Inflation Forecasting Under Different Macroeconomic Conditions: A Case Study of Pakistan

Iqra Iqbal* and Ahsan Satti

Department of Economics and Finance, Pakistan Institute of Development Economics (PIDE), Islamabad, Pakistan

Abstract

Inflation forecasting is an important task for monetary authorities, policymakers, and governments. Prediction about inflation confers a precise image of how the economy is expected to perform in the future. It is essential for researchers to examine which methods are suitable for inflation forecasting. The current research compared Naive model, ARIMA model, Philips curve model, and Philips curve (TAR) for the said purpose. These models were used under different macroeconomic conditions with reference to real-time, revised, and final data from 1974 to 2014. It helped to predict out-of-sample inflation forecast for 2015. Afterwards, regression was roll-forwarded from 1975 to 2015 to forecast inflation for 2016.The current study found that Naive model is superior to other models since RMSE and MAE of Naive model calculated by using real-time, revised, and final data for one year ahead out-of-sample inflation forecasting were less than the other models. On the other hand, for two years ahead out-of-sample inflation forecast, according to real-time data, RMSE showed that Naive model is superior to other models. Whereas, MAE showed that Philips curve threshold auto regressive model is superior to other models. According to the revised and final data for two years ahead out-of-sample inflation forecasting, both forecasting accuracy measures showed that Naive model is superior to other models.

Keywords: ARIMA model, inflation forecasting, macroeconomic conditions, Naive model, Philips curve model

Introduction

Inflation forecasting refers to an activity that helps to predict the future value of inflation. It has a significant effect on the economic agents, such as consumer and investors. If unexpected high inflation prevails, it would be particularly costly for families depending on pensions and bonds for longer time period. If inflation level is higher than the expected inflation, it would

* Corresponding Author: iqraiqbal_16@pide.edu.pk

decrease household real purchasing power, because usually nominal income earned from such assets is fixed. Accordingly, the living standard of senior retired citizens severely gets effected as they age. Similarly, an unanticipated increase in inflation decreases the labor wage and their real buying. Firms and families have to spend their energy and time to reduce the currency holding and businesses to frequent adjustment in price level. Furthermore, cost of capital is likely to be increased by high inflation after tax payment and in this way business investment would decrease. Therefore, such adverse outcome is the consequence of capital depreciation (Yellen, 2015).

Macroeconomic conditions have been defined in the current study with reference to real-time, revised, and final data. Several macroeconomic variables have been printed semi-annually and annually they are projected estimates, known as real-time data. Afterwards, they are subject to revisions with the passage of time when new data is published. The activity of revision analysis provides opportunity for users and creators of the data to analyze to which extent and direction revisions take place. After one year, the data is revised which is known as revised data. The data revised after second year is known as the final data (McKenzie & Gamba, 2008).

Kanyama and Thobejane (2013) stated that inflation forecasting is an important task for monetary authorities, policymakers, and government. Prediction about inflation confer a precise image of how the economy is expected to be accomplished in the future. It is essential for researchers to examine the methods which are suitable and ample to carry out a reliable prediction of inflation which policymakers can utilize to forecast inflation for effective allocation of resources. Hafer and Hein (1990) assessed the relative predicting evaluation of interest rate based models and univariate model to predict inflation. They claimed that univariate model perform better than other models. On the other hand, Stock and Watson (1999) claimed that out-of-sample inflation forecasting from traditional Philips curve remained better than other models.

Over the longer period of time, for the guidance of the monetary policy, Philips curve has been utilized as an essential tool around the globe .It provides guidance to monetary policymakers in order to use expansionary or contractionary monetary policy for controlling the price level. Nevertheless, many contemporary studies showed that in past twenty years, inflation forecast based on the Philips curve underperform the integrated moving average (1, 1) model, Naive model or an unobserved stochastic volatility model.

Therefore, whether or not Philips curve should occupy an important position in policy discussions remains an open question. 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 performs better than the Philip's curve 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 performed better for 1 year ahead of forecasting whereas, Philips curve model performed better for 2 years ahead of inflation forecasting. Therefore, from the above studies a proper opinion concerning the worth of inflation forecast from Philips curve model is unclear since sometimes Philips curve performs better than the Naive model and sometimes underperforms the Naive model.

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 subsamples, however, there are little studies that throw light on questions raised by Stock and Watson. Dotsey and Stark (2005) studied whether the forecasting power is increased by largely decreasing the capacity utilization and their results showed that decreasing capacity utilization does not increase the forecasting power. Nevertheless, Stock and Watson (2008) gave some subtle indication that substantial variation of unemployment gap is in relation with time period when inflation forecast based on Philips curve is comparatively better. Fuhrer and Olivei (2010) also studied Stock and Watson's suggestion and found that Naive model underperforms a threshold model of Philips curve (PC-TAR).

The above discussion showed that different models have been utilized to forecast inflation over different time periods in other countries. Whereas, in case of Pakistan, inflation is also forecasted by using different models. However, no one has used these macroeconomics conditions with reference to the data. The objective of the current research was to compare the forecast evaluation of Naive model, ARIMA model, Philips curve, and Philips curve (TAR) model under different macroeconomic conditions and select the most suitable model which provides authentic prediction under different macroeconomic conditions with respect to the data (real-time, revised, and final data).

