INFLATION FORECASTING UNDER DIFFERENT MACROECONOMIC CONDITIONS: THE CASE STUDY OF PAKISTAN

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CERTIFICATE

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ACRONYMS AND ABBREVIATIONS

SBP	State Bank of Pakistan
GDP	Gross Domestic Product
ARIMA	Auto Regressive Integrated Moving Average
TAR	Threshold Auto Regressive
VAR	Vector Auto Regression
NAIRU	Non Accelerating Inflation Rate of Unemployment
UK	United Kingdom
US	United States
PC	Philips Curve
DF	Dickey Fuller
ADF	Augmented Dickey Fuller
CPI	Consumer Price Index
SPI	Sensitive Price Index
WPI	Wholesale Price Index
IFS	International Financial Statistics
IMF	International Monetary Fund
STAR	Smooth Transition Threshold Autoregressive Model
ANN	Artificial Neural Network
LIM	Leading Indicator Model
HP	Hodrick and Prescott Filter
MSE	Mean Squared Error
RMSE	Root Mean Square Error
PP	Phillips and Perron

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ABSTRACT

Inflation forecasting has been important task for monetary authorities, policy makers and government. Prediction about inflation confer us a precise image of how the economy is expected to accomplish in the future. It is essential job for researchers to examine which methods are suitable for inflation forecasting. We have used Naive model, ARIMA model, Philips curve model and Philips Curve (TAR) under different macroeconomic conditions with reference to real, revised and final data from 1974 to 2014 and predicted out of sample inflation forecast for 2015, afterward we roll forward our regression from 1975 to 2015 to forecast inflation for 2016. We have analyzed RMSE and MAE of naive model are less than other models by using real, revised and final data for one year ahead out of sample inflation forecasting, both forecasting accuracy measures RMSE and MAE show that naive model is most superior to other models. On the other hand for two years ahead out of sample inflation forecast, according to real time data RMSE shows that naive model is most superior to other models whereas MAE shows that Philips curve Threshold auto regressive model is most superior to other models. According to revised and final data for two years ahead out of sample inflation forecasting both forecasting accuracy measures RMSE and MAE shows Naive model is most superior to other models.

Keywords: Inflation forecasting, Macroeconomic conditions, Naive model, Philips Curve

CHAPTER 1

INTRODUCTION

Inflation forecasting refers as an activity predicting future value of inflation. It has significant effect on economic agents such as consumer and investors. If unexpected high inflation prevails, it will be particularly costly for families that depend on pensions and bonds for long time period to provide major share of retirement payment. If inflation level is higher than the expected inflation, it will decrease household real purchasing power, because usually nominal income earned form such assets is fix. Accordingly standard of living of senior retired citizen severely effect as they age. An unanticipated increase in inflation similarly have tendency to decrease the labor wage and their real buying power for a period because due to change in general price level, income and wage adjust slowly. Firms and families have to spend their energies and time to reduce the currency holding and businesses to frequent adjustment in price level during high inflation. Further cost of capital is likely to be increased by high inflation after tax payment, in this way business investment will decrease. Therefore, such adverse outcome is consequence of capital depreciation (Yellen, 2015).

Macro-economic conditions are defined here with reference to real time, revised and final data. Several macroeconomic variables printed semi-annually, annually they are projected estimates known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provides opportunity for users and creator of the data to analyze to which extent and direction revisions take place. After one year data is revised and known as revised data.

When data is revised after second year is known as final data (McKenzie and Gamba, 2008).

Kanyama and Thobejane (2013) stated that Inflation forecasting has been important task for monetary authorities, policy makers and government. Prediction about inflation confer us a precise image of how the economy is expected to accomplish in the future. It is essential job for researchers to examine which methods are suitable and ample to carry out a reliable prediction of inflation, which policy makers can utilize to forecast inflation for effective allocation of resources. Hafer and Hein (1990) have assessed the relative predicting evaluation of interest rate based models and time series univariate model in predicting inflation. They claimed that univariate model better perform or similarly perform in a good way relative to other model. Alles and Horton (1999) used error correction model, interest rate based models, time series univariate model and survey method to evaluate the relative predicting power of these models and found univariate model outperform the other models. On the other hand Stock and Watson (1999) said that out of sample inflation forecasting from traditional Philips curve remained better than other model which was constructed on macroeconomic variables with prices of goods, interest rate and currency prices. Over the long period of time for the guidance of the monetary policy, Philips curve has been utilized as an essential tool around the globe .Philips curve used to forecast inflation and provide guidance for monetary policy makers that they have to use expansionary or contractionary monetary policy to control price level.

Yellen (2015) said economic notion recommend and empirical studies provide confirmation that in an economy the inflation variation from trend somewhat depend on the magnitude of capacity utilization. For instance, unemployment gap is estimated by the difference between the general unemployment rate and natural unemployment rate. Nevertheless, many contemporary studies show that in past twenty year inflation forecast based on the Philips curve underperform the integrated moving average (1, 1) model, naive model or an unobserved stochastic volatility model.

Thus the question arises that either in policy discussions Philips curve has to carry on noteworthy place. Atkenson and Ohanain (2001) wrote the first paper which casts uncertainty about the effectiveness of the Philip's curve, their results showed that naive model better perform than the Philip's curve based model for inflation forecasting. Since then, in many papers the relative forecasting performance has been explored, particularly by Stock and Watson (2007, 2008) naive model better perform for 1 year ahead forecasting whereas Philips curve better perform for 2 year ahead inflation forecasting. Therefore, from the above studies a proper opinion concerning the worth of inflation forecast from Phillips curve models is unclear because sometimes Philips curve better than the naive model and sometimes underperform the naive model. However, an attention-grabbing question is postured by stock and Watson, although, the some indication is in contradiction of the effectiveness of Phillips curve predictions, if you were said that in the following quarter economy was going to turn in the recession with unemployment rate raised by 2% then would you vary the inflation forecast? There is robust indication that numerous monetary policymakers and forecasters would, really vary their predictions, for instance, under the sensible monetary circumstance, Goldman Sachs issue on 4th June 2010 toward the end of year 2009 the anticipated gap of Gross Domestic Product was 6.5 percent. It will need years to abolish the growth above the trend. Therefore, by the late 2011, it is expected that the measures of fundamental consumer inflation reducing near to 0 percent. This opinion was repeated to express the agreement by Federal Open Market Committee in 27th April 2010. "In light of stable longer-term inflation expectations and the likely continuation of substantial resource slack, policymakers anticipated that both overall and core inflation would remain subdued through 2012."

Despite the fact that, most of the studies that inspect the relative performance of the Philips curve model in terms of forecasting put emphasis on the performance of overall sample period and its specific subsamples but there are little studies that throw light on questions raised by Stock and Watson. Dotsey and Stark (2005) studied whether forecasting power is increased by largely decreasing the capacity utilization and their results showed that decreasing capacity utilization don't increase forecasting power. Nevertheless, Stock and Watson (2008) gave some subtle indication that substantial variation of unemployment gap are in relation to time period when inflation forecast based on Philips curve (PC) are comparatively better. Fuhrer and Olivei (2010) also studied Stock and Watson's suggestion and found that naive model underperform a threshold model of Philips curve (PC-TAR).

As in above studies we came to know that different model has been utilized to forecast inflation over different time periods in other countries. Where as in case Pakistan inflation is also forecasted by different models but no one has used these macroeconomics conditions with reference to data.

1.1 Objectives of the study

The objective of this research is to compare the forecast evaluation of naive model, ARIMA model, Philips curve and Threshold Auto Regressive Philips curve model under different macro-economic conditions and select the most suitable model which provide well prediction under different macro-economic conditions with respect to data (real time, revised and final data).

We have also analyzed the differences between revised and real time data, final and real data as well as final and revised data to perceive the magnitude and direction of revisions take place.

1.2 Research questions

- Which model accomplish better forecast of inflation by using real time, revised and final data?

- What is the magnitude and direction of revisions when we calculate the differences between revised and real time data, final and real data as well as final and revised data?

1.3 Significance of inflation

If inflation level raise due to rise in food prices it mostly suffer the poor more because poor people have low incomes, they spend more than half of their income on food. Higher inflation corrode the benefits of growth as well as make the poor worse off .It will make the rich more richer and poor more poor (raise the division between rich and poor).It will also reallocate the income from fix wage earner to variable and huge income earner, for example profits (Easterly & Fischer, 2000).

If low inflation prevail, then we have to bear the cost, such as in current years cost incurred on monetary policymakers, because of low inflation they can't combat recession. It also incur cost on debtor by raising their debt burden. Obviously on the other, lender will have benefit in such condition because he will be getting more real income. Therefore overall impact on economy will be adverse, because debtor normally have less ability to bear losses. Debtor will be bankrupt, if debt burden increase and lead to decrease in collateral as a result worker, families and business holders will suffered (Yellen, 2015).

Khan and Hussain (2005) proposed that in case of Pakistan economy 6 percent is threshold inflation. It will prove ruthless if cross the threshold level and would prove tremendously destructive if change to double digit. Therefore, it become further significant for policy makers to pinpoint the actual reasons of inflation and to plan pro-active policies.

Either inflation is good or bad for economy (Khan & Hussain, 2005) said that in case of Pakistan inflation has positive impact on economy when it is below threshold level 3 to 6 percent, because it will boost investment level, the wage rate and production. On the other hand, when inflation will rise above threshold (suitable) level, it results adverse effects. As money is medium of exchange it will decreases the worth of money. Consequently, consumers and producers as well as debtor and creditor will be uncertain about their advantages and losses, in such uncertain situation investment and saving will be lower. Saving rate will decrease due to the lower return on monetary assets. Then less saving outcome less investment and less economic growth.

1.4 Organization of the Study

Rest of the research as follow: Chapter 2 includes theoretical as well as empirical literature review. Chapter 3 is related to the description of data, its sources and methodology used for estimation. Chapter 4 shed light on the results of Naive model, ARIMA model, PC model, PC-TAR model and which model has performed well for out of sample inflation forecasting under different macro-economic conditions with reference to data (real time data, revised data and final data).Chapter 5 discussed about the conclusion of thesis and policy recommendation.

CHAPTER 2

LITERATURE REVIEW

Literature review is divided into eight sections. Section 2.1 is related to theoretical background of the study. Section 2.2 is related to output gap and economic conditions. Section 2.3 is related to relationship between output gap, inflation and unemployment. Section 2.4 is related to ARIMA methodology. Section 2.5 is related to threshold models. Section 2.6 is related to Text book NAIRU model. Section 2.7 is related to empirical literature review. Section 2.8 is related to research gap.

2.1 Theoretical Background of the Study

Long Run Philips Curve shows inflation and unemployment rate is unrelated at Natural rate of unemployment. At a natural rate of unemployment there will be no inflation. Therefore, the long run Philips curve is vertical.

Short Run Philips Curve generally indicates the reverse association between the inflation rate and the unemployment rate. In short run when firms produce more due to rise in the demand of their product. In order to attract the labor, firm increases its wage rate as compared to the all other firms in the market and also lower the labor skill requirement. Resultantly this strategy will increase the wage inflation and lower the frictional unemployment. (Mortensen, 1970)

2.2 Output Gap and Economic conditions

Jahan and Mahmud (2013) when there is economic recession in the economy total amount of goods and services produced will decrease and during economic boom amount of goods and services rises. These rise and fall in the economic output are called business cycle. Policy makers and economist are conscious about the gap between actual output and potential level of output. Then difference between actual GDP and potential GDP defined as Output gap. Actual GDP shows the amount of goods and services that are produced within one year in the boundary of country. Potential GDP indicates the maximum production of goods and services when economy is efficient. Often, in an economy production capacity is known as potential output. Just as GDP can rise or fall, the output gap can go in two directions: positive and negative. If GDP will increase or decrease, then output gap will move in positive or negative directions. These directions of output gap tell about the state of economy. If there is positive output gap in the economy which indicate that amount of potential output is less than the actual output, show that existence of peak level in the economy. This outcome occurs when demand rises and in order to meet that demand, workers and factories operate above than their efficient capacity. If there is negative output gap, which indicate recession in the economy that's mean actual level of output is less than estimated output level, such outcome occurs when demand falls, workers and factories operate less than their full capacity. A negative output gap signals economy is operating inefficiently and underutilizing its resources. Thus, main aim of the monetary institutions is to stable actual output level, therefore they reduce gap between potential and actual output level, making the output gap a critical and significant role for monetary policy implication.

2.3 Relationship between Output gap, Inflation and unemployment

Fisher, Mahadeva and Whitley (1996) stated that firm can produce output at optimum level (equilibrium level) as well as above and below that optimum level. When there is positive output gap in the economy it will be the outcome of positive demand shock, in short run firms will hire new workers for the production of higher output level in given capital stock to meet the higher demand. In order to attract and hire more labor, firms will raise wage rate as a result labor cost will increase. When firms will produce more than optimum level in given capital stock, it will result to raise average cost consequently it will rise per unit cost of output. Overall labor cost and per unit output cost will increase then prices will rise. In this way real wages reduce more than the rise in the prices of goods it will lead to further increase in inflation (because of high demand accommodation of rise in wages will take place).Inflation level will continue to rise until policy action are not taken to overcome these demand shocks and in long term actual output return to its potential level.

Fisher *et al.*(1996) stated that when there is negative output gap (actual output is less than potential output) in the economy it will be the outcome of supply shock, in short run firms need to hire less workers for the production of less output level in given capital stock to meet output needs. After some time there is more labor supply in the market because there are unemployed people who are willing to work and firms have incentive to hire more workers at low wages it will raise the productivity as well as rate of return on capital stock. Consequently, firms will utilize their spare capital and try to use it full capacity then it's per unit cost will decrease resultantly it will decrease price level and there is deflationary pressure in the economy. Deflation continues to rise until policy actions are not taken to overcome these supply shocks or abundant production creates sufficient income equivalent to the demand. In long run demand will increase due to policy action and actual output will become to the potential output.

2.4 ARIMA Methodology

Box and Jenkins were the first who interpreted the ARIMA methodology and because of this, ARIMA models are most frequently mentioned as Box Jenkins models. Box and Tiao (1975) discussed the general transfer function model by using the ARIMA method.

ARIMA is an abbreviation for Auto Regressive Integrated Moving Average. An order of ARIMA model is generally symbolized as ARIMA (p,d,q), where

p = Order of the autoregressive part

d = Order of differencing

q= Order of the moving average process

The ARIMA methodology investigates and estimate correspondingly spaced intervention data, univariate time series and transfer function data by utilizing the Autoregressive Moving Average (ARMA) or Autoregressive Integrated Moving Average (ARIMA) model. In a response time series, a value is forecasted by the ARIMA model as a linear combination of past shocks, its own previous values and also present as well as previous values of other time series. A complete set of tools is given by the ARIMA technique for Parameter estimates, Identification, and Forecasting of univariate time series model. Moreover, ARIMA technique encourages interrupted time series model as well as Factored, subset and seasonal ARIMA models and also multiple regression examination with ARIMA errors.[*]

2.5 Threshold Models

In order to find the nonlinear movement of financial time series, the growing body of threshold models has been created in the course of recent decades. Tong (1983) developed the Threshold Autoregressive (TAR) model and utilize it in the forecasting of stock price movements and up till now many new models have been proposed like smooth transition threshold autoregressive model (STAR) by Chan and Tong (1986) which is closely related to Threshold Autoregressive (TAR) model. The threshold

[*]The theory section draws mostly from Franses and Dijk (2000)

autoregressive (TAR) model has been vastly influential in economics as Forecasting of economic variables has been the foremost application of Threshold Autoregressive Model.†

A two-regime Threshold Autoregressive (TAR) model takes the form

$y_t = (\alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p}) 1 (q_{t-1} \leq \gamma) + (\beta_0 + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p}) 1 (q_{t-1} > \gamma) + e_t$

Where,

$1(\cdot)$ = indicator function

$q_{t-1} = q(y_{t-1},..., y_{t-p})$ =function of the data

$p \geq 1$= Autoregressive order

γ = Threshold parameter

α_j = Autoregressive slopes when $q_{t-1} \leq \gamma$,

β_j = Slopes when $q_{t-1} > \gamma$.

