Pakistan Institute of Development Economics

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Sacrifice Ratio and Inflation Forecasting: A Case Study of Pakistan.

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Zobia Bhatti

DEDICATION

This thesis is dedicated to my beloved parents

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List of Abbreviations

2SLS	Two Stage Least Squares
ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
AR	Auto regressive
ARIMA	Autoregressive Integrated Moving Average
ARMA	Autoregressive Moving Average
CPI	Consumer Price Index
EMU	Economic and Monetary Union
FC	Factor Cost
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GMM	Generalized Method of Moments
GNP	Gross National Product
IPN	Inflation Persistence Network
J-B	Jarque Berra Test
LFS	Labour Force Survey
MA	Moving Average
MAE	Mean Absolute Error

MAPE	Mean Absolute Percentage Error
MC	Marginal Cost
MP	Market Price
NKHPC	New Keynesian Hybrid Phillips curve
NKPC	New Keynesian Phillips curve
OECD	Organization for Economic Co-operation and Development
PACF	Partial Autocorrelations Functions
PC	Phillips Curve
PP	Phillips-Perron tests
RBC	Real Business Cycle
RMSE	Root Mean Squared Error
SR	Sacrifice Ratio
SVAR	Structural Vector Auto regressions
VAR	Vector Auto Regressions
VMA	Vector Moving Average

ABSTRACT

It is a debatable issue that high and variable inflation causes the welfare loss while on the other hand reducing inflation generally has some cost and the amount of that cost is measured by the sacrifice ratio. Therefore inflation output trade - off is important for central banks when formulating policy. Sacrifice ratio is the main indicator to measure the real cost of disinflation, calculated as the ratio of the cumulative percentage output loss (the difference between actual and potential output) to the size of disinflation. Thus, the sacrifice ratio measures the real output cost per unit of permanent decrease in inflation. Sacrifice ratio is basically divided into two main categories: time invariant sacrifice ratio and episode specific sacrifice ratio. In time invariant sacrifice ratio we took Philips Curve, structural VAR and the New Philips Curve and in episode specific ratio we took Ball method of sacrifice ratio and Zhang method of sacrifice ratio .This study covers all these methods in detail and the main objective of this study is to calculate the sacrifice ratio at aggregate level as well at disaggregated level. We disaggregate data into three sectors namely the agriculture sector, the manufacturing sector and the services sector.

At aggregate level we found a positive sacrifice ratio in almost all the methods but the magnitude of the sacrifice ratio is not large .At disaggregated level the results validate that different sectors have different nature and the sectors which are less sensitive to monetary policy have less sacrifice ratio and vice versa.

Inflation forecasting is the important input in formulating Monterey policy to maintain the price stability and fighting against the inflation evils. Keeping the importance of forecasting, the other objective of this study is to forecast inflation using real time data and end of sample data

INTRODUCTION

1.1 Background

Price stability is one of the most important functions of the monetary policy. To achieve price stability, central banks have, overtime, adopted different options including monetary and exchange rate targeting although they have been unable to delve the day to day increasing challenges with these options. The Reserve Bank of New Zealand in December 1989 was the first central bank which introduced the concept of inflation targeting (IT) as a strategy with a top most apparent agenda to attain price stability. Through this strategy, the objective is attained by an intelligible numerical target value of inflation. All that is needed by a country's central bank is a bit of flexibility in the selection of tools most suited to attain the target (inflation). The sole purpose of implementing or utilization of such tools or frameworks is not to bring process at a constant price level or to maintain zero inflation rather a stable price level that might strengthen the process in attaining target inflation with some tolerance band over a specified time period. Since its inception, the inflation targeting strategy has been widely accepted. This acceptance and popularity has accelerated the influx of scientific literature discussing and studying this framework from different angles.

The inflation targeting strategy gives utmost importance to output stabilization. It maintains that for sustainable growth and creating employment opportunities, price stability is a precondition. The strategy envisioned is that by stabilizing the prices, sustainable and long run benefits for the public may be secured and increased growth rate of real output may be achieved. Empirical literature reflects that high inflation rates are detrimental to long run growth (Bruno and Easterly, 1998) and entail welfare costs (Lucas, 2000). But to control or to bring inflation to normal or down is an important task although it is usually associated with short run output losses (Ball, 1994). It is therefore important to understand sacrifice ratio (accumulated loss in output during disinflations divided by the overall fall in inflation). Central banks give utmost importance to inflation output trade-off while formulating policy. When high inflation is to be controlled, tight monetary policy is put in place which might in turn affect the economic activity. This sort of loss like the slowdown in economic activity can be interpreted as the sacrifice or the price paid for countering or targeting the inflation. Policy makers in such instances remain keen to assess the impact on economy in holistic terms. Hence, disinflation has always been a long standing issue, along with high inflation in monetary economics.

The idea of inflation targeting and its successful implementation through monetary policies in established markets has also attracted the attention of policy makers in small emerging markets in finding ways to control the inflation. The State Bank of Pakistan (SBP) has also taken steps to achieve price stability through inflation targeting. It has undertaken measures like more liberalized foreign exchange rates, improved check and balance on executives of commercial banks, and enhanced transparency of State Bank's operations etc. etc. The use of inflation targeting strategy has been upheld by a number of authors. Moinuddin (2007) suggests that due to the unstable money demand function, monetary aggregate targeting is not feasible therefore; targeting inflation might be an option for the State Bank of Pakistan. Similarly, a study by Akbari and Rankaduwa (2006), wherein they have estimated a price model (function of the exchange rate, foreign prices, money supply and GDP) conclude that the overall monetary policy exerts a weak impact on domestic prices. However, this effect has increased since 1999 and the new monetary environment (inflation targeting monetary policy) can be discussed. On the basis of a comprehensive review of other developing countries in terms of inflation targeting, Khalid (2006), suggests that Pakistan's monetary authority could consider IT as a monetary regime. Similarly, Khan and Schimmelpfening (2006) recommend IT, with a target of 5%. However, Chaudhry and Choudhary (2006) suggest that inflation targeting should not be adopted by the State Bank because the growth rate of import prices is the main determinant of inflation in Pakistan.

The cumulative effect of inflation targeting monetary policy on the output gap is an important consideration in the adoption of inflation targeting monetary policy. The losses or sacrifice in the process of adjusting inflation rate to reach the target rate of inflation, the Sacrifice Ratio (SR), provides an estimate of this loss of output.

Thus, SR calculates the cost of real output per unit of permanent reduction in inflation rate. This relationship between inflation and output has been extensively studied both empirically and theoretically. Okun (1978) introduced this concept of trade - off between inflation and output. The cost of disinflation in terms of percentage output lost in a given time period is calculated mostly using the family of Philips curve (PC*)* like the Simple Philips curve (PC), Augmented Philips curve and recently Hybrid New Keynesian Philips curve (HKPC) which got importance in recent macroeconomic literature.

The NKPC explains current inflation by forward looking inflation expectations and current real marginal cost. The NKPC combines the assumptions of forward looking expectations, rigidities and imperfect competition. The NKPC shows that there is no trade - off between inflation and output or sacrifice ratio is zero but the literature suggests that tradeoff between inflation and output exists. Gali and Gertler (1999) introduced the concept of HNKPC to overcome this shortcoming of the NKPC.

Ball (1994) specifies few deficiencies of the Phillips curve method like the output inflation trade - off is supposed to be constant over the entire period. Keeping the Phillips curve limitations in mind ,Episode Specific Method (ESM) is identified by Ball (1994) in which disinflationary episodes are identified and then sacrifice ratio is calculated as for each period as the cumulative sum of output gap divided by the fall in inflation. Ball's (1994) approach was generalized by Zhang (2005) and he incorporates the persistence effect and long lived effects of inflation and found that the SR is larger when these effects are included. Cecchetti and Rich (2001) criticized the ESM method of calculating the SR. They favored incorporating the structural shocks in the model and they used SVAR methodology for the calculation of the sacrifice ratio. Literature shows that results of sacrifice ratio vary significantly across countries, time periods, episodes and estimation techniques.

The available empirical studies on measuring the sacrifice ratio have, so far, used aggregate time series data on output. It is quite possible that the use of aggregate data might produce errors in the measurement of the sacrifice ratio if monetary policy measures have a heterogeneous impact on the output of various sectors of the economy. There is a large body of literature [Doll (1958), Barnett, Bessler and Thompson (1983), Saunders (1988), Isaac and Rapach (1997), Carlino and Defina (1998), Arnold and Vrugt (2002), and Ibrahim (2005)] that provides empirical evidence in support of the view that the quantitative impact and rapidity of policy measures are highly sector and region specific.

The major inferences drawn by these studies are: monetary policy measures less rapidly affect the primary sector of the economy; There is a weak causal relationship between monetary instruments and prices in agriculture sector while contractionary policy shocks have a stronger and long lasting negative impact on manufacturing output. Thus, the sectors with high manufacturing intensity will bear much higher ratio of loss as they fall in close proximity to monetary policy. In such instances using aggregate data for measuring the sacrifice ratio might compound the differential impact of monetary policy and hence, produce measures of the sacrifice ratio which are downwardly biased.

The review of recent literature reveals that heterogeneity in inflation dynamics has also been studied extensively. Sheedy (2007) points out that inflation persistence is lower when heterogeneity in price stickiness is considered. On the same issue, Leith and Malley (2007) caution the monetary policymakers to be careful as sectoral differences in pricing behavior imply different response to monetary policy. Finally, Imbs *et.al*, (2011) propose that sectoral NKPC estimates make reasonable differences in the response of output due to change in inflation, however, only a few studies have estimated the NKPC at sectoral level.

An inflation target must be anticipating the future as compared to the monetary or exchange rate targets which necessitate the monitoring of current monetary aggregates or exchange rate. It may be considered essential due to relatively long lags between changes in the instrument of monetary policy and the effect on inflation. Therefore, a model of inflation forecasting is needed, for the provision of inflation forecast and equally effective as compared to the inflation target at the policy horizon. Formulation of inflation targeting policies largely depend on reliable inflation forecasts that's why the inflation forecast is probably the most important indicator for monetary policy decisions of central banks. In practice, central banks that intend to target inflation construct their forecasts partly from structural models and partly from forecasting models.

The forecasting literature in recent years has seen considerable refinement of the existing methods as well as production of new forecasting techniques. As inflation forecasts usually have a short-run focus, time series methods are conventionally applied as forecasting tools. Among them univariate autoregressive (AR) models and vector autoregressive (VAR) models are the most popular. More recently, factor models and nonlinear time series models, like Markov switching models and random coefficients models have been applied in inflation forecasting. All these approaches have in common one characteristic that they are quite accurate in forecasting inflation in the short run but are less suitable for longer horizons.

The other popular approach which forecasters have chosen to forecast inflation is the Structural model. In recent decades, macroeconomic forecasting in most institutions was dominated by large structural econometric models which, according to Andrews (1994), delivered good forecasting properties, especially for longer forecasting horizons. The most popular structural model in inflation forecasting is the Phillips curve (see Stock and Watson (2008) for an overview of Phillips curve forecasts). More recently, the New Keynesian Phillips curve (NKPC) has already been successfully employed as a forecasting tool in a single-equation setting [see Jean-Baptiste (2012); Rumler and Valderrama (2010); Kichian and Rumler (2014)]. A number of studies including Canova (2007); Hamilton (2011); Ascari and Marrocu (2003) document that structural models show a relatively superior forecasting performance for longer forecasting horizons, while Faust and Wright (2012) do not find a better performance of structural models for longer horizons.

Croushore (2010) explained very well that when the researchers develop the forecasting model they use the current data set and don't focus on the data of real time and this is the main drawback of this strategy. If data revisions are minor and are random, then the revisions probably do not matter much for forecasting. But the evidence makes clear that data revisions are large and systematic. Data are revised significantly over time which might affect the forecasting or forecast models. A significant body of literature shows that if revised data are used in a forecasting model and then the results are compared to the model being used in real time, the differences in forecasts can be considerable.

The most comprehensive study comparing the impact of data revisions on forecasts is that of Stark and Croushore (2002). They examined three key ways in which data revisions affect forecasts, or, more precisely, in which forecasts generated in real-time data (RTD) differ from forecasts using end of sample (EOS) data. The data revisions affect forecasts through model specification changes, effect on estimated coefficient of the model etc. They find that inflation forecasts tend to be more sensitive to data revisions as compared to forecasts of output growth. They consider that this outcome is the result of the fact that the inflation process is more persistent than the process for output growth.

1.2 Significance of the Study

Keeping in view the importance of inflation targeting monetary policy, this study is the first attempt at measuring the cost of reducing inflation through the sacrifice ratio in case of Pakistan. The sacrifice ratio is measured by almost all methods at the aggregate level. Furthermore, keeping in view the heterogeneous nature of different sectors of the economy, sacrifice ratio is also calculated by different sectors.

To find the sacrifice ratio from the HNKPC at aggregate level as well as at sectoral level, we require estimating the HNKPC both at aggregate level as well as at sectoral level. Literature shows that sectoral NKPC estimates make reasonable difference in the response of output due to change in inflation. This study attempts to estimate the NKPC at sectoral level in Pakistan and fills the gap in Pakistan's economic literature.

Forecasting inflation is an important task for a central bank since the rate of inflation is commonly regarded as the most important indicator of monetary policy. Some central banks, in particular those pursuing direct inflation targeting, even attribute the inflation forecast a crucial role in their monetary policy strategy. The literature on inflation forecasting has been growing rapidly in recent years as more and more forecasting methods have been developed and applied to forecast inflation. These are mostly time series models as well as structural models. In case of Pakistan mostly ARMA and family of VAR is used for forecasting, we use the structural model NKPC for inflation forecasting with the univariate time series ARMA and the Philips Curve. In this study, inflation is forecasted using real time data as well as end of sample data and this also is the first attempt in case of Pakistan to compare the inflation forecasting using real time data as well as end of sample data.

1.3 Objectives

The three specific objectives of this study are:

1. To calculate the sacrifice ratio by using Ball's method, Zhang method, Structural VAR, Hybrid New Keynesian Phillips curve (HNKPC) at aggregate and sectoral level. Sectors consist of agriculture sector, manufacturing sector and services sector.
2. To estimate the forward-looking New Keynesian Phillips curve (NKPC), the Hybrid New Keynesian Phillips curve (HNKPC) at aggregate level and at sectoral level. These sectors consist of agriculture sector, manufacturing sector and services sector.
3. To compare inflation forecasting using the real time data and end of sample data. Univariate time series model, Philips curve and New Keynesian Phillips curve (NKPC) models are applied to forecast the inflation.

1.6 Plan of the Study

The study comprises of eight chapters. Following this introduction the second chapter provides the review of literature; a brief overview of the economy of Pakistan focusing particularly on the variables of this study is given in chapter 3; methodology adopted for this study, the data sources and definition of variables are described in chapter 4;. Aggregate analysis of sacrific is given in chapter 5 and disaggregated analyses of sacrifice ratio are given in chapter 6. Inflation forecasting results are given in chapter 7. Summary, Conclusions and Policy Recommendations have been elaborated in chapter 8.

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the theoretical and empirical literature related to inflation targeting; sacrifice ratio and forecasting in order to understand the developments and innovations in these concepts. This review will be highly useful in developing the model for the Pakistan economy and it will also enable us to make useful comparisons with other countries with similar underlying economic structures. This chapter is divided into five sections as follows: second section explains the history and development of the NKPC along with the literature on the importance of sectoral level NKPC. It is used to calculate cost of disinflation and inflation forecasting. In third section the detail literature of the sacrifice ratio using different methodologies are given. In Fourth section studies of inflation forecasting are discussed. Concluding remarks will give in final section of the chapter.

2.2 The Phillips Curve and New Keynesian Phillips Curve

The Phillips Curve introduced by Phillips (1958) maintains that the workers negotiate high nominal wages when the unemployment level is low and this transmits to inflation. As a result, the trade-off among inflation and unemployment is long-term in the economy. This statistical association is identified as the Phillips Curve. Friedman (1968) criticized Phillips Curve on the basis that it failed to differentiate the real and nominal wages. Friedman (1968) argued that the workers care for real wages not the nominal wages. The firms and households make expectations for future inflation. People learn from past inflation and then modify their inflation expectations according to monetary policy changes. The importance of expectations in money wages was also highlighted by Phelps (1968) who pointed out that unanticipated inflation affects real economic movement. These ideas lead to the Friedman-Phelps adaptive augmented Phillips Curve.

The original Phillips Curve concept was modified once again when rational expectations were introduced in the 1970s. Lucas (1972) focused on the rational behavior of the economic agents. He argued that economic agents adjust inflation expectations as quickly as monetary policy shifts. This indicates that inflation unemployment trade - off does not hold even in the short run. The statistical estimates attained from the past data are no more helpful for predictions, because the reduced coefficients of Phillips Curve change too, with the change in policy; and this is the famous Lucas Critique.

The Phillips Curve faced another challenge in the early seventies during periods of stagflation (increasing inflation along with increasing unemployment) implying a positive rather than a negative relationship between inflation and unemployment.

All these advancements raised fears about the Phillips Curve association. Inflation model had not been developed by the Keynesians at that time. The Keynesian focused more on the aggregate demand policies rather than supply side of the economy for the explanation of the changes in employment and output. The ideas of Keynes (1936), especially that the economy can stay for long time below the full employment level and this generates unemployment, ruled macroeconomics until the resurgence of the classical economic theory in the 1970s, when the Keynesian macroeconomics theory was condemned because of no microeconomic foundations.

The most important academic challenge for the Keynesians was to create microeconomic foundations to the nominal rigidities in the existence of rational expectations. In this perspective, imperative contributions to macroeconomics were done in the form of asymmetric information, staggered contracts, efficiency wage hypothesis and the NKPC in the late 1970s and early 1980s.

The NKPC is one of those important findings, which provide the micro foundations to Keynesian macroeconomics. The NKPC assumed that inflation expectations are rational instead of adaptive and it also highlights the process of inflation dynamics and the rationale for the nominal price rigidities.

The NKPC can be derived from different edition of the time dependent models of Taylor (1980), Rotemberg (1982) and Calvo (1983). The NKPC links current inflation to expected future inflation and real economic activity, such as marginal cost or output gap.

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t \quad (2.1)$$

If we iterated forwardly the original NKPC, it becomes purely forward looking model. Inflation would become a function of sum of discounted expected real marginal costs.

This shows that there is no trade - off between inflation and output. Hence, cost of disinflation or sacrifice ratio is zero. But since the historical experiences suggested that disinflation involves output loss, Gali and Gertler (1999) have tried to bring something in the model that captures this inertia of inflation. They incorporate in their model that a fraction of firm uses backward looking rule of thumb for prices. In this way the model is divided into two types of firms, backward looking firms and forward looking firms which led to the development of the Hybrid NKPC shown in equation 2.2

$$\pi_t = \lambda mc_t + \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} \tag{2.2}$$

This HNKPC, on empirical basis, is an attractive specification as the coefficient on lagged inflation becomes positive and statistically significant. On the other hand, this raised another issue: whether economic agents are more backward looking or forward looking in making economic decisions.

The proxy used for real economic activity, such as marginal cost and output gap also influence the empirics of the NKPC. The literature indicates that the estimated coefficient on output gap and marginal cost have statistically significant as well as insignificant coefficients in the empirical estimations of the NKPC and HNKPC. So next we discuss few important studies which explain the nature of the NKPC, either the expectation are dominating by forward looking behavior or past behavior.

In their prominent study, Gali and Gertler (1999), attempt to resolve the theory of the NKPC with the available empirical proof. They suggest that previous incompatible empirical evidence for the NKPC is due to the use of the output gap as the forcing variable, which associates the inflation dynamics to real economic diversity. The authors suggest the use of marginal costs as a proxy of real economic activity and show that estimated NKPC gave superior results. In addition they expand their econometric model to an HNKPC that, in an ad-hoc mode, allows for the existence of backward looking economic agents besides the firms that form their price expectations in a rational manner. However, their results show that this proportion of backward looking firms is not only small, but also has slight impact on the dynamics of the inflation process. This permits the authors to conclude that a purely forward looking specification, consistent with the theory of the NKPC, brings a good depiction of the inflation dynamics.

For the confirmation of their result Gali *et al*. (2001) in their advance paper reported .the results of the NKPC and HNKPC.for the Euro area over the period 1970-1998. When they evaluate and compared the European and U.S inflation dynamics the results show that the HNKPC looks more superior and has strong forward-looking factor in the U.S as compared to Euro area.

Gali and Gertler (1999) results are confronted by Rudd and Whelan (2005) as they show that the forward-looking behavior has very low influence against backward looking specifications and their results are also consistent with Fuhrer and Moore's (1995) claim that the NKPC is derived from the type of staggered contracting model unable to capture the inflation inertia that we actually have in the data. Their results suggest that the forward looking agents contribute very little to an inflation process when either the output gap or the marginal cost variable is used as employed by Gali and Gertler (1999) and relatively the traditional Phillips curves which is commonly used for policy analysis are better than the new Philips curve.

The empirical results that expected inflation is stronger than lagged inflation have controversial issue in the literature. In this perspective, Rudd and Whelan (2005) and Rudd and Whelan (2006) use both output gap and labor share of income as proxies for real economic activity and driving force variables of inflation. They conclude that the NKPC empirically fitted poorly for the United States data. Specially, labor income share specified is an invalid proxy for real economic activity, and the data also do not support the dominant part of future inflation against the lagged inflation, as told in Gali and Gertler (1999) and Gali et.al, (2001).

Rudd and Whelan (2007) also give the empirical verification that labor income share exhibits counter-cyclical fluctuations in time of economic recession. However, the output gap is pro-cyclical with recessions, which implies that the output gap reduces in periods of economic recession and, that's why, it is a better proxy than labor income share to explain real economic activity.

Zhang et.al, (2009) estimated the *NKPC* for the US using inflation expectations and survey forecasts of inflation for the time period 1968Q4 to 2005Q4. They use output gap as a proxy for real economic activity and the coefficient on output gap is statistically significant and positive. On the other hand the coefficient on lagged inflation overcomes the coefficient on the forward looking inflation in the hybrid NKPC. These empirical results are different to Gali and Gertler (1999) and Gali et.al, (2001), who report that the coefficient on output gap bears a negative) sign and the coefficient on the lagged inflation is smaller than the coefficient on expected inflation.

To examine the strength of the NKPC for Australia Abbas *et al* (2011) use GMM and 2SLS techniques over the period 1959 to 2009. The results of their study show that neither the output gap nor the marginal cost are the driving variables as it is proved in the findings of USA and Euro area study done by Gali and Gertler (1999) . Along these results they also found that reduced form coefficients and structural parameters of the model validate the view that inflation dynamics are forward looking and the lagged inflation coefficient has little impact. On the other hand, they state that explanation of inflation dynamics for the Australian economy is excellent and stable in the NKPC compared to the HNKPC.

The explanation of the inflation dynamics using NKPC in case of Pakistan is investigated by Malik *et.al,* (2007). They also follow the baseline model by Gali and Gertler (1999), over the period 1976–2006 using GMM and both types of models, structural equations and reduced form equations are estimated. They conclude that inflation is dominated by forward looking manners rather than backward looking manners. They also found that marginal cost is the driving variable in inflation equation and output gap has no significant role as implied by Gali and Gertler (1999).

To check whether inflation is forward looking or backward looking in Pakistan, Riaz and Kashif (2012) use the quarterly data from 1970 to 2010 to show that and they found that the inflation has both backward looking and forward looking impact. Furthermore, they found that output gap is insignificant in determining the inflation equation.

2.2.1 Sectoral New Keynesian Philips Curve

The New Keynesian Phillips curve (NKPC) has also been examined using sectoral level data recently. The aggregate inflation data is affected by the difference in prices across different sectors and this affects the empirical performance of the NKPC and the HNKPC too.

In addition, there is a visible sectoral heterogeneity in price rigidity and the rate of price setting varies across economic behavior. This is one of the key conclusions of the European Inflation Persistence Network (IPN) that collect data on prices at a microeconomic level, for different European countries. The time period of nominal rigidities fluctuate not only in different countries, but even more from one sector to the other sector. This type of heterogeneity in price setting is not captured by the aggregate NKPC and to check this type of sectoral inflation dynamics a disaggregated model is necessary to estimate. Following are the few important studies which deal the disaggregated data to enhance the ability of forward looking component of inflation equation in NKPC.

Leith and Malley (2007) developed a sectoral *NKPC*, which econometrically measures the degree of price stickiness in each industry. They estimate Phillips curves for 18 manufacturing industries over the period 1959 to 1996 in USA and found statistically significant variation between industries. This indicates that the monetary policy effect is quite different in different sectors; durable goods industries suffer more inertia than non-durable goods industries. They also found that mostly firms set prices in a forward looking approach, along with this, industries also have an important degree of backward looking manners.

The sectoral Philips curve is estimated by Imbs et.al, (2011) for French data using maximum likelihood method over the period 1978 to 2005 on quarterly basis for 16 sectors,. The analysis of the study is that prices respond significantly to marginal costs and have forward looking nature at the sector level. Secondly in this study aggregate Philips curve is estimated using calibration technique and result are quite similar to the sectoral level and this validate the power of NKPC.

Heterogeneity has significant cost for aggregate inflation behavior is confirmed by Byrne et al. (2010). This study used data for 14 industrial countries: Austria, Belgium, Denmark, France, Portugal, Spain, Sweden, UK, USA Germany, Greece, Ireland, Italy and Netherlands, for 15 sectors. The study covers the period 1971-2005 on annual basis.

Main result of this study are country specific or mix type, the evidence is not very encouraging for the NKPC in a few countries , the model does fine to explain inflation in case of US, France, UK and Germany. Finally they also conclude that assumption of price setting and monopolistic competition condition strongly affects the nature of NKPC.

To check the validity of New Keynesian Philips curve (NKPC), Petrella and Santoro (2012) analysis price-setting in U.S manufacturing industries and this covers 458 manufacturing industries from 1958 to 1996 on annual basis. The result confirms that forward looking nature of the New Keynesian model of price-setting is extensively supported at the sectoral level.

2.3 Sacrifice Ratio

According to Friedman (1968), the inflation and output relationship is an essential element of monetary policy. While low inflation is considered to be beneficial for the economy, at the same time disinflationary policies lead to short term output losses. Most of the empirical literature on disinflations focused on the SR, defined as the costs in terms of output loss that must be faced to achieve a reduction in inflation.

There have been various attempts to estimate the SR in the literature, broadly classified as: Time - invariant sacrifice ratio [Okun, (1978); Gordon and King (1978); and Cecchetti and Rich,(2001)], and Episode Specific methods [Ball, (1994) and Zhang, (2001)]. Ball's technique remains as the "standard" and important method.

In Time- invariant sacrifice ratio different methodologies like simple Philips curve (PC), structural vector auto-regression (SVAR) and New Keynesian Philips curve (NKPC) are used for the calculation of sacrifice ratio. The pioneer of Time- invariant sacrifices ratio method is Okun (1978) who analyzed a set of Phillips curve models to estimate the cost of disinflation in terms of the percentage loss of output during a given period and he found 10% sacrifice ratio on average for the United States. This mean, one % permanent decrease in inflation rate would cause 10% point loss in real Gross National Product (GNP).

Using traditional as well as VAR models, Okun's was refined by Gordon and King (1982) to estimate the U.S sacrifice ratio and found that sacrifice ratio lies between 0 to 8 percent. For Economic and Monetary Union of the European (EMU) countries, sacrifice ratio in the time period of 1960 to 2001 was estimated by Cunado and Gracia (2003) using Philips curve.