Differences between revised and real-time data, final and real-time data as well as final and revised data have also been analyzed to perceive the direction of revisions taking place.

Literature Review

Distinction between Data Sets

Swanson (1996) stated that historical data is used by macroeconomists in order to test the models, analyze the economic policy, economic events, and forecasting. However, some studies have also used historical unrevised data which is accessible to economic agents rather than revised and final data. In other studies, in order to test the validity of the results, published findings must be verified and robustness of such findings should also be assessed using different data sets as revised and final data. Due to these reasons, data set was created in order to present a complete picture of macroeconomic data accessible to forecaster, academic researcher, and policymakers in past.

Reasons for Data Revisions

The current research focused on two major aspects of the selected data sets. One potential reason of revision could be the fact that statistical agencies update initial projected estimates of measures as real-time GDP while encountering additional source of information other than initially calculated aggregates. These revisions are based on information. Secondly, some other revisions result in change in structure of accounting system for economic data. For instance, changes in methods for aggregate calculation (such as chain or fixed weighting system) and alteration in base years (such as 1992 or 1997) are used to calculate the real variables. Additionally, the definition of concepts that are intended to measure, also changes with time which can lead to structural data revision (Croushore & Stark, 2003).

Rees (1970) stated that Philips curve model is an important tool from past since it provides choices to policymakers between inflation and unemployment. The Philips curve model provides different trade-offs and then weights are assigned to both evils of inflation and unemployment by policymakers.

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 outperforming the other models. Fisher et al. (2002) compared the Naive model and general Philips curve model for one and two years inflation forecast horizon. They used rolling regression and concluded that Philips curve model better forecasted the inflation for 2 years and Naive model better forecasted inflation for one year.

Afzal et al. (2002) explored that a comparison has been drawn 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. Onder (2004) compared Naive model, ARIMA model, and Phillips curve model. Philips curve model was constructed on macroeconomic indicators, VAR model, and Vector Error Correction Model for inflation forecasting. 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 model, performed better than autoregressive model before 1983. Later on, ARIMA model performed better than Philips curve model from 1984-2002. Bokil and Schimmelpfennig (2005) used different methods to predict inflation, such as Leading Indicator model (LIM), ARIMA model, and VAR model. The preferred strategy is a leading model of indices in which broad money growth and credit growth in the private sector assist the inflation forecasting.

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

Khan and Schimmelpfennig (2006) examined the factors that help to forecast inflation. They used monthly data from January 1998 to June 2005 to regress the inflation on monetary variables. Main indicators for inflation forecasting included money growth and private sector credit growth. According to Stock and Watson (2007), Philips curve model has a tendency to forecast well for a period less than a year.

To forecast inflation in US (Ang et al., 2007) examined four different methods. These methods comprise term structure model which includes Arbitrage, free, linear and nonlinear specifications, time series ARIMA model, Survey based method and regression, based on Philips curve model. They concluded that other methods do not perform well than survey based method.

Haider and Hanif (2009) used the Artificial Neural Network (ANN) model. They compared the inflation forecasting performance of univariate forecasting models, for instance ARIMA and AR (1) with ANN model. They concluded that ANN model better forecast inflation than the univariate model. Fuhrer and Olivei (2010) also inspected Stock and Watson's evidence which determined that a threshold model of the Philips curve better performs than a Naive model.

Sultana et al. (2013) claimed in macroeconomics forecasting that time series is an important matter. They forecasted the CPI by using ARIMA and decomposition method. Moreover, they used monthly data and compared forecast results by sum square of errors and mean absolute deviation and established that ARIMA model b forecasts inflation in a better way.

Zardi and Chamseddine (2017) compared the forecasting performance of different models in short term by using quarterly data. 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 indicated that up to two quarter ahead, other models better forecast than random walk model. However, at four quarters ahead, random walk model better forecasts inflation than other models.

Methodology and Data Analysis

The dependent variable namely inflation and the independent variable namely output gap (which is difference between actual and potential GDP) along with potential GDP calculated by Hodrick and Prescott filter are presented in this chapter. The data was collected from Pakistan Economics Survey 1974 to 2016. Different models are also presented for inflation forecasting.

Choosing Measure of Inflation

Hanif and Malik (2015) proposed that when there is a need to forecast inflation, then the basic question 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. Such indices include Wholesale Price Index (WPI), Sensitive Price Index (SPI), Consumer Price Index (CPI), and GDP deflator along with Core CPI.

SPI is most regularly presented weekly price index, however, the problem is that it includes seventeen cities and necessary goods. Another measure which is more inclusive has been recognized as GDP deflator, however, it is less frequently available. In WPI, services are not included. In flagship publications, the State bank of Pakistan considers Core inflation as a significant measure, however, it is not the target inflation variable. Therefore, we are just having CPI. This measure is used more frequently since it assesses the inflationary trends, impacts on households, and most cautiously denotes the cost of living. Whereas, according to Dostey et al. (2017) for inflation forecasting they focused on Personal Consumption Expenditures inflation due to two motives. Firstly, when commodity price shocks occur, it is less influenced than CPI. Secondly, CPI is an unrevised measure while on the other side, PCE inflation is revised and considered as more appropriate measure. Therefore, the current study has forecasted inflation by using Household Consumption Expenditures.