And the error e_t is assumed to be a Martingale difference sequence with respect to the past history of y_t.

2.6 Text book NAIRU model

Atkenson and Ohanain (2001) forecasted inflation from textbook NAIRU model state that the change we expect in the inflation rate for future four quarters is proportional to the unemployment rate Un_t minus the NAIRU N^*.

† The theory section draws mostly from Chen (2011).

$$E_t(P^e_{t+4} - P^e_t) = \beta_o(Un_t - N^*) \text{ …………….(ii)}$$

$E_t(P^e_{t+4} - P^e_t) =$ Change in inflation that is expected for future four quarters

$\beta_\circ$= slope of Philips curve

$Un_t =$ Rate of unemployment in quarter t

$N^* =$ Non accelerating inflation rate of unemployment (NAIRU)

We estimate β_o and N^* by using an ordinary least square method.

To measure the inflation in textbook NAIRU model GDP deflator was used.

2.7 Empirical Literature Review

Distinction between data sets

Swanson (1996) stated that historical data is used by macroeconomists, in order to test the models, analyze economic policy, economic events and forecasting. However, in some studies have used historical unrevised, original data at that time which is accessible to economic agents rather revised and final data that should be used (which is provided by public statistical organizations nowadays).In other studies, in order to test the validity of results, published findings should be verified and robustness of such findings should be assessed using different data sets as revised and final data. Due to these reasons, data set was created that could give complete picture of macroeconomic data accessible to forecaster, academic researcher, and policy makers in past. According to this research each data set will be referred to vintage (It contain information set at specific time).

Reasons for data revisions

That research was focusing on two major aspects of data set: i) Nature of revisions in the data would be examined ii) Robustness of significant macroeconomic studies will be tested with respect to other sets of data as revised and final data. Considering the nature of data revisions, distinction between two types will be drawn. Detail of two types is as follows

One potential reason of revision can be due to the fact that statistical agencies update initial projected estimates of measures as real GDP when they encounter with additional source of information other than initially calculated aggregates. These revisions are based on information. Secondly, some other revisions results in change in structure of accounting system for economic data for example, changes in methods for aggregate calculation (such as chain or fixed weighting system) and alteration in base years (such as 1992 or 1997) that are used to calculate real variables. In addition, definition of concepts that are intended to measure also changes with time, which can lead to structural data revision (Croushore & Stark, 2003).

Unstable specification of Philips curve

Many of researches show that the Philips curve specification is not stable over the period of time. According to finding of Stock and Watson (1999, 2007) coefficients of lagged inflation are not stable. Whereas Clark and McCracken (2006) found coefficients of output gap are instable. Dotsey and Stark (2005) likewise found that coefficients of capacity utilization are instable, and these coefficients become insignificant by rolling forward the sample.

Lucas and Rapping (1969) examined the theoretical framework for the long run and short run inflation and unemployment tradeoff they used time series data of the United States for 1904-1965.They concluded Philips curve is short run phenomena. The long run Philips curve does not show the tradeoff between unemployment and inflation where as in the short run there exist relationship between inflation and unemployment.

Rees (1970) stated that Philips curve has been an important tool from the past decade because it provide choices to the policy makers between inflation and unemployment. The Philips curve provides different trade-offs, then weights are assigned to both evils of inflation and unemployment by policy makers. After the war United States chose low inflation rates and higher unemployment rate whereas in western European countries less unemployment level high inflation rate was chosen. These choices between the inflation and unemployment show the political acceptability.

Stock and Watson (1999) explored inflation forecast for the 12-month prospect. They compared the conventional Philips curve with unemployment rates and the Generalized Philips curve in which macro-economic variables, use e.g. interest rate, money supply, commodity prices. They forecasted inflation by using monthly data from 1959 to 1997 and used the simulated out of sample methodology. They analyzed that conventional Philips curve more accurate than the generalized Philip curve for inflation forecast. However, the Generalized Philips curve forecast can be improved by using the aggregate activity index on 168 indicators.

Atkenson and Ohanian (2001) examined the forecast of inflation by two methods, Naive and Philips curve. To compare the usefulness of the Philips curve model with the Naive model. They compared the naive model with the text book NAIRU Philips curve model (P.C), Stock and Watson NAIRU Philips curve model with the unemployment rate and Stock & Watson NAIRU Philips curve with an activity index by using the quarterly and monthly data from 1st quarter of 1984 to 3rd quarter of 1999 to forecast the inflation. Root mean squared error (RMSE) is used to compare the accuracy of inflation forecast of Naive model with textbook P.C model and Stock & Watson P.C model with unemployment rates and activity index. The ratio of RMSE indicates neither the textbook model P.C nor the Stock &Watson P.C, with unemployment rate & activity index perform better than Naive model. They concluded that, Naive model outperforms the Philips curve models.

Ayyoub, Chaudary and Farooq (2001) examined the relationship between inflation and GDP in case of Pakistan economy. They also tried to find either economic growth is encouraged or discouraged by inflation. They used annual data from the time period 1972-2010 and Ordinary Least Square Technique (OLS) method. They found in Pakistan economy there exist negative relationship between inflation and GDP. They also conclude that after specific Threshold level prevailed inflation will be harmful for the economic growth. They suggest for positive impact on economic growth, state bank of Pakistan should kept the inflation level below the 7% and constant.

Fisher,TeLiu and Zhou (2002) compared the Naive model and general Philips curve model for one and two years inflation forecast horizon. They have used rolling regressions with a 15-year window. They have used data from 1967 to 2000, divide the time into 5 sample periods and take the 4 measures of inflation. They concluded that Philips curve model better forecast inflation for 2 year time period and Naive model better forecast inflation for the period of time of one year. During 1977-1984 Philips curve better performs than Naive model and from 1985-1992 Naive model better forecast inflation than the Philips curve model. Over the entire period of 1985-2000 Naive model accurately forecast inflation but from 1993-2000 Philips curve better forecast contrast to (Atkenson & Ohanian,2001) study due to different inflation measure. In short, they concluded Philips curve forecast changes over the period of time and inflation’s measures.

Butt *et al.* (2002) explored that a comparison is made between regressions based approaches and ARIMA models in Pakistan. They found that estimates obtained by using ARIMA model are closer to the actual values of the variable.

Ramakrishnan and Vamvakidis (2002) estimated a multivariate model for Indonesia to identify the leading indicators having predictive power on future inflation using quarterly data from 1980 to 2000 by using Granger Causality tests. Their study identified that the exchange rate, foreign inflation and monetary growth have significant predictive power for inflation in Indonesia.

Onder (2004) compared naive model, ARIMA model, and Phillips curve model, Philips curve constructed on macroeconomic indicators, VAR model and Vector Error Correction Model for inflation forecasting. The quarterly data was utilized from 1987 to 2001 for Turkey .It was concluded that Philips curve model better forecast inflation relative to other models.

Orphanides and Van Norden (2005) used real time data and found that inflation forecast based on Philips curve performed better by using an output gap to measure real activity than autoregressive model before 1983 later on ARIMA model better performed than Philips curve model from 1984-2002.

Bokil and Schimmelpfennig (2005), based on monthly information from 1998 to 2004, used three empirical methods to predict inflation for Pakistan. In their research, a leading indicator model (LIM), a univariate ARIMA model, and an unrestricted VAR model are used. The preferred strategy is a leading model of indices in which broad money growth and credit growth in the private sector assist with inflation forecasting. The univariate strategy also led in a predictive model that was fairly acceptable, although the predictive accuracy of the ARIMA was much less than the LIM. In their research on Pakistan, the model-based VAR strategy produced the least satisfying forecasting model.

In anticipating inflation in Pakistan, Bokhari and Feridun (2006) used a number of methods, ARIMA and VAR models are used to evaluate the four distinct indices, SPI, CPI, WPI and GDP deflator to concentrate on the macroeconomic forecasting issue. The ARIMA (2, 1, 2) was found to perform better than the VAR models.

Khan and Schimmelpfennig (2006) examined in Pakistan economy which factors help to inflation forecasting. They used monthly data from January 1998 to June 2005 to regress the inflation on monetary variable exchange rates, money supply, interest rate, wheat support price and credit to the private sector. They concluded that monetary factors play important role in current inflation. Main indicators for the prediction of future inflation were money growth and private sector credit growth. According to Stock and Watson (2007) Philips curve has a tendency to forecast well for a period less than a year.

To forecast inflation in US (Ang, Bekaert & Wei, 2007) examined the four different methods. That are, term structure model: which includes Arbitrage free, linear and nonlinear specifications, time series Autoregressive integrated Moving Average (ARIMA) model, Survey based method and regression based on Philips curve. They concluded that other methods do not perform well than survey based method. Moreover, the performance of the term structure method was relatively poor.

Haider and Hanif (2009) highlighted the importance and use of artificial neural network (ANN). They stated the use of ANN methodology has been dramatically increased from last two decades. This methodology is used for the forecasting of several macroeconomic indicators by the central bank e.g. currency in circulation, inflation and

GDP growth etc. In this research they have compared the inflation forecasting performance of univariate forecasting models e.g. ARIMA and AR (1) with ANN model. They concluded that ANN model precisely forecast inflation than the univariate model due to less RMSE.

Fuhrer and Olivei (2010) also inspect the Stock and Watson evidence found that a threshold model of the Phillips curve better performs a naive model.

Clausen and Clausen (2010), explored out of sample inflation estimating for Germany, UK and USA. As opposed to different studies, they utilize output gap that is projected with unrevised real time data of GDP. Moreover, besides utilizing the real time data of USA and UK, they also used real time GDP data of Germany which is not utilized previously. They concluded that if Phillips curve is dependent on ex post output gap then It enhance the precision of inflation projection in contrasted with an AR(1) estimates.

Sultana, Rahim, Moin, Aman and Ghauri (2013) said in macroeconomics, to forecast time series is important matter. They forecasted the CPI by using ARIMA and decomposition method. In decomposition method each time series is broken into four parts. They used monthly data for out-of-sample forecast for these models. Further, they compared forecast result by sum square of errors and mean absolute deviation and finds that ARIMA model better forecast inflation.

Iftikhar and Amin (2013) used yearly CPI as measure of inflation for out of sample forecast of inflation in Pakistan. They used Box Jenkins approach and ADF test is being used to check the stationarity. Different ARIMA models are selected in the result of correlogram. According to Akaike Information Criterion the most suitable model is an ARIMA (1, 1, 1) to forecast inflation.

Younus and Roy (2016), they forecasted inflation for July 2016 to June 2017 by using annual data from July 2006 to June 2016 in Bangladesh. They used the spread between the lending and deposit rates, growth in money supply (M2), private sector credit, the exchange rate, and the world food price index. To forecast inflation Unrestricted Vector Auto Regression (VAR) model is applied and they concluded that results shows that spread, the repo and reverse repo rates, and M2 perform better than the other variables in forecasting inflation.

Zardi and Chamseddine (2017) they compared forecasting Performance of different models in short term by using quarterly data in Tunisia. They compared random walk benchmark model with Bayesian Vector Auto Regressive (BVAR), Factor Augmented Vector Auto Regressive (FAVAR), SRIMA and Time varying parameter model (TVAR) for inflation forecasting. Their results indicate that up to two quarter ahead performance of those individual models were better than benchmark univariate random walk model. Because except random walk model all other models include more economic information however, inflation forecasting performance of random walk model is better than all other individual models at four quarters ahead.

In case of Pakistan economy to estimate the output gap (Satti & Malik, 2017) used real time data, Quasi real time data and final data from 1960-2010 by using five different methods Structural Vector Autoregressive (SVAR) method, Hordrick Prescott (HP) filter, linear trend method, production function method and quadratic trend method they concluded that difference in estimates of output gap is found by using real time and final time data. Instead of revised data, real time data provide better prediction of recession and final data increase the intensity of recession than the real time data.

Dostey Fujita and Stark (2017) compared the conditional Philips curve and unconditional Philips curve by using Threshold Auto Regressive method and univariate model. They concluded that the forecast from the Univariate forecasting model was unconditionally superior from the Threshold, Auto Regressive method. Further, in case of a weak economy, inflation forecast based on Philips curve was considered to be better as compared to the strong economy.

2.8 Research Gap

A lot of literature is found on the determinants of inflation, impact of inflation on GDP, impact of inflation on monetary variables and inflation forecasting using ,ARIMA model, ARDL model, Bayesian VAR model, Structural VAR model and Neural network model by using annual, quarterly and monthly time series data. According to best of our knowledge in case of Pakistan no one has used naive model of (Atkenson & Ohanian, 2001), ARIMA model of (Stock & Watson, 2007), Philips curve model and Threshold Auto regressive Philips curve model of (Dostey *et al.* , 2017) to forecast inflation under different macro-economic conditions with respect to data as real, revised, and final time data. Likewise, we have compared our models for inflation forecasting under different macro-economic conditions and choose best method on the basis of lowest Root Mean Square Error (RMSE) and Mean Absolut Error (MAE).

In case of Pakistan no one has calculated the differences between revised and real time data, final and real data as well as final and revised data to perceive the magnitude and direction of revisions take place.

CHAPTER 3

DATA AND METHODOLOGY

3.1 Introduction

This chapter includes the detail of data and methodology which is used for estimation. It is divided into sections 16 sections. Section 3.1 to 3.7 is related to data and section 3.8 to 3.16 is about methodology, forecasting plan and forecasting accuracy measures. Section 3.1 is related to data, its sources and transformation.Section3.2 is related to the concept and definition of macroeconomic conditions with reference to data as real, revised and final data. Section 3.3 is related to the choosing measure of inflation. Section 3.4 is related to output gap as a measure of unemployment gap. Section 3.5 is related to the concept and definition of output gap. Section 3.6 is related to how we measure output gap, statistical and non-statistical methods to calculate potential output. Section 3.7 is related to HP filter method that is used to find potential output level of the economy.

Section 3.8 is related to brief description of methods for estimation. Section 3.9 is related to Naïve model. Section 3.10 is related to ARIMA model. Section 3.11 is related to Philips Curve model. Section 3.12 is related to Threshold Auto Regressive Philips Curve model. Section 3.13 is related to Unit Root test to check the stationarity in the series. Section 3.14 is related to forecasting concept, methods and plan. Section 3.15 is related to Root Mean Square Error. Section 3.16 is related to Mean Absolute Square Error.

3.2 Data and Transformations

We have used real time, revised and final data of Household Consumption Expenditure (HCE) as a proxy of inflation. Further, we have transformed the HCE as percentage growth rate to analyze the change in inflation as current consumption minus previous consumption divided by previous consumption multiplied by 100. On the other hand we have used real time, revised and final data of output gap as a proxy of unemployment gap. Data of Output gap is not directly available, that's why we have used GDP to estimate Output gap .It is difference between actual and potential GDP. Data of Potential GDP is also not directly available to estimate potential GDP we have applied HP Filter. Further, we have find percentage output gap as actual GDP minus Potential GDP divided by potential GDP multiplied by 100.

To construct the real time data, in each year we have collected the data of previous given years as well as its provisional value and it becomes like triangle. Afterward we have separated out real, revised and final data for each year. We have collected the annual time series data of HCE and GDP from 1974 to 2016.The data source are the Pakistan Economic Survey, Pakistan Bureau of Statistic, and State Bank of Pakistan.

3.3 Macroeconomic conditions with respect to data

Mckenzie and Gamba (2008) said that several macroeconomic variables printed semi-annually they are projected unrevised estimates then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provides opportunity for users and creator of the data to analyze to which extent and direction revisions take place. This is a significant component for judgment of worth of printed data and for understanding the information when studying the present economic condition. They also provide instructions for the requirement of data and metadata to construct the real time data for the analysis of revisions.

3.3.1 Real Time Data

"A real-time database is a collection of historical vintages of the same time series, catalogued and indexed by the date on which each vintage became available to the public. As such, the revision to a given reference point for a time series can be identified in a real-time database as the change in value from an earlier vintage of estimates to a later vintage." We explain vintage as in a certain time series data set that denote the most recent estimates with respect to reference point at a specific time.

