

**ADOPTING INFLATION TARGETING AND  
EXCHANGE RATE VOLATILITY IN CASE OF  
PAKISTAN**



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## CERTIFICATE

This is to certify that this thesis entitled: "Adopting Inflation Targeting and Exchange Rate Volatility in Case of Pakistan" submitted by Ms. Iqra Waheed is accepted in its present form by the Department of Economics & Econometrics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of Master of Philosophy in Economics.

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## **Abstract**

Recently in Pakistan inflation rate is moving upward day by day. Targeting inflation is used as an option for the monetary policy as through it there is a possibility of achieving the stability of prices and the growth. Purpose of this study is to evaluate the policy of inflation targeting in Pakistan and to investigate whether policy of inflation targeting leads to higher exchange rate volatility. For evaluating the policy of inflation targeting, yearly data from 1970 to 2019 has been used in the VAR model, and for investigating the volatility in exchange rate, monthly data from 2000 to 2019 has been used in GARCH (1, 1) model. Results suggest that the policy of targeting inflation through interest rate as an instrument has positive impact on the control of inflation and the output level of the economy as well the volatility in inflation leads to higher volatility in exchange rate.

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## **LIST OF ABBREVIATIONS**

IT= Inflation targeting

ERPT = Exchange rate pass through

SBP = State Bank of Pakistan

CB = Central Bank of Pakistan

WB= World Bank

IMF = International monetary fund

IFS = International Financial Statistics

# Chapter 1

## Introduction

The monetary policy objectives are to stabilize the prices and also the real economic activity and the financial sector of the economy. For achieving these objectives optimal monetary policy is required. Optimal monetary policy stabilizes the inflation rate to a low average level and stabilizes the real economic activity. The important issue in framing the monetary policy is the choice of variables to be targeted. The choice variables include the measures of the real activity, relative currency prices and the prices. The measure of real activity can be the output gap and the real GDP growth rate.

It is not possible to sustain high growth rate for a long period through loose monetary policy. For the stability of the prices, different aggregate measures can be targeted which include WPI, CPI, weighted average of commodity prices and GDP deflator. Mostly in the world, CBs use inflation rate instead of the price level for policy target. As for the stability of the prices, relative price of a currency also has aggregate measures that include spot nominal exchange rate, real effective exchange rate or nominal effective exchange rate. The variable choice depends on whether the policy maker is forward looking or not. For the policy of forward looking, the future forecasts of targeted variables of rule are on the right hand side. But backward looking includes only the lag variables Saleem (2010).

Both the exchange rate and inflation are the important elements of the macroeconomics. Inflation is basically the upsurge in the goods and services prices in the economy with time. While exchange rate is also a key factor as it influences the imports and exports. The fluctuations in the

exchange rate are not desired by a country as it affects the imports and exports that are part of the fiscal policy. The goal of the policy makers is to hold the rate at a level to attain the growth that is the goal of the domestic policy. Inflation is also the important indicator of a country that provides information and also the policies of the economy. The prevailing monetary policy is discretionary and it is focusing on the inflation.

Many countries have opted the policy of targeting rules in the last decades and the results are promising. Inflation Targeting has advantage of transparency for public as in exchange rate targeting and the monetary aggregates directing. Bernanke et al. (1999) describes this policy of targeting inflation as “targeting inflation is framework of the monetary policy that sets the quantitative target and is announced publically and the long term goal is low and stable inflation.

### **1.1 Policy of targeting inflation**

This Policy has started many years ago. This was adopted firstly by New Zealand in 1989. It is basically done to maintain the inflation at some announced level. In the policy of IT the main variable is interest rate through which inflation can be controlled or maintained at a certain level. CB has the authority of managing interest rate. Many countries had adopted this policy of targeting inflation. It includes many economies that are undeveloped economies and the emerging ones that had the floating exchange rate for anchoring the expectations of inflation. Recently many developing economies have opted this policy of targeting inflation that includes Poland, Israel, Hungary and Chili. Chile achievement of the successful policy targeting had initiated the discussion of the other way for the CB to opt in the developing countries.

## 1.2 In context of Pakistan

For very long time inflation was not an issue for the policy makers in Pakistan as it was moderate. Except in 1970s when there was an inflation tremor and recent rise in the prices. One way association between the growth of the money and the aggregate demand was assumed by the SBP. There was no policy for the supply of money, only safe limits existed. SBP acted according to the fiscal policy, as according to rate of growth and the inflation in an economy.