Output Gap As a Measure of Unemployment Gap

Jahan and Mahmud (2013) proposed 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 from its nonaccelerating inflation rate of unemployment should be minimized. Then, production would be at maximum capacity in an economy by fully utilizing the resources. It can be said that there would be no inflation, unemployment, and output gap.

Naive Model

The Naive model predicts inflation and states that inflation for future year is anticipated to be equal to the inflation of previous year. RMSE of the model under different macroeconomic conditions has been estimated (real, revised and final data) by using sample period from 2014 to 2016. Equations are given below from 1 to 3.

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

where

inf_{t+1}^{rl} = real-time inflation in next year

inf_{t}^{rl} =real inflation in previous year

$E\left(inf_{t+1}^{rl} - inf_{t}^{rl}\right)$= real inflation in next year would be same that was in previous year.

Real inflation is subject to revisions when it is revised after one year. Afterwards, the RMSE of revised inflation has to be estimated. The equation 2 below is related to the calculation of RMSE of revised inflation.

$$E\left(inf_{t+1}^{re} - inf_{t}^{re}\right) = 0 \quad (2)$$

where

inf_{t+1}^{re}= revised inflation in next year

inf_{t}^{re}= revised inflation in previous year

$E\left(inf_{t+1}^{re} - inf_{t}^{re}\right)$ =revised inflation in next year would be same that was in previous year.

Real inflation is subject to revisions when real inflation is revised after second year. Then, the RMSE of final inflation has to be estimated. The equation 3 mentioned below is related to the calculation of RMSE of final inflation.

$$E\left(inf_{t+1}^{fl} - inf_{t}^{fl}\right) = 0 \quad (3)$$

where

inf_{t+1}^{fl}= final inflation in next year

inf_{t}^{fl}= final inflation in previous year

$E\left(inf_{t+1}^{fl} - inf_{t}^{fl}\right)$= final inflation in next year would be same that was 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".

ARIMA Model

According to Stock and Watson (2007), the rolling ARIMA model was estimated for 2 periods ahead inflation forecasting. Firstly, the model for 1 period ahead inflation out-of- sample forecasting was estimated under different macroeconomic conditions (real-time, revised, and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015. Later on, the regression was roll forwarded from 1975 to 2015 to forecast inflation for 2016 which is given below in equations 4 to 6. The equation 4 has been estimated for real-time data. When real-time inflation is revised after one year, then the revised inflation equation 5 has been estimated. Afterwards, when real-time inflation is revised after two years, then the final inflation equation 6 has been estimated.

$$inf_t^{rl} = \varepsilon_{t-1} \tag{4}$$

where

inf_t^{rl}=real inflation in current time. The ARIMA is MA which shows that real inflation depends on shocks.

$$inf_t^{re} = inf_{t-2}^{re} + \varepsilon_{t-1} \tag{5}$$

where

$inf_t^{re} =$ revised inflation in current time

inf_{t-2}^{re}=revised inflation at second lag

ε_{t-1} = revised inflation depends on the first lag of error term.

It means that revised inflation depends on its second lag as well as at shocks. Therefore, the ARIMA model is (2,1, 1).

$$inf_t^{fl} = inf_{t-1}^{fl} + \varepsilon_{t-1} \tag{6}$$

where

inf_t^{fl} =final inflation in current time

inf_{t-1}^{fl} =final inflation at first lag

ε_{t-1} = final inflation depends on the first lag of error term.

It means that final inflation depends on its first lag as well as at shocks. Therefore, the ARIMA model is (1,1, 1).

Philips Curve Auto-regressive Model

To explore the usefulness of the unconditional Philips curve model for forecasting of inflation, simple Autoregressive Philip curve model has been used in this research. Firstly, the model for 1 period ahead out-of-sample inflation forecasting has been estimated under different macroeconomic conditions (real-time, revised, and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015. Later on, regression was roll forwarded from 1975 to 2015 to forecast inflation for 2016 as given below in equation 7 to 9. The equation 7 has been estimated for the estimation of real-time data. However, when real-time inflation is revised after one year then, the revised inflation equation has been estimated to be 8. After that, when real-time inflation is revised after two years then, the final inflation equation has been estimated to be 9.

$$inf_t^{rl} = inf_{t-1}^{rl} \quad + og_t^{rl} + \varepsilon_t \tag{7}$$

where

inf_t^{rl}=real inflation in current time

inf_{t-1}^{rl}=real inflation at first lag

og_t^{rl} =real output gap at current time period.

$$inf_t^{re} = inf_{t-1}^{re} \quad + og_t^{re} + \varepsilon_t \tag{8}$$

where

inf_t^{re} = revised inflation in current time

inf_{t-1}^{re} =revised inflation at first lag

og_t^{re}= revised output gap at current time period.

$$inf_t^{fl} = inf_{t-1}^{fl} \quad + og_t^{fl} + \varepsilon_t \tag{9}$$

where

inf_t^{fl}=final inflation in current time

inf_{t-1}^{fl} = final inflation at first lag

og_t^{fl} =final output gap at current time period.