3.3.2 Revised Data

Generally revisions are well defined as in time series change in value of statistics with respect to reference point. When data available to public by an authorized government or international statistical agency. Data is revised either due to availability of new observation (for instance one extra month, quarter or year) and more or less previous values are changed, or when in recent dissemination of present time series , the present and probably some previous values are revised.

When data is revised in an additional year, quarter and month is known as revised data.

3.3.3 Final Data

When data is revised in second year, quarter and month is known as final data.

3.4 Choosing Measure of Inflation

Hanif and Malik (2015) said that when we need to forecast inflation basic question which is needed to be catered is the choice of measure that should be used to model the forecasting. In our country, general price level can be accessed through different measures. Data of price indices is collected, complied and disseminated by national statistical agency (Pakistan Bureau of Statistics). Such indices include Wholesale Price Index (WPI), Sensitive Price Index (SPI), Consumer Price Index (CPI) and GDP deflator. Within CPI, we have another index known as Core CPI which excludes the prices of food and energy goods. In recent times Pakistan Bureau of Statistics (PBS) has started publishing data of one more measure of core inflation which is “20 percent trimmed core inflation’’. In the calculation of ‘20 percent trimmed core inflation’, 10 percent goods which shows more variation in price level each from uppermost and lowermost are excluded from CPI.

SPI is most regularly presented weekly price index but problem is that it just includes seventeen cities and necessity goods. Another measure which is more inclusive recognized as GDP Deflator but it is less frequently available. In WPI services are not included. In flagship publications State bank of Pakistan considers Core inflation as significant measure but it is not the target inflation variable. So we are just having CPI, Pakistani government declare annual price level goal for ‘12 month average of Year on Year (YoY) change in CPI’. CPI is more frequently used measure because it assess inflationary trends, impact on households and most cautiously denote the cost of living. Whereas according to Dostey *et al.* (2017) for inflation forecasting we focus on Personal Consumption Expenditures inflation due to two motives. First one is that when commodity price shocks occur it is less influenced than CPI. Secondly, for policy purpose PCE inflation is regularly considered as more appropriate measure. Therefore, we will forecast inflation by using Household Consumption Expenditures.

3.4.1 Personal consumption expenditure

It shows the share of income that is consumed to buy the goods and services as well as purchasing power of consumers.

3.5 Output gap as a measure of Unemployment gap

Jahan and Mahmud (2013) said that the theory of output gap is closely linked to unemployment gap. Both are crucial for fiscal and monetary policy making. Deviances of actual output from its potential output level are linked with deviances of actual unemployment rate from its Nonaccelerating Inflation rate of Unemployment. Then, production will be at maximum capacity in an economy by fully utilizing the resources. We can say there will be no inflation, unemployment and output gap.

3.6 Output gap

It shows the difference between the Potential output and actual output. Actual level of output shows the amount of goods and services produced during a year within the boundaries of a country. Okun's (1962) said that in an economy the potential output level is capability to produce without external shocks. Potential output level is not directly observable. We have to calculate potential output as well as output gap.

3.7 How to measure Output gap

Measurement of output gap is not easy job. We have actual output or actual GDP data but potential GDP and output gap data is not directly available. We can only estimate potential GDP and output gap.The formula of output gap is given below

$$\text{Output gap} = \frac{AY - PY}{PY}$$

Here,

AY= actual output

PY= Potential output

Potential output can be estimated by different methodologies. According to most of the methods it is assumed that actual output will be divided into two components e.g. Trend and cycle. Potential output level is measured from trend. In order to estimate potential output cyclical changes are removed. We will observe potential output by using Hodrick and Prescott filter (Jahan & Mahmud, 2013).

Generally speaking these methods are divided into two types. Which are known as non-structural and structural techniques. Production function method is an instance of a structural technique. This method is more appropriate on theoretical basis but this approach has two noticeable shortcomings. i) We can't judge according to our economy what the proper production function is. ii) Measurement of inputs data (in context of intermediate inputs, measure of factor productivity e.g. labor, capital) is irregular, may not exist and having poor quality (Claus, 2000).

According to non-structural (Statistical) technique we don't need to assess certain economic model to estimate the potential output and as well as output gap. In this method output will decompose into cycle and trend by applying statistical criteria. In this method an automatic filter is applied on output or any other data series. This method has been developed in recent times consist of Hodrick and Prescott (1997) filter. The benefit of statistical method is that they are simple. The shortcoming is that from an economic point of view output can be arbitrary because it is decomposed on the base of statistical principles (Claus, 2000).

3.8 Hodrick and Prescott Filter

The Hodrick-Prescott filter is generally used famous method based on statistical methodology to calculate the potential output. It decompose the output into trend and cycle. In order to estimate potential output cyclical changes are removed from the trends and cycles.

3.9 Methodology

We have to compare naive model, ARIMA model, Philips Curve model and Threshold Philips curve model for inflation forecasting. Naive and ARIMA are univariate model whereas PC and PC-TAR are multivariate models. To investigate what seems to forecasting performance, when we have to estimate these model by using real time, revised and final data.

3.10 Naive model

The naive model makes prediction about inflation and state that inflation for future year is anticipated to be equal to the inflation of previous year. We have estimated RMSE of the model under different macroeconomic conditions (real, revised and final data) by using sample period from 2014 to 2016. Equations are given below from 3.1 to 3.3.

$$E\left(inf_{t+1}^{rl} - inf_{t}^{rl}\right) = 0\text{--------------}3.1$$

Equation 3.1 indicate that inf_{t+1}^{rl} shows real inflation in next year, inf_{t}^{rl} shows real inflation in previous year, $E\left(inf_{t+1}^{rl} - inf_{t}^{rl}\right)$ shows that real inflation in next year will be same that is in previous year.

Real inflation is subject to revisions, when real inflation is revised after one year. Then we have to estimate the RMSE of revised inflation. Below Equation 3.2 is related to the calculation of RMSE of revised inflation.

$$E\left(inf_{t+1}^{re} - inf_{t}^{re}\right) = 0\text{--------------}3.2$$

Equation 3.2 indicate that inf_{t+1}^{re} shows revised inflation in next year, inf_{t}^{re}shows revised inflation in previous year, $E\left(inf_{t+1}^{re} - inf_{t}^{re}\right)$ shows that revised inflation in next year will be same that is in previous year.

Real inflation is subject to revisions, when real inflation is revised after second year. Then we have to estimate the RMSE of final inflation. Below mentioned equation 3.3 is related to the calculation of RMSE of final inflation.

$$E\left(inf_{t+1}^{fl} - inf_t^{fl}\right) = 0 \text{ --------------3.3}$$

Equation 3.3 indicate that inf_{t+1}^{fl} shows final inflation in next year, inf_t^{fl} shows final inflation in previous year, $E\left(inf_{t+1}^{fl} - inf_t^{fl}\right)$ shows that final inflation in next year will be same that is in previous year.

Fisher *et al* 2002 stated that initial point for the explanation of naive model is martingale hypothesis. “Which stated that the sequence of expected value of inflation for the inflation over next 12 months is equal to the inflation over the previous 12 months”

3.11 ARIMA model

According to Stock and Watson (2007), we estimated the rolling ARIMA model for 2 period ahead inflation forecasting .Firstly we have estimated the model for 1 period ahead inflation out of sample forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Later on we roll forward our regression from 1975 to 2015 to forecast inflation for 2016 is given as below equations 3.4 to 3.6. We have estimated equation 3.4 for the estimation of real time data however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 3.5. After that when real time inflation is revised after two years then we have estimated the final inflation equation 3.6.

$$inf_t^{rl} = \varepsilon_{t-1} \text{--------------------3.4}$$

Equation 3.4 indicates that inf_t^{rl} shows the real inflation in current time. Our ARIMA is MA which shows that real inflation depends on shocks.

$$inf_t^{re} = inf_{t-2}^{re} + \varepsilon_{t-1}$$ --------------3.5

Equation 3.5 indicate that inf_t^{re} shows the revised inflation in current time period, inf_{t-2}^{re} shows revised inflation at second lag, ε_{t-1} shows that revised inflation depend on the first lag of error term. It means that revised inflation depend on its second lag as well as at shocks. Therefore, our ARIMA model is (2, 1) as AR (2) and MA (1).

$$inf_t^{fl} = inf_{t-1}^{fl} + \varepsilon_{t-1}$$ --------------3.6

Equation 3.6 indicate that inf_t^{fl} shows the final inflation in current time period, inf_{t-1}^{fl} shows final inflation at first lag, ε_{t-1} shows that final inflation depend on the first lag of error term. It means that final inflation depend on its first lag as well as at shocks. Therefore, our ARIMA model is (1, 1) as AR (1) and MA (1).

3.12 Philips curve Auto regressive model

To explore the usefulness of the unconditional Philips curve model for forecasting of inflation, simple autoregressive Philip curve model used in this research. Firstly we have estimated the model for 1 period ahead out of sample inflation forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Later on we roll forward our regression from 1975 to 2015 to forecast inflation for 2016 is given below in equation 3.7 to 3.9. We have estimated equation 3.7 for the estimation of real time data however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 3.8. After that when real time inflation is revised after two years then we have estimated the final inflation equation 3.9.

$$inf_t^{rl} = inf_{t-1}^{rl} + og_t^{rl} + \varepsilon_t$$ --------------3.7

Equation 3.7 indicate that inf_t^{rl} shows real inflation in current time, inf_{t-1}^{rl} shows real inflation at first lag, og_t^{rl} real output gap at current time period. It shows that real inflation is positively correlated with its lag and output gap.

$$inf_t^{re} = inf_{t-1}^{re} \quad + og_t^{re} + \varepsilon_t\text{--------------}3.8$$

Equation 3.8 indicate that inf_t^{re} shows revised inflation in current time, inf_{t-1}^{re} shows revised inflation at first lag, og_t^{re} shows revised output gap at current time period. It shows that revised inflation is positively correlated with its lag and output gap.

$$inf_t^{fl} = inf_{t-1}^{fl} \quad + og_t^{fl} + \varepsilon_t\text{--------------}3.9$$

Equation 3.9 indicate that inf_t^{fl}shows final inflation in current time, inf_{t-1}^{fl} shows final inflation at first lag, shows og_t^{fl} final output gap at current time period. It shows that final inflation is positively correlated with its lag and negatively correlated with output gap (negative output gap).

3.13 Philips curve Threshold, Auto-regressive Model

We have to estimate the Philips Curve model for 2 period ahead inflation forecasting .Firstly we have estimated the model for 1 period ahead out of sample inflation forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Afterward we roll forward our regression from 1975 to 2015 to forecast inflation for 2016. Further the difference between PC model and PC-TAR is an addition to the Phillips curve is the threshold term, with an effect of the threshold on the output gap. An absolute value of the output gap is threshold variable is given below equations 3.10 to 3.12. We have estimated equation 3.10 for the estimation of real time data however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 3.11.After that when real time inflation is revised after two years then we have estimated the final inflation equation 3.12.

$inf_t^{rl} = inf_{t-1}^{rl} + 1(|og_t^{rl}| > og_*^{rl})og^{rl} + 1(|og_t^{rl}| \leq og_*^{rl})og^{rl} + \varepsilon_t$------------3.10

Equation 3.10 indicate that inf_t^{rl} Shows real inflation in current time, inf_{t-1}^{rl} shows real inflation in previous year, $|og_t^{rl}|$ shows absolute value of real output gap, og_*^{rl} shows potential level of real output gap,

$1(|og_t^{rl}| > og_*^{rl})$ shows when actual real output is greater than threshold real output it takes the value unity, $1(|og_t^{rl}| \leq og_*^{rl})$ shows when actual real output is less than threshold real output it takes the value zero.

$inf_t^{re} = inf_{t-1}^{re} + 1(|og_t^{re}| > og_*^{re})og^{re} + 1(|og_t^{re}| \leq og_*^{re})og^{re} + \varepsilon_t$-----3.11

Equation 3.11 indicate that inf_t^{re} shows revised inflation in current time, inf_{t-1}^{re} shows revised inflation in previous year, $|og_t^{re}|$ shows absolute value of revised output gap, og_*^{re} shows potential level of revised output gap, $1(|og_t^{re}| > og_*^{re})$ shows when actual revised output is greater than threshold revised output it takes the value unity, $1(|og_t^{re}| \leq og_*^{re})$ shows when actual revised output is less than threshold revised output it takes the value zero.

$inf_t^{fl} = inf_{t-1}^{fl} - 1(|og_t^{fl}| > og_*^{fl})og^{fl} + 1(|og_t^{fl}| \leq og_*^{fl})og^{fl} + \varepsilon_t$-------3.12

Equation 3.12 indicate that inf_t^{fl} shows final inflation in current time, inf_{t-1}^{fl} shows final inflation in previous year , $|og_t^{fl}|$ shows absolute value of revised output gap , og_*^{fl} shows potential level of final output gap, $1(|og_t^{fl}| > og_*^{fl})$ shows when actual final output is greater than threshold final output it takes the value unity, $(|og_t^{fl}| \leq og_*^{fl})$ shows when actual final output is less than threshold final output it takes the value zero.

3.14 Unit Root Test

Dickey and Fuller (1979) introduced Dickey Fuller test. This test is essential to analyze either series is stationary or not. A lot of time series in finance and economic have trend and not stationary. Most important cases are exchange rate, real GDP and assets prices. If our series is not stationary then our model will be spurious. According to econometrics our main chore is analyze the proper trend in data. If we find trend in data, then de-trending technique should be used before modeling the data. Unit root is checked by this simple method but this DF test can't capture dynamic and complex structure of various financial and economic series so later on Augmented Dickey Fuller (ADF) test introduced to overcome the problem of complex and dynamic structure of series. We will use ADF test for our complicated analysis. Equation 3.13 of ADF test is given below

Hypothesis

Ho = series is not stationary

Ha=series is stationary.

$$X_t = \beta_1 D_t + \theta X_{t-1} + \sum_{k=1}^{j} \phi_k \Delta X_{t-k} + e_t \text{...........3.13}$$

In above equation variable discretion is as following

$D_t =$ Vector of deterministic terms (constant, trend)

$j =$ lagged difference terms

ΔX_{t-k} = used to approximate the ARMA structure of the errors

e_t = serial correlation of error (errors are homoscedastic)

We can apply this test in three cases. In first case when we have no trend, secondly constant and thirdly trend and constant as well.

Later on to check unit root Phillips and Perron (PP) test was developed in 1988 which become famous to analyze the time series. The major distinction between ADF test and PP test is that PP test does not take in to account the serial correlation whereas ADF take in to account structure of the errors by parametric auto regression.

3.15 Forecasting

Economic forecasting involves predicting economic condition about the future economy. We can forecast at aggregate level for instance unemployment rate, Gross Domestic product (GDP), inflation.

Economic forecasting is important and keep engaged to a lot of institutions. International institutions involve World Bank (WB), International monetary Fund (IMF), at national level Central Banks (e.g. in our country State bank of Pakistan), local governments, large companies and private sector entities. They forecast annually, quarterly, monthly and according to their needs.

There are three main concepts in economic forecasting. Firstly assessment of future economic estimates of crucial macroeconomic variable for different time period for instance unemployment rate, GDP and inflation. Secondly essential critical story, which guide us about future prediction and risk associated if assumption fail. Thirdly economic forecast is significant task it has impact on the actions of households, producers and government. For instance according to predicted economic condition adjustment in fiscal and monetary policy actions take place for the benefit of economy (Carnot, Koen and Tissot, 2005).