The following graph displays the rate of inflation in Pakistan from 1960 onward to 2020.

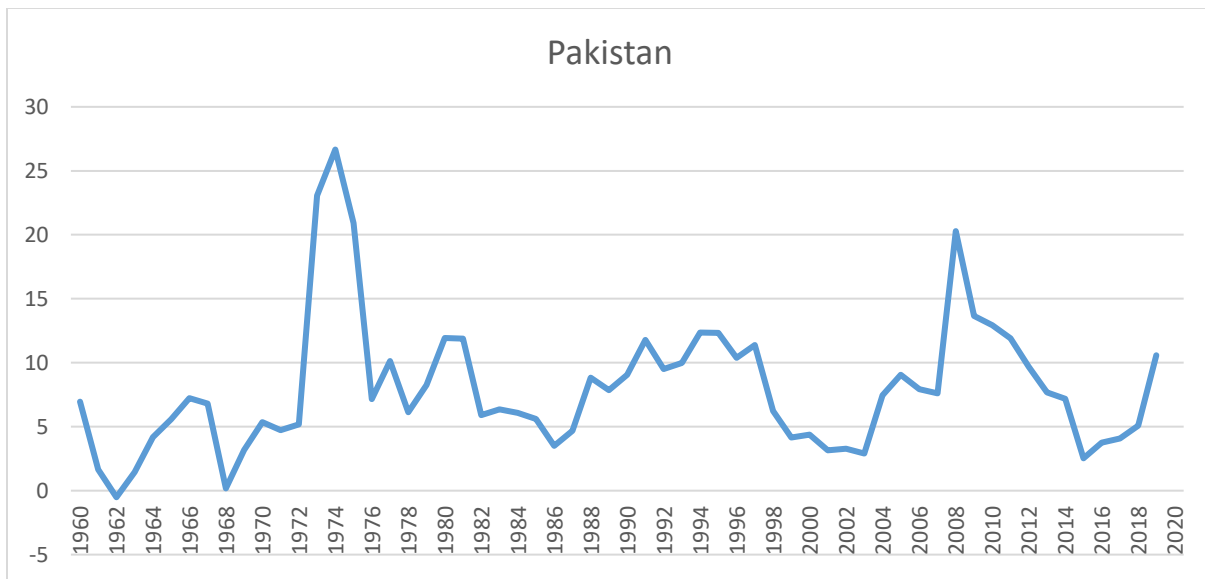


Figure 1 source: [www.worldbank.org](http://www.worldbank.org)

According to the analysis rate of inflation in Pakistan is satisfactory. In 1970's average of 11.9% persisted, but it demolished to 7.5% in the 1980's again in 1990's there was an uplift and inflation became 9.7%. Afterwards in the period of 2000 to 2008 average of rate of inflation was 6.4. From 2008-16 it kept on declining to 2.6 and 2016 onward it has started increasing again. There was a hasty rise in the prices of oil, scarcity of the wheat, rise in the supply of money, rise in rate of

growth of the commercial banks and there was an uplift in the accessibility of the credit to the private sector. These are some of the main aspects that caused the rate of inflation to surpass the average value. But in Pakistan high inflation does not stay for a long period and it approves the theory of inflation that inflation is short-lived.

### **1.3 Preconditions for targeting inflation in Pakistan**

In the whole world before East Asian crisis gold and silver were used as a standard. But after the crisis of East Asia, monetary policy was diverted towards targeting inflation. Some of the economies are targeting inflation and some are non targeters. In this section we will examine the preconditions for targeting inflation and performance of the developing countries that are targeting inflation.

The conditions required for the adoption of the IT are as follows:

- i. Solid promise of price stability.
- ii. Set some approachable target of inflation.
- iii. Set time span in which target is to be achieved.
- iv. CB must be autonomous and there must be transparency and accountability for achieving the desired targets.