Andersen and Wascher (1999) computed the sacrifice ratio for 19 industrialized countries and found that sacrifice ratio varies due to time period covered and model specification. They showed that the average sacrifice ratio rose from 1.5% to 2.5% as a result of fall in average rate of inflation from the 80s to 90s and those lower rates of inflation made the aggregate supply curve flatter. A study by the Reserve Bank of India [RBI (2002)] estimates the Phillips curve and obtains a sacrifice ratio of 2% for India. Kapur and Patra

(2003) estimate an alternative specification of aggregate supply function and obtain estimates of a sacrifice ratio ranging from 0.3 to 4.7%.

Akbari and Rankaduwa (2006) estimate an output-inflation trade-off using OLS method to find sacrifice ratio for Pakistan for the time period 1982-2004. They report that a one percent decline in inflation rate caused by a permanent reduction in monetary growth rate would result in a cumulative output (GDP) decline of 0.87 percent point.

On the other hand, Ball (1994) argues that in the Phillips curve method the output inflation trade - off is supposed to be constant in all the periods. Keeping this limitation of the Phillips curve in mind. Ball (1994) presents the Episode specific method in which disinflationary episodes are identified and then SR is calculated for each period as the cumulative sum of output gap divided by the decline in inflation. This approach of calculating SR depends upon the disinflation episodes assumptions of how to determine the equilibrium output levels. This approach focused only disinflationary episodes not inflation episodes and more importantly no supply shocks and other polices is incorporated which affect the rate of inflation. Ball (1994) used this episode specific sacrifice ratio in 19 OECD countries from 1960 to 1991 and found 65 episodes. The calculated value of Ball (1994) sacrifice ratio varies from 0 % to 3.5%.

The SR is estimated using Ball (1994) technique by many authors over different time periods like the inflation output trade - off is checked by Cetinkaya and Yavuz(2002) in case of Turkey. Analysis showed that, in case of Turkey disinflations are not described by huge output losses. Coficienet *et, al* (2007) estimate the SR for the euro area following the Ball (1994) technique and fond the value of the SR between 1.2% and 1.4% for the Euro area over the period 1985 to 2004.

Using episode specific and SVAR model, Serju (2009) found very low sacrifice ratio for Trinidad, Tobago and Jamaica. On average 0.029% and 0.113% points output loss due to 1% fall in inflation rate in Jamaica and Trinidad & Tobago respectively. The SR in Turkey, Brazil and Italy is calculated by Direkci (2011) using the Ball) method (1994 reasonable results are found. Mazumder (2014) estimated the sacrifice ratio of organization for economic cooperation and development (OECD) economies following Ball (1994) method over a forty year period.

Ball (1994) approach was generalized by Zhang (2005) and he incorporates the persistence effect and long lived effects of inflation and shows that the SR is larger when these effects are included. The empirical study used the 1960 to 1990 unemployment, as well as real GDP data quarterly on G-7 countries. The average sacrifice ratio calculated by Ball (1994) is 1.4 but when Zhang (2005) incorporated the long lived effects, average sacrifice ratio increased to 2.5 for the same data set.

Cecchetti and Rich (2001) criticized the episode specific method of calculating sacrifice ratio. And they are in favor of incorporating the structural shocks in the model. Cecchetti and Rich (2001) used SVAR methodology for the calculation of the sacrifice ratio for the period 1959 to 1997 on quarterly US data, using three different identified models and then estimate the SR over 1 to 5 year horizon. Similarly Feve *et,al* (2007) used SVAR analysis, and provide an estimate of SR is 4.26% for the Euro zone.

Calculating sacrifice ratios using structural vector auto-regression (SVAR) for the twelve euro countries over the time period 1972:1 to 2003:4 Jacques *et al*. (2005) estimated the value of sacrifice ratio and found almost same SR in Euro countries over the entire sample time. The value of SR is between 0.35% and 0.63% in eight of twelve countries While Luxembourg and Germany have high SR, Belgium and Finland show low values, almost 0 and negative in the case of Belgium.

The structural vector auto-regression (SVAR) methodology also provides the dynamic effects of disinflation. The impulse responses in Cecchetti and Rich (2001) show that after a disinflation output falls and ultimately turns back, while inflation decreases permanently. However, variation in the size of sacrifice ratio depends on the timing of the disinflation across model specifications, identification assumptions and data sets.

As we discussed in the last section that NKPC become an important tool in the inflation dynamics and we found lot of empirical literature but Sacrifice ratio is measured by New Keynesian Philips curve (NKPC) is a new concept in the literature and we found hardly few studies related to this issue. Buiter *et.al* (2001) found that the benefit of moderate inflation cannot be enjoyed without incurring the pain of production loss and increased unemployment. He proved that there is no gain without pain. Sacrifice ratio is zero in case of pure forward looking NKPC but there is a positive sacrifice ratio in partly backward looking and partly forward looking NKPC. He finally concluded that painless disinflation is impossible.

The long run Hybrid New Keynesian Philips curve (HNKPC) for Australia is derived by Ryder (2007), modeling inflation expectations using a recursive learning process and he found a sacrifice ratio of 2.5 in this case. The comparison of Sacrifice ratio measured by the traditional Philips curve and the new Keynesian Philips curve is made by Chortareas (2009) for the case of USA. The results indicates that the sacrifice ratio is roughly 2.3% and 1.7%, this means a 1% point reduction in inflation causes a 2.3% and 1.7% points fall in real GDP, respectively.

Sacrifice Ratio study by Ascari (2012) is measured using Medium Scale New Keynesian Model found that cold turkey disinflations have considerable size of output costs or sacrifice ratio which is almost 1, and it means that for each percent point of fall in inflation the economy has to face a cumulative output loss of 1% point. The sacrifice ratio is responsive to the degrees of price indexation and wage. When price and wage indexation is decreased to 0.5 from 1, the Sacrifice ratio falls to 0.25% points. In the same way when the price and wage raised to 0.85 from 0.6, the Sacrifice ratio rises to near 6%.

According to Rouxy and Hofstetter (2012) inflation targeting reduces sacrifice ratios but only when the period of disinflation is long: in a four-year-long disinflation. They have shown that inflation targeting reduces sacrifice ratios by at least 60%. Their results also suggest that inflation targeting and fast disinflations are substitute alternatives in enhancing the credibility of disinflationary processes and reducing their costs.

Brito and Bystedt (2010) found no evidence regarding the inflation targeting regime to improve economic performance as measured by the behaviour of inflation and output growth in developing countries. They claimed the lower output growth during inflation targeting adoption and inflation targeting are more inflation-averse, the costs of disinflation have not been lower than under other monetary regimes.

2.4 Inflation Forecasting

Inflation forecasting is a focal goal for a central bank because the inflation rate is normally considered the most significant indicator of monetary policy. Several central banks, especially those who follow direct inflation targeting, also considered the inflation forecast an important role in their monetary policy. The literature on inflation forecasting are increasing speedily and lot of forecasting methods are introduced and applied to forecast inflation. Time series models, structural models such as SVAR, traditional Phillips Curve equations are the important methods in the recent literature.

At the same time there has been a growing interest in the recent literature regarding the effects of different data vintages on model specification and forecast evaluation. The recent literature showed that the use of real time data in assessing the forecasting performance is more accurate as opposed to using final revised data. The use of final revised data exaggerates the predictive power of explanatory variables relative to real time data. How much difference does the vintage of the data make for forecasts was explored by the Croushore and Stark (2001). They found that real-time data matters for choosing lag length in a univariate context and measures of forecast error, like root-mean-squared error and mean absolute error is deceptively lower when using latest available data rather than real-time data. Therefore, modeling expectations or evaluating forecast, the use of latest-available data is questionable and if comparison is made between the forecasts generated from new models and bench mark model using real time data and final time data, real-time data is more accurate.

Croushore (2008) evaluate the inflation forecasting from the survey of Livingstone and survey of professional forecasters using real time data set. He examined that how the revisions patterns affect the inflation rate and other macro variables. The Livingston survey and Survey of Professional Forecasters developed poor reputations because of the systematic pattern of forecast errors found in the 1970s. Using basic statistical tests, researchers found that the forecast errors from the surveys failed to pass a number of basic tests. In addition, the evaluation of forecast errors depends in part on the choice of actual, with actual taken to be latest available data providing the least favorable evaluation of the forecasts.

A stable predictive relationship between inflation and the output gap, known as a Phillips curve, provides the basis for countercyclical monetary policy in many models. Orphanides and Norden (2004) in their paper evaluate the usefulness of alternative univariate and multivariate estimates of the output gap for predicting inflation. Many of the output gap measures appear to be quite useful for predicting inflation. However, forecasts using real time estimates of the same measures do not perform nearly as well. The relative usefulness of real time output gap estimates diminishes further when compared to simple bi-variate forecasting models which use past inflation and output growth.

Robinson *et al.* (2003) check the real time forecasting performance of Philips curves in Australia. They suggested that the Philips curve based on real output gap have limited capacity in inflation forecasting as compared to simple benchmark approach of inflation forecasting like autoregressive (AR). They conclude that, despite of their generally disappointing performance as forecasting inflation, Phillips curves may play a useful role in real time as a tool for alternative inflation forecasting approach. Maritta and David (2004) used real time data set for inflation forecasting as well estimating the dynamics of Philips curve in New Keynesian framework in Euro area. They conclude that using real time information on expectations improve the inflation forecasting performance for the euro area countries. Clements and Galvao (2010) exploit two ways of estimating forecasting models end of sample data and the use of real time vintages. The empirical forecast comparisons suggest that the predictability of inflation using Phillips curve models are largely unchanged when the exercise is performed in real time compared to the exercise of Stock and Watson (2008). The use of RTD data yields more accurate forecasts than EOS.

Guerin *et al*. (2011) compute both ex post and real time estimates to check the stability of the estimates to GDP revisions. They finally had done forecasting to evaluate the predictive power of the output gap for inflation in the euro area and found that the predictive power of the real time estimates of the output gap for inflation is limited, whereas the ex post estimates of the output gap slightly improve the forecasting performance with respect to their real time counterparts.

Clausen and Clausen (2010) estimate out-of-sample inflation forecasting for Germany, the UK, and the US using output gaps estimated with real-time GDP data. They estimate potential output using HP filter method in all three country datasets and compare results across countries. They conclude that the simple Phillips curves based on ex post output gaps generally improve the accuracy of inflation forecasts as compared to an AR(1) forecast but the real time output gaps is not much useful in inflation forecasting.

Mostly the traditional models of inflation forecasts are based on the *PC* trade off and using the end of sample data. According to Blinder (1997) the stability of the *PC* relationship and its reliability as forecasting tool adds to the popularity of the Philips curve as a forecasting method. On the other hand Stock and Watson (1999) criticized this traditional theory of PC, based on the United States data. They concluded the parameters of PC changed with the passage of time and the other measures of real activity for forecasting inflation are better than the unemployment rate. Atkeson and Ohanian (2001) also criticize the Phillips curve used for inflation forecasting purposes and concluded that

U.S inflation forecasting using Philips curve are not better than those based on a random walk model.

The comparison of the performance of the inflation forecasting is done by Canova.*et.al* (2007) using different important models of inflation forecasting for G-7 countries. They suggested that the performance and statistical analysis of univariate models are better than the bi-variate and tri-variate models. They also suggested that the Phillips curve specifications gave good results of inflation forecasting. The performance of Philips curve for inflation forecasting in Turkey which is considered as a high inflation emerging country was checked by Onder (2004).Comparison of the forecasting performance of the PC with alternative time series models, namely, the ARIMA model, VAR and VEC model, and no-change model were carried out and results showed that inflation forecasts found by the Phillips curve are more accurate than forecasts obtained by the other models.

Matheson (2006) extends the good performance of Philips curve to two small open economies of Australia and New Zealand. The results show that the performance of open economy Phillips curve as compared to a univariate autoregressive benchmark is relatively poor. However, its performance improved when sectoral Phillips curves are used, which separate tradable and non-tradable sectors. Stock and Watson (2008) indicate that Phillips curve for inflation forecasting are better than other multivariate inflation forecast methods for USA data, but their performance based on their specifications, sometimes superior and sometimes inferior than a univariate benchmark model.

Modeling and forecasting inflation in case of Pakistan Bokhari and Feridun(2006) use two factor model, VAR model and ARIMA. The empirics of the study show that the ARIMA model is better in forecasting inflation as compared to other two models. Forecasting inflation for Pakistan Feridun *et al*.(2006) used the time series model ARIMA and concluded that it is a simple and good method for forecasting.. Wasim *et,al*.(2015) used two empirical approaches to forecast inflation, a benchmark univariate Autoregressive and Moving Average (ARMA) model and bi-variate Vector Autoregressive (VAR) model that includes inflation and output gaps estimated from different statistical and structural filters. Results indicate that structural methods perform better than the statistical methods. The results also indicate that univariate ARMA model forecast inflation better than bi-variate VAR models do using any of the output gap measure.

In modern literature of macroeconomics, the New Keynesian Phillips curve (NKPC) got much popularity and become the well accepted theory of inflation dynamics. Regardless of its empirical victory to explaining inflation dynamics, it is least used for inflation forecasting purposes. Inflation forecasting using the NKPC was introduced by Rumler (2010). The performance of the inflation forecasts using NKPC is judged by comparing it to inflation forecasts generated from PC, VAR, and AR model etc. The results showed that the quality of inflation forecasting of all models explains that the NKPC inflation forecasts outperform the time series models, the traditional PC. Using two different measures of real economic activity that are used in the literature as the output gap and the labor share of income, Liu and Jansen(2011) found that the NKPC as a forecasting model outperforms bi-variate and the factor models at longer time period in USA. The NKPC model has the lowest forecast MSE and results are pretty strong and this support the forecasting skill of the NKPC for further future research. Forecasting inflation using HNKPC outperforms in case of USA as compared to other method like Bayesian VAR is also confirmed by Antipin (2008). The HNKPC forecast more precisely than the naive forecast.

2.5 Concluding Remarks

In this chapter we reviewed some important studies of sacrifice ratio which deal with the cost of disinflation. Sacrifice ratio is basically divided in two categories, Constant over time methods and Episode specific methods. In constant over time we gave the reviews related to basic Philips curve, structural VAR and the NKPC while the episode specific methods consist of Ball(1994) and Zhang(2001) own methodologies. To our knowledge, no documented study has been found related to sacrifice ratio at aggregate as well as sectoral level for Pakistan. So this study will full fill this gap.

The detail historical review of NKPC is also given in this chapter and further we extend the NKPC into the disaggregated level .So the review of the sectoral NKPC are also given in this chapter. To our knowledge this is the first attempt to estimate the sectoral NKPC in case of Pakistan. Keeping in the view of the importance of inflation forecasting, we gave the essential reviews of the forecasting inflation using the real time data and end of sample data and this study covers Philips curve methodology, univariate time series method and the NKPC method. Forecasting inflation using the new Keynesian Philips curve is not done before in case of Pakistan, so this study will be the first attempt in which this technique is used as well as real time output gap is used for inflation forecasting for Pakistan. The NKPC using real time output data as compared to the simple output gap is also the value added of this study.

ECONOMIC GROWTH IN PAKISTAN: AN OVERVIEW

3.1. Introduction

Pakistan is the 26th largest economy in the world in terms of purchasing power parity (PPP), 40th largest in terms of gross domestic product (GDP) and sixth largest in terms of population.

At the time of independence in 1947 Pakistan was a predominantly poor agrarian economy. However, overtime it has gone through major structural changes in composition. The share of agriculture in GDP declined from 37.7 % in 1971-72 to 21.2 % in 2009-10. The share of the services sector has increased from 39.4 % to 52.4 % The share of the manufacturing sector has also increased slowly from 16.7 % in 1971-72 to 18.6 % 2009-10 (GOP, 2011).This chapter discusses the historical context of economic growth and inflation in Pakistan.

3.1 Historical Prospective of Economic Growth and Inflation

The separation of East Pakistan in 1971 along with unplanned nationalization of the large scale manufacturing sector and a number of small scale production units affected the economy adversely. Nationalization policy had serious consequences for private sector domestic foreign investment. Sudden rise in oil prices in 1973-4 followed by severe floods in 1976 which destroyed the standing crop of cotton, the major export of Pakistan and over all GDP declined considerably during the seventies averaging 4.8.percent. Eighties was the period of revival of the economy of Pakistan and GDP grew by average

6.5% during the eighties due to massive foreign aid from USA and other countries due to Soviet invasion of Afghanistan. Almost all the sectors showed strong growth.

During the period 1988 to 1999, there were seven different elected governments. This period was very uncertain era and no elected government completed its tenure. The economic growth of Pakistan slowed down and averaged 4.6% during the nineties. The major factors of poor economic performance during nineties included corruption in the public sector, the structural adjustment programs of the World Bank (WB), the International Monetary fund (IMF), and international sanctions after nuclear explosion by Pakistan.

The economy of Pakistan on average, improved once again during the 2000s. The manufacturing and services sector showed notable growth in this period (Table 3.1). Pakistan’s growth rate during 2000-07 was 7% on average and became the fourth fastest growing nation in Asia. However the global financial crises affected the economy of Pakistan quite adversely in the latter half of 2000s. Therefore, the economy faced a serious economic decline; the real GDP growth declined from 6.8 % in 2006-07 to 1.7 % in 2009-10.

In Pakistan, inflation rate averaged 3.3% during sixties and rose to 24% in the mid - seventies, averaging around 11.9%. The inflation rate declined and averaged 7.5 % in the eighties. In early nineties, inflation rate become a serious issue; double digit inflation rates were recorded in the nineties due to both internal and external shocks, monetary policy and pricing policy for agricultural products.

Table 3.1: Aggregate and Sectoral Growth Performance (1960 t0 2011)

Sectors/Time period	1960s	1970s	1980s	1990s	2000s
GDP	6.8	4.8	6.5	4.6	4.8
Agriculture Growth Rate	5.1	2.4	5.4	4.4	3.2
Manufacturing Growth Rate	9.9	5.5	8.2	4.8	7.0
Services Growth Rate	6.7	6.3	6.7	4.6	5.3

Source: Annual reports of the State Bank of Pakistan (various issues)

Over the last 18 years inflation shot up by 13% due to food inflation which averaged around 16.5% over the period. The averages of inflation rate and money supply is given in table 3.2

Table 3.2: Inflation rate and Money supply (1960 t0 2011)

Time Period	1960s	1970s	1980s	1990s	2000s
Inflation Rate	3.3	11.9	7.5	9.7	8.5
Money Growth Rate	11.14	14.43	13.06	14.83	15.63

The inflation rate was at its lowest level in 2002-03, i.e. 3.9 %. However due to rise in the support price of wheat, shortage of wheat and increase in international prices (including the oil price), inflation stood at 9.3% in 2005. Food inflation which is the main component of the CPI rose to 15.0 %. Therefore, in early 2008, inflation rate as measured by the changes in CPI was recorded at 20.3 %. However, in the latter half of the year 2008, it started to decline. During 2009 it declined to 13.6% and stood at 13.9% in 2010. In 2012, the inflation rate further decreased to 10.2%. The relationship between inflation, money supply and growth are investigated by Qayyum (2006) and found that inflation is a monetary phenomenon in the long run in case of Pakistan.

METHODOLOGY, DATA AND DEFINITION OF VARIABLES

4.1 Introduction

This study estimates the inflation dynamics using reduced New Keynesian Philips Curve (NKPC) and Sacrifice ratios both at the aggregate level for all the major sectors and at the disaggregated levels by major sectors discussed in chapter 3. Moreover inflation rate is forecasted using end of sample data and real time data.

This chapter deals with the theoretical framework, data and econometric techniques in detail. The chapter is divided into seven sections: Inflation dynamics using new Keynesian Philips curve is discussed in section two. Sacrifice ratio is explained in section three, and Inflation forecasting is discussed in section 4. Econometric techniques and diagnostic tests are discussed in section 5. Data are discussed in section 6 and variables are defined in section 7. Section 8 concludes the chapter.

4.2 Inflation Dynamics Using New Keynesian Philips Curve

Short run inflation dynamics and its relations with real economic variables is an important issue in macroeconomics. The origin of this relationship goes back to Phillips (1958) who introduced the concept of Phillips curve which is the tradeoff between money wages and unemployment. The labor bargains for high nominal wages when the demand for labor is high and this transmitted to inflation. This relationship of inflation and unemployment is known as the Phillips curve and is represented by equation 4.1 as:

$$\pi_t = \pi_t^e - \beta(u^n) + v_t \quad (4.1)$$

Where

π_t = the inflation rate

π_t^e=Expected inflation rate

β =a parameter that measure the response of inflation with relation to unemployment.

(u^n) =Unemployment rate

v_t =error term and $v_t \sim ND(0, \sigma^2)$

The Phillips Curve was not based on theoretical microeconomic foundations. Considerable advancements have been made during the last few decades in the theoretical framework of inflation dynamics. Mostly the modern analysis of inflation is based on NKPC, a model of price setting based on micro foundations and current inflation is determined by the expected future inflation and output gap or real marginal cost as the driving variables.

4.2.1 New Keynesian Philips Curve

The basic assumption of the new Philips curve is that the monopolistically competitive firms face time limitation on price adjustment [Calvo (1983)].This model indicates that in each period a fraction of (1-θ) of firms adjust their prices while the remaining θ fraction do not change the price. The parameter θ is a measure of the degree of nominal rigidity. This means that the aggregate price level p_t is a mixture of the lagged price level p_{t-1} and the optimal reset price p_t^* , as

$$p_t = \theta p_{t-1} + (1-\theta)p_t^* \qquad (4.2)$$

The firms are identical except for the differentiated product they produce and the optimal rest price at time "t" is expressed as

$$p_t^* = (1-\theta\beta)\sum_{k=0}^{\infty}\beta\theta^k E_t(mc_{t+k}) \qquad (4.3)$$

Here mc_{t+k} is the firm's marginal cost at t and β is the discount factor. Firm's maximization decision problem is as

$$\text{Max } E_t\sum_{i=0}^{\infty}\lambda^i\beta^i\left[\left(\frac{p_t^*}{p_{t+i}}\right)C_{t+i} - mc_{t+i}c_{t+i}\right] \qquad (4.4)$$

By solving the model and then log linearizing around steady state, Gali and Gertler(1999) standard reduced *NKPC* equation is given as:

$$\pi_t = \beta E_t\pi_{t+1} + \lambda mc_t + \mu_t \qquad (4.5)$$

Where;

π_t = Inflation rate

$E_t\pi_{t+1}$ =Expected future inflation

mc_t = marginal cost

μ_t=error term and $\mu_t \sim ND(0, \sigma^2)$

and $\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$

θ is the frequency of price adjustment and β is the discount factor. Real marginal cost is not directly observable, therefore Gali and Gertler (1999) used some restrictions to measure marginal cost. The simplest measure of marginal cost available is based on Cobb Douglas equation where Output Y_t is given by;

$$Y_t = A_t K_t^{\alpha_k} N_t^{\alpha_n} \qquad (4.6)$$

Where A_t represents technology; K_t represents capital; and N_t represents labor. Marginal cost is the ratio of the wage rate to marginal product of labor given by:

$$mc_t = \frac{W_t / P_t}{\partial Y_t / \partial N_t}$$

Where

$$mc_t = \frac{s_t}{\alpha_n} \qquad (4.7) \text{ and}$$

$s_t = W_t N_t / P_t Y_t$ is the labor income share.

In some studies output gap is also used as a relevant indicator of real economic activity in place of marginal cost. Gali and Gertler(1999) define a proportional relationship between marginal cost and output gap.

$$mc_t = \eta\left(y_t - y_t^p\right) \qquad (4.8)$$

$$mc_t = \eta Y_t \qquad (4.8')$$

Where y_t^p is the potential output and η is the output elasticity of real marginal cost, [Glai and Gertler(1999)]. So inside the parentheses is the output gap. Using this relationship we got the following standard equation of NKPC using output gap as a real economic activity is as:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda\eta Y_t + \mu_t \qquad (4.9')$$

or

$$\pi_t = \beta E_t \pi_{t+1} + \kappa Y_t + \mu_t \qquad (4.9)$$

Where π_t= Inflation rate

π_{t+1}=Expected future inflation

Y_t = Output gap

μ_t=error term and $\mu_t \sim \mathrm{ND}(0, \sigma^2)$

4.2.2 <u>Hybrid New Keynesian Philips Curve</u>

Literature shows that disinflation is also costly as inflation goes on and the historical experience also suggests that disinflation involves substantial output loss, [Ball (1994)]. But the drawback of the baseline *NKPC* is that disinflation is costless. By iterating the equation (4.5) forwardly, we get

$$\pi_t = \kappa \sum_{\kappa=0}^{\infty} E_t \beta^k Y_{t+k} \qquad (4.10)$$

This shows that inflation depends completely on discounted future and output gap and reducing inflation without any cost propose that the sacrifice ratio is zero. This statement is not appreciated in literature because disinflation policy has some cost in the form of output loss. To overcome this problem of *NKPC* Gali and Gertler(1999) augmented the standard *NKPC* with lagged inflation. It means both future and the past are important in determining the current inflation. The role of the lagged term is to capture the inflation persistence that is unexplained in the baseline model and further it implies that disinflation is now costly in terms of output reduction.

The aggregate price level is determined by Calvo model.

$$p_t = \theta p_{t-1} + (1-\theta) p_t^* \qquad (4.11)$$

Where p_t^* is the newly set price in period "t". But in this case p_t^* is further divided into forward looking and backward looking firms. Therefore the newly set price index is given as:

$$p_t^* = \omega p_t^b + (1-\omega) p_t^f \qquad (4.12)$$

p_t^b is the price set by the backward looking firms and p_t^f is the price set by the forward looking firms and forward looking firms behave same way as the base line Calvo model, so p_t^f is expressed as:

$$p_t^f = (1-\theta\beta)\sum_{k=0}^{\infty} \beta\theta^k E_t(mc_{t+k}) \qquad (4.13)$$

Backward looking firm sets its price equal to the average of the most recent optimal price with the correction of inflation and correction is mostly based on lagged inflation.

$$p_t^b = \overline{p_{t-1}^*} + \pi_{t-1} \qquad (4.14)$$

By solving the model, the final reduced form of the hybrid Philips curve is as

$$\pi_t = \lambda mc_t + \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} + \mu_t \qquad (4.15)$$

Where π_t=Inflation rate

$E_t(\pi_{t+1}$ = Expected future inflation

π_{t-1}=Past inflation

mc_t= marginal cost

μ_t=error term and $\mu_t \sim ND(0, \sigma^2)$

This equation shows that now the inflation depends on the combination of the past inflation and the future inflation. As Gali and Gertler (1999) define a relationship between marginal cost and output gap (mentioned in equation 4.9), so the reduced hybrid NKPC using output gap is as:

$$\pi_t = \lambda Y_t + \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} + \mu_t \qquad (4.16)$$

Where π_t= Inflation rate

$E_t(\pi_{t+1})$= Expected future inflation

π_{t-1}=Past inflation

Y_t= Output gap

μ_t=error term and $\mu_t \sim ND(0, \sigma^2)$

4.2.3 Sectoral New Keynesian Philips Curve

The NKPC got popularity in the study of inflation dynamics and lot of literature is built on the basis of aggregate data but the frequency of price adjustment varies across economic activities. In the same way nominal rigidities vary across sectors. Therefore to check the validity of results based on aggregate data, we disaggregate the data into three major sectors: Agriculture, Manufacturing and Services sectors.

