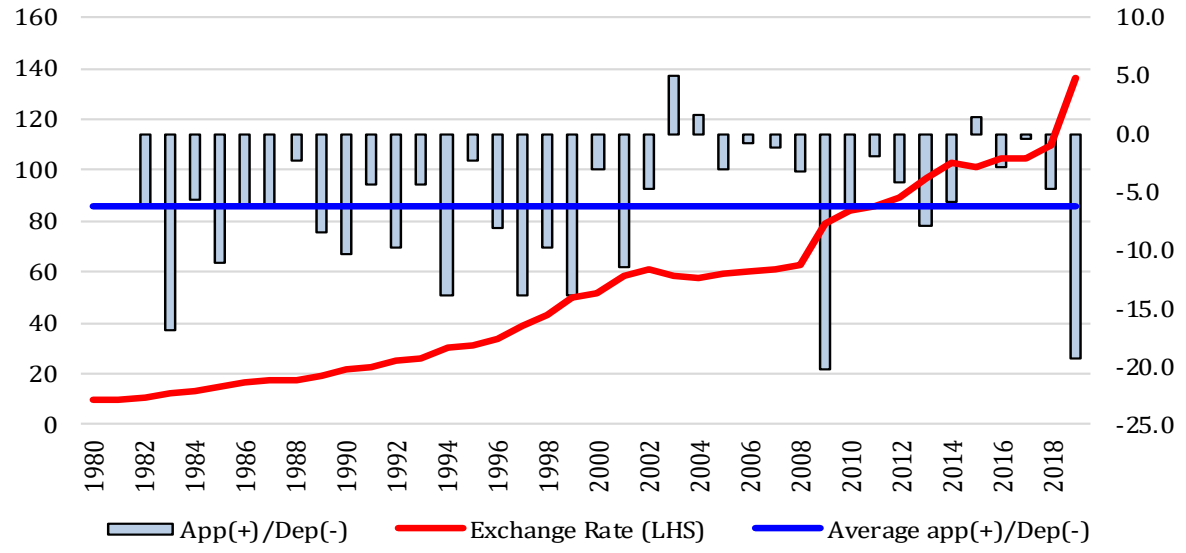


Figure 10: Estimates of Output Gap