### **1.4 Condition of Pakistan for the adoption of IT**

Pakistan is facing bad economic conditions currently due to the miserable condition in the whole world. It has become very important to revise the policies to overcome this critical situation. In 1993 SBP was given autonomy that is the CB. SBP had opted the policy of floating the exchange rate free in 2001, which means that state bank tried to opt to the policy that is based on the market. At that time debate on the implementation of targeting inflation in Pakistan was started. Learning

from other countries experience of targeting inflation we know the conditions for targeting inflation that includes high rate of inflation, low supremacy of fiscal policies, soundness of the financial markets, independence of the CB to choose the monetary policy according to the prevailing situation, commitment by the CB must be strong and information must be disseminated to the public by which they can form expectations. And lastly the nominal anchor must be the one that strongly affects the rate of inflation. We will check the existence of these circumstances in Pakistan.

- The inflation rate in Pakistan currently in 2020 has increased 11.22% as compared to the previous year 2019, while in the previous year it increased 6.74% from the previous year. While in the time period of 1970 to 2019 the average of the rate of inflation was 9.68% with 7.58 standard deviation in the inflation rate. It means that inflation in Pakistan is very high and there is high volatility in it which can impact the output growth negatively. So there is a need that SBP must opt to the tight monetary policy for the uplift of the output in the economy.
- In the policy of targeting inflation selection of the nominal anchor is of huge importance. In Pakistan SBP, for controlling inflation was using broad money as a nominal anchor. The main reason for the expansion of money supply in Pakistan is the repayment of the debt due to which control of the CB to control prices by using broad money as a nominal anchor has vanished away. So M2 cannot be used as an instrument of targeting inflation, as it has cointegration with the inflation only in the short run or only with one lag but do not have any link with more than 1 lag. So there is a need to opt better instrument as an indicator for the adoption of the targeting inflation rule. The variable that can be used in Pakistan as an anchor can be exchange rate, as it is also used by many developing countries. As in Pakistan

we are already following the flexible exchange rate system. There are many evidences of Pakistan that demonstrate a very small pass through of exchange rate to the prices while any increase in the inflation rate passes to the interest rate due to which exchange rate faces depreciation. Interest rate of the short run is another variable which can be used as a policy instrument. As inflation and call money rate have causation in both directions in case of Pakistan. As we analyze the interest rate in Pakistan it was mostly retained at a low level while the inflation remained high that affects the output adversely. It is used as a policy instrument as it is significantly related to the rate of inflation. So for adjusting the level of inflation in the economy rate of interest can be used. But there are rigidities in interest rate as it affects the level of debt and the growth. SBP is mostly unwilling to change the rate of interest, it does not changes with policy but only changes with the situations of the financial market.

## **1.5 Financial markets conditions in Pakistan**

Financial markets of Pakistan are very infantile. It consists of the money market, forex market and the capital market. There are 3 stock markets of the capital market that are located in Islamabad, Karachi and Lahore. As there are very few investors in the capital market so the volatility in the market is very high. While money market consists of the banking zone. There are total of 79 banks operating in Pakistan in 2019. While population of 20% only have bank accounts. Most of the branches of banks are located in urban areas. As a study shows that population of 40% does not have access to the financial institutions (Nenova et al., 2009).

Banks had been very much benefitted from the rigid interest rates. Reforms of the financial sectors and the banks were started in 1990 with the assistance of the WB and the International Monetary Fund. Purpose of reforms was to cut the cost of financial intermediation. And also to



decrease the dependence of the government on borrowing from banks. But the pace of growth was slow due to the growing seignorage, high interest rate and the volatility in the rate of inflation. Financial sector that can regulate by itself conferring the conditions in the market is requirement for the adoption of the targeting inflation policy. If the market is not integrated properly than it will be a hurdle for targeting inflation. Markets are the source of signal to the investors, if there is any distortion in it will bring severities. While the struggle for removing these severities is not successful completely.

### **1.6 SBP independence:**

It is mostly said that CB is independent in its actions, but it's not really true. In fact the SBP is highly affected by the decisions imposed by the government as most of the CBs. Although there is a need to coordinate the monetary policy and the fiscal policy for the developing countries. But the goal of the CB of stabilizing the prices must not be forgiven for the sake of controlling the growth in inflation trends. SBP was given autonomy in 1993 but it is still being diluted by the ministry of finance. Some measures were opted for the stability of the economy, which includes 2004 act of fiscal responsibility and debt limitation Act. But it was unable to control the borrowing of government from SBP. Regime of exchange rate was altered to floating system for the improvement of the competitiveness of exports and deteriorating the reliance on the inflows from external sources. Most of the time the plan of the government for growth is a hindrance in stabilizing the prices by SBP. There is a tightening of the monetary policy whenever government is unable to get foreign sources finance that may be the remittances or the debt from IMF. For financing the governments loans SBP has retained the low interest rate due to which investment and the credit availability was affected adversely. We can measure the independence of the CB by

seeing the dominance of the fiscal policy. Seigniorage is used as proxy of fiscal dominance, it has very high standard deviation. It means there is a need to minimize the dominance of fiscal side. And also to wipe out the fragility of the financial markets as it limits the availability borrowing from the nonbanks.