Calvo (1983) model is used for price setting and the aggregate price level as:

$$p_{jt} = \theta p_{j,t-1} + (1-\theta) p^*_{j,t} \qquad (4.17)$$

Where $p^*_{j,t}$ is newly set price in period “t” and j=1,2,3 are the three different sectors. But in this case p^*_t is further divided into forward looking and backward looking firms in three different sectors. The newly set price index is as:

$$p^*_{jt} = \omega p^b_{jt} + (1-\omega) p^f_{jt} \qquad (4.18)$$

p^b_{jt} is the price set by the backward looking firms in three different sectors and p^f_{jt} is the price sett by the forward looking firms in three different sectors.

Forward looking firms in three different sectors behave same as the base line Calvo model, so p^f_t is expressed as,

$$p^f_{jt} = (1-\theta\beta) \sum_{k=0}^{\infty} \beta\theta^k E_t\left(mc_{jt+k}\right) \qquad (4.19)$$

Backward looking firms in three different sectors set their price equal to the average of the most recent rest price with the correction of inflation and correction is mostly based on lagged inflation.

$$p^b_{jt} = \overline{p^*_{J,t-1}} + \pi_{j,t-1} \qquad (4.20)$$

Firm’s maximization price decision problem is as

$$\text{Max } E_t \sum_{i=0}^{\infty} \lambda^i \beta^i \left[\left(\frac{p^*_{jt}}{p_{j,t+i}}\right) C_{j,t+i} - mc_{j,t+i} c_{j,t+i}\right] \qquad (4.21)$$

By solving the model, the final reduced form of the sectoral hybrid Philips curve is given by:

$$\pi_{jt} = \lambda mc_{jt} + \gamma_j^f E_t\left(\pi_{j,t+1}\right) + \gamma_j^b \pi_{j,t-1} \qquad (4.22)$$

Where π_{jt} =Inflation rate in different sectors

$E_t(\pi_{j,t+1})$ = Expected future inflation in different sectors

$\pi_{j,t-1}$ =Past inflation in different sectors

mc_{jt} = marginal cost in different sectors

4.3 Sacrifice Ratio (SR)

The primary objective of the monetary policy is to control inflation and stabilize the prices. Reducing inflation generally has some cost and the amount of that cost is measured by the sacrifice ratio. Thus the sacrifice ratio calculates the output cost per unit decline in inflation. This relationship between inflation and output has been extensively studied both empirically and theoretically. The origin of this relationship is the introduction of the Philips Curve and Okun (1978) introduced this concept of trade off between inflation and output. He derived the cost of disinflation in terms of percentage output lost in a given time period using the Philips curve model. After this the economists used different techniques to measure the cost of disinflation. In this section we explain different methodologies of sacrifice ratio.

4.3.1 Philips Curve Methodology

The theoretical foundations of the sacrifice ratio are based on the expectations augmented Phillips curve [Okun, (1978); Gordon and King, (1982)]. The basic equation of the Philips curve is given as:

$$(y_t - y_t^p) = \alpha(\pi_t - \pi_{t-1}) + u_t \qquad (4.23)$$

Here y_t and y_t^p are the actual output and potential output respectively and this means that $(y_t - y_t^p)$ is the output gap. The term π_t is the inflation in time t and π_{t-1} is last year inflation rate and Disinflation occurs when $(\pi_t - \pi_{t-1}) < 0$. α is the parameter which measures the cost of disinflation. As the value of α gets larger, the cost of disinflation increases.

$$\alpha = \frac{dY_t}{d\pi_t}$$

4.3.2 Ball's Methodology

Sacrifice ratio estimated by Philips curve is criticized on the grounds that: the sacrifice ratio is identical for decreasing inflation period as well as for increasing inflation period; and the cost of disinflation is not time varying and this means that output inflation trade off is constant for all time period. Ball (1994) introduced the concept of episode specific measurement of output loss and incorporates the solution of the above problems.

Ball's definition of sacrifice ratio is given by:

$$SR = \frac{\sum_{t=s}^{E+1}(y_t - y_t^*)}{\pi_t - \pi_{t-1}} \qquad (4.24)$$

The numerator is the output gap which is the sum of the difference between the actual output (y_t) and potential output (y_t^*)in specific disinflationary episodes (here “s” means the starting year of disinflationary period and “E+1” means the end of disinflationary period plus one year). The denominator is the change in the inflation rate from the start to the end of the identified disinflation episode. *SR* is interpreted as the cost of reducing one percentage point of inflation in terms of aggregate demand reduction, which is similar to α in the Philips Curve.

The variables used in Ball’s study are explained as follows:

The trend inflation is calculated using 3 year centered moving average for annual data. A point where trend inflation is high than the last year and the next year in the time period is called Inflation Peak. A point where trend inflation is low than the last year and the next year in time period is called Inflation Trough. The time starts from an inflation peak to an inflation trough with 1.5 percentage points less than the peak in annual data is known as Disinflation Episode.

Ball (1994) calculates potential output using following three basic assumptions:

• It is assumed that output is in its potential level at the inflation peak.

• Output comes back to its natural level after one year in annual data.

• Trend output increases log linearly between the two points when actual output and potential output are same.

4.3.3 Zhang Methodology

Ball's method is criticized for its simplistic assumptions. The assumption that output is at its potential level when inflation rate is at its peak is generally accepted but the problem arises when the output comes back to its potential level. Is there any long-lasting effects or persistence effects? Furthermore, if these effects exist, how long have the effects of the recession last? Zhang modified Ball's (1994) methodology by relaxing the assumption that output returns to its potential level after one year of the trough. Instead, he uses the Hodrick–Prescott filter to project potential output and incorporates the persistence effect in the calculation of the potential output,

The most important problem in the calculation of SR is the measurement of trend output because little variation in trend output affect the size of *SR*. Potential output is calculated by Zhang using HP filter and assuming output to be at its potential level at the peak level of inflation.

First HP filter of the log real output is calculated and after this the growth rates of HP filter are found.

The potential output is assumed to grow at the rate calculated by HP filter at the start of the episode.

4.3.4 Structural Vector Auto Regressive (SVAR) Methodology

The Ball (1994) and Zhang (2001) methods of calculating sacrifice ratio don't incorporate the monetary policy effects. To check the consequence of monetary policy shocks on the output-inflation relationship, Cecchetti's (1994) structural VAR approach seems to be suitable, since it provides an appropriate calculation of the SR.

We use the following bi-variate unrestricted VAR in first differenced form.

$$\Delta y_t = \sum_{i=1}^{n} \emptyset_{11}^{i} \Delta y_{t-i} + \sum_{i=1}^{n} \emptyset_{12}^{i} \Delta \pi_{t-i} + \mu_t^1 \qquad (4.25)$$

$$\Delta \pi_t = \sum_{i=1}^{n} \emptyset_{21}^{i} \Delta y_{t-i} + \sum_{i=1}^{n} \emptyset_{22}^{i} \Delta \pi_{t-i} + \mu_t^2 \qquad (4.26)$$

Where y_t represents the log of GDP in current period, π_t is the inflation rate and μ_t the vector of innovations includes the shocks that affect the vector of endogenous variables $X_t = [\Delta y_t, \Delta \pi_t]$ at time t. It is assumed that$\mu_t \approx Niid\ N(o, \sigma^2)$.

In this unrestricted version, the innovations μ_t^1 and μ_t^2 do not describe any economic explanation. Since the rationale here is to clearly calculate the effect of a demand shock on inflation and real output, that's why we relate the unrestricted VAR model to its basic structural form.

$$(1-L)y_t = \Delta y_t = \sum_{i=1}^{n} b_{11}^{i} \Delta y_{t-i} + b_{12}^{0}\, \Delta \pi_t + \sum_{i=1}^{n} b_{12}^{i} \Delta \pi_{t-i} + \epsilon_t^{y} \qquad (4.27)$$

$$(1-L)\pi_t = \Delta \pi_t = \sum_{i=1}^{n} b_{21}^{i} \Delta y_{t-i} + b_{21}^{0}\, \Delta y_t + \sum_{i=1}^{n} b_{22}^{i} \Delta \pi_{t-i} + \epsilon_t^{\pi} \qquad (4.28)$$

Where ϵ_t^y and ϵ_t^π are innovation processes that include the respective shocks to aggregate supply and aggregate demand. It is assumed that shocks have zero mean and are uncorrelated and have unitary variance. The objective of this study is to check how much the structural shocks effect inflation and output over time. To assess these magnitudes vector moving averages (VMA) representation of VAR model is used, which give responses of the system to the shocks,

The VAM representation of VAR is given as:

$$(1-L)y_t = A_{11}(L)\epsilon_{t-i}^y + A_{12}(L)\epsilon_{t-i}^\pi = \sum_{i=0}^{\infty} a_{11}^i \epsilon_{t-i}^y + \sum_{i=0}^{\infty} a_{12}^i \epsilon_{t-i}^\pi \tag{4.29}$$

$$(1-L)\pi_t = A_{21}(L)\epsilon_{t-i}^y + A_{22}(L)\epsilon_{t-i}^\pi = \sum_{i=0}^{\infty} a_{21}^i \epsilon_{t-i}^y + \sum_{i=0}^{\infty} a_{22}^i \epsilon_{t-i}^\pi \tag{4.30}$$

The calculation of the *Sacrifice ratio (SR)* is based on the structural impulse response function from the equation (4.53) and (4.54). n× (n-1)/2 of identification rules is necessary when we move from the reduced model form VAR to the structural representation. It is assumed that $\mu_t$is the linear combination of ϵ_t. We also used additional identifying restriction for the model that aggregate demand shocks have no permanent effect on the level of output, following Blanchard and Quah (1989). Our additional identifying restriction for the model is that

$$\begin{bmatrix} e_y \\ e_\pi \end{bmatrix} = \begin{bmatrix} 1 & g_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_y \\ \mu_\pi \end{bmatrix} \tag{4.31}$$

Where e_y and e_π are the structural disturbances and μ_y and μ_π are the residuals in the reduced form equations.

The summation of the coefficients $A_{22}(L)$ measures the shocks of monetary policy on its level. The cumulative effect of output resulting from monetary policy shocks is shown as a function of the coefficients$A_{12}(L)$. The *Sacrifice ratio (SR)* over the time horizon (τ) is calculated as,

$$S(\tau) = \frac{\sum_{j=0}^{\tau}\left(\frac{\partial y_{t+j}}{\partial \in_t^{\pi}}\right)}{\left(\frac{\partial \pi_{t+\tau}}{\partial \in_t^{\pi}}\right)} = \frac{(\sum_{i=0}^{0} a_{12}^{i}) + (\sum_{i=0}^{1} a_{12}^{i}) + \ldots\ldots + (\sum_{i=0}^{\tau} a_{12}^{i})}{(\sum_{i=0}^{\tau} a_{22}^{i})}$$

$$= \frac{(\sum_{i=0}^{\tau}\sum_{j=0}^{i} a_{12}^{i})}{(\sum_{i=0}^{\tau} a_{22}^{i})} \qquad (4.32)$$

The output loss is measured in the numerator and the difference in the level of inflation is measured in the denominator.

4.3.5 New Philips Curve Methodology

The NKPC incorporates the assumption of nominal rigidities and imperfect competition and it is based on the rational expectation hypothesis and micro foundations which is absent from the traditional form. Moreover, the assumption of rational inflationary expectations makes the Phillips Curve forward looking, as inflation depends on the expected inflation and the output gap. Gali and Gertler (1999) specify the following form of NKPC.

$$\pi_t = \beta E_t \pi_{t+1} + \lambda y_t \qquad (4.33)$$

The lack of inertia leads to the idea that a credible anti-inflationary policy can reduce inflation without any output cost. This can be confirmed by solving forwardly, the NKPC equation as,

$$\pi_t = \alpha \sum_{i=0}^{\infty} \beta^i E_t y_{t+i} \qquad (4.34)$$

This shows that present level of inflation depends on the expected values of output gap. The historical knowledge tells that disinflations involve a considerable output loss [Ball (1994)]. To overcome this problem researchers have focused on the hybrid form of new and old Philips Curve as:

$$\pi_t = \lambda y_t + \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} \qquad (4.35)$$

This shows that current inflation rate depends on a combination of expected future inflation rate and lagged inflation rate. The lagged term explains the inflation persistence that is unexplained in the baseline model. Moreover, the inclusion of lagged term also implies that disinflations now have costly output reduction. Here the term λ shows the tradeoff between inflation and output or the cost of disinflation.

4.4 Inflation Forecasting

Forecasting inflation is an important input of monetary policy as the rate of inflation is considered to be the most vital objective of monetary policy. Monetary policy is more concerned with future inflation rather than current inflation levels because of the transmission lags. The literature on forecasting inflation has increased rapidly in recent years and lot of forecasting techniques have been introduced and applied to forecast inflation rate and most of the central banks switched to inflation targeting regime. On the other hand there has been much interest in the recent literature regarding the effects of different data vintages on model specification, forecast evaluation, and in the use of real time data in assessing predictability, as opposed to using final revised data, based on concerns that the use of final revised data may exaggerate the predictive power of explanatory variables relative to actually available data at that time (see, Orphanides (2001), Croushore and Stark (2001, 2003), Stark and Croushore (2002), and Orphanides and van Norden (2005)). Our main interest is how best to account for data revisions in a real time forecasting exercise as compared to the traditional approach defined as the values of all the observations from the latest available vintage of data and uses these to estimate the forecasting model. Hence this is known as the end-of-sample vintage approach (EOS). In this study we attempt to employ the NKPC, as a forecasting technique and compare it with time series models and the basic Philips curve model using the real time data and end of sample data.

4.4.1 Forecasting with Univariate Time Series Models

Different univariate and multivariate time series models for inflation forecasting are well appreciated in literature and these models like ARMA and ARIMA models are well accepted for being simple, parsimonious robust and for providing good results. The general form of the ARIMA (p,d,q) is given as:

$$Y_t = \emptyset_1 Y_{t-1} + \ldots\ldots\ldots + \emptyset_p Y_{t-p} + \theta_1 u_{t-1} + \ldots\ldots\ldots + \theta_q u_{t-q} + u_t \qquad (4.36)$$

ARIMA *(p,d,q)* models can only be based on time series data that are non-stationary. Here p is the lag length of AR, q is lag length of MA and d is the order of integration. This means that mean, variance and covariance of the series are constant over time. However most of the economic series show trend over time so mean of one year will be different from that of another year, which means series is non stationary. In order to avoid this problem we need to de-trend the data through the process of differencing. The first difference of a series is given by:

$$\Delta Y_t = Y_t - Y_{t-1} \qquad (4.37)$$

If after the first differencing the series is stationary then the series is also called integrated to order one and the model becomes an ARIMA model. If the series is not stationary after taking the first difference then same process of differencing is repeated until the series become stationary. If we difference a series d times in order to induce stationarity, the series is called integrated of the order d. Thus this is called ARIMA (p,d,q),with p being the number of AR terms, d being the order of integration and q being the number of MA terms. ARIMA (p,d,q) using back shift operator is written as:

$$\Delta^d Y_t\left(1 - \emptyset_1 L - \emptyset_2 L^2 - \ldots - \emptyset_p L^p\right) = \left(1 + \theta_1 L + \theta_2 L^2 + \cdots + \theta_q L^q\right) u_t \qquad (4.38)$$

Where $\left(1 - \emptyset_1 L - \emptyset_2 L^2 - \ldots - \emptyset_p L^p\right)$ is the autoregressive operator.

$\left(1+\theta_1 L+\theta_2 L^2+\cdots+\theta_q L^q\right)$ is the moving average operator

4.4.2 Forecasting from the Traditional Philips Curve

The Phillips curve is an important tool in current economic modeling. The original work by Fischer (1926), Phillips (1958) and Samuelson and Solow (1960) was focused on a statistical relationship between wages and the unemployment, and later on inflation-unemployment or inflation output relationship. Different forms of Phillips curves are used to forecast inflation and the results are mixed. According to Stock and Watson (1999) Phillips curve performs moderately well and Atkeson and Ohanian (2001) prove that they are outperformed by naive models. We also used a traditional Phillips Curve (PC) for inflation forecasting

$$\pi_t=\alpha+\beta\pi_{t-1}+\gamma y_t \tag{4.39}$$

y_t is the output gap in end of sample data and in real time data $y_t$is real time output gap and π_t is the final vintage inflation rate because inflation rate is not revised. One period ahead forecast from the Philips curve is written as:

$$E(\pi_{t+1})=\alpha+\beta\pi_t+\gamma y_{t+1} \tag{4.40}$$

In the same line the H period head forecast by Philips curve is written as:

$$E(\pi_{t+h})=\alpha+\beta\pi_{t+h-1}+\gamma y_{t+h} \tag{4.41}$$

4.4.3 Inflation Forecasting using New Philips Curve

There are two ways of inflation forecasting from the NKPC. The simple way would be to directly use the following equation to generate a forecast:

$$\pi_t = \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} + \lambda(mc_t) \qquad (4.42)$$

This requires data on expected inflation which is not available in terms of quality and length of time series. The other method of inflation forecasting is to use present value formulation of the NKPC, as Gali and Gertler (1999) used this method for calculating

$$\pi_t = \delta_1 \pi_{t-1} + \left(\frac{\lambda}{\delta_2 \gamma_f}\right) \sum_{s=0}^{\infty} \left(\frac{1}{\delta_2}\right)^s E_t[mc_{t+s}] \qquad (4.43)$$

Where $\delta_1 = \left(1 - \sqrt{1 - 4\gamma_f \gamma_b}\right) \big/ 2\gamma_f$ And $\delta_2 = \left(1 + \sqrt{1 - 4\gamma_f \gamma_b}\right) \big/ 2\gamma_f$ are the stable and unstable roots. The parameters $\gamma_{f,} \gamma_b$ and λ are the coefficients of the original NKPC equation.Marginal cost forecasting is calculated from a bi-variate VAR containing inflation and marginal cost following Campell and Shiller (1987). Fundamental inflation, π_t^* is calculated by applying summation formula,

$$\pi_t^* = \delta_1 \pi_{t-1} + \left(\frac{\lambda}{\delta_2 \gamma_f}\right) e_1' \left(1 - \frac{1}{\delta_2} A\right)^{-1} Z_t \qquad (4.44)$$

We use the fundamental inflation equation for forecasting used by Galí and Gertler (1999). The *h*-step ahead forecast of fundamental inflation is given as:

$$\hat{\pi}^*_{t+h} = \delta_1 \pi^*_{t+h-1} + \left(\frac{\lambda}{\delta_2 \gamma_f}\right) e'_1 \left(1 - \frac{1}{\delta_2} A\right)^{-1} A^h Z_t \qquad (4.45)$$

4.5 Econometric Techniques and Diagnostic Tests

The econometrics techniques and diagnostic test which are used for the estimation are discussed in this section. The H-P filter, linear trend and quadratic trend is used to measure output gap, GMM is used to estimate the *NKPC*, SVAR is used to calculate the sacrifice ratio and the Box Jenkins method is used to forecast inflation.

4.5.1 Linear Trend Method

The simplest way of estimating potential output through linear trend under the assumption that potential output grows at a constant rate and output gap is deviation of actual output from the fitted trend line. Potential output is estimated by estimating a regression of log of output on time trend with constant included. This approach decomposes the actual output into trend and cyclical components. The trend (potential) output is represented by

$$\hat{Y}_t = \beta_0 + \beta_1 t + \varepsilon_t \qquad (4.54)$$

and the cyclical component $c = Y - \hat{Y}_t$ which is a measure of output gap. The advantage of linear trend is that it is simplest approach to apply and its does not require a list of time series variables for estimating potential output rather it just needs GDP series.

4.5.2 Quadratic Trend Method

In the quadratic trend method the GDP is regressed on time and square of time with constant included which can be written as:

$$\hat{Y}_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t \qquad (4.55)$$

The difference between the linear trend method and the quadratic trend method is that former attempts to separate the series into permanent and cyclical components without looking into the observed behavior of output while latter is more flexible which fits the data well and therefore separates the structural and cyclical components that seems more realistic.

4.5.3 Hodrick-Prescott Filter

Another approach of finding output gap widely used is the Hodrick and Prescott (1997) Filter under the assumption that GDP growth, though not constant, is smooth over time. H-P Filter divides the GDP into two parts GDP* (potential or trend component) and C (Cyclical component).

$$GDP = \mathrm{GDP}* + \mathrm{C} \qquad (4.56)$$

Where GDP* is the sum of squares of its second difference which can be found by minimizing the following loss function:

$$Min\ L = \sum_{t=1}^{t} C_t^2 + \lambda(\Delta GDP_t^* - \Delta GDP_{t-1}^*)^2 \qquad (4.57)$$

$$= \sum_{t=1}^{t}(GDP_t - GDP_t^*)^2 + \lambda \sum_{t=2}^{t}[(GDP_t^* - GDP_{t-1}^*) - (GDP_{t-1}^* - GDP_{t-2}^*)]^2 \quad (4.58)$$

Lambda is set equal to 1600 for quarterly data, as used by Hodrick and Prescott (1997) and 400 and 100 is used for annual data.

The same exercise of the calculation of output gap by the liner time trend, Quadratic time trend and HP filter are also done at sector level.

4.5.4 Generalized Method of Moments (GMM)

A basic assumption of regression analysis is that the right-hand side variables are uncorrelated with the disturbance term. If this assumption is violated, OLS is biased and inconsistent. There are a number of situations where some of the right-hand side variables are correlated with disturbances. When the right-hand side variables are correlated with the errors, than the standard approach to estimate the equation is instrumental variables regression. The instrumental variables are a set of variables, known as instruments and these are correlated with the explanatory variables in the equation, and uncorrelated with the disturbances.

We use GMM to eliminate the effect of variable and error association. This method was introduced by Hansen (1982) and widely used for the analysis of economic and financial data.

Let X_t be a (k×1) vector of stationary variables and θ stand for a (a×1) unknown vector of coefficients and let K (θ, X_t) be a (b×1) vector of variables and coefficients.

$$E\ \{K\ (\theta, X_t)\} = 0 \qquad (4.46)$$

Let $Z_t = (x_t', x_{t-1}' \ldots \ldots . x_1')$ be a (Tk×1) vector including all the observations in a sample of size T, and let the (r×1) vector valued function g(θ; Z_t) show the sample average of K (θ, X_t),

$$g(\theta, Z_t) = \frac{1}{T}\sum_{t=1}^{T} K(\theta, X_t) \qquad (4.46)$$

The idea behind GMM is estimator $\widehat{\theta_t}$ is the value of θ that minimizes the scalar

$$\vartheta(\theta, Z_t) = [g(\theta, Z_t)]' W_t [g(\theta, Z_t)] \qquad (4.47)$$

Where $[W_t]_{T=1}^{x}$ is a (r×r) positive definite weighting matrices which is a function of the data $Z_{t.}$ Next we use the instrumental variable for GMM estimation and assume a linear model,

$$y_t = x_t'\beta + \mu \qquad (4.48)$$

Where, X_t is a (h×1) vector of explanatory variables. We assume that few explanatory variables are endogenous and E ($x_t.u_t$) ≠0. Let Z_t be a (r ×1) vector of instrumental variables that are highly correlated with X_t but uncorrelated with u_t . We used two periods' lag inflation, labour share, output gap, call money rate, wage inflation and CPI inflation instruments.

This means E ($z_t.u_t$) = 0 and the true value β_0 is assumed to satisfy the r orthogonality conditions

$$E[Z_t(y_t - x_t'\beta_0)] = 0 \qquad (4.49)$$

This is known as a special case of GMM framework in which moment conditions are equal to number of parameter estimated. In this case we have unique solution of the system and the model is called exactly identified. But the number of moment equations does not always have to be equal to the number of parameters we want to estimate. If we have more parameters than moment equations, the model is said to be under identified. In this condition we do not have sufficient information to find answer to the equation system.

If the number of moment equations exceeds the number of parameters, there is no unique solution to the system of equations. In this case the model is called over identified. So if we cannot set the sample moments equal to zero, we will try to find a vector of parameters $\widehat{\beta_0}$, so that the sample moments come as close to zero as possible. This is basic idea behind the generalized method of moments described earlier.

When the number of orthogonality conditions is greater than the number of parameters to be estimated, the model is over identified. *J-statistics* is used to verify whether the instrument variables which are used in the model are suitable. The Durbin-h test and LM test are used to test autocorrelation in the model.

4.5.5 Structural Vector Auto Regressive (SVAR)

The SVAR can be written as

$$B(L)\, y_t = U_t \qquad (4.50)$$

$B(L) = B_0 - B_1L - B_2L^2 - ...... - B_pL^p$ is autoregressive lag order polynomial. U_t is uncorrelated error term. The variance covariance matrix of the structural error term is normalized such as $E(u_t u_t') = \Sigma_u = I_k$

In order to allow estimation of the structural model we first need to derive its reduced form representation. This involves expressing y_t as a function of lagged y_t only. The reduced form representation is given as:

$$B_0^{-1}B_0y_t = B_0^{-1}B_1y_{t-1} + \ldots\ldots + B_0^{-1}B_py_{t-p} + B_0^{-1}u_t \qquad (4.51)$$

The same model can be represented as:

$$y_t = A_1\, y_{t-1} + \ldots\ldots + A_py_{t-p} + \varepsilon_t \qquad (4.52)$$

Where $A_i = B_0^{-1}B_i$, $i=1,\ldots..p$ and $\varepsilon_t = B_0^{-1}u_t$

Equivalently the model can be written more compactly as:

$$A(L)\, y_t = \varepsilon_t \qquad (4.53)$$

$A(L) = 1 - A_1L - A_2L^2 - ...... - A_pL^p$ denotes the autoregressive lag order polynomial.

The reduced-form innovations ε_t are in general a weighted average of the structural shocks u_t. The response of the vector y_t to reduced-form shocks ε_t will not tell us anything about the response of y_t to the structural shocks u_t. To learn about the structure of the economy, restrictions on selected elements of B_0^{-1} are imposed. $n\times (n-1)/2$ of identification rules is necessary when we move from the reduced model form VAR to the structural representation. As we are deriving the sacrifice ratio (how much output is changed due to one percentage change in inflation) using the SVAR, so we also assume that aggregate demand shocks have no permanent effect on the level of output following Blanchard and Quah (1989).

4.5.6 Box-Jenkins Methodology

The Box-Jenkins technique is used for identifying, estimating and forecasting autoregressive integrated moving average (ARIMA) models. The methodology involves three steps:

1. Model Identification.

2. Model Estimation.

3. Diagnostic checks on model competence followed by forecasting.

The details of these steps are given below.

4.5.6.1 Model Identification

The preliminary model identification is to calculate the autocorrelations functions (ACF) and partial autocorrelations functions (PACF) and check the stationary of the series. If the series is not stationary than take the logarithm and first difference of the raw data. After making the series stationary check again the ACF and PACF of the series. Next inspect the graphs of the ACF and PACF carefully and determine which models can be estimated. This leads to a tentative identification.

4.5.6.2 Model Estimation

Once the values of *p*, *d*, and *q* are guessed, coefficients of the model are ready to estimate. This program follows the maximum likelihood estimation process outlined in Box-Jenkins (1976). The maximum likelihood equation is solved by nonlinear function maximization. Back casting is used to get estimates of the initial residuals.