3.15.1 Methods of Forecasting

According to Clements and Hendry (1999) economic forecasting has different methods. First one is guessing it has negligible assumptions as compare to other techniques. i)

Guessing is not reliable method because good predictions are reported and bad predictions will be ignored. A lot of people can predict, if some of them have correct guest it will be hard to justify according to this approach. ii) Expert judgment is also subjective approach. Different people can have their own opinion. Predictions from this approach are less reliable.

iii) Extrapolation is good until tendencies carry on, but this method is itself suspicious because in different time different extrapolators will be utilized. Furthermore this method will fail when we have to forecast in tendencies change. iv) Leading indicators are used to forecast inflation. This method needs constant relationship between lead and led variable. When there is rationale for lead variable, then the indicator will helpful otherwise we will have misleading results. For instance even in case of “leading indicators” as housing starts result to finalized accommodation. But record is worse (as in housing market the delay can restrict and wide booms and busts).

v) Surveys can guide us about future events by taking information from producers and consumers (Households) but it depend upon their plans. But this method will fail if adverse fluctuations take place in business consequently all plans will revise. vi) Time series models are widely used technique in which historical patterns are observed. These can be univariate or multivariate but similarly like other approaches, they emphasis on “measurable Uncertainty.”

vii) Econometric equation system is key instrument for economic prediction. These equations are used with economic rationality by historical knowledge to analyze the behavior of economic agents. In this econometric technique economist have benefit because they know theoretical background and empirical literature of how economies will perform, which provide them basis to understand the exploration method which may outcome thoughtfulness, their failure and policy recommendation over time. In short, in economic forecasting principle approaches are time series and econometric methods. We can modify our forecast results through indicators.

Carnot, Koen and Tissot (2005) said that for economic forecasting there are four different approaches. First one is subjective forecasting which completely rely on guessing or experts judgment. Such forecast are less commonly used because they are unreliable. Secondly indicator based approach which is commonly used in business cycle. Third and fourth approach is, time series and structural model. Time series model is frequently depend on statistical properties instead of casual association among economic variables by mean of economic theory. We can describe the economic theory by Structural models.

There are a lot of ways to forecast like single number forecast, range of number forecast and entire distribution forecast. Single number forecast is well named as point forecast. Point forecast can be different from the actual value, but a good point forecast should be closer to the actual value. The difference between actual and forecasted value is named as forecasting error to assess the forecasting performance of model.

3.15.2 Forecasting Plan

We have estimated our each model by using real, revised and final data from 1975 to 2014 and forecasted inflation for one period ahead out of sample forecast for 2015.Then we rolled forward our regression 1975 to 2015 and forecasted inflation for second period ahead out of sample forecast for 2016. Further, we have compared the error, good forecast should have minimum variance. Root means square error (RMSE) and Mean squared error (MSE) and are widely used tools to measure forecast accuracy (Chong and Hendry, 1986).

3.16 Root Mean Square Error

Root mean square (RMSE) is generally used as significant tool to compare the forecast accuracy of different models. RMSE are calculated by finding the errors (difference between actual and forecasted value) then we take square root of mean squared the errors. Its formula is given below

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(A_t - F_t)^2}{n}}$$

$A =$ Actual value

F = Forecasted value

n = no of observations

After calculating RMSE of various model, we have compared the RMSE of various models to find the most appropriate model for forecasting. Model which has lowest value of RMSE is known as best model for inflation forecasting.

3.17 Mean Absolute Error

Mean absolute error (MAE) is also generally used as significant tool to compare the forecast accuracy of different models. MAE are calculated by finding the errors (difference between actual and forecasted value) then we take absolute of error, sum them and divide by number of observations. Its formula is given below

$$MAE = \frac{1}{n}\sum_{t=1}^{n}(A_t - F_t)$$

$A =$ Actual value

F = Forecasted value

n = no of observations

After calculating MAE of various model, we have compared the MAE of various models to find the most appropriate model for forecasting. Model which has lowest value of MAE is known as best model for inflation forecasting.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is divided into ten sections. Section 4.1 is about unit root test and section 4.2 is related to descriptive statistics of level series. Section 4.3 and section 4.4 is related to descriptive statistic of differences between real, revised and final GDP and inflation. Section 4.5 and section 4.6 is related to graphical analysis of differences between real, revised and final GDP and inflation. In Section 4.7 to 4.9 we conclude the results of estimations for one and two step ahead out of sample inflation forecasting under different macroeconomic conditions with reference to data by different models which are ARIMA model, Phillips Curve model and Phillips Curve Threshold Auto-regressive Model. Section 4.10 is about RMSE and MAE to analyze the forecast accuracy of different models as well as economic conditions.

4.2 Unit Root Test

We are using annual time series data, as we are familiar that time series data is more or less trendy and non-stationary. To avoid the spurious regression we have to check stationarity, We also check for structural break because our data has no breaks and annual time series. Therefore, we have used Augmented Dickey Fuller (ADF) test to check stationarity in the data. The results of ADF test are given in table 4.1.

Table-4.1: Unit Root

Variables	Series at Level (ADF)	Series at first difference (ADF)	Series at second difference (ADF)	Order of Integration
Real inflation	-0.764 (0.0001)			I(0)
Revised inflation	-0.799 (0.0001)			I(0)
Final inflation	-0.862 (0.0000)			I(0)
Real GDP	-0.608 (0.9731)	-3.359 (0.0712)	-6.573 (0.0000)	I(2)
Revised GDP	-0.228 (0.9902)	-4.904 (0.0015)		I(1)
Final GDP	-0.424 (0.9832)	-3.346 (0.0731)	-6.803 (0.0000)	I(2)
Real Time Output Gap	-0.291 (0.0766)	-0.887 (0.0000)		I(1)
Revised Output Gap	-0.525 (0.0070)			I(0)
Final Output Gap	-0.534 (0.0067)			I(0)

*P value are in parenthesis

Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually they are projected estimates known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provide opportunity for users and creator of the data to analyze to which extent and direction revisions take place. After one year data is revised and known as revised data. When data is revised after second year is known as final data (McKenzie & Gamba, 2008).

Table 4.1 shows the results of Augmented Dickey Fuller (ADF) test for unit root at level, first and second difference. The result shows that real, revised and final inflation are stationarity at 5% level of significance. Such as our p value for these variables is less than 5% level of significance which means that we have rejected the null hypothesis. Our null hypothesis is that series is non stationary. It means that real, revised and final inflation are stationary at level and their order of integration is I (0).

The real, revised and final GDP are not stationarity at 5% level of significance. Such as our p value for these variables is greater than 5% level of significance which means that we don't rejected the null hypothesis. Our null hypothesis is that series is non stationary. It means that real, revised and final GDP real are not stationary at level. In order to make series stationary we have transformed real, revised and final GDP by taking first difference. Then we have applied ADF test. Now, revised GDP is stationary at 5% level of significance. Such as our p value for this variable is less than 5% level of significance which means that we have rejected the null hypothesis. Our null hypothesis is that series is non stationary. Therefore, it means that revised GDP is stationary at first difference and its order of integration is I (1).

On the other hand, the real and final GDP are not stationary at 5% level of significance. Such as our p value for these variables is greater than 5% level of significance which means that we don't rejected the null hypothesis. Our null hypothesis is that series is non stationary. Therefore, it means that real and final GDP real are not stationary at level. In order to make series stationary we have transformed real and final GDP by taking second difference. Then we have applied ADF test. Now, the real and final GDP are stationary at 5% level of significance. . Such as our p value for these variables is less than 5% level of significance which means that we have rejected the null hypothesis. Our null hypothesis is that series is non stationary. It means that real and final GDP is stationary at second difference and their order of integration is I (2).

The revised and final output gap are stationary at 5% level of significance. Such as our p value for these variables is less than 5% level of significance which means that we have rejected the null hypothesis. Our null hypothesis is that series is non stationary. Therefore, it means that revised and final output gap are stationary at level and their order of integration is I (0).

The real output gap have p value above than 5% level of significance so, we cannot reject the null. Our null hypothesis is that series is non stationary which means that real output gap is not stationary at level. Therefore, in order to make series stationary we have transformed real output gap by taking first difference. Then we have applied ADF test. Now, the real output gap is stationary at 5% level of significance. . Such as our p value for this variables is less than 5% level of significance which means that we have rejected the null hypothesis. Our null hypothesis is that series is non stationary. Therefore, it means that real output gap is stationary at first difference and its order of integration is I (1).

4.3 Descriptive Statistics

In this section we have presented descriptive analysis of all variables from the time period of 1974 to 2016. We have also divided our sample into five subsamples. We have descriptively analyzed the data set as a measure of variability as well as measure of central tendency. In this study standard deviation (SD) and stability ratio (SR) is used as measure of variability. The higher the value of standard deviation and stability ratio mean that subsample has more volatility as compared to other samples and vice versa. We have used mean as measure of central tendency. Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. After one year data is revised and known as revised data. When data is revised after second year is known as final data. The descriptive statistics of series at level are given in table 4.2.

Table 4.2 Descriptive Statistics

Variables	Years	Max	Min	Mean	SD	SR
Real inflation	1974-2016	23698864	65880	4574049	6812651	0.671405
	1974-1980	191330.0	65880.00	124637.2	43241.20	0.346937
	1981-1990	640352.0	230851.0	415920.0	132176.6	3.146699
	1991-2000	2423420	731327.0	1517688	600150.1	2.528847
	2001-2010	11815289	2665418	6064085	3265444	1.857048
	2011-2016	23698864	15584183	19669298	2880980	6.827294
Revised inflation	1974-2016	23285749	69315	4560047	6669747	0.683691
	1974-1980	196752.0	69315.00	124623.3	43519.41	2.863626
	1981-1990	618832.0	234728.0	410042.1	125321.2	3.271929
	1991-2000	2385558	701629.0	1495157	589177.8	2.537701
	2001-2010	12245101	2567321	6065686	3235208	1.874898
	2011-2016	23285749	15159996	19250136	3149046	6.113006
Final inflation	1974-2016	23266454	67743	4560990	6644882	0.686391
	1974-1980	198614	67743	126731.6	45000.44	2.81623
	1981-1990	611710	235586	406916.2	122458.3	3.322896
	1991-2000	2342417	697448	1493923	582502.9	2.564662
	2001-2010	12188896	2586762	6122642	3163540	1.935377
	2011-2016	23266454	14839587	19166773	3242910	5.910362
Real GDP	1974-2016	7072453	908179.5	3258597	1862877	1.749228
	1974-1980	1226439	908179.5	1027548.	121681.8	8.44455
	1981-1990	2308599	1295619	1790202	357930.1	5.001541
	1991-2000	3513009	2424168	2987282	371641.6	8.038072
	2001-2010	5670768	3618761	4670386	788353.2	5.92423
	2011-2016	7072453	5817406	6408024	466646.6	13.73207
Revised GDP	1974-2016	7060143	892442.5	3255285	1854822	1.755039
	1974-1980	1225657	892442.5	1034970	123701.7	0.119522
	1981-1990	2296104	1307275	1793766	348496.0	5.147164
	1991-2000	3528715	2425249	2981094	364140.4	8.186661
	2001-2010	5681531	3615865	4657483	773399.7	6.022091
	2011-2016	7060143	5815029	6401505	460271.2	13.90812
Final GDP	1974-2016	7059122	902730.2	3258704	1848991	1.762423
	1974-1980	1232158	902730.2	1041012	120725.6	8.62296
	1981-1990	2296930	1311283	1801657	339776.8	5.302472
	1991-2000	3529345	2422983	2989893	364109.8	8.211515
	2001-2010	5643602	3607532	4656153	767345.9	6.067867
	2011-2016	7059122	5797596	6393359	470028.1	13.60208

The table 4.2 shows that over the entire sample mean of real inflation, revised inflation, real GDP, revised GDP and final GDP is less than subsamples. It means that entire sample is understating the magnitude of these variables as compared to subsample. Over the entire sample period standard deviation of real inflation, revised inflation, real GDP, revised GDP and final GDP is more than subsamples. It means that entire sample is more volatile than subsample. As we are familiar that just SD is not best measure of volatility because according to this measure samples with highest volatility also have highest value of mean that's why it's better to use Stability ratio as a measure of volatility. Stability ratio shows that over the complete sample values of stability ratio of real inflation, revised inflation, real GDP, revised GDP and final GDP is less than subsamples. It means that entire sample is less volatile than subsample.

Real inflation indicate that the maximum values over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 191330, 640352, 2423420, 11815289 and 23698864 respectively. Which shows that real inflation has lowest value over the subsample 1974 to 1980 and highest value over the subsample 2011 to 2016 as compare to other subsamples.

Real inflation indicate that the minimum values over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 65880, 230851, 731327, 2665418 and 15584183 respectively. Which shows that real inflation has lowest value over the subsample 1974 to 1980 and highest value over the subsample 2011 to 2016 as compare to other subsamples.

Real inflation indicate that mean values over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 124637.2, 415920, 1517688, 6064085 and 19669298 respectively. Which shows that real inflation has lowest value over the subsample 1974 to 1980 and highest value over the subsample 2011 to 2016 as compare to other subsamples.

Real inflation indicate that standard values over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 43241.20, 132176.6, 600150.1, 3265444 and 2880980 respectively. Which shows that real inflation has lowest value over the subsample 1974 to 1980 and highest value over the subsample 2001 to 2010 as compare to other subsamples. As we are familiar that just SD is not best measure of volatility because according to this measure samples with highest volatility also have highest value of mean that's why it's better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 2011 to 2016 has highest value of SR, its means that this subsample is more volatile whereas the subsample 1974 to 1980 has lowest value of SR which shows the lowest volatility as compared to other subsamples.

Revised inflation and final inflation indicate that the maximum and minimum values of revised and final inflation have lowest value over the subsample 1974 to 1980 and highest value over the subsample 2011 to 2016 as compared to other subsamples. Mean value of revised and final inflation have lowest value over the subsample 1974 to 1980 and highest value over the subsample 2011 to 2016 as compare to other subsamples. Standard deviation of revised and final inflation have lowest value over the subsample 1974 to 1980.Revised inflation has more SD over the subsample 2001 to 2010 which shows higher volatility whereas the final inflation has more SD over the subsample 2011 to 2016 which shows higher volatility as compared to other subsamples. On the other hand, revised and real inflation indicate that SR of subsample 2011 to 2016 has highest value, its means that this subsample is more volatile whereas the subsample 2001 to 2010 has lowest value of SR which shows the lowest volatility as compared to other subsamples.

Further, the average values of real, revised and final inflation indicate that over the subsample 2011 to 2016 real inflation is more than revised and final inflation as compared to other subsamples. It shows that as compared to other subsamples, in this subsample of 2011 to 2016 real inflation is more overstated, inappropriately forecasted and policy gap. The average values of real, revised and final GDP indicate that over the subsample 2011 to 2016 final GDP is more than real and revised GDP as compared to other subsamples. It shows that as compared to other subsamples, in this subsample real GDP is more understated, inappropriately forecasted and policy gap.

4.4 Descriptive Statistics of differences between real, revised and final GDP

In this section we have presented descriptive analysis of differences between real, revised and final GDP from the time period of 1974 to 2016. We have also divided our sample into five subsamples. We have descriptively analyzed the data set as a measure of variability as well as measure of central tendency. In this study standard deviation and stability ratio is used as measure of variability. The higher the value of standard deviation and stability ratio mean that subsample has more volatility as compared to other samples and vice versa. We have used mean as measure of central tendency. Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provide opportunity for users and creator of the data to analyze to which extent and direction revisions take place. After one year data is revised and known as revised data. When data is revised after second year is known as final data. The results of differences between real, revised and final GDP are given in table 4.3.