### **1.7 Volatility in Inflation and Growth:**

There is a huge uncertainty in the growth of the economy due to volatility in the rate of inflation. While volatility of inflation affects the inflation rate positively. And also economic growth also get affected by the uncertainty in inflation. In Pakistan there is higher volatility in the rate of inflation and there is an inflationary growth (Saleem.N, 2010). The priority of the SBP is achieving the growth instead of stabilizing the prices. But now it has started to adjust the interest rate but for the sake of fiscal deficit financing due to which the commitment of the CB weakens. And also the system of conveyance of the information to the public is not strong as lack of forward looking model. All these things work as an obstacle to adoption of the IT policy. By striving for these objectives economy can be returned to the track of stable growth.

### **1.8 Inflation rate and Exchange rate**

In the open economies, the exchange rate is affected by interest rate which further affects the net exports which is transmitted to the aggregate demand. And inflation is affected by the import prices. So in order to stabilize the prices and output monetary policy also stabilizes the rate of exchange of the economy. In the determination of the rate of inflation and the currency's value expectations are very much vital. The currency depreciates whenever there is an upsurge in the supply of money. There exist a causation in all these. It creates a series as there is an upsurge in

the supply of money, inflation is generated which forces the interest rate to rise due to which the currency depreciates in foreign exchange market. Due to this depreciation of the domestic currency the prices of the imported goods (mostly raw material) rises which increases the production cost. This increase in the production cost will lead to higher prices of domestic goods, which will alter the demand function which will lead to higher inflation. Any activity of the exchange rate disturbs the stance of monetary policy which influences the CB to regulate the variables of the monetary policy. Exchange rate was fixed in Pakistan till 1990s period. Specific relation was not found in these variables.

## **1.9 Research gap**

Most of the research work in literature addressed the influence of interest rate on inflation, whereas there are very few studies that have evaluated the policy of targeting inflation in Pakistan and how it affects the exchange rate fluctuations in case of Pakistan.

(Saleem, 2010) assesses the conditions for targeting inflation in Pakistan. Targeting inflation is a policy option for achieving the price stability in the economy. And also explores the preparedness of state bank for targeting inflation as it requires autonomy of the CB while interest rate is considered as a nominal anchor for the price stability in the long run. In this study we will evaluate the policy of inflation targeting in Pakistan.

While (Siok.et al, 2012) inspected the influence of the exchange rate on the IT performance between the Asian and the European countries. This study shows the significant association between the movement of exchange rate, inflation and the output level of the economy.

This research study considers the interactive association of the monetary policy with movements in the exchange rate, the interest rate and the rate of inflation in Pakistan. We will check whether

IT is a good policy for Pakistan in the present situation of the high rates of inflation and will recognize whether exchange rate volatility is affected by targeting inflation in Pakistan or not?

### **1.10 Problem statement**

The stability of the prices is the main plan of the CBs. There is a vital importance of understanding the relationship of the supply of money, rate of inflation and the output. CB has the responsibility of the designing of the monetary policy via the nominal anchor that can be the exchange rate or the rate of inflation. Typically CB rises the rate of interest for regulating the rate of inflation and for eluding the depreciation of the currency.

In Pakistan the main goal of monetary policy are management of the monetary system and the stability of the financial sector. According to SBP Act, 1956 monetary policy is supportive for stimulating the economic growth and the stability of the prices. SBP attains its goal by targeting monetary aggregates for achieving the inflation target and the output or the growth of the economy (Akhtar, 2007). CB is responsible for achieving the price stability. Recently Pakistan is facing pathetic rise in inflation level. As in 2018 inflation was about 5.1% and in 2019 it was about 8.9 percent and recently it has crossed 10 percent. So this rapid rise in inflation has elevated the questions on the monetary policy of Pakistan and the causes of this upward movement of prices. There is a need to revisit the monetary policy to control the economic distress.