Philips Curve Threshold Auto-regressive Model

The Philips Curve model for 2 period ahead inflation forecasting has to be estimated. Firstly, the model has been estimated for 1 period ahead out-of-sample inflation forecasting under different macroeconomic conditions (real-time, revised, and final data) by using sample period from 1975 to 2014 and forecasted inflation for 2015. Afterwards, the regression was roll forwarded from 1975 to 2015 to forecast inflation for 2016. Furthermore, the difference between Philips curve model and PC-TAR is an addition to the Philips curve as the threshold term with an effect of the threshold on the output gap. An absolute value of the output gap as threshold variable is given below in the equations 10 to 12. The equation 10 has been estimated 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, the revised inflation equation 11 has been estimated. After that when real-time inflation is revised after two years then, the final inflation equation 12 has been estimated.

$$inf_t^{rl} = inf_{t-1}^{rl} + 1\left(|og_t^{rl}| > og_*^{rl}\right)og^{rl} + 1\left(|og_t^{rl}| \leq og_*^{rl}\right)og^{rl} + \varepsilon_t \quad (10)$$

where

inf_t^{rl}= real inflation in current time,

inf_{t-1}^{rl} = real inflation in previous year

$|og_t^{rl}|$ =absolute value of real output gap

og_*^{rl} = threshold level of real-time output gap,

$$inf_t^{re} = inf_{t-1}^{re} + 1(|og_t^{re}| > og_*^{re})og^{re} + 1(|og_t^{re}| \leq og_*^{re})og^{re} + \varepsilon_t \quad (11)$$

where

inf_t^{re} =revised inflation in current time

inf_{t-1}^{re}=revised inflation in previous year

$|og_t^{re}|$=absolute value of revised output gap

og_*^{re}=threshold level of revised output gap

$$inf_t^{fl} = inf_{t-1}^{fl} - 1(|og_t^{fl}| > og_*^{fl})og^{fl} + 1(|og_t^{fl}| \leq og_*^{fl})og^{fl} + \varepsilon_t \quad (12)$$

where

inf_t^{fl} = final inflation in current time

inf_{t-1}^{fl}=final inflation in previous year

$|og_t^{fl}|$=absolute value of revised output gap

og_*^{fl} =threshold level of final output gap,

Results and Discussion

Descriptive Statistics of Differences between Real, Revised, and Final GDP

In this section, the descriptive analysis of differences between real, revised, and final GDP has been presented from the time period of 1974 to 2016. The sample of the current study has also been divided into five subsamples. The data set has been descriptively analyzed as a measure of variability and central tendency. In this study, standard deviation and stability ratio is used as measure of variability. Since it has been known that Standard Deviation (SD) is not the best measure of volatility because according to this measure, samples with highest volatility have highest value of mean. That is why, it is better to use stability ratio as a measure of volatility. Mean, as measure of central tendency, has been used by the current study. Several macroeconomic variables are projected estimates known as real-time data. Then, they are subject to revisions with the passage of time when new data is published. The activity of revision provides opportunity to analyze the extent and direction of revisions. After one year, the data is revised which is known as revised data. The data revised after second year is known as the final data. The results of differences between real, revised, and final GDP are given in Table 1.

Table 1

Descriptive Statistics of Differences between Real, Revised, and Final GDP

Variables	Years	Mean	SD	SR
Revised – Real GDP	1974-2016	-3,098	32882.64	-10.6142
	1974-1980	7421.690	21381.96	2.88101
	1981-1990	3563.547	24089.97	6.76011
	1991-2000	-6188.317	32285.81	-5.21722
	2001-2010	-12903.33	51008.51	-3.95314
	2011-2016	-6519.452	16167.94	-2.47995
Final- Real Time GDP	1974-2016	427	38314.88	89.7304
	1974-1980	13464.47	25462.17	1.891064
	1981-1990	11455.02	28816.63	2.515633
	1991-2000	2610.92	27789.46	10.64355
	2001-2010	-14233.12	62984.65	-4.42522
	2011-2016	-14665.70	8848.737	-0.60336
Final- Revised GDP	1974-2016	3,525	27050.21	7.673818
	1974-1980	6042.777	16628.62	2.751818
	1981-1990	7891.475	18393.33	2.330785
	1991-2000	8799.242	35358.26	4.01833
	2001-2010	-1329.791	35751.31	-26.8849
	2011-2016	-8146.246	14110.84	-1.73219

Table 1 shows that over entire sample average, the value of difference between revised and real-time GDP is -3,098. This value has a negative sign which indicates that the revised GDP is less than real GDP and real GDP was overstated. On average, over full sample GDP is revised in a negative direction. On the other hand, over the subsample on average difference between revised and real GDP was more than the full sample which indicates that over sub samples revised GDP is less than real GDP and real GDP was more overstated. On average, over subsamples GDP is largely revised in a negative direction than full sample.