4.5.6.3 Diagnostic Checking

Once a model has been fit, the final step is the diagnostic checking of the model. The checking is carried out by studying the autocorrelation plots of the residuals of the different estimated models. By checking their significance and insignificance and then verifying the AIC, SBC with the Adjusted R square of the different estimated models and choose the parsimonious one and the model is parsimonious which minimizes the AIC and SBC and has the highest adjusted R square.

4.5.6.4 Forecasting Evaluation Techniques

After the diagnostics of the different models, the best one is choose and the final step is to forecast from this model. Let the actual and forecasted value in period t is y_t and $\hat{y}_t$ respectively. The forecast evaluation statistics are reported in the table 4.1.

The RMSE is used as relative measures to compare forecasts for the same series across different models, the smaller the error, the better the forecasting ability of that model.

Table 4.1 Forecast Evaluation Techniques

Forecast Evaluation techniques	Formulas
Root mean squared error (RMSE)	$\sqrt{\sum_{i=1}^{n}(y_t - \hat{y}_t)^2/n}$

4.6 Variables used and the Data Sources

The annual data ranging from 1971 to 2011 are obtained from the Pakistan Economic Survey and Annual Report of the State Bank of Pakistan. The data is collected on the following variables: Inflation is measured as percentage change in GDP deflator as well as the percentage change in CPI at aggregate level, is obtained from the Pakistan Economic Survey. GDP deflator is calculated as the ratio of the nominal and real product. Data on the real GDP at factor cost and market prices adjusted in millions of national currency are also taken from the Pakistan Economic Survey. As described earlier that this study also undertakes analysis at the disaggregated level also, data for the agriculture, manufacturing, and the services sector. Data for the agriculture sector comprises of major crops, minor crops, livestock, fishing and forestry. Manufacturing sector data includes large scale manufacturing, small scale manufacturing, mining and quarrying, and the services sector comprises of construction services, electricity and gas distribution services, transport, storage and communication, whole sale and retail trade, banking and insurance, ownership of dwelling, public administration, defense, and other services. All the sector based data are taken from the Pakistan economic Survey.

Inflation is measured as percentage change in GDP deflator in different sectors. Data on GDP deflator is corrected for rebasing of GDP in 1999-2000.Output gap is measured by three ways as linear trend method; quadratic trend method and H-P filter method .The detail of these methods are given in section 3.5.

The Gross Domestic Product (GDP) and the output gap are among the most important variables that police makers take into account when making decisions particular, monetary policy. GDP is the major information on the economic activity, and the output gap is a key concept in monetary policy decisions as it allows us to infer about the actual versus potential economic growth. However, the recent literature on real-time data has shown the presence of important revisions in the GDP and the output gap data. Croshoure and Stark (2000, 2001) organized a real-time data set for the U.S. GDP/GNP, and found relevant growth revisions. Orphanides and Norden (2002) constructed several historical series for the output gap using real-time data for the U.S. and estimated many revision indicators.

In this study, we organize a real-time data set for Pakistan's GDP. The data set containing the GDP data releases between 1971 and 2011. Using this data set, we investigate the behavior of the revisions of GDP and output gap estimates, obtained using three methods: Hodrick-Prescott (HP) filter, linear trend (LT), quadratic trend (QT).

Wage inflation is the annual percentage change in nominal wage. The call money rate is taken from the Annual Report and Monthly Statistical Bulletins. of the State Bank of Pakistan (various issues) For the calculation of the sacrifice ratio using Ball and Zhang methods, we calculate the three year inflation moving average variable at aggregate level as well as different sectors level.

Different vintages of data from different issues of Economic Survey of Pakistan are explained by the Table 4.2.

<u>Table 4.2 Calculation of Real Time GDP Data</u>

Data to which Data Pertain	Data release Date i=1973	i=1974	i=1975	i=1976	………	i=2010	i=2011
J=1963	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
.	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
.	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
.	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
.	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
J=1973	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
J=1974		$Y_i(j)$	$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
J=1975			$Y_i(j)$	$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
J=1976				$Y_i(j)$		$Y_i(j)$	$Y_i(j)$
.						$Y_i(j)$	$Y_i(j)$
.						$Y_i(j)$	$Y_i(j)$
.						$Y_i(j)$	$Y_i(j)$
.						$Y_i(j)$	$Y_i(j)$
.						$Y_i(j)$	$Y_i(j)$
J=2010						$Y_i(j)$	$Y_i(j)$
J=2011							$Y_i(j)$

The entries in the Table are represented by $Y_i(j)$ where the subscript i represents the time or year at which data has been released and (j) in parentheses refers to the data pertaining to period. The diagonal elements at the end of each column represent the provisional data or first release or preliminary data. While the element just above the diagonal of each column represents the revised data and the element above that is the final data of the corresponding year.

4.7 Concluding Remarks

In this chapter we discussed the theoretical framework of NKPC and we estimate the reduced NKPC, sacrifice ratio and inflation forecasting. We also explained the different econometric techniques used for estimation. The construction of real time and end of sample data is also discussed in this chapter.

AGGREGATE ANALYSIS OF THE SACRIFICE RATIO

5.1 Introduction

There is a general consensus among economists that inflation is bad, but there is no agreement on how bad it is. While some maintain that inflation is the main evil and, that monetary reforms should be carried out to eliminate it, others argue that reducing inflation would lessen output and employment, and the cost of the output loss would be more than the gains from price stability. Yet another group believes that the costs of inflation are small anyway, and could be managed by other sources. In this study we therefore attempt to estimate the cost of disinflation for Pakistan.

The estimates of the costs of disinflationary policies or the SR is defined as the costs in terms of output loss that must be faced to attain a fall in inflation. The details of different methodologies of estimating sacrifice ratio have been described in chapter 4, in this chapter we present the results of sacrifice ratio in Pakistan by using those different techniques at aggregate level.

This chapter is divided into four sections. In the first section we give an introduction of the chapter and in the second section we give the results of NKPC for the aggregate data. Section 3 give the estimated results of sacrifice ratio using aggregate data and in the final section we gave concluding remarks of the chapter.

5.2 Aggregate Sacrifice Ratio in Pakistan

In this section we give the estimation results of the aggregate sacrifice ratio for different episode using different techniques like Ball and Zhang methods. We also estimate the time invariant sacrifice ratio using Philips curve, structural VAR and finally with NKPC.

5.2.1 Inflation Episode Specific sacrifice ratio

The idea of case by case or episode specific sacrifice ratio was developed by Ball (1994). In this method first the disinflation periods are identified and then sacrifice ratios are estimated. This method overcomes the criticism of constant sacrifice ratio over all the time period which is the implicit assumption in estimating the sacrifice ratio by Philips curve method. Ball's methodology is further extended by Zhang (2001) who introduced the concept of persistence effect in sacrifice ratio.

The first step in episode specific sacrifice ratio method is to identify the different disinflationary episodes - episodes in which trend inflation falls considerably. So first we identify the disinflationary episodes on the basis of fall in trend inflation which is calculated by the three years moving average of inflation series of annual data. The details of construction of the disinflationary episodes are given in chapter 4.The details of the constructed disinflationary episodes is shown in the Table 5.1.We found three disinflation episodes in the data and the length of time periods of disinflation range between 4 to 7 years in both CPI based inflation rate and GDP deflator based inflation rate. The maximum decline in inflation is 14.08 in case of CPI and 12.09 in case of GDP deflator.

Table 5.1 Disinflationary Episodes

	Based on CPI			**Based on GDP deflator**		
	Episode1	**Episode 2**	**Episode 3**	**Episode 1**	**Episode 2**	**Episode 3**
Start	1974	1980	1995	1973	1980	1995
End	1978	1985	2002	1978	1985	2002
Duration	4 years	5 years	7 years	5 years	5 years	7 years
Decline in inflation rate	14.08	6.84	8.13	12.09	6.13	7.68

5.2.1.1.Results based on Ball's Method

We use GDP at factor cost as well as GDP at market price along with the two measures of inflation rate by CPI and GDP deflator for the robustness of the results. The results of sacrifice ratio measured by the CPI inflation rate are in Table 5.2

Output loss is measured by two methods for comparison purpose. HP Filter and Peak to peak method are used to calculate the output loss. The results support each other. Episode 1 and episode 3 indicate the positive sacrifice ratio. In these episodes one percent falls in inflation leads to 0.24 and 0.13 percent output loss in first disinflation episode and 0.53 and 0.72 percent output loss in third episode using GDP at factor cost and market price respectively.

Table 5.2 Sacrifice Ratio Using CPI Based Inflation Rate (Ball's Method)

Disinflation Episodes	Inflation Decline	Output loss using GDP(FC)		Sacrifice ratio	
		HP filter	**Peak to peak Method**	**HP filter**	**Peak to peak Method**
Episode 1	14.08	7.12	3.43	0.51	0.24
Episode 2	6.84	-0.65	-0.31	-0.10	-0.05
Episode 3	8.13	13.05	4.36	1.61	0.53
		Output loss using *GDP*(MP)			
Episode 1	14.08	5.03	1.84	0.36	0.13
Episode 2	6.84	-0.79	-0.23	-0.11	-0.03
Episode 3	8.13	11.42	5.86	1.40	0.72

It is usually believed that economic growth can take place in the presence of political stability but in case of Pakistan this conventional wisdom is contradicted .This is also shown in episode 2 which is the military regime. Sacrifice ratio is negative in case of episode 2. The negative sacrifice ratio means that growth rate of GDP did not decline. The growth rate of the GDP in 1980's remained at 7.1% on average and the inflation rate remained at 7.6% on average as compared to 12.2% in 1970s.The estimated results of sacrifice ratio using GDP deflator are given in Table 5.3. The results are almost similar to the CPI case. Episode 1 and episode 3 have positive sacrifice ratio while the episode 2 experienced negative sacrifice ratio and the magnitudes of the sacrifice ratio are almost similar.

Table 5.3 Sacrifice Ratio Using GDP Deflator based inflation (Ball's Method)

Disinflation Episodes	Inflation Decline	Output loss using GDP(FC)		Sacrifice ratio	
		HP filter	Ball method	HP filter	Ball method
Episode 1	12.09	8.51	3.93	0.70	0.32
Episode 2	6.13	-0.65	-0.31	-0.11	-0.05
Episode 3	7.68	13.06	4.37	1.70	0.57
		Output loss using GDP(MP)			
Episode 1	12.09	4.57	4.32	0.37	0.36
Episode 2	6.13	-0.79	-0.23	-0.12	-0.04
Episode 3	7.68	11.42	5.87	1.49	0.76

5.2.1.2 Zhang's Method

The most critical issue for the estimation of the sacrifice ratio is the calculation of trend output, as minor change in fitted output makes large differences in sacrifice ratios. Zhang's method includes the possible persistence effect. This method makes flexible assumption about output that it can return to its potential at any time after the trough. The size of the sacrifice ratio measured by Zhang method is greater than that of the Ball's method. The results confirm that episode 1 and episode 3 have positive sacrifice ratio while the episode 2 has still negative sacrifice ratio. Along with the signs of the sacrifice ratio it also confirms that the size of the sacrifice ratio measured by the Zhang's technique is larger than the size estimated by Ball's method

Table 5.4 Sacrifice Ratio Using CPI Based Inflation Rate (Zhang's method)

Disinflation Episodes	Inflation Decline	Output loss using GDP(FC)	Sacrifice Ratio
Episode 1	14.08	10.949	0.778
Episode 2	6.84	-6.759	-0.988
Episode 3	8.13	28.621	3.519
		Output loss using GDP(MP)	
Episode 1	14.08	2.378	0.169
Episode 2	6.84	-0.153	-0.022
Episode 3	8.13	35.31	4.34

The sacrifice ratios calculated by the GDP at factor price and at market price have also similar results in both cases of inflation rate calculated by GDP deflator and CPI. The results of the sacrifice ratio calculated using CPI based inflation rate and GDP deflator based inflation rate are given in Table 5.4 and Table 5.5 respectively.

Table 5.5 Sacrifice Ratio Using GDP Deflator Based Inflation Rate (Zhang's Method)

Disinflation Episodes	Inflation decline	Output loss using GDP(FC)	Sacrifice Ratio
Episode 1	12.09	17.670	1.461
Episode 2	6.13	-6.759	-0.988
Episode 3	7.67	28.62	3.519
		Output loss using GDP(MP)	
Episode 1	12.09	11.099	0.918
Episode 2	6.13	-0.153	-0.025
Episode 3	7.67	35.31	4.340

The results of sacrifice ratio by Ball and Zhang methods support each other and confirm that during the period of 70's economy fell into recession; separation of East Pakistan, nationalization of industrial financial and other institutions adversely affected the output and this is also explained by the disinflationary episode 1. The disinflationary episode 2 shows that economy moves to the recovery stage but the process of recovery is slow. It also shows that there is no clear cut trade-off between inflation and output rather both output and inflation rate are high. The disinflationary episode 3 again lies in the period of recession. In this period inflation was in double digits, and economy was facing poor economic growth, implying a trade-off between inflation and economic growth.

5.2.2 Time Invariant Sacrifice Ratio

The time invariant methods was pioneered by Okun (1978) who evaluated Phillips curve model to estimate the cost of disinflation in terms of the percentage loss of output during a given period. Gordon and King (1982) derived the sacrifice ratio using both traditional and Vector Autoregressive (VAR) models. Cecchetti and Rich (2001) get estimates of the sacrifice ratio utilizing Structural Vector Auto regressions (SVAR), identifying aggregate demand and aggregate supply shocks. In this study we add Hybrid New Keynesian Philips Curve (HNKPC) for the estimation of the sacrifice ratio. The results of sacrifice ratio estimated by these methods are given below in detail.

5.2.2.1. Results Based on Philips curve Method

For the calculation of sacrifice ratio, first we estimated the Philips curve using output gap as a proxy of real economic activity. Output gap is measured by three methods namely the linear trend output, Quadratic trend output and by HP Filter. The detail of the output gap measured by these three methods is explained in chapter 4. The output gap measured by quadratic time trend and HP Filter is preferred to the output gap measured by the linear trend because it follows the pattern of the Pakistan business cycle , as mentioned by Arby (2001). The results of sacrifice ratio estimated by PC at aggregate level are given in Table 5.6 and the values in the parenthesis are the p values. The PC is estimated using GMM and we also apply the Durbin-h test for autocorrelation and found no autocorrelation in the model.

Table 5.6 Sacrifice Ratio by PC

Output gap Methods	Philips curve	Sacrifice Ratio	Durbin-h test
Quadratic Trend	$\pi_t = 0.06Y_t + 0.54\pi_{t-1}$ (0.091) (0.073)	0.13	1.80*
HP filter	$\pi_t = 0.67Y_t + 0.54\pi_{t-1}$ (0.053) (0.044)	1.46	1.76*

* Tabulated value of $Z_{0.95} = 1.96$

The output gap measured by linear trend is statistically insignificant which means that this variable has no economic meaning.. The sacrifice ratio measured by the PC followed the Ball' method and these results are also validating the sacrifice ratio estimates for India ranging from 0.3 to 4.7 by Kapur and Patra (2000).

5.2.2.2 Results based on Structural VAR

Ball and Zhang's methodology does not consider the effects of monetary policy shocks into the calculation of the sacrifice ratio. To see the effect of monetary shocks Cecchetti's (1994) structural VAR modelling approach seem more suitable.

We use annual data on output and inflation rate. Output is measured by real GDP and inflation is measured by the CPI. GDP data have been converted into logarithms. Initially stationarity analysis of the series (through correlogram, Augmented Dickey-Fuller (ADF) and Phillips-Perron tests) suggests that real output and CPI are both I (1) processes i.e., real output and inflation rate both contain a unit root.The unit root in the output process allows the long run restriction on the effects of aggregate demand shocks to be well defined and meaningful, while the evidence of a unit root in the inflation process allows for permanent shifts in its level.

The next step in our estimation procedure requires choosing the optimal lag length in VAR model. For this selection, we use information criteria like Akaike and Schwarz information criteria and likelihood ratio tests. The criteria used suggest that two lags are to be taken for this model. The estimated VAR model is as

$$\Delta y_t = 0.04 + 0.12\Delta y_{t-1} + 0.25\Delta y_{t-2} - 0.01\Delta\pi_{t-1} - 0.11\Delta\pi_{t-2} \quad (5.1)$$

$$\Delta\pi_t = 0.05 + 0.30\Delta y_{t-1} - 0.31\Delta y_{t-2} + 0.74\Delta\pi_{t-1} - 0.24\Delta\pi_{t-2} \quad (5.2)$$

After estimating the VAR model we precede to the identification of the supply and demand shocks from the VMA representation. The detail of all these restrictions is discussed in the chapter 4 in the theoretical framework. Structural shocks are not directly measureable so these are calculated using additional identifying restrictions of Blanchard-Quah (1989). The demand shock have no long run impact on the level of real output. Following Cecchetti and Rich (2001) the final estimated form of the sacrifice ratio is given as:

$$S(\tau) = \frac{\sum_{j=0}^{\tau}(\frac{\partial y_{t+j}}{\partial \epsilon_t^{\pi}})}{(\frac{\partial \pi_{t+\tau}}{\partial \epsilon_t^{\pi}})} = \frac{(\sum_{i=0}^{\tau} \sum_{j=0}^{i} a_{12}^{i})}{(\sum_{i=0}^{\tau} a_{22}^{i})} \quad (5.\ 3)$$

Where τ is the time limit for the calculation of the effects of shockϵ_t^{π}. For annual data 5 years are used for the calculation of the effect of shock in economic literature. Sacrifice ratio is interpreted as the ratio of cumulative output loss due to one percentage point decrease in inflation. The estimated results of Sacrifice ratio calculated by the SVAR are given in the Table 5.7

Table 5.7 Sacrifice Ratio using SVAR

$\boldsymbol{\tau}$	5
Sacrifice Ratio	0.53

5.2.2.3 Results Based on New Keynesian Philips Curve

To obtain the results of the NKPC, we estimated the equation using the GMM approach. Gali and Gertler (1999) were the first who used labor's share of income as their proxy for real marginal cost and claim its empirical success. They find that real marginal cost is an important determinant of inflation. Since then many others have tested the NKPC with the labour share, and there results also suggest that the model performs well using this variable. However, Rudd and Whelan (2007) have opposed this and questioned using a NKPC with the labor income share. They correctly point out that the labor share represents average cost and not marginal cost. Furthermore, they also provide empirical evidence that labor income share displays counter-cyclical movements in periods of economic recession. The output gap, on the other hand, is pro-cyclical with recessions, which implies that the output gap decreases in periods of economic recession and, as a result, it is a better proxy than labor income share to describe real economic activity.

Rudd and Whelan (2005,2006) use both labor share of income and output gap as proxies of real economic activity and conclude that NKPC is empirically poor fitted to the US data. Labor income share does not turn out to be a valid proxy for real economic activity and the data also does not support the dominant role of future inflation against the lagged inflation, as reported in the Gali and Gertler (1999).

Following the pattern of Rudd and Whelan (2005, 2006), we use the output gap as a proxy of real economic activity. In this case we estimate the output gap by three different methods: Linear trend output; Quadratic trend output and HP filtered output. The output gaps by these three different methods are shown in figures 5.1 to 5.3.

Figure 5.1 highlights the sustained negative output gap in two periods 1971 to 1981 and 1998 to 2011.From 1981 to 1997 the output gap is positive.

Figure 5.1 Output Gap (%) Based On Liner Time Trend (1971 to 2011)

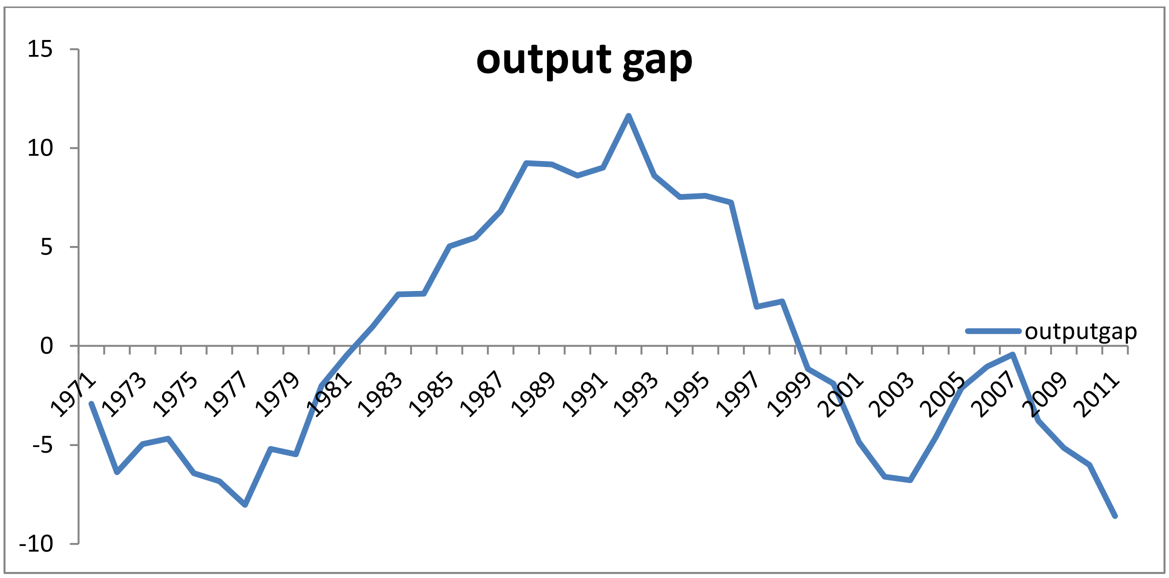


Figure 5.2 shows that potential output obtained by the quadratic trend method is very near to actual output. The actual output is above the potential output in the time period of 1981 to 1996 and 2005 to 2009. This shows that there is excess demand in this time period.

Figure 5.3 shows that potential output obtained by the HP filter traces nearly perfect actual output. The figure shows that during the period of 1985 to 1996 and 2006 to 2011 there is excess demand in the economy because the actual output is greater than the potential output.

Figure 5.2 Output Gap (%) Based On Quadratic Time Trend (1971 to 2011)

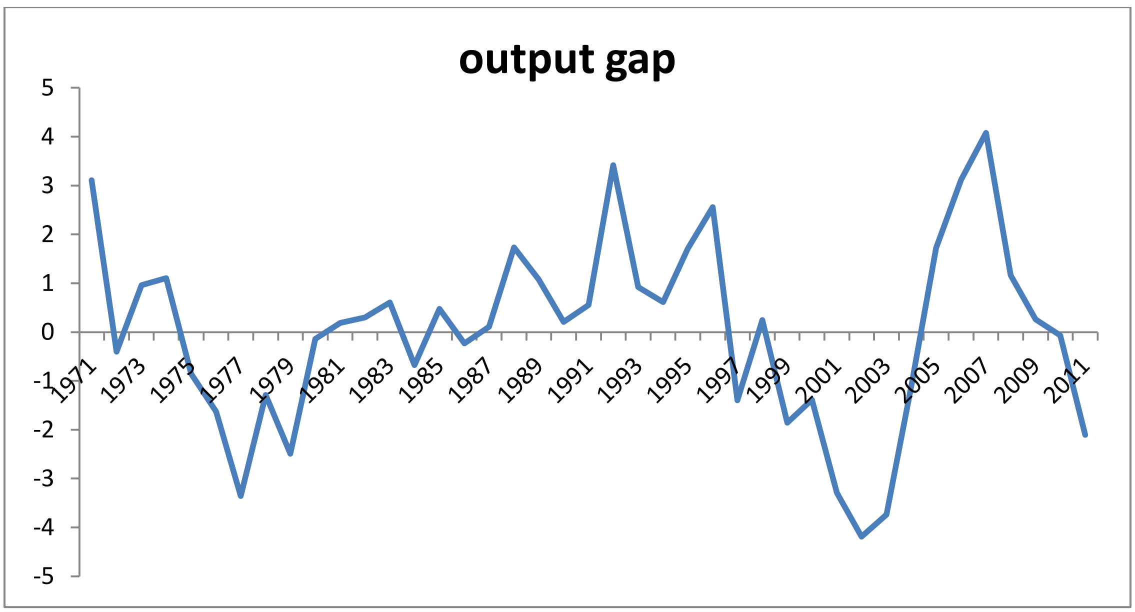
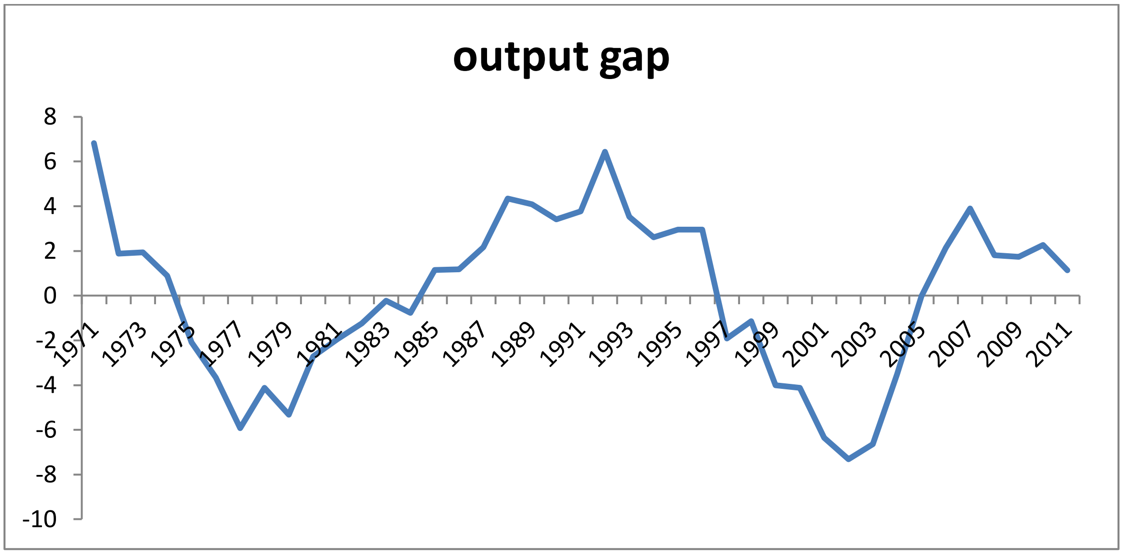


Figure 5.3 Output Gap (%) Based On Hodrick Prescott Filter (1971 to 2011)



It also shows that output gaps is positive between 1971 to 1975, 1985 to 1997 and 2005 2011.In contrast the reaming periods were dominated by the negative output gap, telling excess capacity in the economy.

Now we estimate the NKPC equation using different proxies of output gap as driving force of inflation. We prefer the output gap measured by the Quadratic time trend and HP Filter method to the linear time trend method because these follow the business cycle pattern of the Pakistan economy [see Arby (2001) and Noman (2011)]. Estimated results are given in table 5.8

Table 5.8 NKPC Results (Aggregate)

	Output Gap	Exp Inflation	j-stat	LM test
Current inflation π_t	0.163 (1.28)	1.09 (20.69)	5.11 (0.925)	2.55*
Current inflation π_t	0.196 (1.58)	1.02 (20.28)	4.63 (0.947)	3.54*
Current inflation π_t	0.381 (1.13)	1.01 (27.19)	5.10 (0.926)	2.10*

* Tabulated value of $\chi^2_{(0.95,1)} = 3.84$

The GMM is used for the estimation of the NKPC. We used first and second lag of inflation, labor share, output gap, call money rate, wage inflation and CPI inflation as instruments. The results show that coefficient associated with the future inflation is positive and highly significant in all the three cases while the coefficient of output gap has a positive sign but is statistically insignificant in all cases (t statistics are given in parentheses). The diagnostic tests validate the models, as j-stats shows the instruments are valid in all the cases (P values are given in parentheses) and the LM test statistics show that there is no autocorrelation problem at first lag as the calculated value of chi square (2.55) is less than the tabulated value(3.84).