This case study analyses the inflationary process in Pakistan. It includes the inflation rate and the response of CB to achieve the stability in the economy. In the prevailing economic condition this study will suggest that whether IT is a good policy or not for achieving the price stability. And also its effects on the fluctuations in the volatility of the exchange rate.

## **1.11 Research objectives**

The objectives of this research are to:

1. Evaluate the adoption of the policy of targeting inflation in Pakistan.
2. Explores whether inflation targeting creates higher exchange rate volatility in Pakistan.

## **1.12 Research questions**

- Does policy of targeting inflation will be a best policy in the present economic scenario in Pakistan?
- Whether IT will lead to higher volatility in exchange rate movement in Pakistan?

## **1.13 Significance of the research**

Evidence shows that Pakistan has high inflation rates and are still high. Government tries to control these high rates via monetary and the fiscal policy. Consequently there is much literature on the causes and the effects of inflation in the economy that is caused by the fiscal policy expansion or the monetary policy shocks. However the monetary policy effectiveness on the control of inflation and the exchange rate volatility has not been addressed adequately. This research contributes to the literature and to check whether this policy of targeting inflation is a best policy for Pakistan or not.

## **1.14 Organization of study**

The study has been divided into four different chapters. First is the introduction of the topic i.e. adopting IT and exchange rate volatility in Pakistan? Literature review constitutes the second chapter. After that is the third chapter covering the Data and Methodology in which collection of required data, proxies to be used and the most appropriate methodology employed in order to get the accurate results will be discoursed. And at last results are discussed in the last chapter.

## **Chapter 2**

### **Literature review**

#### **2.1 Introduction**

IT is the basic plan for the monetary policy that obligates the CB for the achievement of the low rate of inflation. Batini (2006), IT has two main objectives, First objective is to maintain or commit to a specific target or level for the inflation. This shows that stabilization of prices is the foremost focus of the policy. The second is that through targeting inflation the inflation can be targeted for future. The policy of targeting inflation has successfully uphold the prices in the industrial countries. From the successful experience of those economies developing countries may also follow their approach and get benefit from it. It can improve the transparency of the system and enforce the policymakers for the more development of the reforms. It is sometimes referred as “inflation forecast targeting”. In short term inflation is determined by the price levels and the wages contracts and also the past or prevailing inflation. The CBs can only influence the expected inflation and bring it closer to the targeted level of inflation. Many studies are conducted to analyze IT as a monetary policy. Majority of the studies favor targeting inflation as a policy for developing economies as it provides them with better platform for economic development.

#### **2.2 Performance of the policy of IT**

Masson et. al (1997) in many advanced economies targeting inflation is used as a monetary policy which has increased the transparency and responsibility in these economies. Some of the preconditions required for making targeting inflation policy successful are fiscal authority should be free and fixed nominal anchor that can be the exchange rate. And a framework that links the

policies to inflation rate, these conditions are not present in most of the developing countries. But some of the developing countries can adopt targeting inflation policy by adopting some changes in institutions.

Batini (2006), surveyed the data of 31 CB which include 8 industrial markets and 13 emerging markets. The paper illustrates that as compared to other policies there are many benefits of targeting inflation in the emergent markets. Countries that are targeting inflation had better performance in controlling inflation and the inflation expectations with the prevailing level of output level, as compared to the countries with different policy instruments. Also the volatility of the foreign reserves, interest rate and the exchange rates is controlled and the currency crisis risk is smaller by adopting the policy of IT. The survey indicates that it is not essential for IT to meet the preconditions related to technicalities, institutions and the economy.

Carlos (2006) replicated the analysis of Ball and Sheridan's (2005). Data of 36 developing countries was used, out of which 13 targeted inflation. The study suggest that targeting inflation benefitted the developing economies. Results show that the fall in the inflation indorsed the current system of the IT developing countries and economies that adopted IT faced less volatility in growth. So the claim that targeting inflation hinders the growth of the economy is rejected. The empirical evidence shows that targeting inflation add ups to the output of the economy.

Barbosa (2008), views the case of Brazil. They started to target inflation in 1999 in the floating exchange rate framework. Brazil has faced high rates of inflation in the past. By targeting inflation the Brazil's economy moved towards stable macroeconomic conditions. Monetary policy has become more transparent and accountable by adopting IT in Brazil. By targeting inflation private agents are assured that government will make sure that inflation rate do not cross the certain

number. It is better for an economy to keep inflation rate to one digit. As it reaches the second digit the economies macroeconomic stability will be disturbed as people's expectations will change.