The difference between revised and real GDP indicates that over the subsamples of 1974-1980, 1981-1990 average values were 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 a 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 a negative direction.

The difference between revised and real GDP indicates 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. According to SR, subsample 1981 to 1990 has the highest value of SR which means that this subsample is more volatile, whereas the subsample 1991 to 2000 has the lowest value of SR which shows the lowest volatility as compared to other subsamples.

The difference between final and real GDP indicates that over the subsamples of 1974-1980 and 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 a positive direction. On the other hand, the difference between final and real GDP shows that over the subsamples of 2001-2010 and 2011-2016, average values are -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 a negative direction.

The difference between final and real GDP indicates 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. According to SR, subsample 1991 to 2000 has highest value of SR which 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 difference between final and revised GDP indicates that over the subsamples of 1974-1980 and 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 the revised GDP and revised GDP was understated. On average, over 70s, 80s, and 90s GDP is revised in a positive direction. On the other hand, the difference between final and revised GDP shows that over the subsamples of 2001-2010 and 2011-2016 average values are -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 a negative direction.

The difference between final and revised GDP indicates 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.

Descriptive Statistics of Differences between Real, Revised, and Final Inflation

In this section, descriptive analysis of differences has been presented between real, revised, and final inflation from the time period of 1974 to 2016.

Table 2

Descriptive Statistics of Differences between Real, Revised, and Final Inflation

Variables	Years	Mean	*SD*	*SR*
Revised - Real inflation	1974-2016	-14001.79	452046.7	-0.031
	1974-1980	-13.92857	3751.575	-0.0037
	1981-1990	-5877.900	15631.02	-0.376
	1991-2000	195576.8	684762.5	0.2856
	2001-2010	1600.700	379919.5	0.0042
	2011-2016	-419162.5	571399.0	-0.7336

Variables	Years	Mean	*SD*	*SR*
Final- Real inflation	1974-2016	-13058.84	472531.8	-0.0276
	1974-1980	2094.42	3387.869	0.6182
	1981-1990	-9003.85	17859.36	-0.5042
	1991-2000	194343	670355.0	0.2899
	2001-2010	58556.60	427652.1	0.1369
	2011-2016	-502525	593977.6	-0.846
Final- Revised inflation	1974-2016	942.90	115834.9	0.0081
	1974-1980	2108.35	3951.029	0.5336
	1981-1990	-3125.95	7498.416	-0.4169
	1991-2000	-1233.80	21148.04	-17.1405
	2001-2010	56955.90	197333.1	3.4646
	2011-2016	-83362.50	163838.7	-0.5088

Table 2 shows that the average value of difference between revised and real inflation is 14001.79. This value has a negative sign which indicates that the revised inflation is less than real inflation and real inflation was overstated. On average, inflation is revised in a negative direction. On the other hand, over the subsample, on average difference between revised and real inflation is more in magnitude than full sample. It indicates that over sub samples revised inflation is less than real inflation and real inflation was more overstated. On average, over subsamples inflation is largely revised in a negative direction than full sample.

The difference between revised and real inflation shows that over the subsamples of 1974-1980 and 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 a negative direction. On the other hand, the difference between revised and real inflation indicates that over the subsamples of 1991-2000 and 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 a positive direction.

The difference between revised and real inflation indicates 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. Therefore, according to SR, subsample 2011 to 2016 has lowest value of SR which 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 difference between final and real inflation indicates that over the subsamples of 1974-1980 and 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 a 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 a negative direction.

The difference between final and real inflation indicates 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. According to SR, subsample 2011 to 2016 has lowest value of SR which means that this subsample is least volatile, whereas the subsample 1974 to 1980 has highest value of SR which shows more volatility as compared to other subsamples.

The difference between final and revised inflation indicates 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 a 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 a negative direction.

The difference between final and revised inflation indicates 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. According to SR, subsample 2001 to 2010 has highest value of SR which 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.

Graph of Differences of Real, Revised, and Final GDP

In this section, graphical analysis of differences has been presented between real, revised, and final GDP from the time period of 1974 to 2016.The graph of differences between real, revised, and final GDP is given below.