5.2.2.3 New Keynesian Hybrid Philips Curve

The main flaw of the NKPC is that, a credible anti-inflationary policy can reduce inflation without any output cost.

This can be confirmed by solving forwardly, The NKPC equation becomes,

$$\pi_t = \alpha \sum_{i=0}^{\infty} \beta^i E_t y_{t+i} \qquad (5.3)$$

This shows that present level of inflation depends on the expected values of output gap. The historical knowledge tells that disinflations involve a considerable output loss [Ball (1994)]. To overcome this problem researchers have focused on the hybrid form of new and old Philips curves, as

$$\pi_t = \lambda y_t + \gamma_f E_t(\pi_{t+1}) + \gamma_b \pi_{t-1} \qquad (5.4)$$

This shows that inflation depends on a combination of expected future inflation and lagged inflation. The lag term explains the inflation persistence that is unexplained in the baseline model. Furthermore, the inclusion of lag term also implies that disinflations now have costly output reduction. Here the term λ shows the trade-off between inflation and output or the cost of disinflation.

The reduced hybrid *NKPC is* estimated by GMM using different measures of output gap are given in the table 5.9 (t statistics are given in parentheses).Two periods' lag inflation, labour share, output gap, call money rate, wage inflation and CPI inflation are used as instruments.

Table 5.9 Hybrid NKPC Results (aggregate)

	Output Gap	Exp Inflation	Past Inflation	j-stat	Durbin-h Test
Current inflation π_t	0.192 (1.33)	0.36 (2.60)	0.64 (5.35)	7.34 (0.118)	1.36*
Current inflation π_t	0.819 (2.06)	0.33 (2.06)	0.68 (5.61)	6.36 (0.173)	1.15*
Current inflation π_t	0.106 (2.24)	0.56 (4.15)	0.44 (3.96)	6.32 (0.182)	1.54*

* Tabulated value of $Z_{0.95} = 1.96$

The results are quite similar to the reduced NKPC results. The signs of expected future inflation and the past inflation are positive and highly significant. The nature of the results are mixed, in some cases the forward looking inflation overcome the past inflation while in other cases coefficient of past inflation is greater than the future inflation. So this shows that the both lag and lead inflation are important in the determination of current inflation. This mean that inflation is mostly driven by its own past and policy actions might affect inflation with a long time lag. The sign of output gap is according to the theory and statistically significant in two cases and insignificant in one case.

The diagnostic of the models indicate that the hybrid NKPC has no autocorrelation problem because calculated values of Durbin-h are less than the tabulated value of $Z_{0.95} = 1.96$. The J-stats point out that instruments are valid (p values of the diagnostics tests are given in parentheses).

The results of reduced NKPC and reduced hybrid NKPC show that output gap plays significant role in hybrid form and nature of inflation expectation are mixed, both lag inflation and lead inflation are important in inflation determination. As we are interested in measuring sacrifice ratio using hybrid NKPC so this is measured by using the following equation

$$\pi_t = \underset{(2.06)}{0.819} Y_t + \underset{(2.06)}{0.33} E_t(\pi_{t+1}) + \underset{(5.61)}{0.68} \pi_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.5)$$

This means, one percent point fall in inflation rate results into 1.22 percent reduction of output. The magnitude of sacrifice ratio according to the Ryder (2007) is 2.5 for Australia. The highest value of Sacrifice ratio calculated by episode specific method is 4.30 and sacrifice ratio by Philips curve, SVAR are 1.46 and 0.53 respectively.

5.3 Concluding Remarks

In this chapter we calculated the sacrifice ratios using different methodologies at aggregate level. Basically the sacrifice ratio is divided into two main categories like time invariant sacrifice ratio and the episode specific sacrifice ratio. Time invariant sacrifice ratio indicates that sacrifice ratio is positive at aggregate level. In time invariant we also used Hybrid NKPC shows mix type of results

In episode specific sacrifice ratio method; we calculate different disinflationary episodes and calculate the sacrifice ratio in different time periods. We found two positive sacrifice ratios during 1974 to 1978 and 1995 to 2002. Sacrifice ratio is negative in one episode from 1980 to 1985.In this phase monetary policy is contractionary and Negative sacrifice ratio shows that reducing inflation rate has no output loss.

DISAGGREGATE ANALYSIS OF THE SACRIFICE RATIO

6.1 Introduction

The importance of using the disaggregate data in NKPC is explained by Lawless and Whelan (2007) as NKPC is based on micro foundation, so it is more appropriate to apply to the individual firms and sectors as well as to the aggregate data. This would be an important robustness check. Disaggregated data differentiates the degree of price stickiness. Bils and Klenow (2004) found that price stickiness varies systematically across sectors; for example service sector have more sticky prices than the manufacturing sector. Calvo (1983) explains that changes in sectoral compositions of output worsen the aggregate results. For example, changes in government policy affects output composition differently in different sectors. To check the heterogeneity of the data we disaggregate the economy into three sectors; the agriculture sector, manufacturing sector and the services sector. In this chapter we test that whether the sectoral level analysis of inflation dynamics confirms the aggregate pattern or not?

This chapter is divided into five sections: after the introduction the results of sacrifice ratios in the agriculture, manufacturing and the services sector are presented in sections 6.2, 6.3 and 6.4 respectively. Concluding remarks are given in the last section.

6.2 Sacrifice ratio in Agriculture Sector

6.2.1 Episode Specific Sacrifice Ratio

First we calculate the inflation rate in agriculture sector using output deflator and after computing the inflation rate, we identify different disinflationary episodes based on three years moving average of inflation rate and then on the basis of these episodes we calculate the sacrifice ratio using inflation rate calculated by the GDP deflator. The details of different episodes are given in sections 6.2, 6.3 and 6.4 respectively.

Table 6.1.which shows three disinflationary episodes, the duration of the episodes ranges from 4 to 5 years. The range of decline in inflation rate is 8 to 13 percent.

Table 6.1 Disinflationary Episode in Agriculture Sector

	Episode 1	**Episode 2**	**Episode 3**
Start	1973	1980	1997
End	1978	1985	2001
Duration	5 years	5 years	4 years
Decline in inflation rate	13.929	11.650	8.283

The calculation of sacrifice ratio using Ball and Zhang methods are presented in table 6.2. The estimated results show that all the episodes have positive sacrifice ratio in both Ball and Zhang methods. The size of the sacrifice ratio calculated by Zhang's method is greater than that measured by the Ball's method. Episode 2 has small sacrifice ratio as compared to the other episodes. The sacrifice ratio in different episodes shows that output losses exist while reducing inflation rate. During the seventies Pakistan's economy was adversely affected both domestic and external crises.. During 1977–88, agricultural growth rate was 4% per annum compared to 2 % during 1972–77. Agricultural production during this period was facilitated by expansion of irrigation water supplies from Tarbela and the increase in the domestic production and use of fertilizers. The extraordinary growth in cotton yield during the 1980s and early 1990s also continued to sustain agricultural growth, which remained at 4.5% per annum during 1988–96.

Table 6.2 Sacrifice Ratios in Agriculture Sector

Disinflation Episodes	**Inflation Decline**	**Output loss**		**Sacrifice ratio**	
		Ball	**Zhang**	**Ball**	**Zhang**
Episode 1	13.929	5.572	16.359	0.400	1.174
Episode 2	11.650	1.806	2.319	0.155	0.199
Episode 3	8.283	3.485	14.982	0.421	1.808

6.2.2 Time invariant sacrifice ratio

Time invariant sacrifice ratios are based on those methods in which single value of sacrifice ratio is calculated namely Philips curve model, traditional and structural VAR and the hybrid new Keynesian Philips curve method.

6.2.2.1 Sacrifice ratio Based on Philips curve Method

The Philips curve in agriculture sector is estimated using GMM and we also apply Durbin-h for autocorrelation .No autocorrelation is found in the model. The estimated results of the Philips Curve is given in Table 6.3

Table 6.3 Sacrifice ratio in Agriculture Sector Using PC

Sectors	**Philips Curve**	**Sacrifice ratio**	**Durbin-h Test**
Agriculture Sector	$\pi_t = 0.25Y_t + 0.13\pi_{t-1}$ (0.00) (0.04)	0.29	1.54*

6.2.2.2 Results Based on Structural VAR

We use annual data on output and inflation rate. Output is measured by real GDP and inflation is measured by the GDP deflator in agriculture sector. GDP data have been converted into logarithms. Initially stationarity analysis of the series based on correlogram, Augmented Dickey-Fuller (ADF) and Phillips-Perron test suggests that real output and inflation rate are both I(1) processes means real output and inflation rate both contain a unit root. The next step in our estimation procedure requires choosing the optimal lag length in VAR model. For this selection, we use information criteria like Akaike and Schwarz criteria and likelihood ratio tests etc. The criteria suggest three lags are to be taken for agriculture sector VAR model. The restriction that demand shock have no long run impact on the level of real output following the Cecchetti and Rich (1999) is used and the calculated value of the sacrifice ratio is given in the Table 6.4

Table 6.4 SVAR Sacrifice ratio

	Agriculture Sector
τ	5
Sacrifice Ratio	0.038

We take the time duration of monetary effect of 5 years which is acceptable and mostly used in the literature for annual time series data.

6.2.2.3 New Keynesian Philips Curve

First we estimated the NKPC and the hybrid NKPC using output gap as a proxy of really economic activity. Then we estimated the sacrifice ratio using Hybrid NKPC .Output gap is measured by three methods namely linear trend method, quadratic trend method and HP-filter method. The graphs of output gap in percent using these three methods are given as,

Figure 6.1 Output gap (%) based on Liner Time Trend (Agriculture sector)

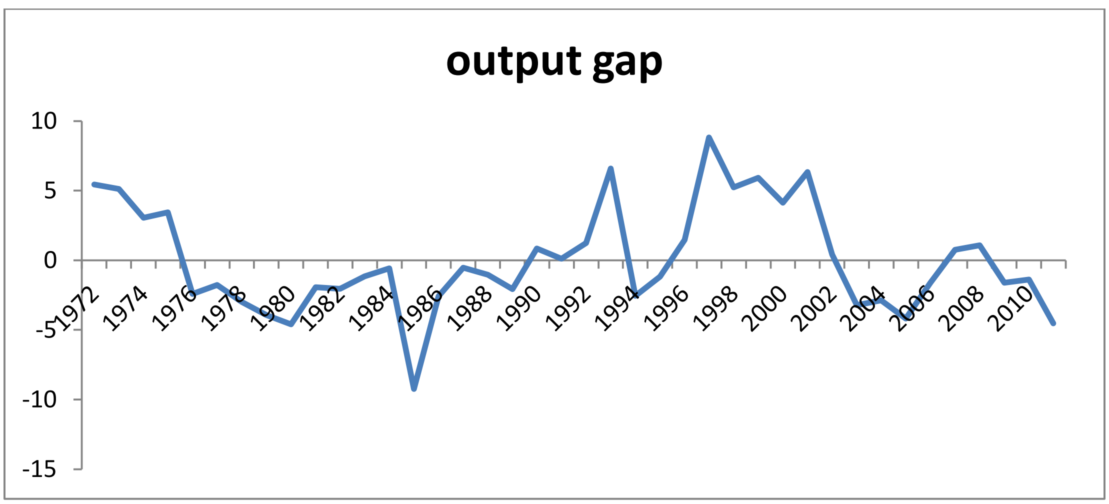
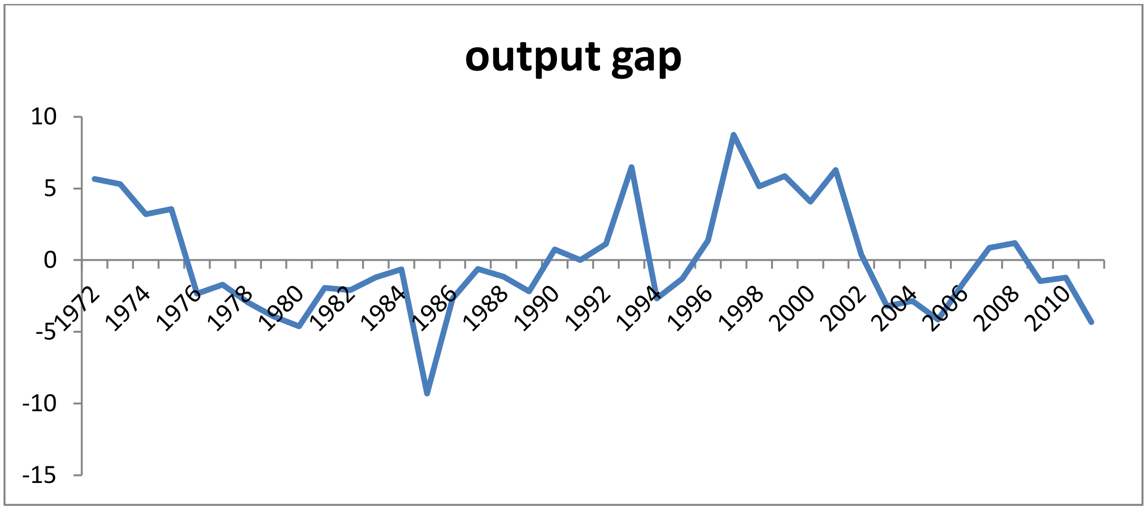


Figure 6.1 shows that the potential output is above than actual output in the time period of 1976 to 1989, 2003 to 2007 and 2009 to 2011.In these periods output gaps are negative while in the remaining time periods output gaps are positive.

Figure 6.2 <u>Output Gap (%) Based on QuadraticTime trend (Agriculture sector)</u>



The pattern of the movements of actual and potential output is approximately same as it is in linear trend method.

The growth performance of agriculture sector in the early seventies was poor, the average growth rate of agriculture output averaged 2.4% during this period. The important reasons of poor performance of the agriculture sector growth was the war and separation of East Pakistan, virus attack on cotton, droughts and floods, uncertainties resulting from land reforms of 1972 and unpleasant relation between the landlords and tenants. The agriculture growth improved in 1980s and averaged 5.4%. various factors helps in improving the growth performance in eighties as transfer of major economic activities from public sector to private sector, improvement in output prices, investment in research and infrastructure and introduction of new cotton varieties etc.[Ahmad, H. K. (2011)].

The agriculture growth in 1990s slowed down to 4.4% due to floods and virus attack on cotton crop, water logging and salinity, insufficient availability of irrigation water and sharp increases in the cost of production. Growth rate was negative in the 2000-01 (-2.2%) and in 2001-02 it was very low as 0.1%. during the next two year (2002-03 and 2003-04) the growth rate recovers modestly as 4.15 and 2.2% respectively. The agriculture growth faces fluctuations in 2000s and the average growth rate in 2000s is 1.7%.

Figure 6.3 Output gap (%) Based on HP-Filter (Agriculture sector)

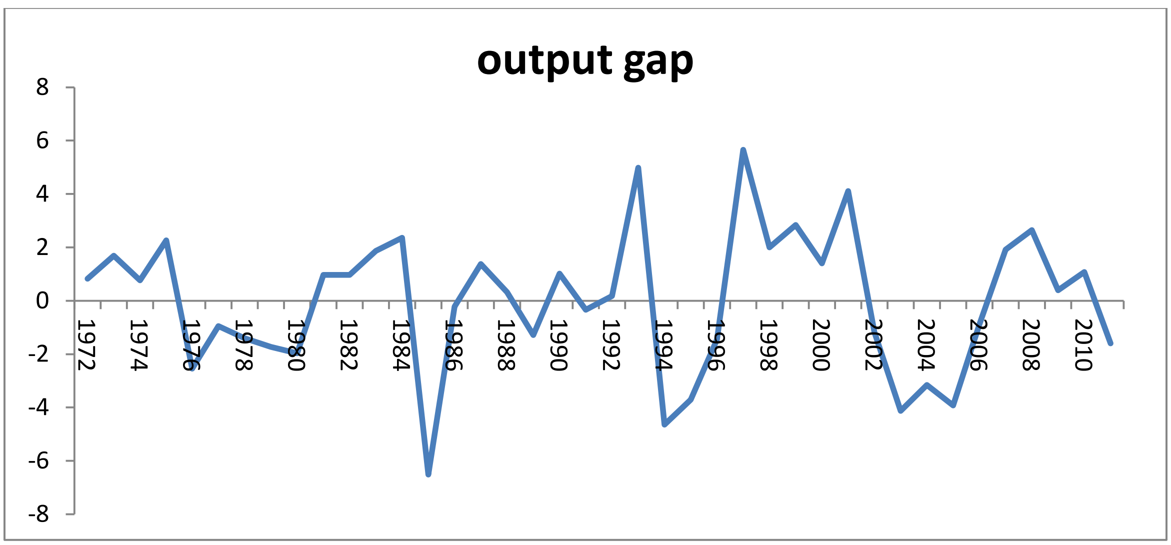


Figure 5.6 shows that the potential output obtained from HP filter method shows that output gaps are negative during 1976 to 1980, 1985 to 1986, 1994 to 1996 and 2002 to 2006.

The NKPC is estimated by GMM using two periods lagged inflation, labor share, output gap, call money rate, and wage inflation and CPI inflation as instruments. The result of NKPC using output gap as a proxy of real economic activity are given in table 6.5.

Table 6.5 NKPC Results using Output Gap (Agriculture sector)

	Output gap	**Exp Inflation**	**j-stat**	**LM Test**
Current inflation π_t	0.018 (0.20)	0.94 (19.03)	7.42 (0.593)	2.75*
Current inflation π_t	0.639 (0.74)	0.89 (15.76)	6.87 (0.443)	2.20*
Current inflation π_t	0.938 (1.09)	1.02 (17.49)	6.98 (0.639)	2.99*

* Tabulated value of $\chi^2_{(0.95,1)} = 3.84$,

The estimated results indicate that the forward looking inflation component is important in current inflation determination while the coefficient of output gap has positive sign but is statistically insignificant in all the cases, which means that output gap is not an important indicator in the agriculture inflation dynamic equation. Instruments are valid in this model (p-values of the diagnostic tests are given in the parentheses). According to LM test, no autocorrelation problem is found in the agriculture NKPC as calculated value is less than he tabulated value.

6.2.2.3 Hybrid New Keynesian Philips Curve

To check the impact of output gap we estimate the hybrid NKPC using output gap as a measure of real economic activity.GMM is used for estimation. The estimated results are given in the table 6.6 (t statistics of the variables are given in parentheses)

Table 6.6 Hybrid NKPC Results (Agriculture sector)

	Output gap	Exp inflation	Past inflation	j-stat	Durbin-h test
Current inflation π_t	0.004 (0.07)	0.24 (2.41)	0.73 (6.62)	4.90 (0.672)	1.80*
Current inflation π_t	0.899 (1.84)	0.24 (2.05)	0.76 (6.33)	4.05 (0.852)	1.66*
Current inflation π_t	0.768 (2.05)	0.30 (2.98)	0.70 (5.75)	4.143 (0.763)	1.76*

* Tabulated value of $Z_{0.95} = 1.96$

Contrary to the aggregate results reported in chapter 5, the results of the agriculture sector show that backward looking inflation is more important as compared to the forward looking inflation. This means that farmers base their expectations on the past information. The results show that output gap measured by the quadratic trend and HP filter have significant impact while the linear trend has no impact on inflation .The diagnostic test indicates that there is no autocorrelation problem in hybrid *NKPC* because calculated values of Durbin-h are less than the tabulated value of $Z_{0.95} = 1.96$. . The J-stats show that instruments are valid in the entire estimated model (p-values of the diagnostic tests are given in the parentheses). Sacrifice ratio using hybrid NKPC is given in the Table 6.7

Table 6.7 Sacrifice ratio Using NKPC

Sectors	*NKPC*	Sacrifice ratio	Durbin-h Test
Agriculture Sector	$\pi_t = 0.678Y_t + 0.30E_t(\pi_{t+1}) + 0.70\pi_{t-1}$ (0.00) (0.00) (0.07)	1.47	1.76*

* Tabulated value of $Z_{0.95} = 1.96$

6.3 Manufacturing Sector

6.3.1 Episode Specific Sacrifice Ratio

In the manufacturing sector inflation rate is measured by output deflator. Four episodes are found in the manufacturing sector. Episode 1 has large time duration it contains 8 years and the small disinflationary period last for 2 years in episode 3. The range of decline in inflation rate is 2 to 17 %. The detail of all these episodes is given in table 6.8.

Table 6.8 Disinflationary Episode in Manufacturing Sector

	Episode 1	**Episode 2**	**Episode 3**	**Episode 4**
Start	1973	1982	1990	1995
End	1981	1985	1992	2001
Duration	8 years	3 years	2 years	6 years
Decline in inflation rate	17.081	2.069	2.937	6.922

The estimated results of the sacrifice ratio by Ball and Zhang method are presented in the table 6.9.

Table 6.9 Sacrifice Ratio in Manufacturing Sector

Disinflation Episodes	**Decline in inflation rate**	**Output loss**		**Sacrifice ratio**	
		Ball	**Zhang**	**Ball**	**Zhang**
Episode 1	17.081	8.207	20.611	0.481	1.206
Episode 2	2.069	0.930	3.603	0.449	1.741
Episode 3	2.937	-1.502	-2.652	-0.511	-0.902
Episode 4	6.922	1.531	24.669	0.221	3.563

All the episodes have positive sacrifice ratio except the episode 3 which experienced negative sacrifice ratio in both the cases of Ball and Zhang techniques. The sacrifice ratio estimated by Zhang method is quite larger than the Ball's sacrifice ratio, which indicates that the cost of disinflation is larger in the case of Zhang as compared to Ball's methodology.

. The nationalization policy of the industrial sector in 1972 resulted in a significant drop in private investment, while the public sector investment increased almost ten - fold in real terms between 1969-70 and 1976-77. In this era expenditures on defense rose sharply adding to the fiscal burden along with the losses of public sector industries. These non-development expenditures resulted in cuts in development expenditures. In the early eighties the climate for private investment improved as the government provided guaranties future nationalization, tax concessions etc. As a result growth rate of the manufacturing sector averaged 8.2%. In the 90's the manufacturing sector slowed down again due to structural problems in cotton industry and the poor performance in manufactured exports. This is because of failure of adjusting the value of exchange rate to offset the effect of domestic inflation on the competitiveness of exports.

6.2.2 Time invariant sacrifice ratio

Time invariant sacrifice ratios are based on those methods in which single value of sacrifice ratio is calculated namely Philips curve model, traditional and structural VAR and the hybrid new Keynesian Philips curve method.

6.2.2.1 Sacrifice ratio Based on Philips curve Method

We first estimate the Philips curve using GMM and then calculate the sacrifice ratio in manufacturing sector. The Durbin-h test is applied for autocorrelation test and no autocorrelation is found in the model. The estimated results of the Philips Curve and sacrifice ratio is given in Table 6.10

Table 6.10 sacrifice ratio at Sectoral Level Using PC

Sectors	**Philips Curve**	**Sacrifice ratio**	**Durbin-h Test**
Manufacturing Sector	$\pi_t = 0.05Y_t + 0.16\pi_{t-1}$ (0.03) (0.09)	0.06	1.67*

6.4.2.2 Results Based on Structural VAR

We use annual data on output and inflation rate. Output is measured by real GDP and inflation is measured by the GDP deflator in manufacturing sector. GDP data have been converted into logarithms. Initially stationarity analysis of the series based on correlogram, Augmented Dickey-Fuller (ADF) and Phillips-Perron tests suggests that real output and inflation rate are both I(1) processes means real output and inflation rate both contain a unit root. The next step in our estimation procedure requires choosing the optimal lag length in VAR model. For this selection, we use information criteria like Akaike and Schwarz criteria and likelihood ratio tests etc. The criteria suggest two lags are to be taken for manufacturing sector VAR model

After estimating the VAR model, the next step is the identification of the supply and demand shocks but these Structural shocks are not directly measureable. Blanchard-Quah identifying restrictions are used for the calculation of structural shocks. The restriction that demand shock have no long run impact on the level of real output following the Cecchetti and Rich (1999) is used and the calculated value of the sacrifice ratio in manufacturing sector are given in the Table 6.11

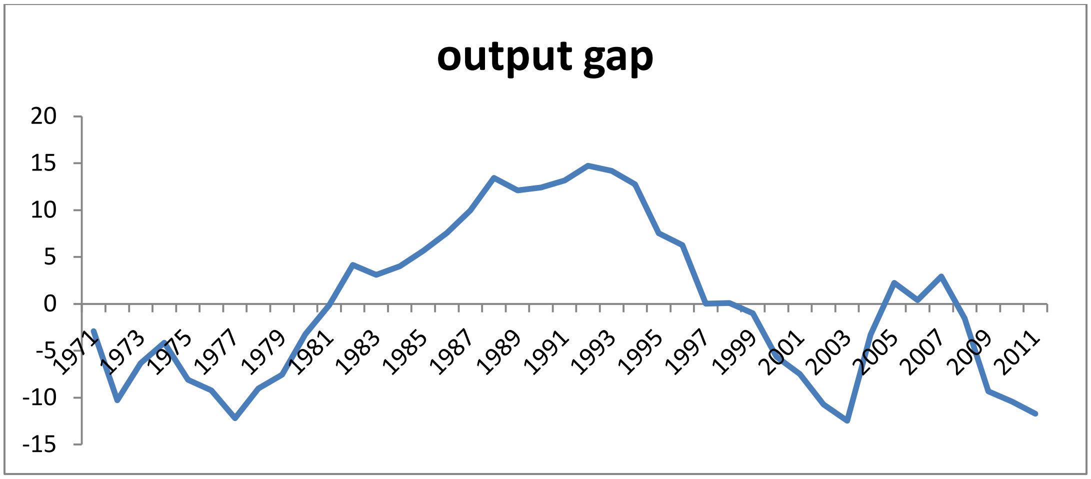
Table 6.11 sacrifice ratio Using SVAR

	Manufacturing Sector
τ	5
Sacrifice ratio	0.046

6.2.2.3 New Keynesian Philips Curve

The NKPC and hybrid NKPC is estimated in manufacturing sector using output gap as proxy of real economic activity. In manufacturing sector output gap is measured by three methods name linear time trend method, quadratic time trend and HP filter method. The graphs of actual output, potential output and the output gaps in percent are given as,

Figure 6.4 Output Gap (%) Based on Linear Time Trend (Manufacturing Sector)



The figure 6.4 show that actual output is above than the potential output only in the time period of 1982 to 1998 and the reaming time period output gap is negative.