Mendoca (2013) estimates the adverse effects originated due to targeting inflation in Brazil on the fiscal side of the economy because of the disinflation in the economy. OLS, VAR model and GMM was used for this empirical analysis. For adopting the disinflationary policy it is important that it must be credible and do not have any social cost. Brazil is still working to build credibility, so the results shows rise in the interest rate and also the primary surplus is generating. So by building the credibility the adverse effect can be eliminated.

### **2.3 IT and Exchange rate**

Buffie, et. al (2018) investigated the management of the policy of exchange rate and the monetary policy in the small open economy of the two sector model that do not have perfect substitution of the foreign and domestic financial assets. Results suggest that efficiency of the policy of targeting inflation can be enhanced by exchange rate management. There exist high level of risk of uncertainty of the policy of targeting inflation because self-fulfilling expectations leads to macroeconomic fluctuations. Besides, the small shocks in inflation may intensify the shocks in inflation in the ex-post period. Both of these complications fade when CB stands firmly contrary to the wind in the managed float system of exchange rate. (Ebeke and Fouejieu.A, 2015) investigates the impacts of targeting inflation on the selection of the regime of exchange rate. Results suggest that countries that are targeting inflation have more flexibility in regime of exchange rate. (Kempf.H and France.D, 2010) and (Prasertnukul.W et.al, 2010) inspects the policy of IT impact on ERPT for developing economies. The study reported a fall in pass through to the prices index.



(Nogueira R.P, 2007) evaluates the Indication of ERPT for developed as well as the developing countries. Analysis was taken out by comparing the different periods of before opting the policy of targeting inflation and after opting the policy of targeting inflation. The results shows that the ERPT has declined by opting the policy of targeting inflation for the producer prices as well as consumer prices. Prices of producer response to changes in exchange rate is greater than prices of consumer response to change in exchange rate. While ERPT does not vanishes away entirely from the economy as over the period of long run it is significant.

(Coulibaly.D,2010) inspects the influence of targeting inflation to the ERPT of the developing countries to the prices of the goods. 27 countries were analyzed which includes both the countries that are targeting inflation and the countries that are not targeting inflation. Data shows that the countries that are targeting inflation had faced a decline of the pass through to the indexes of prices. Like prices of consumers, prices of producers and prices of imports. The disintegration of variances shows that the involvement of the exchange rate tremors to the variabilities of the prices is more vital in the countries that are targeting inflation. And it decreases when the economy opts targeting inflation policy. (Minella, A.2003) consider the challenges in Brazil during the period of targeting inflation. Targeting inflation policy has vital role in stabilizing the macroeconomic situation of a country. The main focus of the study was on the key challenges that are the credibility of the CB and the volatility in exchange rate. The results of the study specify that targeting inflation is working as a good controller of expectations. And CB is responsive to the expectations of the rise in prices. Inflation rate has declined from the pertaining level and lastly that pass through of exchange rate is greater for the prices that are controlled. It means that market based prices will lead to a lesser pass through of exchange rate to the prices.

(Buffie, E.F. 2018) inspects the deterexity of the policy of the exchange rate and the monetary policy for the model of small economy with only two sectors which do not have perfect swap of the foreign financial assets and the domestic financial assets. The study indicates that if exchange rate is managed properly than it enriches the efficiency of policy of targeting inflation. If the exchange rate is flexible than policy of targeting inflation has indeterminacy as any changes in economy are fulfilled by itself due to the expectations. (Pham, T. A. T.2020) suggest that there is significant shift in inflation due to the tremors in exchange rate. This evidence is found in many countries however it varies from the countries that are targeters and the countries that are not targeters. Similarly the results are diverse for the short term and the long term.

## **2.4 IT and Exchange rate volatility**

(Pontines, 2011) inspects the countries targeting inflation, whether the exchange rate volatility is high or low. The results suggest that both the nominal and the real exchange rate are lower in countries that are targeting inflation. Roe developing countries it is lower while for industrial countries it is higher. (Ouyang.A, 2015) investigates the impact of targeting inflation on volatility of the real exchange rate for developing countries. In targeting inflation regime volatility is higher in real exchange rate in developed due to the external prices while in developed countries there is no modification in the volatility of exchange rate.