Table 4.3 Descriptive Statistics of differences between real, revised and final GDP

Variables	Years	Max	Min	Mean	SD	SR
Revised - Real GDP	1974-2016	97,211	-88,302	-3,098	32882.64	-10.6142
	1974-1980	48164.18	-15737.05	7421.690	21381.96	2.88101
	1981-1990	55666.16	-17233.97	3563.547	24089.97	6.76011
	1991-2000	33318.36	-73346.03	-6188.317	32285.81	-5.21722
	2001-2010	97211.00	-88302.00	-12903.33	51008.51	-3.95314
	2011-2016	21873.14	-27314.33	-6519.452	16167.94	-2.47995
Final- Real GDP	1974-2016	113,380	-109,776	427	38314.88	89.7304
	1974-1980	48750.66	-9163.657	13464.47	25462.17	1.891064
	1981-1990	58671.84	-38651.31	11455.02	28816.63	2.515633
	1991-2000	35790.21	-39571.33	2610.92	27789.46	10.64355
	2001-2010	113380.0	-109776.0	-14233.12	62984.65	-4.42522
	2011-2016	-6105.294	-29879.59	-14665.70	8848.737	-0.60336
Final- Revised GDP	1974-2016	81,038	-72,433	3,525	27050.21	7.673818
	1974-1980	40686.64	-9065.911	6042.777	16628.62	2.751818
	1981-1990	46013.78	-22572.15	7891.475	18393.33	2.330785
	1991-2000	66234.71	-72433.35	8799.242	35358.26	4.01833
	2001-2010	81038.00	-37929.00	-1329.791	35751.31	-26.8849
	2011-2016	3558.455	-32679.33	-8146.246	14110.84	-1.73219

The table 4.3 shows that the over the entire sample average value of difference between revised and real GDP is -3,098. This value has negative sign which indicate that revised GDP is less than real GDP and real GDP was overstated, on average over full sample GDP is revised in negative direction. On the other hand, over the subsample on average difference between revised and real GDP is more than full sample. Which indicate that over sub samples revised GDP is more less than real GDP and real GDP was more overstated, on average over subsamples GDP is largely revised in negative direction than full sample.

The difference between revised and real GDP indicate that over the subsamples of 1974-1980, 1981-1990 average values are 7421.69 and 3563.54 respectively. These values have positive signs which indicate that revised GDP is more than real GDP and real GDP was understated, on average over 70s and 80s GDP is revised in positive direction. On the other hand, the difference between revised and real GDP shows that over the subsamples of 1991-2000, 2001-2010, 2011-2016 average values are -6188.31, -12903.33 and -6519.452 respectively. These values have negative signs which indicate that revised GDP is less than real GDP and real GDP was overstated, on average over these sub-sample GDP is revised in negative direction.

Over the subsample of 2001 to 2010 magnitude of average value of difference between revised and real GDP is maximum than other sub samples. Therefore, as compared to subsamples, real GDP was more overstated and on average over this sub-sample GDP is maximally revised in negative direction. On the other hand, over the subsample of 1981-1990 magnitude of average value of difference between revised and real GDP is minimum than other sub samples. Therefore, as compared to subsamples, real GDP was least understated and on average over this sub-sample GDP is minimally revised in positive direction.

The difference between revised and real GDP indicate that over the subsample of 2001 to 2010 have higher standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 2011 to 2016 has lowest SD which means that this subsample has less volatility. As we are familiar that just SD is not best measure of volatility because according to this measure samples with highest volatility also have highest value of mean that’s why it’s better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 1981 to 1990 has highest value of SR, its means that this subsample is more volatile whereas the subsample 1991 to 2000 has lowest value of SR which shows the lowest volatility as compared to other subsamples.

The maximum values of difference between revised and real GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 48164.18, 55666.16, 33318.36, 97211.00 and 21873.14 respectively. Which shows that over the subsample 2001 to 2010 maximum difference between revised and real GDP is highest whereas over the subsample 2011 to 2016 maximum difference between revised and real GDP is lowest as compare to other subsamples.

The minimum values of difference between revised and real GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -15737.05, -17233.97, -73346.03, -88302 and -27314.33 respectively. Which shows that over the subsample 2001 to 2010 minimum difference between revised and real GDP is least whereas over the subsample 1974 to 1980 minimum difference between revised and real GDP is more as compare to other subsamples.

The difference between final and real GDP indicate that over the subsamples of 1974-1980, 1981-1990, 1991-2000 average values are 13464.47, 11455.02 and 2610.92 respectively. These values have positive signs which indicate that final GDP is more than real GDP and real GDP was understated, on average over 70s, 80s and 90s GDP is revised in positive direction. On the other hand, the difference between final and real GDP shows that over the subsamples of 2001-2010, 2011-2016 average values -14233.12 and -14665.70 respectively. These values have negative signs which indicate that final GDP is less than real GDP and real GDP was overstated, on average over these sub-samples GDP is revised in negative direction.

Over the subsample of 2011 to 2016 magnitude of average value of difference between final and real GDP is maximum than other sub samples. Therefore, as compared to subsamples, real GDP was more overstated and on average over this sub-sample GDP is maximally revised in negative direction. On the other hand, over the subsample of 1990-2000 magnitude of average value of difference between final and real GDP is minimum than other sub samples. Therefore, as compared to subsamples, real GDP was least understated and on average over this sub-sample GDP is minimally revised in positive direction.

The difference between final and real GDP indicate that over the subsample of 2001 to 2010 have higher standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 2011 to 2016 has lowest SD which means that this subsample has less volatility. As we are familiar that just SD is not best measure of volatility because according to this measure samples with highest volatility also have highest value of mean that's why it's better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 1991 to 2000 has highest value of SR, its means that this subsample is more volatile whereas the subsample 2001 to 2010 has lowest value of SR which shows the lowest volatility as compared to other subsamples.

The maximum values of difference between final and real GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 48750.66, 58671.84, 35790.21, 113380.0 and -6105.29 respectively. Which shows that over the subsample 2001 to 2010 maximum difference between final and real GDP is highest whereas over the subsample 2011 to 2016 maximum difference between final and real GDP is lowest as compare to other subsamples.

The minimum values of difference between final and real GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -9163.65, -38651.31,-39571.33, -109776.0, and -29879.59 respectively. Which shows that over the subsample 2001 to 2010 minimum difference between final and real GDP is least whereas over the subsample 1974 to 1980 minimum difference between final and real GDP is more as compare to other subsamples.

The difference between final and revised GDP indicate that over the subsamples of 1974-1980, 1981-1990, 1991-2000 average values are 6042.777, 7891.475 and 8799.242 respectively. These values have positive signs which indicate that final GDP is more than revised GDP and revised GDP was understated, on average over 70s, 80s and 90s GDP is revised in positive direction. On the other hand, the difference between final and revised GDP shows that over the subsamples of 2001-2010, 2011-2016 average values -1329.79 and -8146.24 respectively. These values have negative signs which indicate that final GDP is less than revised GDP and revised GDP was overstated, on average over these sub-samples GDP is revised in negative direction.

Over the subsample of 1991 to 2000 magnitude of average value of difference between final and revised GDP is maximum than other sub samples. Therefore, as compared to subsamples, revised GDP was more understated and on average over this sub-sample GDP is maximally revised in positive direction. On the other hand, over the subsample of 2001-2010 magnitude of average value of difference between final and revised GDP is minimum than other sub samples. Therefore, as compared to subsamples, revised GDP was least overstated and on average over this sub-sample GDP is minimally revised in negative direction.

The difference between final and revised GDP indicate that over the subsample of 2001 to 2010 have highest value of standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 2011 to 2016 has lowest value of standard deviation. It means that this subsample has less volatility as compared to other subsamples.

The maximum values of difference between final and revised GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 40686.64, 46013.78, 66234.71, 81038.00 and 3558.45 respectively. Which shows that over the subsample 2001 to 2010 maximum difference between final and revised GDP is highest whereas over the subsample 2011 to 2016 maximum difference between final and revised GDP is lowest as compare to other subsamples.

The minimum values of difference between final and revised GDP over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -9065.911, -22572.15, -72433.35, -37929, and -32679.33 respectively. Which shows that over the subsample 1991 to 2000 minimum difference between final and revised GDP is least whereas over the subsample 1974 to 1980 minimum difference between final and revised GDP is more as compare to other subsamples.

4.5 Descriptive Statistics of differences between real, revised and final inflation

In this section we have presented descriptive analysis of differences between real, revised and final inflation from the time period of 1974 to 2016. We have also divided our sample into five subsamples. We have descriptively analyzed the data set as a measure of variability as well as measure of central tendency. In this study standard deviation and stability ratio is used as measure of variability. The higher the value of standard deviation and stability ratio mean that subsample has more volatility as compared to other samples and vice versa. We have used mean as measure of central tendency. Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provide opportunity for users and creator of the data to analyze to which extent and direction revisions take place. After one year data is revised and known as revised data. When data is revised after second year is known as final data. The results of differences between real, revised and final inflation are given in table 4.4.

Table 4.4 Descriptive Statistics of differences between real, revised and final inflation

Variables	Years	Max	Min	Mean	SD	SR
Revised - Real inflation	1974-2016	2143216	-1446954	-14001.79	452046.7	-0.031
	1974-1980	5422.00	-5218.000	-13.92857	3751.575	-0.0037
	1981-1990	13035.00	-42827.00	-5877.900	15631.02	-0.376
	1991-2000	2143216	-57698.00	195576.8	684762.5	0.2856
	2001-2010	624413.0	-543330.0	1600.700	379919.5	0.0042
	2011-2016	306957.0	-1446954	-419162.5	571399.0	-0.7336
Final- Real inflation	1974-2016	2100075	-1503912	-13058.84	472531.8	-0.0276
	1974-1980	7284.000	-3749.000	2094.42	3387.869	0.6182
	1981-1990	9050.000	-47732.00	-9003.85	17859.36	-0.5042
	1991-2000	2100075	-69569.00	194343	670355.0	0.2899
	2001-2010	625117.0	-555426.0	58556.60	427652.1	0.1369
	2011-2016	202103.0	-1503912.	-502525	593977.6	-0.846
Final-Revised inflation	1974-2016	579913	-320409	942.90	115834.9	0.0081
	1974-1980	7858.500	-4007.000	2108.35	3951.029	0.5336
	1981-1990	9615.000	-12952.00	-3125.95	7498.416	-0.4169
	1991-2000	34240.00	-43141.00	-1233.80	21148.04	-17.1405
	2001-2010	579913.0	-129552.0	56955.90	197333.1	3.4646
	2011-2016	171898.0	-320409.0	-83362.50	163838.7	-0.5088

The table 4.4 shows that the average value of difference between revised and real inflation is 14001.79. This value has negative sign which indicate that revised inflation is less than real inflation and real inflation was overstated, on average inflation is revised in negative direction.

On the other hand, over the subsample on average difference between revised and real inflation is more in magnitude than full sample. Which indicate that over sub samples revised inflation is more less than real inflation and real inflation was more overstated, on average over subsamples inflation is largely revised in negative direction than full sample.

The difference between revised and real inflation shows that over the subsamples of 1974-1980, 1981-1990, 2011-2016 average values are -13.92, -5877.9 and -419162.5 58556.60 respectively. These values have negative signs which indicate that revised inflation is less than real inflation and real inflation was overstated, on average over these sub-sample inflation is revised in negative direction. On the other hand, the difference between revised and real inflation indicate that over the subsamples of 1991-2000, 2001-2010, average values are 195576.8 and 1600.7 respectively. These values have positive signs which indicate that revised inflation is more than real inflation and real inflation was understated, on average over 90s and 20s inflation is revised in positive direction.

Over the subsample of 2011 to 2016 magnitude of average value of difference between revised and real inflation is maximum than other sub samples. Therefore, as compared to subsamples, real inflation was more overstated and on average over this sub-sample inflation is maximally revised in negative direction. On the other hand, over the subsample of 1974-1980 magnitude of average value of difference between revised and real inflation is minimum than other sub samples. Therefore, as compared to subsamples, real inflation was least overstated and on average over this sub-sample inflation is minimally revised in negative direction.

The difference between revised and real inflation indicate that over the subsample of 1991 to 2000 have higher standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 1974 to 1980 has lowest SD which means that this subsample has less volatility. As we are familiar that just SD is not best measure of volatility because according to this measure samples with higher volatility also have higher value of mean that's why it's better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 2011 to 2016 has lowest value of SR, its means that this subsample is least volatile whereas the subsample 1991 to 2000 has highest value of SR which shows the maximum volatility as compared to other subsamples.

The maximum values of difference between revised and real inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 5422, 13035, 2143216, 624413 and 306957 respectively. Which shows that over the subsample 1991 to 2000 maximum difference between revised and real inflation is highest whereas over the subsample 1974 to 1980 maximum difference between revised and real inflation is lowest as compare to other subsamples.

The minimum values of difference between revised and real inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -5218, -42827, -57698, -543330 and -1446954 respectively. Which shows that over the subsample 2011 to 2016 minimum difference between revised and real inflation is least whereas over the subsample 1974 to 1980 minimum difference between revised and real inflation is more as compare to other subsamples.

The difference between final and real inflation indicate that over the subsamples of 1974-1980, 1991-2000, 2001-2010 average values are 2094.42, 194343 and 58556.60 respectively. These values have positive signs which indicate that final inflation is more than real inflation and real inflation was understated, on average over 70s, 90s and 20s inflation is revised in positive direction. On the other hand, the difference between final and real inflation shows that over the subsamples of 1981-1990, 2011-2016 average values -9003.85 and -502525 respectively. These values have negative signs which indicate that final inflation is less than real inflation and real inflation was overstated, on average over these sub-samples inflation is revised in negative direction.

Over the subsample of 2011 to 2016 magnitude of average value of difference between final and real inflation is maximum than other sub samples. Therefore, as compared to subsamples, real inflation was more overstated and on average over this sub-sample inflation is maximally revised in negative direction. On the other hand, over the subsample of 1974-1980 magnitude of average value of difference between final and real inflation is minimum than other sub samples. Therefore, as compared to subsamples, real inflation was least understated and on average over this sub-sample inflation is minimally revised in positive direction.

The difference between final and real inflation indicate that over the subsample of 1991 to 2000 have higher standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 1974 to 1980 has lowest SD which means that this subsample has less volatility. As we are familiar that just SD is not best measure of volatility because according to this measure samples with higher volatility also have higher value of mean that's why it's better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 2011 to 2016 has lowest value of SR, its means that this subsample is least volatile whereas the subsample 1974 to 1980 has highest value of SR which shows the more volatility as compared to other subsamples.

The maximum values of difference between final and real inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 7284, 9050, 2100075, 625117 and 202103 respectively. Which shows that over the subsample 1991 to 2000 maximum difference between final and real inflation is highest whereas over the subsample 1974 to1980 maximum difference between final and real inflation is lowest as compare to other subsamples.

The minimum values of difference between final and real inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -3749, -47732, -69569, -555426 and -1503912 respectively. Which shows that over the subsample 2011 to 2016 minimum difference between final and real inflation is least whereas over the subsample 1974 to 1980 minimum difference between final and real inflation is more as compare to other subsamples.

The difference between final and revised inflation indicate that over the subsamples of 1974-1980, 2001-2010 average values are 2108.35 and 56955.90 respectively. These values have positive signs which indicate that final inflation is more than revised inflation and revised inflation was understated, on average over 70s and 20s inflation is revised in positive direction. On the other hand, the difference between final and revised inflation shows that over the subsamples of 1981-1990, 1991-2000, 2011-2016 average values -3125.95, -1233.80 and -83362.50 respectively. These values have negative signs which indicate that final inflation is less than revised inflation and revised inflation was overstated, on average over these sub-samples inflation is revised in negative direction.

Over the subsample of 2011 to 2016 magnitude of average value of difference between final and revised inflation is maximum than other sub samples. Therefore, as compared to other subsamples, revised inflation was more overstated and on average over this sub-sample inflation is maximally revised in negative direction. On the other hand, over the subsample of 1991-2000 magnitude of average value of difference between final and revised inflation is minimum than other sub samples. Therefore, as compared to other subsamples, revised inflation was least overstated and on average over this sub-sample inflation is minimally revised in negative direction.

The difference between final and revised inflation indicate that over the subsample of 2001 to 2010 have higher standard deviation. It means that this subsample has more volatility as compared to other subsamples whereas the subsample 1974 to 1980 has lowest SD which means that this subsample has less volatility. As we are familiar that just SD is not best measure of volatility because according to this measure samples with higher volatility also have higher value of mean that's why it's better to use Stability ratio as a measure of volatility. Therefore, according to SR subsample 2001 to 2010 has highest value of SR, its means that this subsample is more volatile whereas the subsample 1991 to 1990 has lowest value of SR which shows the lowest volatility as compared to other subsamples.