During the 1970s, the growth rate of manufacturing sector declined to 5.5% compared to the average of 9.9% in the 1960s.The polices adopted by government during the 1970s like nationalization of the industrial sector, devaluation of the rupee, reduction in the manufacturing sector subsidies and export subsidies etc reduced the growth performance of manufacturing sector. In 1980s the market oriented policies were adopted like import policy was liberalized, tariff structure was rationalized etc and these friendly policies enhanced the growth performance of the manufacturing sector to 8.21%. In spite of liberalization the growth performance of manufacturing sector in 1990s was low and the reasons of low growth rate were political instability, bad law and order situation, inadequate power supply cotton crop failures etc. The growth performance in the 2000s was encouraging. The annual average growth rate was 8.7%.The policies of liberalization along with the continues improvement in macroeconomic environment, accommodative monetary and fiscal policies, stable exchange rate and continued global expansion have helped in achieving good growth rates in manufacturing sector.

The pattern of output gap measured by the quadratic time trend is different from the linear time trend, the output gap is positive in this case at the time period of 1982 to 1996 and 2004 to 2009. This is shown in figure 5.8. The pattern of output gap measured by the HP filter is near to the quadratic time trend and it is shown in the figure 5.9. The potential output is above the actual output from the time period 1976 to 1980 and 1996 to 2004.

Figure 6.5 Output Gap (%) Based on Quadratic Time Trend (Manufacturing sector)

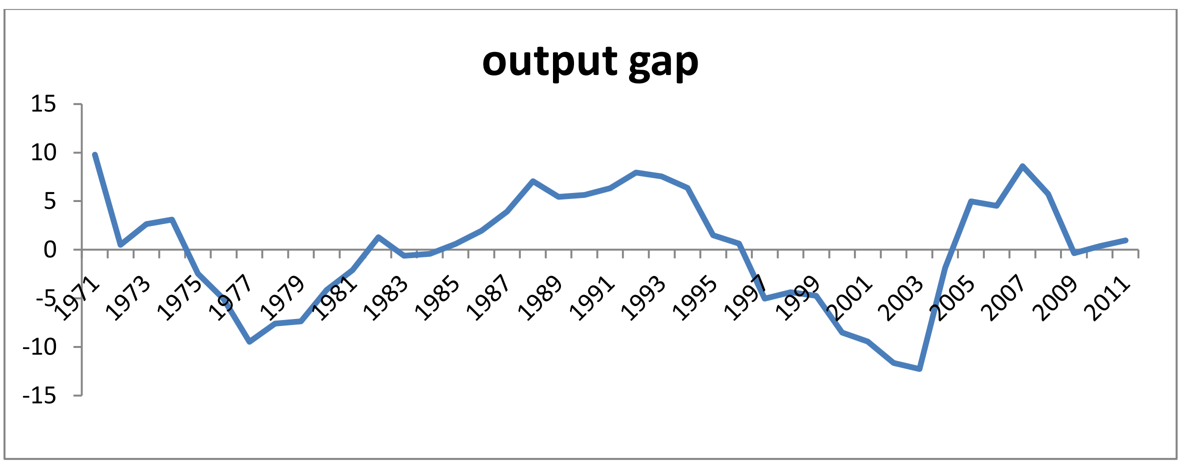
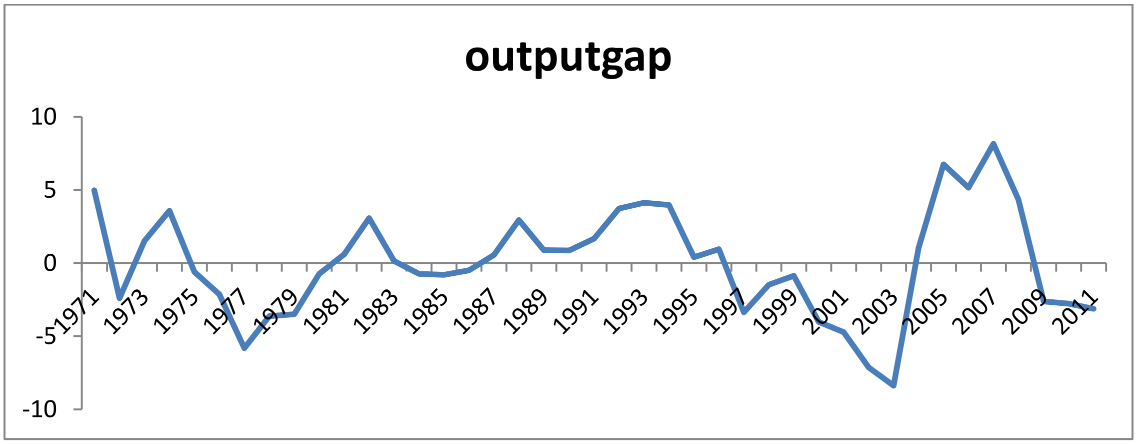


Figure 6.6 Output Gap (%) Based on HP Filter (manufacturing sector)



The output gap measured by the quadratic trend and HP-filter method is near to the manufacturing growth history of the Pakistan as compared to the linear trend method.

The NKPC is estimated using GMM and the estimated results of *NKPC* using different proxies of output gap shows that the expected future inflation has positive and significant impact on the present inflation determination in all the cases but the output gap has correct sign and is statistically insignificant in only one case namely linear detrended method. In other two cases the coefficient of output gap is positives and significant which is according to literature. All this is shown in the table 5.5 (t statistics of the variables are given in parentheses).

The diagnostics of the model shows no problem of autocorrelation as the calculated value of LM test is less than the tabulated value. The j-stats value shows that the instruments used in the models are reliable (p-values of the diagnostic tests are given in the parentheses).

Table 6.12 NKPC Results (Manufacturing Sector)

	Output gap	Exp inflation	j-stat	LM test
Current inflation π_t	0.019 (0.99)	1.01 (19.03)	6.28 (0.686)	2.44*
Current inflation π_t	0.826 (3.05)	0.98 (15.59)	5.65 (0.686)	2.10*
Current inflation π_t	0.740 (2.04)	0.98 (15.52)	6.35 (0.608)	2.87*

* Tabulated value of $\chi^2_{(0.95,1)} = 3.84$

6.2.2.3 Hybrid New Keynesian Philips Curve

The result of Hybrid NKPC using output gap has shown in the table 6.13 (t statistics of the variables are given in parentheses). GMM is used to estimate hybrid NKPC.

Table 6.13 Hybrid NKPC Results (Manufacturing Sector)

	Output gap	Exp inflation	Past inflation	j-stat	Durbin-h test
Current inflation π_t	0.075 (0.47)	0.73 (0.85)	0.29 (0.39)	2.75 (0.275)	1.69*
Current inflation π_t	0.184 (1.97)	0.52 (3.01)	0.47 (3.38)	3.088 (0.543)	1.81*
Current inflation π_t	0.715 (2.94)	0.54 (1.91)	0.51 (2.28)	0.663 (0.881)	1.62*

* Tabulated value of $Z_{0.95} = 1.96$

In this case the expected future inflation is stronger than the past inflation. The expected future inflation as well as past inflation is insignificant in the first model in which output gap is measured by linear time trend.

The output gaps measured by other two methods have positive sign and significant impact on inflation. The hybrid *NKPC* results of manufacturing sector show that firms prefer forward looking expectation. The result of diagnostics test indicates that the instruments are reliable (p-values of the diagnostic tests are given in the parentheses). Autocorrelation problem is not detected in the model as the calculated value of Durbin-h is less than the tabulated value. The sacrifice ratio is calculated using hybrid Philips curve in the Table 6.14

Table 6.14 Sacrifice Ratio Using NKPC in Manufacturing Sector

Sectors	***NKPC***	**Sacrifice ratio**	**Durbin-h Test**
Manufacturing Sector	$\pi_t = 0.715Y_t + 0.54E_t(\pi_{t+1}) + 0.51\pi_{t-1}$ (0.02) (0.06) (0.00)	1.40	1.62*

6.4 Sacrifice Ratio in Services Sector

6.4.1 Episode Specific Sacrifice-ratio

The inflation rate in services sector also calculated by output deflator and four disinflationary episodes are found in case of services sector. The episodes consist of 3 to 5 years of disinflationary period. In the disinflation episodes the decline in inflation rate ranges between 4 to 11 percent. The detail of these episodes are given in the table (6.15)

Services sector contribute major share in economy of Pakistan, the last few decades shows significant change in the structure of the economy. The share of agriculture sector is decreasing while the share of manufacturing and services sector is increasing since last few decades. Therefore service sector is the largest contributor to the *GDP* of the Pakistan.

Table 6.15 Disinflation Episodes in Services Sector

	Episode 1	Episode 2	Episode 3	Episode 4
Start	1973	1980	1994	1999
End	1977	1985	1997	2002
Duration	4 years	5 years	3 years	3 years
Decline in inflation rate	11.827	5.943	4.424	10.651

The sacrifice ratio calculated by episodes specific using Ball and Zhang techniques are reported in the table 6.16

Table 6.16 Sacrifice Ratio in Services Sector

Disinflation Episodes	Inflation Decline	Output loss		Sacrifice ratio	
		Ball	**Zhang**	**Ball**	**Zhang**
Episode 1	11.82	4.093	20.253	0.346	1.712
Episode 2	5.94	-2.741	-14.076	-0.461	-2.368
Episode 3	4.42	-0.383	2.848	-0.086	-0.643
Episode 4	10.65	1.666	2.762	0.156	0.259

In the services sector episode1 and episode 4 have positive sacrifice ratio while the remaining two episodes have negative sacrifice ratio in both cases. The experiment of nationalization in the seventies adversely affected the services sector. The sacrifice ratio in this era in services sector is 1.71 which means that 1% decline in inflation rate reduce the services output by 1.71%. In the period of 1980 to 1985 and 1994 to 1997 decline in inflation rate has positive effect on services output the last episode shows that reducing inflation rate has a minor effect on the output

6.4.2Time invariant sacrifice ratio

Time invariant sacrifice ratios are based on those methods in which single value of sacrifice ratio is calculated namely Philips curve model, traditional and structural VAR and the hybrid new Keynesian Philips curve method.

6.4.2.1 Sacrifice ratio Based on Philips curve Method

We first estimate the Philips curve using GMM and then calculate the sacrifice ratio in services sector. The Durbin-h test is applied for autocorrelation test and no autocorrelation is found in the model. The estimated results of the Philips Curve and sacrifice ratio is given in Table 6.17

Table 6.17 Sacrifice ratio in Services Sector Using PC

Sectors	**Philips Curve**	**Sacrifice ratio**	**Durbin-h Test**
Services Sector	$\pi_t = 0.10Y_t + 0.20\pi_{t-1}$ (0.02) (0.08)	0.13	1.69*

6.4.2.2 Results Based on Structural VAR

Output is measured by real GDP and inflation is measured by the GDP deflator in services sector. GDP data have been converted into logarithms. Initially stationarity analysis of the series based on correlogram, Augmented Dickey-Fuller (ADF) and Phillips-Perron tests suggests that real output and inflation rate are both I(1) processes means real output and inflation rate both contain a unit root. The next step in our estimation procedure requires choosing the optimal lag length in VAR model. For this selection, we use information criteria like Akaike and Schwarz criteria and likelihood ratio tests etc. The criteria suggest one lag for services sector VAR model. After estimating the VAR model, the next step is the identification of the supply and demand shocks but these Structural shocks are not directly measureable. Blanchard- Quah identifying restrictions are used for the calculation of structural shocks. The calculated value of the sacrifice ratio for services sector is given in the Table 6.18

Table 6.18 Sacrifice Ratio using SVAR

	Service Sector
$\boldsymbol{\tau}$	5
Sacrifice ratio	0.081

6.4.2.3 New Keynesian Philips Curve

We estimate the *NKPC* using three different methods of output gap i.e., linear time trend, quadratic time trend and HP filter method. First we give the graphs of the actual output, potential output and the output gap measured by these three methods. The output gap measured by the linear trend method is positive only from the time period 1982 to 1998 and the reaming time period, output gap is negative.

This is shown in the figure 6.7.The output gap measured by the quadratic trend and HP filter method have the same trend and shown in the figure 6.8 and 6.9 respectively.

Figure 6.7 Output Gap (%) Based on Linear Time Trend (Services sector)

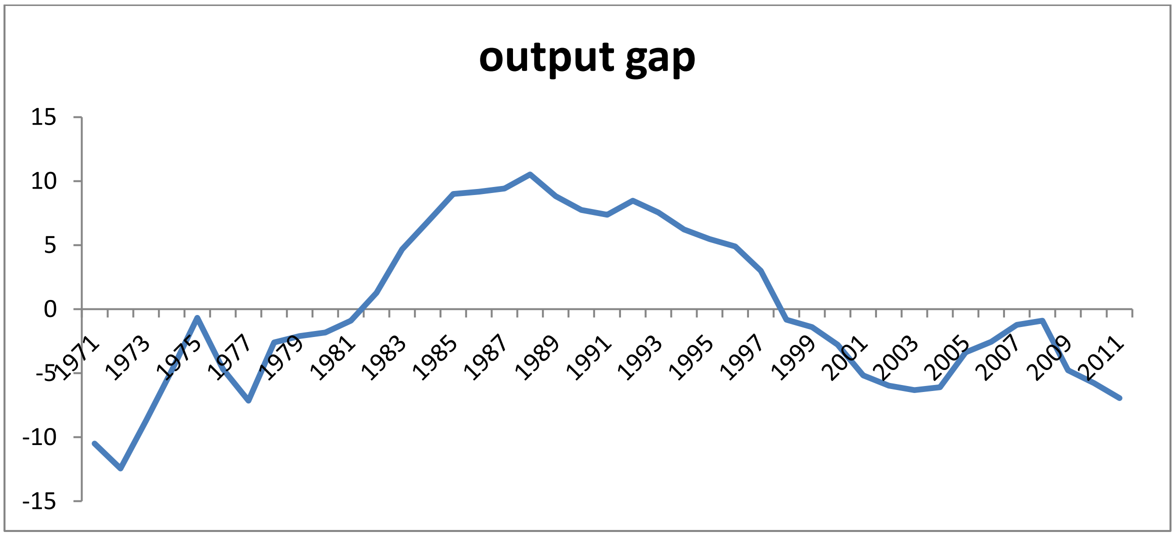


Figure 6.8 Output Gap (%) Based on Quadratic Time Trend (services sector)

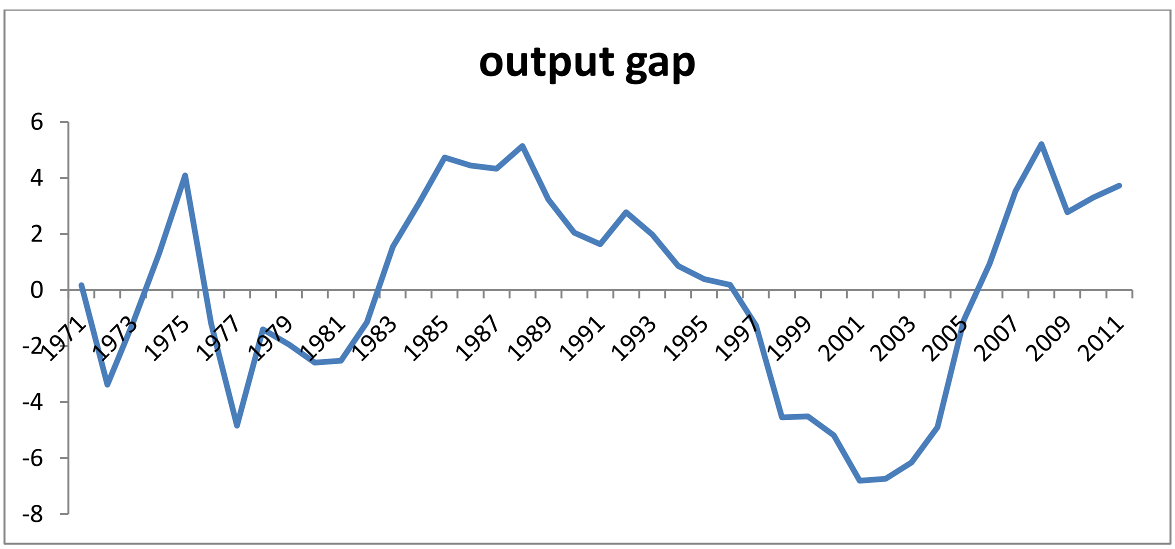
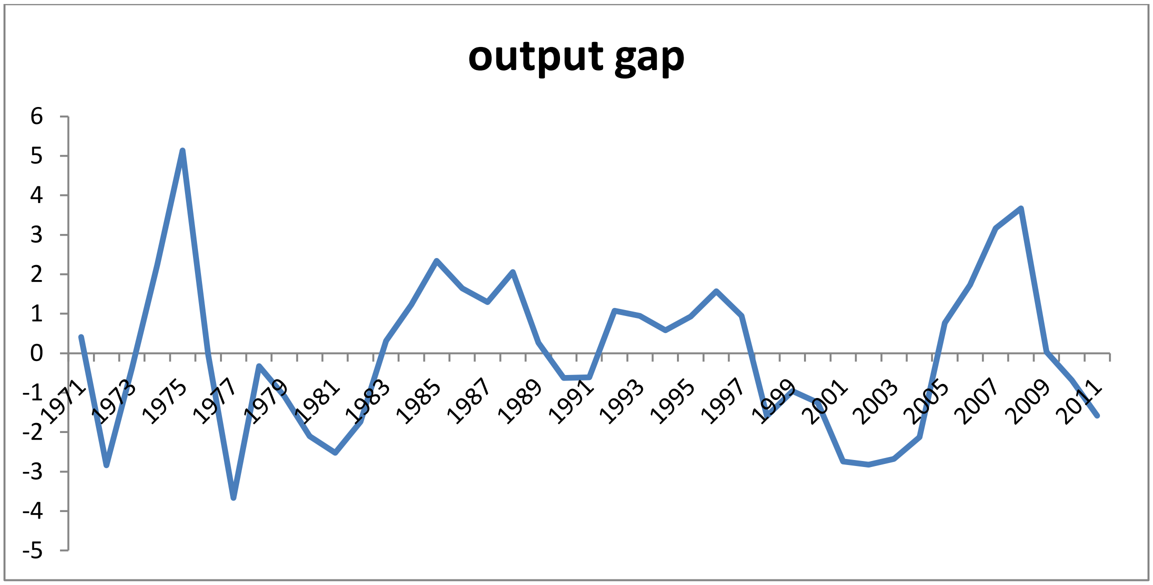


Figure 6.9 Output Gap (%) based on HP Filter (services sector)



The shares of services are rising as compared to other sectors of economy over the period. Services sector has increased 39% of GDP in 1961 to 54% of GDP. Services sector has strong linkages with other sectors of economy; it provides essential inputs to agriculture sector and manufacturing sector. It has significantly contributed to GDP growth. During the 1960s services sector recorded a high growth rate of 8% but the growth rate of the services sector fell down to 6% during the seventies. This shows that growth rate in the seventies fell sharply and reached to 6.32% .In eighties the growth rate of services sector reached up to 6.65% and in nineties the growth rate of services sector decreases to 4.73% and in twenties the growth rate of services sector become 5.4%

GMM is used to estimate the NKPC. The reduced NKPC using output gap as an economic activity variable confirms that forward looking inflation expectations significantly impact the present inflation and in this case output gap have insignificant impact on the inflation equation with positive sign. The estimated results are given in the table 6.19 (t statistics of the variables are given in parentheses)

Table 6.19 NKPC Results (services sector)

	Output gap	**Exp inflation**	**j-stat**	**LM Test**
Current inflation π_t	0.084 (0.37)	0.98 (2.33)	3.59 (0.732)	3.80*
Current inflation π_t	0.045 (1.44)	1.02 (4.42)	3.69 (0.717)	3.21*
Current inflation π_t	0.934 (1.33)	1.00 (20.14)	3.44 (0.751)	3.47*

* Tabulated value of $\chi^2_{(0.95,1)} = 3.84$

The diagnostic tests show no problem of autocorrelation in the model and the instruments are valid (p-values of the diagnostic tests are given in the parentheses).

6.4.2.3 Hybrid New Keynesian Philips Curve

The hybrid NKPC are estimated using GMM and the results show that backward looking inflation expectation are more important than future expected inflation. The output gap measured by the quadratic time trend and HP Filter method play significantly important role. All this is shown in the table 6.20 (t statistics of the variables are given in parentheses)

Table 6.20 Hybrid NKPC Results (services sector)

	Output gap	Exp inflation	Past inflation	j-stat	Durbin-h test
Current inflation π_t	0.02 (0.79)	0.49 (6.37)	0.51 (6.70)	5.80 (0.669)	1.73*
Current inflation π_t	0.188 (1.92)	0.38 (4.39)	0.59 (7.73)	6.42 (0.599)	1.49*
Current inflation π_t	0.534 (4.66)	0.43 (4.33)	0.56 (6.24)	7.31 (0.503)	1.11*

* Tabulated value of $Z_{0.95} = 1.96$

The diagnostic test shows that there is no problem of autocorrelation in the model, and the j-stats show that instruments are valid in all models (p-values of the diagnostic tests are given in the parentheses).

6.5 Concluding Remarks

In this chapter we calculated the sacrifice ratio using different methodologies at sectoral level. Basically the sacrifice ratio is divided into two main categories like time invariant sacrifice ratio and the episode specific sacrifice ratio. Time invariant sacrifice ratio indicates that sacrifice ratio is positive both at aggregate and sectoral level.We found three positive sacrifice episodes in agriculture sector. In manufacturing and services sector we found four sacrifice episodes.

The sectoral level analysis of NKPC in Pakistan shows mix results; In case of Agriculture and services sectors past inflation dominates the future inflation but in the case of manufacturing sector future inflation outperforms the past inflation. On the other side output gap in each sector plays significant role. The diagnostic tests used both in aggregate level as well as at sectors level show the same results for example j-stat indicate that instruments are valid in all cases. The LM test and Durbin-h test statistics show no autocorrelation problem in the reduced form of the NKPC and the reduced hybrid NKPC both at aggregate level as well at sectors level.

INFLATION FORECASTING

7.1 Introduction

Inflation forecasting is very important issue because it influences economic decisions in many ways. For example Investors require good inflation forecasts because the returns to stocks and bonds depend on what happens to inflation rate. Commerce and production sector need to know inflation forecasts to set the price of their goods and plan production. In the same way forecasting inflation is a central work for a central bank because the rate of inflation is usually considered as the most vital indicator of monetary policy. Monetary policy is more concerned with future inflation rather than current inflation levels because of their Monterey polices.

Lot of techniques are used for inflation forecasting in economics literature. Most of these models consist of time series model like transfer models, autoregressive models etc and as well as structural models like structural VAR, traditional Philips curve equations etc. In creating models to use for forecasting, economists use the most recent vintage of historical data available to them to develop and test alternative models. They often com pare the forecasts from a new model to forecasts from alternative models or to forecasts that were made by others in real time. However, since the analysis of the new forecasts is often based on the final revised data, rather than the data that were available to economic agents who were making forecasts in real time, the results of such exercises may be misleading. To avoid such problems in creating forecasting models, we have developed a data set that gives a snapshot of the macroeconomic data available at any given date in the past. We call the information set available at a particular date a "vintage" and we call the collection of such vintages a "real-time data set." The detail of the real time data is discussed in chapter 4. In this study we used the univariate time series model, traditional Philips curve and widely accepted model of inflation dynamics, the NKPC, for the out of sample inflation forecasting purpose. We then compare all these forecasting methods using real time data and finally revised data.

This chapter is divided into five sections. Second section gives the results of inflation forecasting using end of sample data. In third section Real time data is used for inflation forecasting and in fourth section comparison of forecasting method are done. The last section gives concluding remarks of the chapter.

7.2 Forecasting Using End of Sample Data

In this section inflation is forecasted using final available data and univariate time series method, backward Philips curve and new Keynesian Philips curve are used.

7.2.1 Univariate Time Series Method

Numbers of techniques are available for forecasting economic time series. An important approach, which includes only the time series being forecast, is known as univariate forecasting. Autoregressive moving average (ARMA*)* modeling is a precise subset of univariate modeling, in which a time series is expressed in terms of past values of itself (the autoregressive component) plus current and lagged values of a 'white noise' error term (the moving average component). The Box-Jenkins ARIMA methodology is used for inflation forecasting which has the following important steps.

1. Model Identification: First of all raw data is transferred to stationary data and stabilize variables. The next step is to examine the ACF and PACF of the data and identify the potential models.

2. Model Estimation: estimate all the potential models

3. Diagnostic checks on model competence followed by forecasting: Select the best estimated model using suitable criterion and then go for forecasting.

Following the box-Jenkins methodology, first we check the stationarity of the data because data must be stationary before choosing the suitable ARMA model. To check the stationarity of the data, we plot the data and it is clear that the data is stationary. This is shown in figure 6.1.

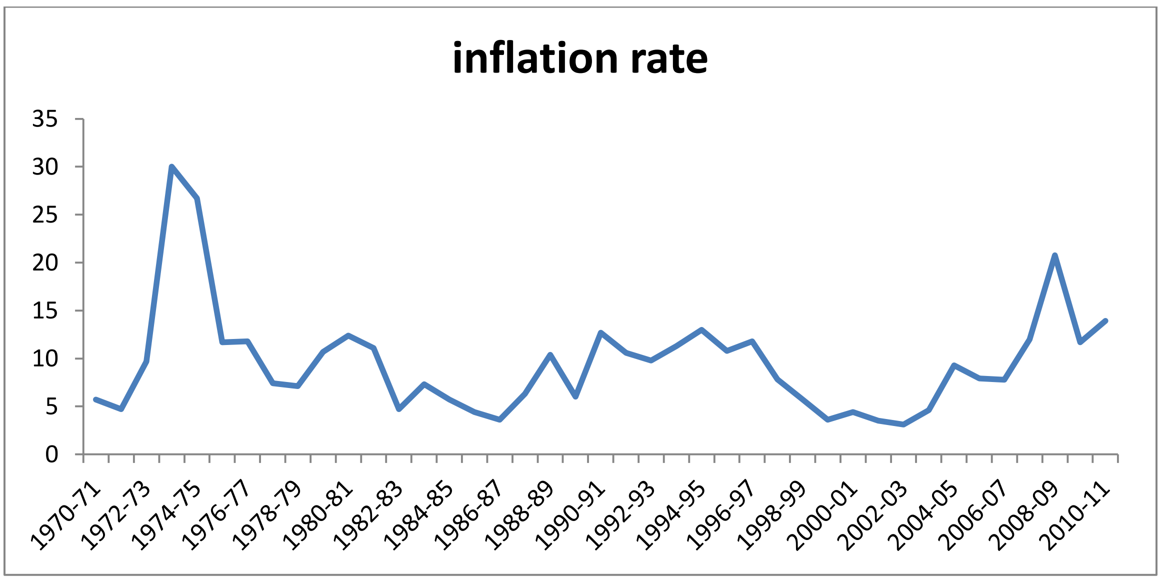
The ADF and PP test also indicates that at level data is stationary. The results of ADF and PP test are given in table 7.1. $\boldsymbol{\delta}$ (sigma) is the value of ADF and PP coefficient.

Table 7.1 Unit Root Tests Result of Inflation Rate

$$\Delta\pi_t = \alpha + \delta\pi_{t-1} + \sum_{i=1}^{p} \Delta\pi_{t-i} + u_t$$

	Calculated value	δ	Critical Value	Remarks
ADF test	-3.325	-0.436393	-2.936	Stationary
PP test	-3.439	-0.436393	-2.936	Stationary

Figure 7.1 Inflation Rate in Pakistan



After determining the correct order of integration, the next step is to find an appropriate *ARMA* model and the Box-Jenkins methodology is good approach for deciding it because it is not only about model identification but in fact; it is an iterative approach adding model estimation and diagnostic checking along with the model identification. After diagnosing the correlogram of the stationary data, we found the spikes at lag 1 both on *ACF* and *PACF*.