Figure 1

Differences of Real, Revised, and Final GDP

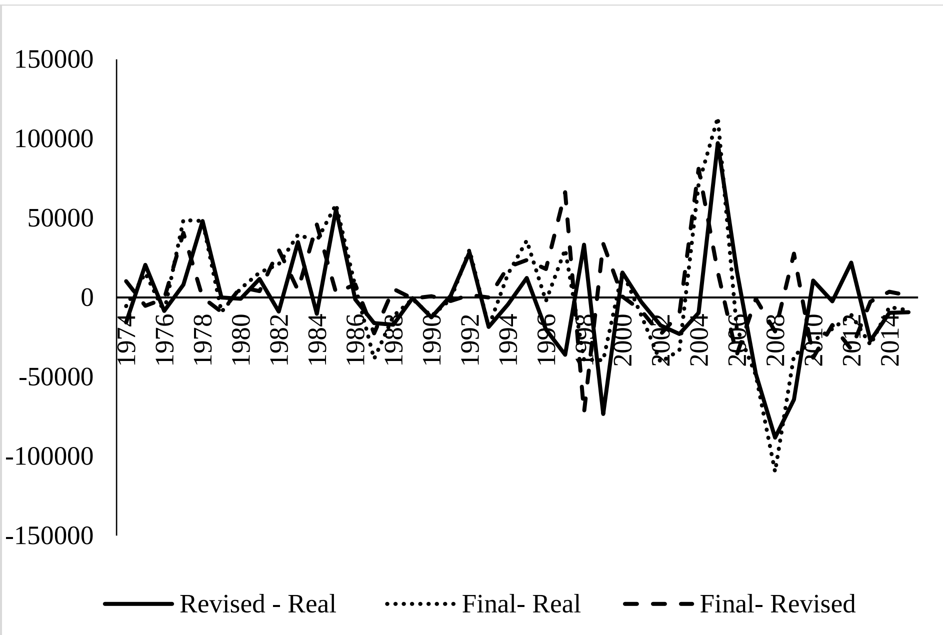

Figure 1 shows that over sub sample period from 1974-1980 and 1981-1990 mostly the difference between revised and real GDP is positive. It indicates that revised GDP is more than real GDP and real-time GDP was understated. On average, over 70s and 80s GDP is revised in a positive direction. On the other hand, over the subsamples from 1991-2000, 2001-2010, and 2011-2016 mostly the difference between revised and real GDP is negative. It indicates that revised GDP is less than real-time GDP and real-time GDP was overstated. On average, over 90s, 2000s GDP is revised in a negative direction.

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

In 2005, the difference between revised and real GDP, final and real GDP, and final and revised GDP is maximum as compared to other positive differences. Asghar et al. (2012) stated that the fact that Pakistan economy was subject to 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 and final and real GDP is minimum as compared to other negative differences. Pakistan Economic survey 2008 reported that Pakistan economy was subject to adverse external and internal shocks. For instance, internal shocks that lower the growth included 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.

Graph of Differences of Real, Revised, and Final Inflation

In this section, graphical analysis of differences has been presented between real, revised, and final inflation from the time period of 1974 to 2016. The graph of differences between real, revised, and final inflation is given below.

Figure 2

Differences of Real, Revised, and Final Inflation

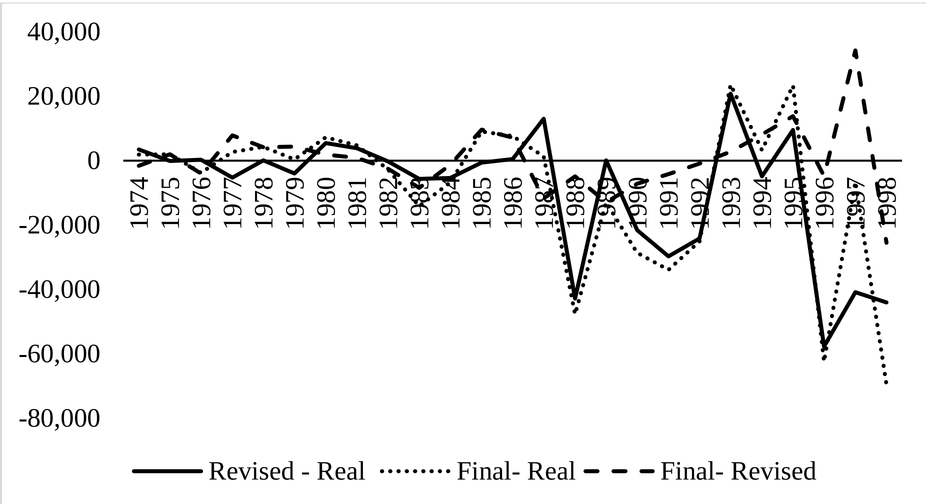

Figure 2 shows that over sample period from 1974 to 1986, the differences between revised and real inflation, final and real inflation along with final and revised inflation are minimum. It shows that over the time period from 1974-1998 difference between revised and real inflation is negative. It indicates that real inflation was overstated. On average, over this sample period inflation is revised in a negative direction.

It shows that over subsample period from 1974 to 1986 the difference between final and real inflation is positive. It indicates that real inflation was understated. On average, over this time period inflation is revised in a positive direction. On the other hand, over the subsamples from 1987-1998 mostly the difference between final and real inflation is negative. It indicates real inflation was overstated. On average, over this time period inflation is revised in a negative direction. It shows that over the time period from 1974 to 1998 the difference between final and revised inflation is positive. It indicates that revised inflation was understated. On average, over this time period inflation is revised in a positive direction.