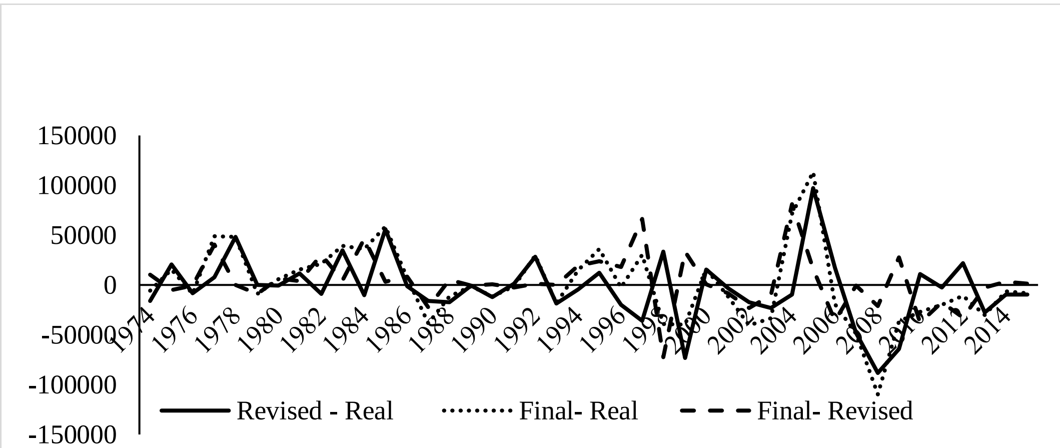
The maximum values of difference between final and revised inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are 7858.50, 9615, 34240, 579913 and 171898 respectively. Which shows that over the subsample 2001 to 2010 maximum difference between final and revised inflation is highest whereas over the subsample 1974 to 1980 maximum difference between final and revised inflation is lowest as compare to other subsamples.

The minimum values of difference between final and revised inflation over the subsamples 1974 to 1980, 1981 to1990, 1991 to 2000, 2001 to 2010, and 2011 to 2016 are -4007, -12952, -43141, -129552 and -320409 respectively. Which shows that over the subsample 2011 to 2016 minimum difference between final and revised inflation is least whereas over the subsample 1974 to 1980 minimum difference between final and revised inflation is more as compare to other subsamples.

4.6 Graph of Differences of Real, Revised and Final GDP

In this section we have presented graphical analysis of differences between real, revised and final GDP from the time period of 1974 to 2016.Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually they are projected estimates known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provides opportunity for users and creator of the data to analyze to which extent and direction revisions take place. When after one year data is revised and known as revised data. When data is revised after second year is known as final data. The graph of differences between real, revised and final GDP is given below.

Figure 4.1: Differences of Real, Revised and Final GDP



The Figure 4.1 shows that over sub sample period from 1974-1980 and 1981-1990 mostly the difference between revised and real GDP is positive. Which indicate that revised GDP is more than real GDP and real GDP was understated, on average over 70s and 80s GDP is revised in positive direction. On the other hand, over the subsamples from1991-2000, 2001-2010, and 2011-2016 mostly the difference between revised and real GDP is negative. Which indicate that revised GDP is less than real GDP and real GDP was overstated, on average over 90s, 2000s GDP is revised in negative direction.

It shows that over sub sample period from 1974-1980, 1981-1990, 1991-2000 mostly the difference between final and real GDP is positive. Which indicate that final GDP is more than real GDP and real GDP was understated, on average over 70s, 80s and 90s GDP is revised in positive direction. On the other hand, over the subsamples from 2001-2010, 2011-2016 mostly the difference between final and real GDP is negative. Which indicate that final GDP is less than real GDP and real GDP was overstated, on average over 2000s GDP is revised in negative direction.

It shows that over sub sample period from 1974-1980, 1981-1990, 1991-2000 mostly the difference between final and revised GDP is positive. Which indicate that final GDP is more than revised GDP and revised GDP was understated, on average over 70s, 80s and 90s GDP is revised in positive direction. On the other hand, over the subsamples from 2001-2010, 2011-2016 the difference between final and revised GDP is negative. Which indicate that final GDP is less than revised GDP and revised GDP was overstated, on average over 2000s GDP is revised in negative direction.

In 2005 the difference between revised and real GDP, final and real GDP, final and revised GDP is maximum as compared to other positive differences. Asghar ,Awan and

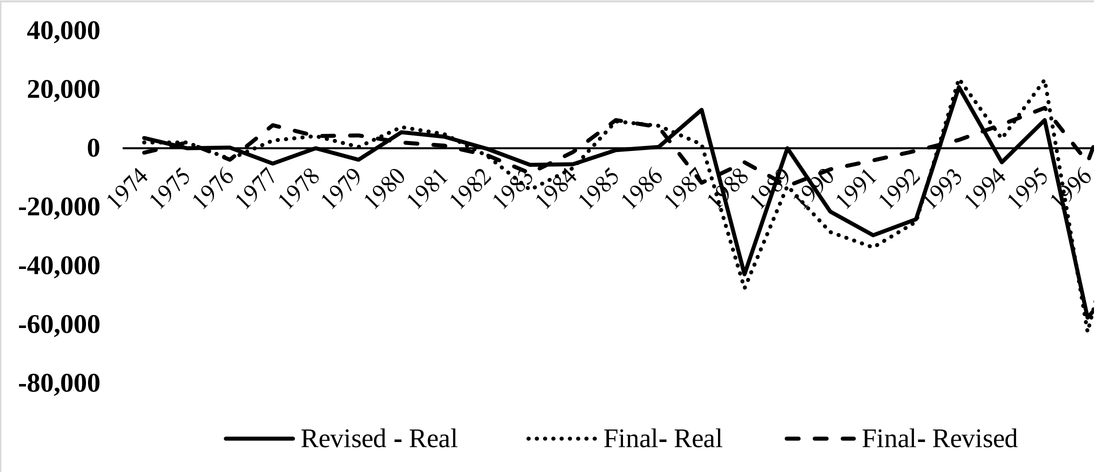
Rehman (2012) stated that it capture the fact that Pakistan economy was subject high growth rate due to controllable levels of fiscal deficit, stabilized exchange rate ,lower debt ratios and decrease in poverty ratio.

In 2008 the difference between revised and real GDP, final and real GDP is minimum as compared to other negative differences. Pakistan Economic survey 2008 reported that It capture the fact that Pakistan economy was subject to adverse external and internal shocks. For example internal shocks that lower the growth were adverse supply shock, unfavorable political conditions and instability in law and order condition, deficit in current and fiscal account as well as coupled with external shocks and suffered from global recession, global financial crises, , rise in global price level of food and energy.

4.7 Graph of Differences of Real, Revised and Final Inflation

In this section we have presented graphical analysis of differences between real, revised and final inflation from the time period of 1974 to 2016.Several macroeconomic variables e.g. GDP, inflation and unemployment printed semi-annually they are projected estimates known as real time data. Then they are subject to revisions with passage of time when new data is published or when considerable rise in the facts on the basis of they are constructed become available. The activity of revision analysis provide opportunity for users and creator of the data to analyze to which extent and direction revisions take place. When after one year data is revised and known as revised data. When data is revised after second year is known as final data. The graph of differences between real, revised and final inflation is given below.

Figure 4.2: Differences of Real, Revised and Final Inflation

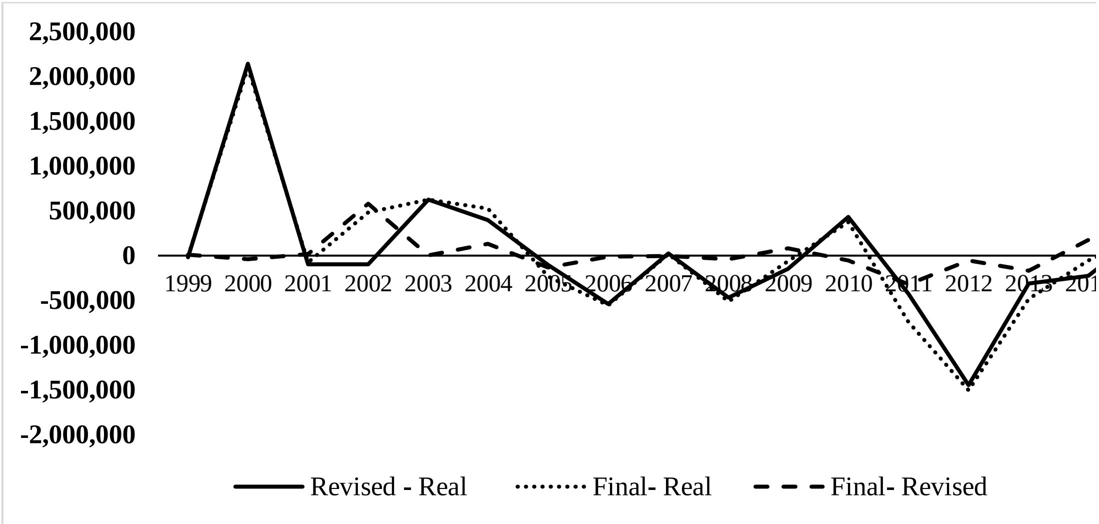


The Figure 4.2 shows that over sample period from 1974 to 1986 the differences between revised and real inflation, final and real inflation, final and revised inflation are minimum. It shows that over the time period from 1974-1998 difference between revised and real inflation is negative. Which indicate that revised inflation is less than real inflation and real inflation was overstated, on average over this sample period inflation is revised in negative direction.

It shows that over sub sample period from 1974 to 1986 the difference between final and real inflation is positive. Which indicate that final inflation is more than real inflation and real inflation was understated, on average over this time period inflation is revised in positive direction. On the other hand, over the subsamples from 1987-1998 mostly the difference between final and real inflation is negative. Which indicate that final inflation is less than real inflation and real inflation was overstated, on average over this time period inflation is revised in negative direction.

It shows that over the time period from 1974 to 1998 the difference between final and revised inflation is positive. Which indicate that final inflation is more than revised inflation and revised inflation was understated, on average over this time period inflation is revised in positive direction.

Figure 4.3: Differences of Real, Revised and Final Inflation



The Figure 4.3 shows that over sub sample period from 1999 to 2005 mostly the difference between revised and real inflation is positive. Which indicate that revised inflation is more than real inflation and real inflation was understated, on average over this sample period inflation is revised in positive direction. On the other hand, over the time period from 2006-2016 mostly the difference between revised and real inflation is negative. Which indicate that revised inflation is less than real inflation and real inflation was overstated, on average over this time period inflation is revised in negative direction.

It shows that over sub sample period from 1999 to 2005 mostly the difference between final and real inflation is positive. Which indicate that final inflation is more than real inflation and real inflation was understated, on average over this time period inflation is revised in positive direction. On the other hand, over the subsamples from 2006-2016 mostly the difference between final and real inflation is negative. Which indicate that final inflation is less than real inflation and real inflation was overstated, on average over this time period inflation is revised in negative direction.

It shows that over the time period from 1999 to 2005 mostly the difference between final and revised inflation is positive. Which indicate that final inflation is more than revised inflation and revised inflation was understated, on average over this time period inflation is revised in positive direction. On the other hand, over the time period from 2006-2016 mostly the difference between final and revised inflation is negative. Which indicate that final inflation is less than revised inflation and revised inflation was overstated, on average over these this time period inflation is revised in negative direction.

After 1998 to 2016 the difference between revised and real inflation, final and real inflation, final and revised inflation is unstable as compared to previous time span. It capture the fact that Pakistan economy was subject to external and internal shocks at this time. For example it is suffered from political instability, global recession, drought, global financial crises, deficit in current and fiscal account, dependence on imported goods, grant and aids, rise in global price level of food and energy. Pakistan economic survey 2016 reported that in recent years 2013 to 2016 inflation level has been declined due to stable exchange rate, decrease in global goods and oil prices, proper check and control of prices by price control authority by government.

4.8 ARIMA Model

According to Stock and Watson (2007), we estimated the rolling ARIMA model for 2 period ahead inflation forecasting .Firstly we have estimated the model for 1 period ahead inflation forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Later on we roll forward our regression from 1975 to 2015 to forecast inflation for 2016 is given below equations 4.1 to 4.6. . We have estimated equation 4.1 and 4.2 for the estimation of real time data, however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 4.3 and 4.4. After that when real time inflation is revised after two years then we have estimated the final inflation equation 4.5 and 4.6.

$$inf_t^{rl} = \underset{(0.009)}{0.442}\varepsilon_{t-1} \text{-------(4.1)}$$

Equation 4.1 indicate that for one step ahead out of sample forecast real inflation estimates shows that real inflation depend on shocks. Therefore our ARIMA model is (0, 1) as MA (1) coefficient value is 0.442 and it is highly significant. Which means that if there is unexpected shock to the inflation rate then inflation rate will increase by 0.44 percent.

$$inf_t^{rl} = \underset{(0.007)}{0.442}\varepsilon_{t-1} \text{-------- (4.2)}$$

Equation 4.2 indicate that for two step ahead out of sample forecast real inflation estimates shows that real inflation depend on shocks. Therefore our ARIMA model is (0, 1) as MA (1) coefficient value is 0.442 and it is highly significant. Which means

* P values are in parenthesis

that if there is unexpected shock to the inflation rate then real inflation will increase by 0.44 percent.

$$inf_t^{re} = 0.315inf_{t-2}^{re} + 0.808\varepsilon_{t-1} \text{ ------------- (4.3)}$$
$$(0.061) \qquad (0.037)$$

Equation indicate 4.3 that for one step ahead out of sample forecast revised inflation estimates shows that revised inflation depend on its second lag as well as at shocks. Therefore our ARIMA model is (2, 1) as AR (2) and MA (1) coefficient values are 0.315 and 0.808 both are significant.

Which means that if previous years revised inflation increase by 1% then current revised inflation will increase by 0.31%. If there is unexpected shock to the revised inflation rate, then revised inflation will increase by 0.80 percent.

$$inf_t^{re} = 0.315inf_{t-2}^{re} + 0.808\varepsilon_{t-1} \text{---------- (4.4)}$$
$$(0.054) \qquad (0.033)$$

Equation 4.4 indicate that for two step ahead out of sample forecast revised inflation estimates shows that revised inflation depend on its second lag as well as at shocks. Therefore our ARIMA model is (2, 1) as AR (2) and MA (1) coefficient values are 0.315 and 0.808 both are significant. Which means that if previous years revised inflation increase by 1% then current revised inflation will increase by 0.31%. If there is unexpected shock to the inflation rate, then inflation rate will increase by 0.80 percent.

$$inf_t^{fl} = 0.776inf_{t-1}^{fl} + 0.859\ \varepsilon_{t-1} \text{------------- (4.5)}$$
$$(0.014) \qquad (0.001)$$

* P values are in parenthesis

Equation 4.5 indicate that for one step ahead out of sample forecast final inflation estimates shows that final inflation depend on its first lag as well as at shocks. Therefore, our ARIMA model is (1, 1), as AR (1) and MA (1) coefficient values are 0.776 and 0.859 both are significant. Which means that if previous years final inflation increase by 1% then current final inflation will increase by 0.77%.if there is unexpected shock to the inflation rate, then inflation rate will increase by 0.85 percent.

$$inf_t^{fl} = \underset{(0.012)}{0.776}\, inf_{t-1}^{fl} + \underset{(0.001)}{0.859}\, \varepsilon_{t-1} \text{-----------} \quad (4.6)$$

Equation 4.6 indicate that for two step ahead out of sample forecast final inflation estimates shows that final inflation depend on its first lag as well as at shocks. Therefore, our ARIMA model is (1, 1), as AR (1) and MA (1) coefficient values are 0.776 and 0.859 both are significant.Which means that if previous year's final inflation increase by 1% then current final inflation will increase by 0.77%. If there is unexpected shock to the inflation rate, then inflation rate will increase by 0.85 percent.

According to equation 4.3 to 4.6 our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases.