This suggests that we might have *AR* (1), *MA* (1) or *ARMA* (1,1) specifications. For selection of the best model we compare the AIC, SC D.W and AdjR^2 of the estimated model.

Table 7.2 Properties of Different ARMA Models

	ARMA (1, 1)	AR (1)	MA(1)
AIC[1]	**6.00**	6.01	6.00
SBC**	**6.10**	6.10	6.15
DW	**1.98**	1.74	1.74
Adj-R^2	**0.32**	0.30	0.32

So the best possible model is the *ARMA* (1, 1)[2] because it full fill the complete fundamentals of best estimated model, (t statistics are given in prentices).

$$\pi_t = 9.86 + 0.306\pi_{t-1} + 0.42\varepsilon_{t-1} \qquad (7.1)$$

(6.52) (2.50) (1.73)

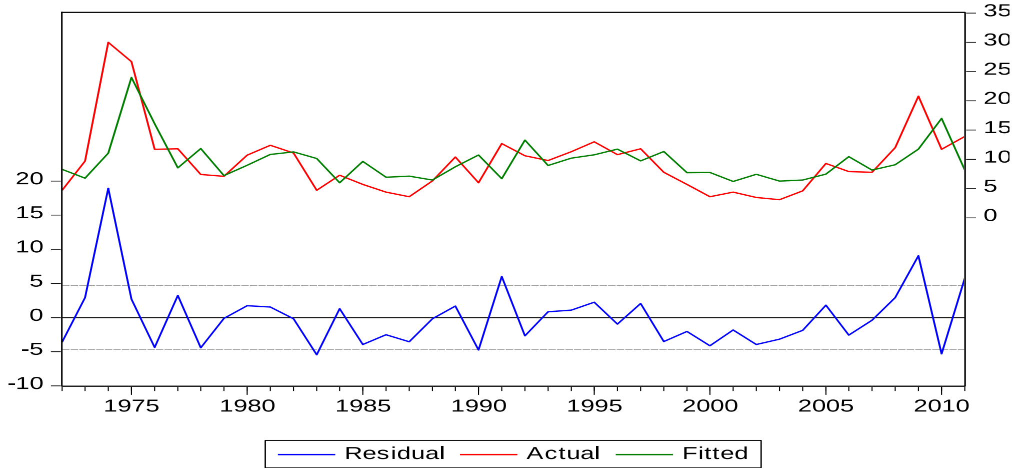
We apply the LM test for serial correlation on the final ARMA (1, 1) and we found no serial correlation in the model. The results of LM test are as LM Test=0.0495(0.9517)

* And ** show Akaike information criterion is a measure of the relative quality of statistical models for a given set of data and Schwarz Bayesian criterion is model selection among a finite set of models respectively.

[2] The estimated time of ARMA(1,1) is 1971-2000, as we are using out of sample forecasting so the sample period of forecasting is 2001 to 2012.

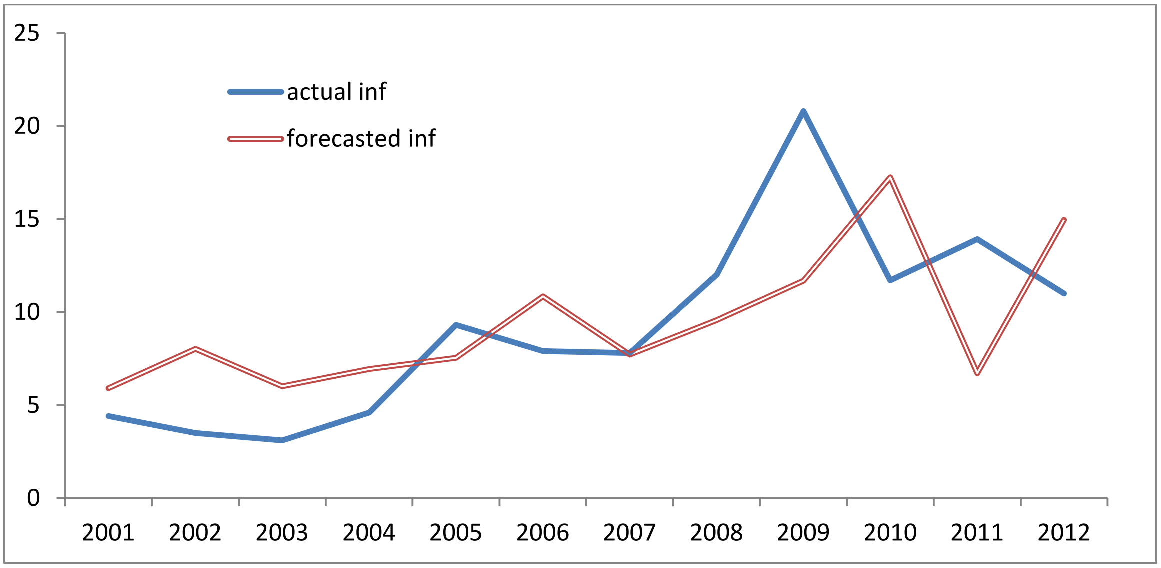
To get an initial feel for the fit of the model, we plot the graph of the actual and fitted residuals. The actual and fitted values are depicted in the upper part of the figure 7.2 show a general co-movement between the actual values of inflation and fitted values of inflation.

Figure 7.2 Residual Actual Fitted Graph



We have forecasted inflation rate out of sample and check the predictability power of the model. If the size of the difference between the actual and the fitted values is low, than the model has a good forecasting power. The forecasted inflation is shown in the following figure 7.3.

Figure 7.3 Inflation Forecasting Using ARMA Model



7.2.2 Philips Curve Approach (PC)

The Phillips curve was introduced by Phillips (1958) as an empirical association between unemployment and nominal wage growth rate. The advancement in research modifies the Philips curve relationship into unemployment and inflation rate. After this The Phillips curve become an essential workhorse in current economic modeling and it relates the real and the nominal side of the economy. In this section we focused on the forecasting power of the Philips curve in case of Pakistan. However, several studies find that the Phillips curve's worth as a forecasting tool is narrowed. For example, Atkeson and Ohanian (2001) and Matheson (2008) find that Phillips curve based forecasters are outperformed by simple forecaster's methods.

Stock and Watson (2008) evaluate Phillips curve forecasts to different multivariate specifications of forecasting models and result shows a good Phillips curve performance for the US. On the other hand, Clausen and Clausen (2010) get that the Phillips curve performs poorly when examining data from Germany, the UK and the US.

In this study we estimate the traditional expectation augmented Phillips curve with adaptive expectations and evaluate their forecasting performance to the remaining methods.

$$\pi_t = \beta\pi_{t-1} + \gamma y_t \qquad (7.2)$$

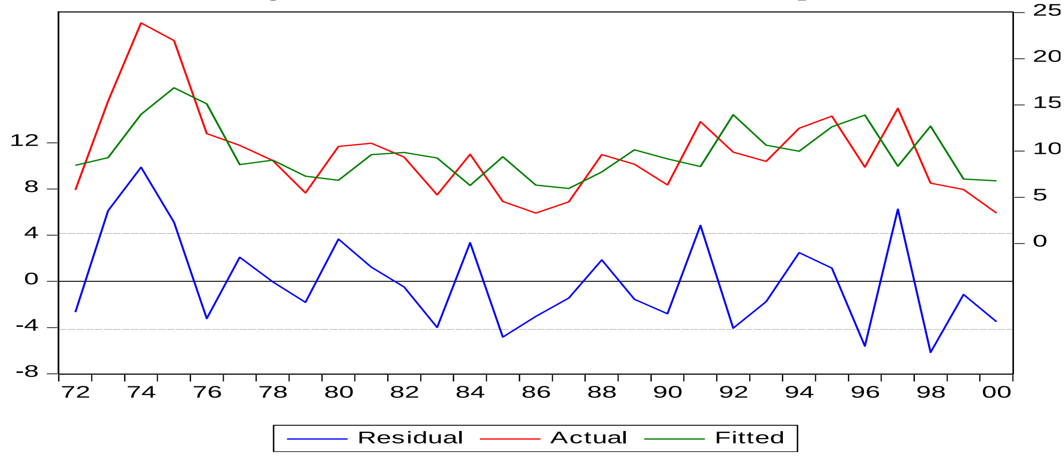
The estimated Philips curve equation is as,

$$\underset{}{\pi_t} = \underset{(0.00)}{0.94\pi_{t-1}} + \underset{(0.07)}{0.37y_t} \qquad (7.3)$$

First we estimated the parameters of the equation using the time period 1971 to 2000, and then we forecast out of sample values from this equation. This shows that the output gap as well as past inflation is significant. To obtain an initial sense for the fit of the model, we will check the actual fitted residual graph.

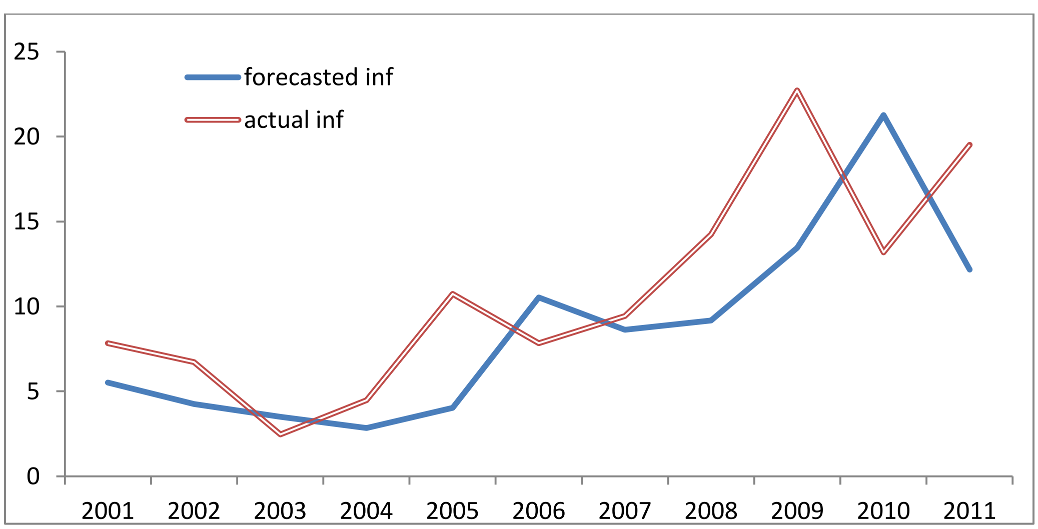
The graph shows that the actual and fitted values represented on the upper portion of the graph show a general co movement between the actual value of inflation and the fitted values. The normality test of the residuals $\chi2_{(2)}$ =0.88 shows that the residuals are normally distributed. We also apply Durbin-h test for the serial correlation and found no serial correlation as the calculated value of durbin-h (1.67) is less than the Tabulated value of $Z_{0.95} = 1.96$ in the equation 7.3

Figure 7.4 Residual Actual Fitted Graph



The actual and forecasted values of inflation using Philips curve is shown in the figur7.5

Figure 7.5 Inflation Forecasting Using PC



7.2.3 New Hybrid Keynesian Philips Curve

New Keynesian models became standard tools in applied macroeconomic analysis. These are used extensively to study the impact of shocks on economic activity and enlighten the decisions of monetary policy makers in several central banks worldwide. But, these models are not much used for forecasting purpose and in case of Pakistan, no study is found according to my best knowledge.

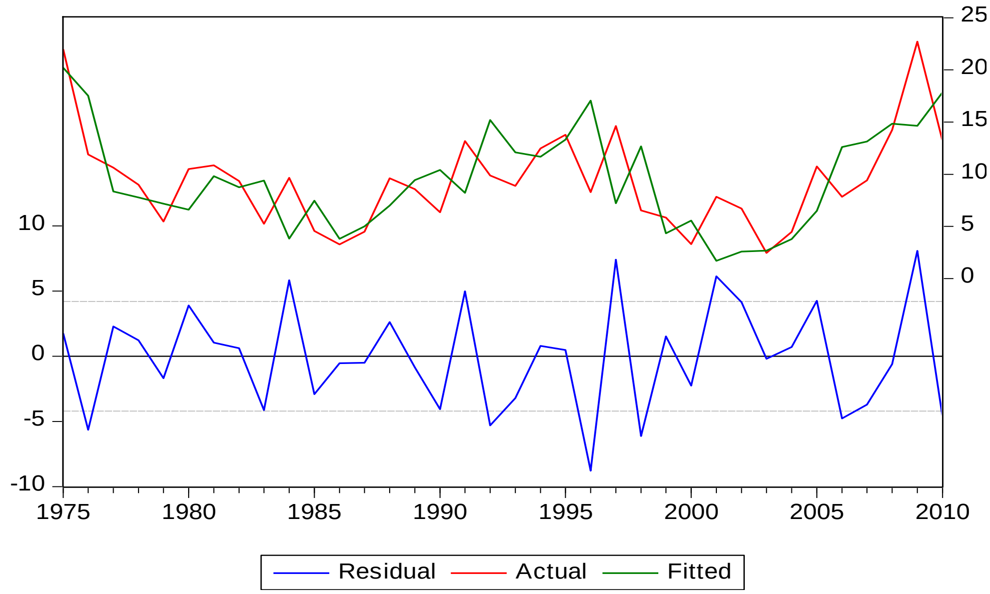
As we estimate the hybrid *NKPC* using different models in the chapter 5 but in this chapter we are using the out of sample forecasting and for this purpose we truncated the data to 1971 to 2000. The hybrid *NKPC* for inflation forecasting purpose is given in the equation 7.4 (p values are in the parenthesis).

$$\pi_t = \underset{(0.04)}{0.89} Y_t + \underset{(0.04)}{0.17} E_t(\pi_{t+1}) + \underset{(0.00)}{0.80} \pi_{t-1} \qquad (7.4)$$

First of all we look at the behaviour of actual and fitted value of this *NKPC* specification. This is shown in the figure 7.6.

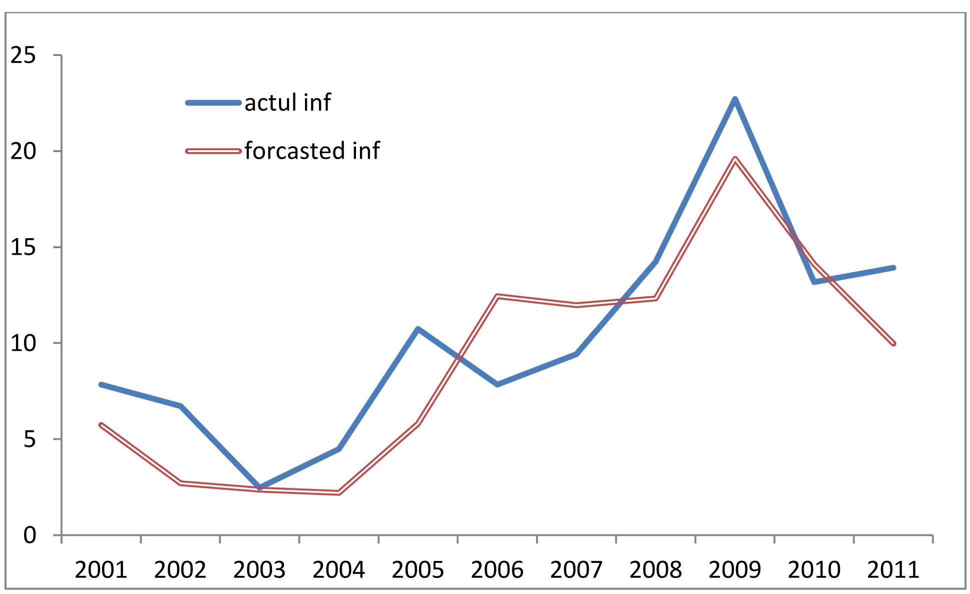
The graph shows that the actual value of the inflation and the fitted value of the inflation co-move and in some periods, divergence between these two series is also found.

Figure7.6 Residual Actual Fitted Graph



Finally we examine the actual versus forecasted values by the figure 6.7.

Figure 7.7 Inflation Forecasting Using NKPC



7.3 Inflation Forecasting using real time output gap data

In this section real time output gap measured by H-P filter, linear time trend and quadratic time trend is used for the inflation forecasting purpose in simple Philips curve and NKPC. The detail calculation of real time output gap is given in chapter 3.

7.3.1 Philips Curve Approach (PC)

The uncertainty related to estimating output gaps is widely acknowledged. However, Phillips curve equations remain a workhorse of many macroeconomic models. Such a relationship, referred as a Phillips curve, is often seen as a helpful guide for policymakers aiming to maintain low inflation and stable economic growth. According to Philips curve, when aggregate demand exceeds potential output, the economy is subject to inflationary pressures and inflation should be expected to rise. Under these circumstances, policymakers aiming to contain the acceleration in prices might wish to adopt policies restricting aggregate demand. Similarly, when aggregate demand falls short of potential supply, inflation should be expected to fall, prompting policymakers to consider the adoption of expansionary policies.

After estimating different real time output gap series, we proceed to the estimation of Philips curve[3]. The coefficient of real time output gap is significant, p-values are given in parentheses and this analysis suggests that different output gaps are helpful in forecasting inflation. The estimated results are shown in the Table 7.3

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[3] The estimation period of the Philips curve is truncated to 1971 to 2000, as we are forecasting out of sample period (2001 2012).

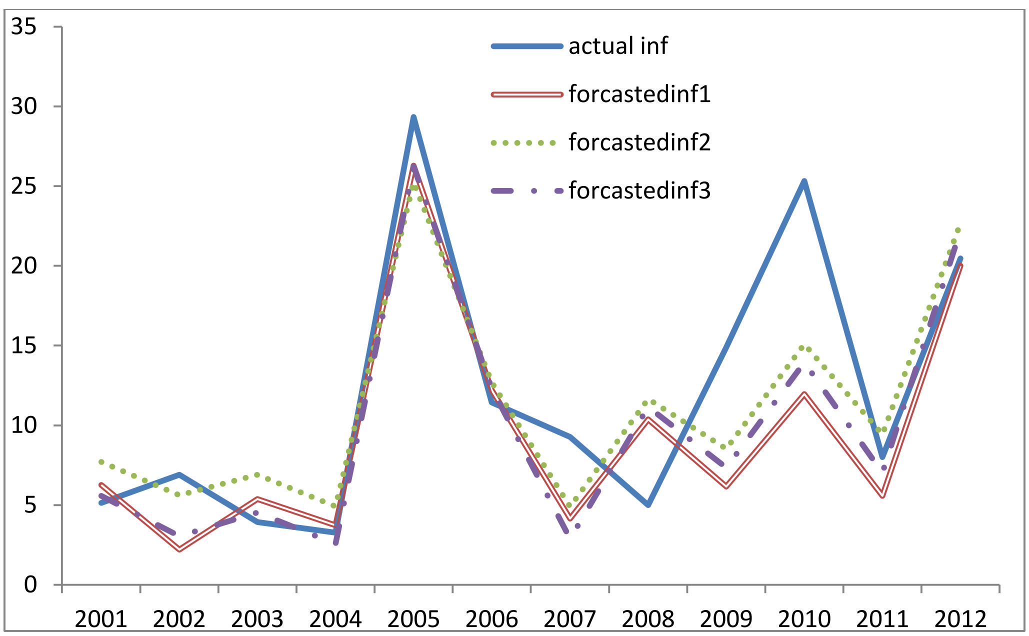
Table 7.3 Real Time Philips Curve Results

	Output Gap	Past Inflation	Durbin-h test
Current inflation π_t	0.203 (0.001)	0.743 (0.000)	1.57*
Current inflation π_t	0.369 (0.030)	0.878 (0.000)	1.72*
Current inflation π_t	0.408 (0.081)	0.867 (0.000)	1.41*

*Tabulated value of $Z_{0.95} = 1.96$

After estimating the Philips curve, we forecast inflation rate for out of sample data from these three types of Philips curve. It is shown in the figure 7.8.

Figure 7.8.Inflaton Forecasting Using Real-time PC



Forecastedinf1, Forecastedinf2, Forecastedinf3 is the inflation forecasting using Philips curve estimated by H-P filter output gap ,linear output gap and quadratic output gap respectively.

7.3.2 Hybrid New Keynesian Philips Curve

The hybrid New Keynesian Phillips curve (HNKPC), which links current inflation to expectations of future inflation, past inflation and a measure of excess demand in the form of the output gap, has become important instrument in modern macroeconomic analysis. In this section we use real time output gap as an economic activity in HNKPC for forecasting inflation[4]. The estimated results of HNKPC are given in the table 7.4 (t-statistics are given in the parentheses)

Table 7.4 Real Time HNKPC Results

	Output gap	**Exp inflation**	**Past inflation**	**j-stat**	**Durbin-h test**
Current inflation π_t	0.81 (0.11)	0.42 (2.76)	0.58 (7.72)	8.05 (0.234)	1.81*
Current inflation π_t	0.05 (0.26)	0.42 (4.27)	0.59 (7.42)	7.81 (0.252)	1.89*
Current inflation π_t	0.105 (0.28)	0.36 (2.20)	0.58 (6.17)	5.64 (0.465)	1.84*

* Tabulated value of $Z_{0.95} = 1.96$

This table shows that role of real output gap by different methods are not helpful in forecasting inflation. The coefficient of expected inflation and past inflation are significant in inflation determination equation. The output gap has positive sign but

[4] As we are using out of sample forecasting so the sample size is truncated to 1971 to 2000 for the estimation of HNKPC.

insignificant in all three cases (linear method, quadratic method and H-P filter). This entire mean that real output gap has no role in inflation determination and HNKPC are not useful in inflation forecasting using real time data.

7.4 Forecasting Evaluation

In this section we collect the information from the different forecasting methods for evaluation and then find out the best one method for inflation forecasting. The Root Mean Square Error (RMSE*)* is used for the forecasting assessment.

The statistics in the table 7.5 and 7.6 indicates that the ARMA model is better for forecasting as compared to the simple PC, NKPC and Real Time PC forecasting. The value of RMSE is low in the *ARMA* as compared to the other approach indicates that the model is reasonable.

Table 7.5 Out-of- Sample Forecast Evaluation: RMSE

Estimation period	**Forecasting period**	**h.step**	ARMA (1,1)	PC	NKPC	Real time PC1	Real time PC2	Real time PC3
1971-2000	2001-2012	12	0.432	0.661	0.561	0.611	0.631	0.623
1972-2001	2002-2012	11	0.454	0.664	0.564	0.636	0.673	0.675
1973-2002	2003-2012	10	0.436	0.654	0.549	0.678	0.687	0.695
1974-2003	2004-2012	9	0.467	0.675	0.575	0.674	0.647	0.609
1975-2004	2005-2012	8	0.458	0.688	0.588	0.647	0.684	0.671
1976-2005	2006-2012	7	0.492	0.655	0.545	0.630	0.603	0.601
1977-2006	2007-2012	6	0.488	0.696	0.536	0.681	0.618	0.677
1978-2007	2008-2012	5	0.442	0.672	0.552	0.622	0.639	0.619
1979-2008	2009-2012	4	0.441	0.698	0.589	0.634	0.643	0.640
1980-2009	2010-2012	3	0.487	0.673	0.573	0.691	0.611	0.619
1981-2010	2011-2012	2	0.456	0.666	0.556	0.652	0.625	0.625
1982-2011	2012-2012	1	0.421	0.643	0.563	0.637	0.607	0.638

7.5 Concluding Remarks

In this chapter we use the end of sample data and real time data for forecasting out of sample. The traditional *Philips curve (PC), NKPC* and univariate time series model *ARMA* is used for forecasting. After forecasting the inflation series we made a comparison of these techniques. For comparison purpose we apply different diagnostics tests. The diagnostic results indicated that the *ARMA* models is reasonable for forecasting purposes as compared to others using both end of sample data and real time data.

SUMMARY, CONCLUSIONS, AND POLICY RECOMMENDATIONS

8.1 Introduction

This chapter is divided in to three sections; first section give the brief introduction of this chapter and the second section will give the summary of the dissertation .The final conclusions and policy implications of this study will give in the third section.

8.2 Summary

It is the belief that price stability is a precondition for sustained growth and employment. Stabilizing prices generate long run benefits to the public and helps to increase growth rate of real output. Empirical work has shown high inflation rates are detrimental to long run growth (Bruno and Easterly, 1998) and entail welfare costs (Lucas, 2000). But bringing inflation down is no free lunch either and is usually associated with short run output losses (Ball, 1994). It is therefore important to understand sacrifice ratio (accumulated loss in output during disinflations divided by the overall fall in inflation).Thus inflation output trade off is important for central banks when formulating policy. To control the high inflation, tight monetary policy is adopted which can lower the speed of economic activity. This output loss can be considered as the price paid for restricting inflationary pressures. In this case, policy makers are eager in assessing the overall impact on the economy. So disinflation is a long standing issue, along with high inflation in Monterey economics. In this study we measured the sacrifice ratio at aggregate level by episode specific sacrifice ratio and time invariant sacrifice ratio. In episode specific method we used the Ball and Zhang method to measure the sacrifice ratio and in time invariant method we used the PC, structural VAR and the HNKPC to estimate the sacrifice ratio.

The NKPC is different from the traditional Philips curve in way that it incorporates the micro foundations that explain the nominal rigidities and price stickiness. Basically the NKPC relates the current inflation to the future inflation and the proxy of real economic activity. There is no lag inflation in the NKPC but the empirical findings suggest that inflation is highly persistent and this means that lag inflation explain most of the current inflation. On the other hand NKPC also shows that there is no cost of disinflation but the literature and history showed that disinflation is costly .To overcome all these problems, the lag inflation is incorporated in NKPC and hybrid NKPC was introduced in which it is assumed that few firms set the backward rule of thumb and rest of the firms behaved in forward looking manner.

This is also the fact that price adjustment varies across the different economic activities. This means that the duration of nominal rigidities varies one sector to another. Thus to see the variation in different sectors, sectoral NKPC is also estimated in this study. The monetary policy measures have a heterogeneous impact on the output of various sectors of the economy this shows that sacrifice ratio also varies in different sectors. In this study sectoral sacrifice ratio is also measured.

Monetary policy is more effective when it is forward looking (Faust and Wright (2013) and Svensson (2005)). Central banks forecast inflation considering all relevant factors. State Bank of Pakistan being central bank of the country can only have some control over the future inflation. This raises the importance of inflation forecasting in monetary policy making. There has been much interest in the recent literature regarding the effects of different data vintages on model specification and forecast evaluation. The use of real-time data in assessing predictability, as opposed to using final revised data, based on concerns that the use of final revised data may exaggerate the predictive power of explanatory variables relative to what could actually have been achieved at the time using the then available data .Keeping this importance issue in mind, we use both the real time data and the final revised data for inflation forecasting. We used the basic univariate time series model ARMA, PC and the NKPC in this study.

8.3 Conclusions and Policy Recommendations of the Study

For the empirical analysis of the study we used the annual time series of final revised data and real time data from 1971 to 2011. We found three disinflationary episodes in episode specific method at aggregate level. Sacrifice ratio is negative in one episode and the time duration of this episode is the period of late seventies to late eighties. Monetary policy during this period is contractionary. This mean reducing inflation has no output loss in this case. The other two episodes cover the period 1974-1978 and 1995-2002. The first disinflationary episode which started from 1974 till 1978 had positive sacrifice ratio, in this era and expansionary Monterey policy was adopted. During this period the government faced both internal and external problems; for example breakup of East Pakistan, oil price shocks decline in the aid flows floods, droughts and crop failures.