Figure 3

Differences of Real, Revised, and Final Inflation

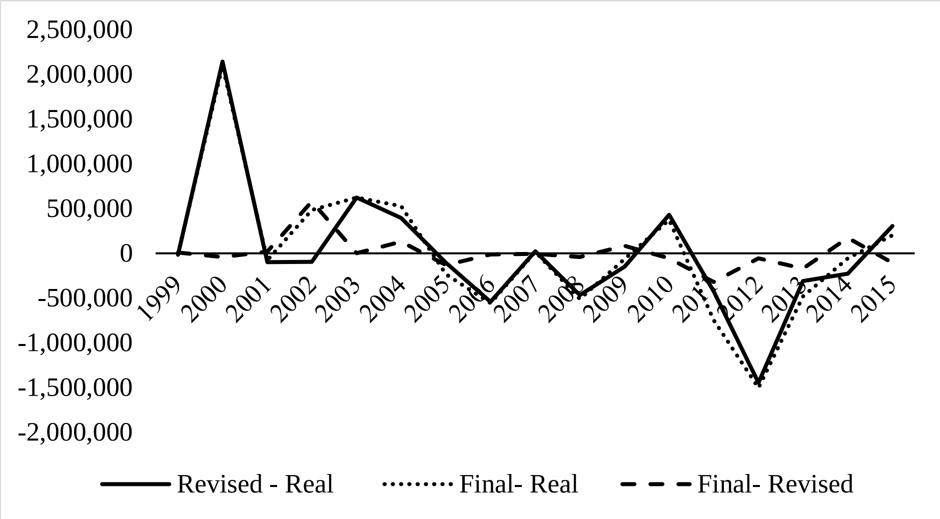

Figure 3 shows that over subsample period from 1999 to 2005 mostly the difference between revised and real inflation is positive. It indicates that real-time inflation was understated. On average, over this sample period inflation is revised in a positive direction. On the other hand, over the time period from 2006-2016 mostly the difference between revised and real inflation is negative which indicates that real-time inflation was overstated. On average, over this time period inflation is revised in a negative direction.

It shows that over subsample period from 1999 to 2005 mostly the difference between final and real inflation is positive which indicates that real inflation was understated. On average, over this time period inflation is revised in a positive direction. On the other hand, over the subsamples from 2006-2016 mostly the difference between final and real inflation is negative which indicates that real-time inflation was overstated. On average, over this time period inflation is revised in a negative direction.

It shows that over the time period from 1999 to 2005 mostly the difference between final and revised inflation is positive which indicates that revised inflation was understated. On average, over this time period inflation is revised in a positive direction. On the other hand, over the time period from 2006-2016 mostly the difference between final and revised inflation is negative which indicates that revised inflation was overstated. On average, over this time period inflation is revised in a negative direction.

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

Results of Forecast Measures

Relative forecasting performance of different models and macroeconomic conditions has been assessed with reference to data, for instance real, revised, and final inflation. Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) have been used to compare the forecast accuracy. The values of RMSE and MAE for Naive, ARIMA, Philip curve and PC-TAR model are given in following tables.

Table 3

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 3 shows the results of one-step ahead out-of-sample forecast with real time inflation. Both forecasting accuracy measures shows that RMSE and MAE of Naive are less than other models. Which indicate that Naive model better forecast inflation than other models.

Table 4

Forecasting Results of Real Inflation for Two-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 shows the results of two-step ahead out-of-sample forecast with real-time inflation. According to RMSE, Naive model better forecasts inflation than other models. Whereas, on the other hand, MAE shows that Philips curve (TAR) model is superior to other models.

Table 5

Forecasting Results of Revised Inflation for One-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 5 shows the results of one-step ahead out-of-sample forecast with revised inflation. Both forecasting accuracy measures show that the values of RMSE and MAE of Naive model are less than other models which indicate that Naive model better forecasts inflation than other models.

Table 6

Forecasting Results of Revised Inflation for Two-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 6 shows the results of two-step ahead out-of-sample forecast with revised inflation. Both forecasting accuracy measures show RMSE and MAE of Naive model are less than other models which indicate that Naive model better forecasts inflation than other models.

Table 7

Forecasting Results of Final Inflation One-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 7 shows the results of one-step ahead out-of-sample forecast with final inflation. Both forecasting accuracy measures show that RMSE and MAE of Naive model are less than other models which indicate that Naive model better forecasts inflation than other models.

Table 8

Forecasting Results of Final Inflation Two-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 8 shows the results of two-step ahead out-of-sample forecast with final inflation. Both forecasting accuracy measures show that RMSE and MAE of Naive model are less than other models which indicate that Naive model better forecasts inflation than other models.

Conclusion

Inflation forecasting is an important job for monetary policymakers because they need to keep it balanced as it affects economic agents. Inflation decreases the purchasing power of consumers and reduces the profits of firms. In order to keep tabs over inflation, forecasting inflation is needed by using appropriate econometric models. Therefore, the current research explored which model better forecasts inflation under different macro-economic conditions with reference to data (real, revised, and final data). For this purpose, the study utilized different models which included Naive model, ARIMA model, Philips curve model, and Philips curve (TAR) model.