4.9 Philips Curve Model

According to Dostey *et al.* (2017), we have to estimate the Philips curve model for 2 period ahead inflation forecasting .Firstly we have estimated the model for 1 period ahead inflation forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Later on we roll forward our regression from 1975 to 2015 to forecast inflation for 2016 is given below equations 4.7 to 4.12**.** We have estimated equation 4.7 and 4.8

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* P values are in parenthesis

for the estimation of real time data, however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 4.9 and 4.10. After that when real time inflation is revised after two years then we have estimated the final inflation equation 4.11 and 4.12.

$$inf_t^{rl} = \underset{(0.166)}{0.213} inf_{t-1}^{rl} + \underset{(0.559)}{0.627} og_t^{rl} + \varepsilon_t \text{--------} (4.7)$$

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Equation 4.7 indicate that for one step ahead out of sample forecast real inflation estimates shows that previous year real inflation has positive effect on current year real inflation. If there is 1% increase in previous year real inflation then current year real inflation increases by 0.21%.Our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases. Real output gap has positive effect on real inflation. If there is 1% increase in real output gap then current year real inflation increases by 0.62%.

$$inf_t^{rl} = \underset{(0.158)}{0.213} inf_{t-1}^{rl} + \underset{(0.551)}{0.27} og_t^{rl} + \varepsilon_t \text{-------------} (4.8)$$

Equation 4.8 indicate that for two step ahead out of sample forecast real inflation estimates shows that previous year real inflation has positive effect on current year real inflation. If there is 1% increase in previous year real inflation then current year real inflation increases by 0.21%.Our result is consistent with "adaptive expectations" if, in previous years inflation has increased then current year inflation will also increases. Real output gap has positive effect on real inflation. If there is 1% increase in real output gap then current year real inflation increases by 0.27%.

$$inf_t^{re} = \underset{(0.335)}{0.151} inf_{t-1}^{re} + \underset{(0.483)}{0.614} og_t^{re} + \varepsilon_t \text{----------------} (4.9)$$

Equation 4.9 indicate that for one step ahead out of sample forecast revised inflation estimates shows that previous year revised inflation has positive effect on current year

* P values are in parenthesis

revised inflation. If there is 1% increase in previous year revised inflation then current year revised inflation increases by 0.15%. Our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases. Revised output gap has positive effect on revised inflation. If there is 1% increase in revised output gap then current year revised inflation increases by 0.61%.

$$inf_t^{re} = \underset{(0.326)}{0.151 inf_{t-1}^{re}} + \underset{(0.476)}{0.614 og_t^{re}} + \varepsilon_t \text{---------------} (4.10)$$

Equation 4.10 indicate that for two step ahead out of sample forecast revised inflation estimates shows that previous year revised inflation has positive effect on current year revised inflation. If there is 1% increase in previous year revised inflation then current year inflation increases by 0.15%. Our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases. Revised output gap has positive effect on revised inflation. If there is 1% increase in revised output gap then current year revised inflation increases by 0.61%.

In case of equation 4.7 to 4.10 indicate that there is positive correlation between output gap and inflation. Here positive sign of output gap indicate that actual output is more than potential output, there is demand shock in the economy, firms has hired more labors to increase production at high wages due increase in labor demand therefore labor cost will increase and firms have utilized their existing capital more than full capacity that's why per unit output cost has increased. Then both labor and production cost rise leads to increase in inflation. Our result is consistent with (Whitley *et al.*, 1997) positive output gap results inflationary process.

$$inf_t^{fl} = \underset{(0.0537)}{0.09 inf_{t-1}^{fl}} - \underset{(0.901)}{0.09 og_t^{fl}} + \varepsilon_t \text{----------------} (4.11)$$

* P values are in parenthesis

Equation 4.11 indicate that for one step ahead out of sample forecast final inflation estimates shows that previous year final inflation has positive effect on current year final inflation. If there is 1% increase in previous year final inflation then current year final inflation increases by 0.9%. Our result is consistent with “adaptive expectations” if in previous years inflation has increased then current year inflation will also increases. Whereas Final output gap has negative effect on final inflation. If there is 1% increase in final output gap then current year final inflation decreases by 0.9%.

$$inf_t^{fl} = \underset{(0.530)}{0.090}\ inf_{t-1}^{fl} - \underset{(0.899)}{0.09} og_t^{fl} + \varepsilon_t \text{---------------} (4.12)$$

Equation 4.12 indicate that for two step ahead out of sample forecast final inflation estimates shows that previous year final inflation has positive effect on current year final inflation. If there is 1% increase in previous year final inflation then current year final inflation increases by 0.9%. Our result is consistent with “adaptive expectations” if in previous years inflation has increased then current year inflation will also increases. Whereas final output gap has negative effect on final inflation. If there is 1% increase in final output gap then current year final inflation decreases by 0.9%.

In case of equation 4.11 to 4.12 indicate that there is negative correlation between output gap and inflation. Here negative sign of output gap indicate that actual output is less than potential output, there is supply shock in the economy, firms cost of production decreased. Then decrease in cost leads to decrease in inflation. Our result is consistent with (Whitley *et al.*, 1997) negative output gap results deflationary process.

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* P values are in parenthesis

Bank of Canada (2012) pointed out that negative output gap lead the economy in recession, then there will be low price level and high unemployment. Ţiţan and Georgescu (2013) empirically analyzed that in Romania there is negative output gap and inflation has decreased on the other hand unemployment rate has increased.

4.10 Philips Curve Threshold Auto-regressive Model

According to Dostey *et al.* (2017), we estimated the Philips Curve model for 2 period ahead inflation forecasting .Firstly we have estimated the model for 1 period ahead inflation forecasting under different macroeconomic conditions (real, revised and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015.Afterward we roll forward our regression from 1975 to 2015 to forecast inflation for 2016 is given below equations 4.13 to 4.18.We have estimated equation 4.13 and 4.14 for the estimation of real time data, however real time data is subject to revisions. When real time inflation is revised after one year then we have estimated the revised inflation equation 4.15 and 4.16. After that when real time inflation is revised after two years then we have estimated the final inflation equation 4.17 and 4.18.

$$inf_t^{rl} = \underset{(0.192)}{0.20} inf_{t-1}^{rl} + \underset{(0.364)}{0.70}\ 1(|og_t^{rl}| > og_*^{rl}) og^{rl} + \underset{(0.367)}{2.08}\ 1(|og_t^{rl}| \leq og_*^{rl}) og^{rl} + \varepsilon_t \quad \text{-- (4.13)}$$

Equation 4.13 indicate that for one step ahead out of sample forecast real inflation estimates shows that previous year real inflation has positive effect on current year real inflation. If there is 1% increase in previous year real inflation then current year real inflation increases by 0.20%.Our result is consistent with “adaptive expectations” if in previous years inflation has increased then current year inflation will also increases.

Positive real output gap (actual real output gap is greater than threshold real output gap) has positive effect on real inflation. When there is 1% change in positive output gap then real inflation increases by 0.70%. Negative real output gap (actual real output gap is less than threshold real output gap) has positive effect on real inflation. If there is 1% increase in real output gap then current year real inflation increases by 2.08%.

$$inf_t^{rl} = \underset{(0.813)}{0.20}\, inf_{t-1}^{rl} + \underset{(0.356)}{0.70}\, 1(|og_t^{rl}| > og_*^{rl}) og^{rl} + \underset{(0.361)}{2.08}\, 1(|og_t^{rl}| \leq og_*^{rl}) og^{rl} + \varepsilon_t \text{ -- (4.14)}$$

Equation 4.14 indicate that for two step ahead out of sample forecast real inflation estimates shows that previous year real inflation has positive effect on current year real inflation. If there is 1% increase in previous year real inflation then current year real inflation increases by 0.20%.Our result is consistent with "adaptive expectations" if, in previous years inflation has increased then current year inflation will also increases.

Positive real output gap (actual real output gap is greater than threshold real output gap) has positive effect on real inflation. If there is 1% increase in real output gap then current year real inflation increases by 0.70%.Negative real output gap (actual real output gap is less than threshold real output gap) has positive effect on real inflation. If there is 1% increase in real output gap then current year real inflation increases by 2.08%.

$$inf_t^{re} = \underset{(0.414)}{0.13} inf_{t-1}^{re} + \underset{(0.532)}{0.55}\, 1(|og_t^{re}| > og_*^{re}) og^{re} + \underset{(0.526)}{2.52}\, 1(|og_t^{re}| \leq og_*^{re}) og^{re} + \varepsilon_t \text{--(4.15)}$$

Equation indicate 4.15 that for one step ahead out of sample forecast revised inflation estimates shows that previous year revised inflation has positive effect on current year revised inflation. If there is 1% increase in previous year revised inflation then current year revised inflation increases by 0.13%.Our result is consistent with "adaptive expectations" if, in previous years inflation has increased then current year inflation will also increases.

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* P values are in parenthesis

Positive revised output gap (actual revised output gap is greater than threshold revised output gap) has positive effect on revised inflation. If there is 1% increase in revised output gap then current year revised inflation increases by 0.55%.Negative revised output gap (actual revised output gap is less than threshold revised output gap) has positive effect on revised inflation. If there is 1% increase in revised output gap then current year final inflation increases by 2.52%.

$$inf_t^{re} = \underset{(0.405)}{0.133}\, inf_{t-1}^{re} + \underset{(0.526)}{0.55}\, 1(|og_t^{re}| \leq og_*^{re})og^{re} + \underset{(0.520)}{2.52}\, 1(|og_t^{re}| \leq og_*^{re})og^{re} + \varepsilon_t \text{—(4.16)}$$

Equation 4.16 indicate that for two step ahead out of sample forecast revised inflation estimates shows that previous year revised inflation has positive effect on current year revised inflation. If there is 1% increase in previous year revised inflation then current year revised inflation increases by 0.13%.Our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases.

Positive revised output gap (actual revised output gap is greater than threshold revised output gap) has positive effect on revised inflation. If there is 1% increase in revised output gap then current year revised inflation increases by 0.55%.Negative revised output gap(actual revised output gap is less than threshold revised output gap) has positive effect on revised inflation. If there is 1% increase in revised output gap then current year final inflation increases by 2.52%.

In case of equation 4.13 to 4.16 real and revised positive output gap has positive effect on inflation then our result is consistent with (Watanabe, 1997) rise in capacity utilization leads to increase in inflationary process. (Citu &Twaddle, 2003) stated that when there is positive output gap inflation will increase due high resource utilization,

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* P values are in parenthesis

in labor market there is low unemployment rate, and firms will enhance their output with already employed labors by raising their work hours and wage rate.

Bank of Canada (2012) point out that positive output gap shows economic activity is above potential capacity it is generally linked with boom horizon. That's why increased pressure in labor market cause unemployment rate to fall and price level to rise.

Ţiţan and Georgescu (2013) , considered eight countries of European Union for the analysis of relationship between inflation, unemployment and output gap. They summarized that empirically for seven countries there is positive output gap and inflation has increased on the other hand unemployment rate has decreases.

$$inf_t^{fl} = \underset{(0.553)}{0.08} inf_{t-1}^{fl} - \underset{(0.7713)}{0.153}\, 1\left(\left|og_t^{fl}\right| > og_*^{fl}\right) og^{fl} + \underset{(0.771)}{0.77}\, 1\left(\left|og_t^{fl}\right| \le og_*^{fl}\right) og^{fl} + \varepsilon_t \text{-(4.17)}$$

Equation 4.17 indicate that for one step ahead out of sample forecast final inflation estimates shows that previous year final inflation has positive effect on current year final inflation. If there is 1% increase in previous year final inflation then current year final inflation increases by 0.8%. Our result is consistent with "adaptive expectations" if in previous years inflation has increased then current year inflation will also increases.

Positive final output gap (actual final output gap is greater than threshold final output gap) has negative effect on final inflation. If there is 1% increase in final output gap then current year final inflation decreases by 0.15%. Negative final output gap (actual final output gap is less than threshold final output gap) has positive effect on final inflation. If there is 1% increase in final output gap then current year final inflation increases by 0.77%.

$$inf_t^{fl} = \underset{(0.547)}{0.08} inf_{t-1}^{fl} - \underset{(0.845)}{0.15}\, 1\left(\left|og_t^{fl}\right| > og_*^{fl}\right) og^{fl} + \underset{(0.768)}{1.03}\, 1\left(\left|og_t^{fl}\right| \le og_*^{fl}\right) og^{fl} + \varepsilon_t \text{..(4.18)}$$

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[*] P values are in parenthesis

Equation 4.18 indicate that for two step ahead out of sample forecast final inflation estimates shows that previous year final inflation has positive effect on current year final inflation. If there is 1% increase in previous year inflation then current year inflation increases by 0.8%. Our result is consistent with “adaptive expectations” if in previous years inflation has increased then current year inflation will also increases.

Positive final output gap (actual final output gap is greater than threshold final output gap) has negative effect on final inflation. If there is 1% increase in final output gap then current year final inflation decreases by 0.15%.Negative final output gap (actual final output gap is less than threshold final output gap) has positive effect on final inflation. If there is 1% increase in final output gap then current year final inflation increases by 1.03%.

In case of equation 4.17 and 4.18 our result shows that positive final output gap has negative effect on inflation which is contradictory with (Whitley *et al.*, 1997) when there is “Demand shock” its mean that actual output is greater than potential output (positive output gap) firms will hire more labor at high wage and produce more output by utilizing capital more than optimal level that’s why per unit cost increase leads to raise the inflationary pressure.

In case of equation 4.13 and 4.18 our result shows that negative real ,revised and final output gap has positive effect on inflation which is contradictory with (Whitley *et al.*,1997) when there is “Supply shock” its mean that actual output is less than potential output (negative output gap) firms cost of production decreased. Then decrease in cost leads to decrease in price level results deflationary process. However , our results are further more contradictory with (Bank of Canada, 2012) pointed out that negative output gap lead the economy in deflationary gap, then there will be low price level and high unemployment. (Ţiţan and Georgescu , 2013) empirically analyzed that in

Romania there is negative output gap and inflation has decreased on the other hand unemployment rate has increased.

Equation 4.7 to 4.18 indicate that output gap have not significant effect on inflation because we have not included the supply side of the economy. Supply side have significant effect to increase the inflation level in Pakistan. Saleem and Ahmad (2015) also narrated that no explicit attention has been given to the supply side variables. They said that from 1979 to 2012 Exchange rate, international oil prices, Interest rate and money supply have significant positive effect on the inflation level of Pakistan. Malik (2016) also analyzed energy sector has important role to cause inflation and oil prices have positive strong impact on inflation.

4.11 Results of Forecast Measures

We have assessed relative forecasting performance of different models and macroeconomic conditions with reference to data e.g. real, revised and final inflation. We have used Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) to compare the forecast accuracy. The values of RMSE and MAE for Naive, ARMA, PC and PC-TAR a model are given in tables

Table 4.5: Forecasting Results of Real Inflation for 1 step Ahead Forecast

Models	RMSE	MAE
Naive	3.765	2.895
ARIMA	6.556	5.374
PC	6.067	5.397
PC TAR	5.566	4.754

Table 4.5 shows the results of one step ahead out of sample forecast with real time inflation. Both forecasting accuracy measures shows that the values of RMSE and MAE of Naive are less than ARIMA model PC model and PC-TAR model. Which indicate

that Naive better forecast inflation than ARIMA model PC model and PC-TAR model.

Table 4.6: Forecasting Results of Real Inflation for 2 Step Ahead Forecast

Models	RMSE	MAE
Naive	3.760	2.863
ARIMA	4.704	3.326
PC	4.194	2.966
PC TAR	3.948	2.792

Table 4.6 shows the results of two step ahead out of sample forecast with real time inflation. According to RMSE the value of RMSE of Naive is less than ARIMA model PC model and PC-TAR model. Which indicate that on the basis of RMSE Naive model better forecast inflation than ARIMA model, PC model and PC-TAR model. Whereas on the other hand MAE shows that Philips curve Threshold auto regressive model is most superior to Naive model, ARIMA and PC model

Table 4.7: Forecasting Results of Revised Inflation for 1 Step Ahead Forecast

Models	RMSE	MAE
Naive	3.054	2.344
ARIMA	5.349	4.005
PC	4.324	4.185
PC TAR	4.321	4.185

Table 4.7 shows the results of one step ahead out of sample forecast with revised inflation. Both forecasting accuracy measures shows that the values of RMSE and MAE of Naive are less than ARIMA model PC model and PC-TAR model. Which indicate that Naive better forecast inflation than ARIMA model PC model and PC-TAR model.