The third disinflationary episode covered the period 1995 and ended in 2002. The contractionary Monterey policy which was adopted in 1991 continued until 1999 However, after 1999 an expansionary Monetary policy was adopted. During this period economic growth decelerated due to the poor performance of in the manufacturing sector and stagnation in agriculture sector.

In the agriculture sector we found three disinflationary episodes and all three sacrifice ratios are positive. While in manufacturing and services sector we found four disinflationary episodes. In manufacturing sector we have three positive sacrifice ratio and one negative sacrifice ratio. In services sector we found two positive sacrifice ratios and two negative sacrifice ratios.

This study shows that estimates of sacrifice ratio are sensitive to different estimation methods. The main reason of output loss in different disinflationary episodes are not only due to tighter monetary policy but the government instability, institutional and structural factors in labor and product market also play major role.

The analysis shows that tighter monetary policy has small welfare loss and the key policy implication from this study is that the comparatively smaller sacrifice ratio makes it helpful for policy makers to try to cut inflation to single digit without fear of considerable output reduction. This leads towards the policy of inflation targeting as the short run cost of falling inflation is low and inflation targeting may be an option for the SBP.

Sacrifice ratio in manufacturing sector is comparatively large as compared to the agriculture sector and services sector, this show that manufacturing sector is directly affected by monetary policy tools. Thus monetary policy measures have a heterogeneous impact on the output of various sectors of the economy and the contractionary monetary shocks are more harmful to output growth in the non-farm sector whereas disinflation does not seem to have affected output growth in the farm sector.

The NKPC at aggregate level shows that past inflation overcomes the future inflation in inflation determination equation and the output gap as a proxy of real economic activity plays a significant role. Past inflation is dominated by the future inflation at aggregate level means that economic agents suffer from inertia and they are myopic and do not consider future important in forming their expectations. This means the price setters have backward looking behaviour.

The results at sectoral level confirm that the heterogeneity in data matters. In the agriculture and services sector past inflation played an important role in the inflation equation as compared to the future inflation. In the manufacturing sector future inflation is dominated by past inflation while the output gap is significant in each sector

The inflation forecasting results show that univariate time series model is better than the Philips curve and the NKPC. While the real time output gaps don't help in forecasting inflation in this study and these results are similar to Clausen and Clausen (2010). All this show that real time data forecasting is not helpful in inflation forecasting as compared to the final revised data.

References

Abbas, S. K., and Sgro, P. M. (2011). New Keynesian Phillips curve and inflation dynamics in Australia. *Economic modelling*, 28(4), 2022-2033.

Ahsan ul Haq Satti, Malik, W. S., and Saghir, G. (2007). New Keynesian Phillips curve for Pakistan. *The Pakistan Development Review*, 395-404.

Akbari, A., and Rankaduwa, W. (2006). Inflation targeting in a small emerging market economy: The case of Pakistan. *SBP Research Bulletin*, 2(1), 169-190.

Andersen, P. S., and Wascher, W. L. (1999). *Sacrifice ratios and the conduct of monetary policy in conditions of low inflation*. Bank for International Settlements, Monetary and Economic Department, working paper (82).

Andrews, D. W. (1994). Empirical process methods in Econometrics, *Handbook of Econometrics*, (4), 2247-2294.

Antipin, J. E., and Luoto, J. (2008). *Forecasting performance of New Keynesian model*. Working paper (451), Helsinki School of Economics.

http://epub.lib.aalto.fi/pdf/wp/w451.pdf

Arby, M. F. (2001). *Long-run trend, business cycles and short-run shocks in real GDP*. SBP Working Paper (1).

Arnold, J.M. Ivo, and Evert B. Vrugt. (2002). Regional effects of monetary policy in the Netherlands. *International Journal of Business and Economics* 1(2), 123–34.

Ascari, G., and Marrocu, E. (2003). Forecasting inflation: a comparison of linear Phillips curve models and nonlinear time series models.

http://crenos.unica.it/crenos/node/193

Ascari, G., and Ropele, T. (2012). Sacrifice Ratio in a Medium-Scale New Keynesian Model. *Journal of Money, Credit and Banking*, *44*(2), 457-467.

Atkeson, A., and Ohanian, L. E. (2001). Are Phillips curves useful for forecasting inflation? *Federal Reserve Bank of Minneapolis Quarterly Review*, 25(1), 2-11.

Ball, L. (1994). *What determines the sacrifice ratio?* in *Monetary Policy* . 155-193 University of Chicago Pres, 155-182.
www.nber.org/chapters/c8332

Barnett, C. Richard, David A. Bessler, and Robert L. Thompson.(1983). The money supply and nominal agricultural prices. *American Journal of Agricultural Economics* (65), 303–7.

Bernanke, B. (1986). *Alternative explorations of the money-income correlation*. Camegie-Rochester Conference Series on Public Policy. Amsterdam: North-Holland,49-99.
http://www.princeton.edu/~erp/ERParchives/archivepdfs/M321.pdf

Bils, M. (1987). The cyclical behavior of marginal cost and price. *The American Economic Review*, 838-855.

Blanchard, O. J., and Quah, D. (1989). The dynamic effects of aggregate demand and supply disturbances. *American Economic Review*,*79*(4), 655-673

Blanchard, O. J., and Quah, D. (1993). The dynamic effects of aggregate demand and supply disturbances: Reply. *American Economic Review*,*83(3)*, 653-658.

Blanchard, O. J., and Watson, M. W. (1986). *Are business cycles all alike?*. in The American business cycle: Continuity and change. University of Chicago Press,123-180.
www.nber.org/chapters/c10021.pdf

Blinder, A. S. (1997). Is there a core of practical macroeconomics that we should all believe?. *The American Economic Review*, 87(1), 240-243.

Bokhari, S. H., and Feridun, M. (2006). Forecasting inflation through econometric models: an empirical study on Pakistani data. *Doğuş Üniversitesi Dergisi*, 7(1), 39-47.

http://openaccess.dogus.edu.tr/bitstream/handle/11376/432/bokhari.pdf?sequence=1

Brito, R. D., and Bystedt, B. (2010). Inflation targeting in emerging economies: Panel evidence. *Journal of Development Economics*, *91*(2), 198-210.

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

Buiter, W. H., and Grafe, C. (2001). No pain, no gain? The simple analytics of efficient disinflation in open economies.
www.willembuiter.com/flate.pdf

Byrne, J. P., Kontonikas, A., and Montagnoli, A. (2010). The time series properties of UK inflation: evidence from aggregate and disaggregate data. *Scottish Journal of Political Economy*, 57(1), 33-47.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics* 12 (3), 383-398.

Campell, J. Y., and Shiller, R. J. (1987). Cointegration and tests of present value models. *Journal of Political Economy*, (95), 1062–1088.

Canova, F. (2007), G7 Inflation Forecasts: Random Walk, Phillips Curve or What Else?, *Macroeconomic Dynamics*, 11(1): 1-30.

Carlino, Gerald, and Robert Defina. (1998). The differential regional effects of monetary policy,. *The Review of Economics and Statistics* 80(4): 572–87.

Cecchetti, S. G., and Rich, R. W. (2001). Structural estimates of the US sacrifice ratio. *Journal of Business and Economic Statistics*, *19*(4), 416-427.

Çetinkaya, A. A., and Yavuz, D. (2002). *Calculation of Output-Inflation*

Sacrifice Ratio: The Case of Turkey. Document de travail, Research Department of the Central Bank of the Republic of Turkey. https://ideas.repec.org/p/tcb/wpaper/0211.html

Chaudhry, M. A., and Choudhary, M. A. (2006). Why the State Bank of Pakistan should not adopt inflation targeting. *SBP Research Bulletin*, *2*(1), 195-209.

Clausen, J., and Clausen, B. (2010). *Simulating Inflation Forecasting in Real-Time: How Useful Is a Simple Phillips Curve in Germany, the UK, and the US?*. IMF Working Papers, 1-21.

Clements, M. P., and Galvão, A. B. (2013). Real-Time Forecasting of Inflation And Output Growth With Autoregressive Models In The Presence Of Data Revisions. *Journal of Applied Econometrics*, *28*(3), 458-477.

Coffinet,J.(2007). Estimating the sacrifice ratio for the euro area. *Banque de France Bulletin Digest*, 160.

https://www.banque-france.fr/fileadmin/user_upload/banque_de_france/Economists_and_researchers/160etud1.pdf

Croushore, D. (1997). The Livingston Survey: still useful after all these years. *Business Review-Federal Reserve Bank of Philadelphia*, *2*(1).

Croushore, D. (2010). An Evaluation of Inflation Forecasts from Surveys UsingReal-time Data. *The BE Journal of Macroeconomics*, *10*(1).

Croushore, D., and Stark, T. (2001). A Real-time Data Set for Macroeconomists:.*Journal of econometrics*, 105(1), 111-130.

Croushore, D., and Stark, T. (2003). A Real-time Data Set for Macroeconomists: Does the Data Vintage Matter?,. *Review of Economics and Statistics*, 85(3), 605-617.

Cuñnado, J., and De Gracia, F. P. (2003). Sacrifice Ratios: Some Lessons from EMU countries, 1960-2001,. *International Review of Applied Economics*, *17*(3), 327-337.

Dandan Liu and Dennis Jansen,(2011). Phillips curve Does a Factor help? An Evaluation of the Predictive Power for U.S. Inflation, *Empirical Economics*, 40(3), 807-826.

Dean Croushore,(2008). Frontiers of Real-time Data Analysis, Federal Reserve Bank of Philadelphia,. Working Papers, (8).

Direkçi, T. B. (2011). Determination of the sacrifice rate in Turkey, Brazil and Italy: A comparison among countries. *Journal of Development and Agricultural Economics*, *3*(7), 335-342.

Doll, J. Raymond,.(1958). Some Implications of Monetary Policy on Agriculture. *Journal of Farm Economics*, 40(1), 21–9

Durai, S. R. S., and Ramachandran, M. (2013). Sectoral Effects of Disinflation: Evidence from India. *Macroeconomics and Finance in Emerging Market Economies*, *6*(1), 77-87.

Durand, J. J., Huchet-Bourdon, M., and Licheron, J. (2008). Sacrifice ratio Dispersion Within the Euro Zone: What can be Learned About Implementing a Single Monetary Policy?. *International Review of Applied Economics*, *22*(5), 601-621.

Enders, W. (2008). *Applied econometric Time series*. John Wiley & Sons.

Faust, J., and Wright, J. H. (2013). Forecasting inflation. *Handbook of Economic Forecasting*, *2*(Part A), 3-56.

Felipe, J. (2009). Does Pakistan need to adopt inflation Targeting? Some questions. *SBP Research Bulletin*, *5*(1), 113-161.

Feridun, Mete et al. (2006) *Forecasting Inflation in Developing Nations: The Case of Pakistan*, MPRA Paper(1024), 1-29.

Feve, P., Matheron, J., and Sahuc, J. G. (2010). Disinflation Shocks in the Euro zone: A DSGE perspective. *Journal of Money, Credit and Banking*, *42*(2), 289-323.

Filardo, A.J. (1998). New Evidence on the Output Cost of Fighting Inflation, *Federal Reserve Bank of Kansas City Economic Review*, 83 (3), 33-61.

Friedman, M. (1968). The Role of Monetary Policy. *American Economic Review* 58(1), 1-17.

Fuhrer, J. and G. Moore (1995). Inflation Persistence. *Quarterly Journal of Economics* 110 (1), 127-159.

Gali, J. and M. Gertler (1999).Inflation Dynamics: A structural Econometric Analysis. *Journal of Monetary Economics* 44 (2), 195-222.

Gali, J, M. Gertler and J. D. Lopez-Salido (2001). European Inflation Dynamics. *European Economic Review* 45 (7), 1237-1270.

Gordon, R. J., King, S. R., and Modigliani, F. (1982). The output cost of disinflation in traditional and vector autoregressive models. *Brookings Papers on Economic Activity*, 205-244.

Guerin, P., Maurin, L., and Mohr, M. (2015). Trend-cycle Decomposition of Output and Euro Area Inflation Forecasts: A Real-time Approach Based on Model Combination. *Macroeconomic Dynamics*, 19(2), 363-393.

Hamilton, J. D. (2011). Calling recessions in real time. *International Journal of Forecasting*, 27(4), 1006-1026.

Hansen, L. P., and Sargent, T. J. (1982). Instrumental Variables Procedures for Estimating Linear Rational Expectations Models. *Journal of Monetary Economics*, *9*(3), 263-296.

Hodrick, Robert J., and Edward C. Prescott (1997), Postwar U.S. Business Cycles: An Empirical Investigation, *Journal of Money, credit, and Banking*, 1-16. C

Hutchison, M. M., and Walsh, C. E. (1998). The Output-Inflation Trade-off and Central Bank Reform: Evidence from New Zealand. *The Economic Journal*, *108*(448), 703-725.

Ibrahim, H. Mansor,(2005). Sectoral effects of monetary policy: Evidence from Malaysia. *Asian Economic Journal* 19(1): 83–102.

Imbs, J, E. Jondeau and F. Pelgrin(2011). Sectoral Phillips curves and the aggregate Phillips curve. *Journal of Monetary Economics* 58(4), 328-344.

Isaac, G. Alan, and David E. Rapach. (1997). Monetary Shocks and Real Farm Prices: A Re-examination. *American Journal of Agricultural Economics* (79): 1332–39.

Jean-Baptiste, F. (2012). Forecasting with the new Keynesian Phillips curve: Evidence from survey data. *Economics Letters*, 117(3), 811-813.

Jondeau, E., and Le Bihan, H. (2005). Testing for the New Keynesian Phillips curve. Additional International Evidence, *Economic Modelling*, *22*(3), 521-550.

Kapur, M and Patra, M D (2000), *The price of low inflation*, Reserve Bank of India Occasional Papers, 21(2), 191-233.

Khalid, A. M. (2006). Is Inflation Targeting the Best Policy Choice for Emerging Economies? A Survey of Emerging Market Experiences and Lessons for Pakistan. *SBP Research Bulletin*,(*2),* 145-165.

Kichian, M., and F. Rumler (2014), Forecasting Canadian Inflation: A Semi-Structural NKPC Approach, *Economic Modeling*, (43): 183-426.

Leith, C. and J. Malley (2007). A Sectoral Analysis of Price-setting Behavior in US manufacturing industries. *Review of Economics and Statistics* 89 (2), 335-342.

Liu, D., and Jansen, D. W. (2007). Macroeconomic Forecasting Using Structural Factor Analysis. *International Journal of Forecasting*, *23*(4), 655-677.

Lucas, R. E. (1972). Expectations and the Neutrality of Money. *Journal of EconomicTheory*, *4*(2), 103-124.

Lucas, R. E. (1973). Some international evidence on output-inflation tradeoffs. *The American Economic Review*,(63), 326-334.

Lucas, R. E. (2000). Inflation and welfare. *Econometrica*, *68*(2), 247-274.

Mankiw, N. G. (2001). The Inexorable and Mysterious Trade-off Between Inflation and Unemployment. *The Economic Journal*, *111*(471), 45-61.

Mark Bils and Peter J. Klenow,(2004). Some Evidence on the Importance of Sticky Prices, *Journal of Political Economy*, 112(5), 947-985.

Matheson, T. D. (2008). Phillips curve Forecasting in a Small Open Economy. *Economics Letters*, *98*(2), 161-166.

Mazumder, S. (2014). Determinants of the Sacrifice Ratio: Evidence from OECD and non-OECD countries. *Economic Modelling*, (*40)*, 117-135.

Mitra, P., Biswas, D., and Sanyal, A. (2014). Estimating Sacrifice Ratio for Indian Economy–A Time Varying Perspective. *Annual Statistics Conference of the RBI, Jaipur ,*. 25-26.

Moinuddin (2007). Choice of Monetary Policy Regime: Should SBP Adopt Inflation Targeting. *SBP Working Paper* (19).

Oi, W. Y. (1962). Labor as a quasi-fixed factor. *The Journal of Political Economy*, 538-555.

Okun, A. M. (1978). Efficient disinflationary policies. *The American Economic Review*,68(2), 348-352.

Onder, A. O. (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., and Van Norden, S. (2002). The unreliability of output-gap estimates in real time. *Review of Economics and Statistics,* 84(4), 569-583.

Orphanides, Athanasios and van Norden, Simon,(2005). The Reliability of Inflation Forecasts Based on Output Gap Estimates in Real Time*, Journal of Money, Credit and Banking*, 37(3), 583-601.

Petrella, I., and Santoro, E. (2012). Inflation dynamics and real marginal costs: new evidence from US manufacturing industries. *Journal of Economic Dynamics and Control*, *36*(5), 779-794.

Phelps, E. S. (1968). Money Wage Dynamics and Labour-Market Equilibrium. *Journal of Political Economy* 76 (4), 678-711.

Phillips, A. W. (1958). The RelationBbetween Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957 . *Economica* 25 (100), 283-299.

Qayyum, A. (2006). Money, Inflation, and Growth in Pakistan. *The Pakistan Development Review*, 203-212.

Robinson, T, A Stone, and M van Zyl (2003), *The Real-time Forecasting Performance of Phillips curves*, Reserve Bank of Australia, Discussion Paper,(12).

http://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.rba.gov.au%2Fpublications%2Frdp%2F2003%2Fpdf%2Frdp2003-12.pdf;h=repec:rba:rbardp:rdp2003-12

Rotemberg, J. J. (1982). Sticky Prices in the United States. *Journal of Political Economy* 90(6), 1187-1211.

Rotemberg, J. J., and Woodford, M. (1999). The Cyclical Behavior of Prices and Costs. *Handbook of Macroeconomics*, (*1)*, 1051-1135.

Roux, N. D., and Hofstetter, M. (2014). Sacrifice ratios and Inflation Targeting: the Role of Credibility. *International Finance*, 17(3), 381-401.

Rudd, J. and K. Whelan (2005). New tests of the new-Keynesian Phillips curve. *Journal of Monetary Economics* 52 (6): 1167-1181.

Rudd, J. and K. Whelan (2006). Can rational expectations sticky-price models explain inflation dynamics?. *American Economic Review* 96 (1), 303-320.

Rudd, J. and K. Whelan (2007). Modeling inflation dynamics: A critical review of recent research."*Journal of Money, Credit and Banking*, Supplement 39(1), 155-170.

Rumler, F., and Valderrama, M. T. (2010). Comparing the New Keynesian Phillips Curve with Time Series Models to Forecast Inflation. *The North American Journal of Economics and Finance*, *21*(2), 126-144.

Ryder, B. (2007). The Australian Phillips Curve in the Long Run. *Australian meeting. of the Econometric Society* ,1-16. https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=ESAM07&paper_id=239

Saeed, S. K., and Riaz, K. (2011). Phillips Curve: Forward or Backward Looking?. *World Applied Sciences Journal*, 16(4),516-522.

Samuelson, P. A., and Solow, R. M. (1960). Analytical Aspects of Anti-Inflation Policy. *The American Economic Review*,(2), 177-194.

Saunders, J. Peter. (1988). Causality of U.S. Agriculture Prices and the Money Supply: Further empirical evidence. *American Journal of Agricultural Economics* 70(3), 588–96.

Serju, P. (2009). Estimating theOoutput Cost of Disinflation: An Application to Jamaica , Trinidad and Tobago. *Journal of Business, Finance and Economics in Emerging Economies*, *4*(1).

Sheedy, K.(2007). Inflation Persistence When Price Stickiness Differs Between Industries. Centre of Economic Performance Discussion Paper (838).http://personal.lse.ac.uk/sheedy/papers/HeterogeneousPriceStickiness.pdf

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica* 48(1), 1-48.

Sims, C. A. (1986). Are forecasting models usable for policy analysis?. *Federal Reserve Bank of Minneapolis Quarterly Review*, *10*(1), 2-16.

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

Stark, T., and Croushore, D. (2002). Forecasting with a Real-time Data set for macroeconomists. *Journal of Macroeconomics*, *24*(4), 507-531.

Stock, J. H., and Watson, M. W. (2008). *Phillips curve inflation forecasts*. National Bureau of Economic Research,. Working paper (14322).

Taylor, J. B. (1980). Aggregate Dynamics and Staggered Contracts. *Journal of Political Economy* 88(1), 1-23.

Wasim ,M and Badar, N. (2015). Measuring Business Cycle and Inflation Forecast. *Research Journal of Finance and Accounting* .6,(.9),22-34.

Zhang, L H, (2001), Sacrifice Ratios with Long-Lived Effects Johns Hopkins University, Department of Economics.
http://krieger2.jhu.edu/economics/wpcontent/uploads/pdf/papers/all4202001.pdf

Zhang, L. H. (2005). Sacrifice Ratios with Long-Lived Effects. *International Finance*, *8*(2), 231-262.

Zhang, C, D. R. Osborn, and D. H. Kim (2008). The New Keynesian Phillips curve: From Sticky Inflation to Sticky P rices. *Journal of Money, Credit and Banking* 40(4), 667-699.

Zhang, C, D. R. Osborn, and D. H. Kim (2009), Observed Inflation Forecasts and the New Keynesian Phillips curve, *Oxford Bulletin of Economics and Statistics* 71 (3), 375-398.

Zhang, C., and Murasawa, Y. (2011). Output Gap Measurement and the New Keynesian Phillips curve for China. *Economic Modelling*, *28*(6), 2462-2468.

APPENDIX

We use the following ADF equation for unit root test

$$\Delta\pi_t = \alpha + \delta\pi_{t-1} + \sum_{i=1}^{p} \Delta\pi_{t-i} + u_t$$

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{p} \Delta y_{t-i} + u_t$$

Table1 Unit Root Result of Inflation and Output Gap (aggregate level)

	Calculated value at level		Critical Value	Remarks
	Inflation rate	**Output Gap**		
ADF test	-3.49 (0.02)	-3.90 (0.01)	-2.936	stationary
PP test	-3.57 (0.01)	-3.93 (0.00)	-2.936	Stationary

*P-values are given in parenthesis

The table 1 shows that both the inflation rate and output gap are stationary at level so there is no co-integration between these two variables.

Table 2 Unit Root Results of CPI and Output (aggregate level)

	Calculated value at level		Calculated value at first difference		Critical Value	Remarks
	CPI	**OUTPUT**	**CPI**	**OUTPUT**		
ADF test	-0.54 (0.65)	-1.67 (0.49)	-4.27 (0.02)	-5.78 (0.00)	-2.936	Stationary at first difference
PP test	-1.11 (0.70)	-1.43 (0.57)	-3.35 (0.01)	-5.38 (0.01)	-2.936	Stationary at first difference

*P-values are given in parenthesis

Table 3 Unit Root Result of Inflation and Output Gap (Services sector)

	Calculated value At level		Critical Value	Remarks
	Inflation rate	**Output Gap**		
ADF test	-4.55 (0.01)	-10.59 (0.00)	-2.936	Stationary
PP test	-4.60 (0.00)	-21.02 (0.00)	-2.936	Stationary

*P-values are given in parenthesis

Table4 Unit root result of inflation and output gap (Manufacturing sector)

	Calculated value At level		Critical Value	Remarks
	Inflation rate	**Output Gap**		
ADF test	-5.11 (0.02)	-16.72 (0.00)	-2.936	Stationary
PP test	-5.13 (0.01)	-12.19 (0.00)	-2.936	Stationary

*P-values are given in parenthesis

Table5 Unit Root Result of Inflation and Output Gap (Agriculture sector)

values → Tests ↓	Calculated value At level		Critical Value	Remarks
	Inflation rate	**Output Gap**		
ADF test	-4.29 (0.01)	-5.36 (0.00)	-2.936	Stationary
PP test	-4.42 (0.00)	-5.51 (0.00)	-2.936	Stationary

*P-values are given in parenthesis

Table 3, 4 and 5 show that both the inflation rate and output gap are stationary at level so there is no co-integration between these two variables.

The summary of sacrifice ratio calculated by different methods at aggregate level as well as at sectors level are given in table (5.17) and (5.18)

Table 6 Sacrifice Ratio (Constant over time)

	Ball method				Zhang method			
	Episode 1	Episode 2	Episode 3	Episode 4	Episode 1	Episode 2	Episode 3	Episode 4
Aggregate level	0.13	-0.03	0.72		0.16	-0.02	4.32	
Agriculture sector	0.40	0.16	0.42		1.17	0.19	1.80	
Manufacturing sector	0.48	0.44	-0.51	0.22	1.20	1.74	-0.90	3.56
Services sector	0.34	-0.46	-0.08	0.15	1.72	-2.36	-0.64	0.25

Table 7 Sacrifice Ratio (Time Invariant Method)

	Aggregate level	**Agriculture sector**	**Manufacturing Sector**	**Services sector**
PC	1.46	0.29	0.06	0.13
SVAR	0.53	0.04	0.05	0.08
HPC	1.22	1.47	1.40	1.87

Comparison of model estimates using real time data and end of sample data

Table7 Philips Curve estimates

	Output gap using Linear trend	Output gap using Quadratic trend	Output gap using H-P Filter
Real time data	0.203*	0.369*	0.408*
Revised data	0.04	0.06*	0.67*

* shows that output gap is significant at 5% level of significance

The output gap estimates of Philips curve shows that PC is significant important both in real time data as well as revised data.

Table 8 New Keynesian Philips Curve estimates

	Output gap using Linear trend	Output gap using Quadratic trend	Output gap using H-P Filter
Real time data	0.81	0.05	0.105
Revised data	0.192	0.106*	0.819*

* shows that output gap is significant at 5% level of significance

The output gap estimates of NKPC shows that NKPC is significant important in revised data but the real time output gaps are not statistically significant.

On the average percentage difference between the real time output data and revised output data is 4.8%.

GMM Estimation Steps

To obtain GMM estimates in E-views, we first specify the orthogonality condition using the instruments used in the equation. For the GMM estimator to be identified, there must be at least as many instrumental variables as there are parameters to estimate. E-Views will, by default, add a constant to the instrument list. We use first and second lag of inflation, labour share, output gap, call money rate, wage inflation and CPI inflation as instruments. We estimate the following NKPC using this instrument list

$$\pi_t \quad Y_t \ \ (\pi_{t+1})$$

Instrument list z_{it}= first and second lag of inflation, labour share, output gap, call money rate, wage inflation and CPI inflation.

The orthogonality conditions are as

$$\sum(\pi_t - c(1)y_t - c(2)\pi_{t+1}) = 0$$

$$\sum(\pi_t - c(1)y_t - c(2)\pi_{t+1})z_{it} = 0$$

We Check the Time Series (HAC) Weighting Matrix and these GMM estimates robust to heteroskedasticity and autocorrelation of unknown form. As we are estimating the linear equation so we use the N-Step Iterative. The estimated results are given below

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(1)	1.096920	0.053013	20.69160	0.0000
Y1	0.136383	0.041518	3.284941	0.0024

R-squared	0.142256	Mean dependent var	9.387627
Adjusted R-squared	0.175852	S.D. dependent var	4.560539
S.E. of regression	4.945298	Sum squared resid	831.5030
Durbin-Watson stat	2.231286	J-statistic	5.114804
Instrument rank	13	Prob(J-statistic)	0.925479