(Kurihara.Y, 2013) studied whether exchange rate volatility has reduced due to targeting inflation. Results express that there is reduction in the volatility of the exchange rate by opting the policy of targeting inflation which leads to growth of the economy. (Kara.H, 2008) analyzed the effect of pass through from the inflation that is imported to the domestic inflation has slowed pace by adopting the policy of targeting inflation. Study suggest that the conditions set for this policy

are not necessary as they are itself adjusted after the adoption of the policy of targeting inflation. (Pontines.V, 2013) evaluates the presence of high volatility of exchange rate in the economies that are targeting inflation. The main problem is that countries does not randomly select the monetary policy. The enquiry proposes that the economies faces low volatility of both the real and nominal exchange rate when they are targeting inflation. While the industrial countries had higher volatility of the nominal and real exchange rate when they are following the policy of targeting inflation.

(Castillo, C.2014) defined the model of macro economy that pretends to be an economy with two targets. The targets are to object the volatility of the nominal exchange rate and to target the inflation. As there are two targets so there will be two instruments for policy according to the Tinbergen–Aoki Condition. For the target of inflation rate, monetary policy will be used and for the target of adjusting the unpredictability of the exchange rate, CB will interfere in the FOREX market to modify the reserve of foreign currency stocks. The results suggest that there must be a coordination of the timing of the posture of the monetary policy on its instruments to achieve the targets. If not coordinated than both will affect oppositely to the economy due to which only one target could be attained and mostly it will be the target of inflation.

(Kuncoro, H.2020) evaluates the controversy of the increased instability in the exchange rate when the policy of targeting inflation is opted. If exchange rate is held flexible in the economy it will boost the volatility of the exchange rate. While some researchers have opposite view, they claim that volatility of the exchange rate will be lower by the adoption of the policy of targeting inflation. This study will consider that whether the policy of interest rate that is used for targeting inflation policy leads to the moderation of the volatility in the exchange rate framework. The outcomes demonstrates that both the policies of the interest rate and the intercession in foreign exchange does not helped in condensing the volatility of the exchange rate. While the policy of

targeting inflation main focus is on the stabilization of domestic currency due to which the stabilization of the external currency is neglected that causes the volatility in exchange rate to amplify. The outcomes propose that the trustworthiness of the CB is very essential for the adoption of the policy of targeting inflation as it functions mainly by signaling effect.

(Caputo.R, 2020) examines the basic causes of the high scale variations in the exchange rate. DSGE model is used that includes the preferences of the CB. After the identification of the direction of the shocks SVAR model will be used for the estimations. Both the countries that are targeting inflation and the countries that are not targeting inflation were analyzed. The study had the results in distinction with the earlier studies as this study discovers that the shocks in the exchange rates are basically the main reason of the dynamics in the real exchange rate while the real shocks in the economy that are blamed to be the cause of the dynamics in the volatility of exchange rate are not that much important. The model of DSGE discloses that as the policy of the CB has more focus on the inflation rate there is lack of concentration on the variations of the exchange rate due to which the tendency of the nominal shocks that influences the real exchange rate increases but there is a decline in the influence of the real shocks. Outcomes of the study are that by opting the policy of targeting inflation with the free exchange rate policy leads to the increase in significance of the demand of the economy and also the shocks in the risk premium that are influential to the real exchange rate.

## **2.5 IT in Pakistan**

Many economists accomplished the non-existence of the pass through of exchange rate to the prices. As Choudhri and Khan (2002) established a model and did not discovered the presence of the ERPT, though Hyder and Shah (2004) exposed the presence of the ERPT with a bigger

VAR. Khalid (2005) explored the foundation of the inflation, he argued the imported prices, and printing of excess money and the open economy lead to the inflation. Its results also specify these variables with some other variables as a cause of inflation. Other variables include the deficit to GDP ratio, depth of the money, depreciation of the rate of exchange and also the domestic credit. SBP can regulate the rate of inflation by the proper investigation of the future behavior of the following variables. Granger causality and VAR was used for the estimation of the determinants.