Annual real time, revised, and final time series data were used from 1974 to 2016. This task was accomplished for one and two years ahead out-of-sample forecasting by using rolling window. The Philips curve model was considered with backward looking expectations and output gap. However, Philips curve (TAR) was extended by the addition of the threshold level of output gap. The superior and proper models were selected on the basis of their forecasting performance. For the measurement of forecasting performance, RMSE and MAE were used as a criterion.

The current study concluded that for one year ahead out-of-sample forecasting, according to real-time, revised, and final data, both forecasting accuracy measures (RMSE and MAE) showed that Naive model is superior to other models. However, by using real-time data for two years ahead out-of-sample forecasting, RMSE showed that Naive model is superior to other models, whereas MAE showed that Philips curve (TAR) model is superior to other models. On the other hand, by using revised and final data, both forecasting accuracy measures showed that Naive model is superior to other models.

Policy Recommendations

An important goal of policymakers is to keep inflation under control. Therefore, there arises a need for inflation forecasting which allows the policymakers and researchers to accurately predict and portray it. In case of Pakistan, the current study suggests the use of Naive model for one year ahead out-of-sample inflation forecasting under real-time, revised, and final data. It also suggests that Naïve model should also be used for two years ahead out-of-sample inflation forecasting under revised and final data. Whereas, under real-time data Naive and Philips curve (TAR) models should 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. https://doi.org/10.1111/1467-8462.00111

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. https://doi.org/10.1016/j.jmoneco.2006.04.006

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. http://dx.doi.org/10.5539/ijef.v4n4p135

Bokil, M., & Schimmelpfennig, A. (2005). *Three attempts at inflation forecasting in Pakistan* (International Monetary Fund Working Paper). https://rb.gy/wg4fk

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. https://doi.org/10.1162/003465303322369759

Dotsey, M., & Stark, T. (2005). The relationship between capacity utilization and inflation. *Business Review*, (Q2), 8–17. https://econpapers.repec.org/article/fipfedpbr/y_3a2005_3ai_3aq2_3ap_3a8-17.htm

Dotsey, M., Fujita, S., & Stark, T. (2017). *Do Phillips curves conditionally help to forecast inflation?* (Federal Reserve Bank of Philadelphia Working Paper No. 11-40). https://web.archive.org/web/20170810183229id_/https://www.phil.frb.org/-/media/research-and-data/publications/working-papers/2011/wp11-40.pdf

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

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 No. 10-2). Federal Reserve Bank of Boston. http://dx.doi.org/10.2139/ssrn.1633926

Hafer, R. W., & Hein, S. E. (1990). Forecasting inflation using interest-rate and time-series models: Some international evidence. *Journal of Business*, *63*(1), 1–17.

Haider, A., & Hanif, M. N. (2009). Inflation forecasting in Pakistan using artificial neural networks. *Pakistan Economic and Social Review*, *47*(1), 123–138

Hanif, M. N., & Malik, M. J. (2015). Evaluating Performance of Inflation Forecasting Models of Pakistan. *SBP Research Bulletin*, *11*(1), 43–78

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* [Paper presentation]. Economic Society of South Africa 2013 Conference, South Africa.

Khan, M. M. S., & Schimmelpfennig, M. A. (2006). *Inflation in Pakistan: Money or wheat?* (IMF Working Paper No. 6/60). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=898721

McKenzie, R., & Gamba, M. (2008). Data and metadata requirements for building a real-time database to perform revisions analysis. 1–16. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=f5fda18c4f1c0447c9cba6f4ba8b803aaba99c82

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. https://doi.org/10.1080/1540496X.2004.11052566

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*, *37*(3), 583–601.

Rees, A. (1970). The Phillips curve as a menu for policy choice. *Economica*, *37*(147), 227–238 https://doi.org/10.2307/2551971

Stock, J. H., & Watson, M. W. (1999). Forecasting inflation. *Journal of Monetary Economics*, *44*(2), 293–335. https://doi.org/10.1016/S0304-3932(99)00027-6

Stock, J. H., & Watson, M. W. (2007). Why has US inflation become harder to forecast? *Journal of Money, Credit and Banking*, *39*(s1), 3–33. https://doi.org/10.1111/j.1538-4616.2007.00014.x

Stock, J. H., & Watson, M. W. (2008). *Phillips curve inflation forecasts* (National Bureau of Economic Research Working Paper No.14322). https://doi.org/10.3386/w14322

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. https://doi.org/10.11648/j.ijber.20130206.17

Swanson, N. (1996). Forecasting using first-available versus fully revised economic time-series data. *Studies in Nonlinear Dynamics & Econometrics*, *1*(1), 47–64. https://doi.org/10.2202/1558-3708.1012

Yellen, J. L. (2015, September 24). *Inflation dynamics and monetary policy* [Lecture]. The Philip Gamble Memorial Lecture, University of Massachusetts. https://www.federalreserve.gov/newsevents/speech/yellen20150924a.htm

Zardi, S. C. (2017). *Forecasting inflation in a macroeconomic framework: An application to Tunisia* (Graduate Institute of International and Development Studies Working Paper No. HEIDWP07-2017). https://bccprogramme.org/wp-content/uploads/2021/04/zardi_heidwp07-2017_2.pdf