Table 4.8: Forecasting Results of Revised Inflation for 2 Step Ahead Forecast

Models	RMSE	MAE
Naive	3.054	2.315
ARIMA	5.488	3.884
PC	6.249	4.418
PC TAR	6.187	4.374

Table 4.8 shows the results of two step ahead out of sample forecast with revised inflation. Both forecasting accuracy measures shows that the values of RMSE and MAE of Naive are less than ARIMA model, PC model and PC-TAR model. Which indicate that Naive better forecast inflation than ARIMA model, PC model and PC-TAR model.

Table 4.9: Forecasting Results of Final Inflation 1 Step Ahead Forecast

Models	RMSE	MAE
Naive	2.987	2.293
ARIMA	5.174	5.103
PC	5.426	4.615
PC TAR	5.471	4.668

Table 4.9 shows the results of one step ahead out of sample forecast with final inflation. Both forecasting accuracy measures shows that the values of RMSE and MAE of Naive are less than ARIMA model PC model and PC-TAR model. Which indicate that Naive better forecast inflation than ARIMA model, PC model and PC-TAR model.

Table 4.10: Forecasting Results of Final Inflation 2 Step Ahead Forecast

Models	RMSE	MAE
Naive	3.024	2.339
ARMA	7.704	5.456
PC	6.176	4.367
PC TAR	6.217	4.396

Table 4.10 shows the results of two step ahead out of sample forecast with final inflation. Both forecasting accuracy measures shows that the values of RMSE and MAE of Naive are less than ARIMA model PC model and PC-TAR model. Which indicate that Naive better forecast inflation than ARIMA model PC model and PC-TAR model.

Table 4.5, 4.7 and 4.9 indicate that we have compared macroeconomic conditions with reference to real, revised and final inflation data. According to one step ahead out of sample forecast indicate that RMSE and MAE of revised and final inflation are less than real inflation. Therefore we conclude that revised and final inflation are more accurate than real inflation. On the other hand according to real, revised and final data for one year ahead out of sample inflation forecasting, both forecasting accuracy measures RMSE and MAE shows Naive model is most superior to other models.

Table 4.6, 4.8 and 4.10 indicate that we have compared macroeconomic conditions with reference to real, revised and final inflation data. According to two step ahead out of sample forecast indicate that RMSE of real and revised inflation are less than final inflation. Therefore we conclude that real and revised inflation are more accurate than final inflation. On the other hand according to real time data for two years ahead out of sample inflation forecasting, RMSE shows that Naive model is most superior to other models whereas MAE shows that Philips curve Threshold auto regressive model is most superior to other models. According to revised and final data for two years ahead out of sample inflation forecasting both forecasting accuracy measures RMSE and MAE shows Naive model is most superior to other models.

CHAPTER 5

CONCLUSION

Inflation forecasting is important job for monetary policy makers because they need to keep it balance as it affects the economic agents. Inflation decreases the purchasing power of consumers and reduce the profits firms. In order to keep control over inflation we need to forecast inflation by appropriate econometric model. Therefore, in this study our first objective is to explore which model better forecast inflation under different macro-economic conditions with reference to data (real, revised and final data). For this purpose, we have utilized different models, which are naive model, ARIMA model, Philips curve model and Philips curve Threshold auto regressive model under different macroeconomic conditions with reference to real, revised and final data.

We have used annual real, revised and final time series data from 1974 to 2016. We have accomplished this task from one and two year ahead out of sample forecasting by using rolling window. We have considered the Philips curve model with backward looking expectations and output gap. However, Philips curve Threshold auto regressive model (PC-TAR) is extended by the addition of threshold level of output gap. We have selected superior and proper model on the bases of their forecasting performance. For the measurement of forecasting performance, we have used Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) as a criterion.

We concluded that for one year ahead out of sample forecasting according to real, revised and final data, both forecasting accuracy measures RMSE and MAE shows Naive model is most superior to other models. Further, revised and final inflation are more accurate than real inflation.

However, by using real time data for two years ahead out of sample forecasting, RMSE shows that Naive model is most superior to other models whereas MAE shows that Philips curve Threshold auto regressive model is most superior to other models. On the other hand by using revised and final data both forecasting accuracy measures RMSE and MAE shows Naive model is most superior to other models. Further, real and revised data is more accurate than final inflation.

5.1 Policy Recommendation

One of the important goals of policy makers is to keep the inflation level under control. Therefore, here need of inflation forecasting arise which let the policy makers and researchers to predict and portray it. In case of Pakistan, we recommend that for a one step ahead out of sample forecasting under real, revised and final data Naive model is superior as compared other models.

Further we recommend that for a two step ahead out of sample inflation forecasting under real time data Naive and Philips curve threshold autoregressive model are superior as compared other models. However, under revised and final time data according to both forecasting accuracy measures shows that naive model is superior as compared other models.

We suggest that for 1 year ahead out of sample inflation forecasting under real, revised and final data naive model can be used. Whereas for 2 years ahead out of sample inflation forecasting under revised and final data naive model can be used whereas under real time data naive and Philips curve threshold auto regressive model can be used.

REFERENCES

Afzal, M., Rehman, H. U., & Butt, A. R. (2002). FORECASTING: A DILEMMA OF MODULES. *Pakistan Economic and Social Review*, *40*(1), 1-18.

Alles, L., & Horton, D. (1999). An Evaluation of Alternative Methods of Forecasting Australian Inflation. *Australian Economic Review*, *32*(3), 237-248.

Ang, A., Bekaert, G., & Wei, M. (2007). Do macro variables, asset markets, or surveys forecast inflation better?. *Journal of monetary Economics*, *54*(4), 1163-1212.

Asghar, N., Awan, A., & Rehman, H. (2012). Human capital and economic growth in Pakistan: a cointegration and causality analysis. *International Journal of Economics and Finance*, *4*(4), 135-147.

Atkeson, A. E. O. (2001). Are Phillips Curves Useful for Forecasting Inflation? [*]. *Federal Reserve bank of Minneapolis quarterly review*, *25*(1), 2-2.

Ayyoub, M., Chaudhry, I. S., & Farooq, F. (2011). Does Inflation Affect Economic Growth? The case of Pakistan. *Pakistan Journal of Social Sciences (PJSS)*, *31*(1).

Bank of Canada. 2012. “The Output Gap”. Available at: https://www.bankofcanada.ca/wp-content/uploads/2010/11/output_gap.pdf

Bokharı, S. M., & Feridun, M. (2006). Forecasting inflation through econometric models: an empirical study on Pakistani data.

Bokil, M., & Schimmelpfennig, A. (2005). Three attempts at inflation forecasting in Pakistan (Vol.5). International Monetary Fund.

Box, G. E. P. and Tiao, G. C. (1975), "Intervention Analysis with Applications to Economic and Environmental Problems," JASA, 70, 70–79.

Carnot, N., Koen, V., & Tissot, B. (2005). *Economic forecasting*. Springer.

Chan, K. S., & Tong, H. (1986). On estimating thresholds in autoregressive models. *Journal of time series analysis*, *7*(3), 179-190.

Chen, H., Chong, T. T. L., & Bai, J. (2012). Theory and applications of TAR model with two threshold variables. Econometric Reviews, 31(2), 142-170.

Chong, Y. Y., & Hendry, D. F. (1986). Econometric evaluation of linear macro-economic models. *The Review of Economic Studies*, *53*(4), 671-690.

Citu, F., & Twaddle, J. (2003). The output gap and its role in monetary policy decision-making. *Reserve Bank of New Zealand Bulletin*, *66*(1), 5-14.

Clark, T. E., & McCracken, M. W. (2006). The predictive content of the output gap for inflation: resolving in-sample and out-of-sample evidence. *Journal of Money, Credit and Banking*, 1127-1148.

Clark, T. E., & McCracken, M. W. (2006). The predictive content of the output gap for inflation: resolving in-sample and out-of-sample evidence. *Journal of Money, Credit and Banking*, 1127-1148.

Claus, I. (2000). Estimating potential output for New Zealand: a structural VAR approach.

Claus, I. (2000). Is the output gap a useful indicator of inflation. *Reserve Bank of New Zealand Discussion Paper No. DP2000/05*.

Clausen, M. J. R., & Clausen, B. (2010). *Simulating Inflation Forecasting in Real-Time: How Useful is a Simple Phillips Curve in Germany, the UK L4434, and the US?* (No. 10-52). International Monetary Fund.

Clausen, M. J. R., & Clausen, B. (2010). *Simulating Inflation Forecasting in Real-Time: How Useful is a Simple Phillips Curve in Germany, the UK L4434, and the US?* (No. 10-52). International Monetary Fund.

Clements, M. P., & Hendry, D. F. (1999). On winning forecasting competitions in economics. Spanish Economic Review, 1(2), 123-160.

Clements, M., & Hendry, D. (2002). An overview of economic forecasting. *A Companion to Economic Forecasting. Oxford: Blackwell*, 1-18.

Croushore, D., & Stark, T. (2003). A real-time data set for macroeconomists: Does the data vintage matter?. *Review of Economics and Statistics*, *85*(3), 605-617.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), 427-431.

Dotsey, M., & Stark, T. (2005). The relationship between capacity utilization and inflation. *Federal Reserve Bank of Philadelphia Business Review*, 8-17.

Dotsey, M., & Stark, T. (2005). The relationship between capacity utilization and inflation. *Federal Reserve Bank of Philadelphia Business Review*, 8-17.

Dotsey, M., Fujita, S., & Stark, T. (2017). Do Phillips Curves Conditionally Help to Forecast Inflation?.

Fischer, S., & Easterly, W. (2000). Inflation and the Poor. *Policy Research Working Paper Series*, *2335*.

Fisher, J. D., Te Liu, C., & Zhou, R. (2002). When can we forecast inflation?. *Economic Perspectives*, *26*(1), 32-45.

Fisher, P. G., Mahadeva, L., & Whitley, J. D. (1996, January). The Output Gap and Inflation: Experience at the Bank of England. In *BIS Model Builders Meeting, Basle (January)*.

Franses, P. H., & Van Dijk, D. (2000). *Non-linear time series models in empirical finance*. Cambridge University Press.

Fuhrer, J. C., & Olivei, G. (2010). The role of expectations and output in the inflation process: an empirical assessment. *FRB of Boston Public Policy Brief*, (10-2).

Fuhrer, J. C., & Olivei, G. (2010). The role of expectations and output in the inflation process: an empirical assessment. *FRB of Boston Public Policy Brief*, (10-2).

Hafer, R. W., & Hein, S. E. (1990). Forecasting inflation using interest-rate and time-series models: Some international evidence. *Journal of Business*, 1-17.

Haider, A., & Hanif, M. N. (2009). Inflation forecasting in Pakistan using artificial neural networks. *Pakistan economic and social review*, 123-138

Hanif, M. N., & Malik, M. J. (2015). Evaluating Performance of Inflation Forecasting Models of Pakistan.

Hussain, M. (2005). Inflation and growth: Estimation of threshold point for Pakistan. *Pakistan Business Review, 17*(3), 1-15.

Iftikhar, N. & Iftikhar-ul-amin (2013).Forecasting the Inflation in Pakistan; The Box-Jenkins Approach. World Applied Sciences Journal 28 (11): 1502-1505, 2013. ISSN 1818- 4952.

Jahan, S., & Mahmud, A. S. (2013). What Is the Output Gap. *Finance & Development*, *50*(3), 38-39.

Kanyama, I. K., & Thobejane, B. M. (2013). Forecasting macroeconomic variables in South Africa: parametric vs. non-parametric methods. In *Economic Society of South Africa 2013 Conference*.

Khan, M. (2005). Inflation and growth in MCD Countries. *Unpublished Manuscript. Washington, DC: International Monetary Fund*.

Khan, M. M. S., & Schimmelpfennig, M. A. (2006). *Inflation in Pakistan: Money or wheat?* (No. 6-60). International Monetary Fund.

Lucas Jr, R. E., & Rapping, L. A. (1969). Price Expectations and the Phillips Curve. *American Economic Review, 59*(3), 342-350.

Malik, A. (2016). The Impact of Oil Price Changes on Inflation in Pakistan. *International Journal of Energy Economics and Policy*, *6*(4), 727-737.

McKenzie, R., & Gamba, M. (2008). Data and metadata requirements for building a real-time database to perform revisions analysis.

McKenzie, R., & Gamba, M. (2008). Interpreting the results of Revision Analyses: Recommended Summary Statistics. *Contribution to OECD/Eurostat Task Force on "Performing Revisions Analysis for Sub-Annual Economic Statistics*.

McKenzie, R., & Gamba, M. (2008). Interpreting the results of Revision Analyses: Recommended Summary Statistics. *Contribution to OECD/Eurostat Task Force on "Performing Revisions Analysis for Sub-Annual Economic Statistics*

Mortensen, D. T. (1970). Job search, the duration of unemployment, and the Phillips curve. *The American Economic Review*, *60*(5), 847-862.

Okun, Arthur M. 1962. Potential GNP: Its Measurement and Significance, American Statistical Association 1962 Proceedings of the Business and Economic Statistics Section. Washington, DC: American Statistical Association, pp. 98-104.

Önder, A. Ö. (2004). Forecasting inflation in emerging markets by using the Phillips curve and alternative time series models. *Emerging Markets Finance and Trade*, *40*(2), 71-82.

Orphanides, A., & Van Norden, S. (2005). The reliability of inflation forecasts based on output gap estimates in real time. *Journal of Money, Credit and Banking*, 583-601.

Ramakrishnan, U., & Vamvakidis, A. (2002). IMF Working Paper: Forecasting Inflation in Indonesia.

Rees, A. (1970). The Phillips curve as a menu for policy choice. *Economica*, *37*(147), 227-238.

References

Saleem, S., & Ahmad, K. (2015). Crude Oil Price and Inflation in Pakistan. *Bulletin of Business and Economics*, *4*(1), 10-18.

Satti, A. U. H., & Malik, W. S. (2017). The Unreliability of Output-Gap Estimates in Real Time. *The Pakistan Development Review*, *56*(3), 193-219.

Stock, J. H., & Watson, M. W. (1999). Forecasting inflation. *Journal of Monetary Economics*, *44*(2), 293-335.

Stock, J. H., & Watson, M. W. (2007). Why has US inflation become harder to forecast? *Journal of Money, Credit and banking*, *39*, 3-33.

Stock, J. H., & Watson, M. W. (2008). *Phillips curve inflation forecasts* (No. w14322). National Bureau of Economic Research.

Sultana, K., Rahim, A., Moin, N., Aman, S., & Ghauri, S. P. (2013). Forecasting inflation and economic growth of pakistan by using two time series methods. *International Journal of Business and Economics Research*, *2*(6), 174-178.

Swanson, N. (1996). Forecasting using first-available versus fully revised economic time-series data. *Studies in Nonlinear Dynamics & Econometrics*, *1*(1).

Tiao, G. C., & Box, G. E. (1981). Modeling multiple time series with applications. *journal of the American Statistical Association*, *76*(376), 802-816.

ȚIȚAN, E., & Georgescu, V. (2013). INVESTIGATING MACROECONOMIC STABILITY USING THE OUTPUT GAP. *Romanian Statistical Review*, (2).

Țițan, E., & Georgescu, V. (2013). Investigating the Relationships between the Output Gap, Inflation and Unemployment. In *Finance and Economics Conference* (pp. 2013-01).

Watanabe, T. (1997). Output Gap and Inflation: the case of Japan. *Monetary Policy and the Inflation Process*, 93-112.

Yellen, J. L. (2015). Inflation dynamics and monetary policy. *The Philip Gamble Memorial Lecture, University of Massachusetts, Amherst, MA, September*, *24*.

Younus, S., & Roy, A. (2016). *Forecasting inflation and output in Bangladesh: Evidence from a VAR model*. Research Department and Monetary Policy Department, Bangladesh Bank.

Zardi, S. C. (2017). *Forecasting inflation in a macroeconomic framework: An application to Tunisia* (No. 07-2017). Graduate Institute of International and Development Studies Working Paper.