According to Moinuddin (2007) the demand function of money in Pakistan is fragile so it can't be used as an anchor for targeting the inflation level. So M2 is not noteworthy for this purpose. He recommended the adoption of the "lite" IT in Pakistan. Hyder and Shah (2004) conducted the study for the investigation of the regimes in which there existed the presence of the ERPT. By employing the VAR model, study investigated the presence of it in the period of 1988 to 2003. Several economist considered or argued the inflation to be the monetary phenomenon. Like Khan and Siddiqui (1990), Jones and Khilji (1988), and Hussain and Tariq (1997) and Bengali, et al. (1997), tried to discover the factors responsible for causing inflation. And all of them argued the inflation as a monetary phenomenon. This started a new insight of the process of inflation in Pakistan. Money is upheld by few economists as the determining factor of inflation. But some argue that it's not the only determining factor there are some other determinants too. Like the prices of energy, prices of wheat and the prices of the imported goods. Khan and Qasim (1996) analyzed the supply of money, prices of wheat and the manufacturing value added as the determinants of inflation.

Yasir (2005) and Khan and Senhadji (2001), tried to approximate the inception level for the rate of inflation in Pakistan. They proposed the inception level for the rate of inflation as 9.0%, above this level inflation becomes hostile for the growth of the economy. The causes of the

inflation has a debate in Pakistan due to which extensive attention has been created towards it. Qayyum and Haq (2006) verified the proposition of the monetarists that “inflation is a monetary phenomenon”. Data from 1960 to 2005 annual was used for the assessment and determined that the proposition is effective for Pakistan. ARDL was used with the approach of general to specific. The results of the study declares that almost 90% of deviation in the rate of inflation is caused by the monetary policy easing by the State bank. Chaudhry and Choudhary (2006) estimated the insignificance of the monetary policy for regulating the inflation in Pakistan. But on the other side the hypothesis of the long run association of the growth in money and the output was not been denied. The key cause for the rise in inflation is not the misconduct in monetary policy but the prices of the imported goods. They additionally accomplish that by opting the policy of targeting inflation in Pakistan will cause recession.

Khalid (2006) analyzed the stability of the prices as essential ingredient for the successful conduction of the monetary policy. And for it targeting inflation is an appropriate choice for the SBP. This discussion of the monetary policy pointed to the selection of the anchor that is to be used for conducting the monetary policy. There were different views for the adoption of the nominal anchor some of them propose interest rate as an important instrument as it highly influences the supply of money.

Some of the studies are conducted to study the IT in Pakistan. Ayub et. al (2014) evaluates the relation of nominal interest rate and inflation rate in Pakistan. Their relationship is also called fisher hypothesis, in its which measure the equilibrium relation of nominal interest rate and the inflation rate for the long run. Results showed that long run association between inflation rate and the interest rate do exist during the time period of 1973 till 2010 in Pakistan. Yasmin (2013) explores the government borrowing (money supply and CB) and inflation relationship. The results

suggest that in the long run inflation is strongly affected by the money supply and the government borrowing. Money supply and inflation have bidirectional causality while inflation and government borrowing have uni-direction relationship. The results suggest that to control inflation in Pakistan government borrowing must be restricted.

Saleem (2010) evaluates the situations of targeting inflation in Pakistan. The latest inflationary trend in Pakistan demands for the new up to date monetary policy. In this study targeting inflation is considered as an option of policy for achieving stability of prices. From 1970 to 2009 Pakistan faced inflation rate around 10%, this forced policy makers to target inflation. The empirical evidence showed that inflation is a monetary phenomenon and CB have control over inflation rate by using interest rate as an instrument as negative relation exist between interest rate and inflation. And also that prices do impact interest rate and also the inflation. Khalid (2005) studies whether the policy of targeting inflation is a good choice for Pakistan or not keeping in view the developing countries experiences. Many countries had positive outcomes of targeting inflation. The study suggest that in Pakistan it is the best time for the policy makers to adopt the policy of targeting inflation. As inflation rate is low so it will be helpful to improve the economies conditions by using targeting inflation as a monetary policy. With reference to Pakistan,

Malik (2007) identified multiple objectives of monetary policy in Pakistan including output stabilization, price stability, interest rate smoothing, exchange rate management, stability of trade flows and foreign exchange reserves. Moreover, Ahmad and Malik (2011) found that interest rate smoothing is an important objective of monetary policy in Pakistan. Malik (2007) recognizes five objectives of the monetary policy that are stabilization of output, stability of prices, management of exchange rate, smoothening of interest rate, and reducing the trade deficit. But it is only the

positive analysis. Khan and Qayyum (2007) evaluated that shocks in supply side and the channel of exchange rate are more important than the shocks in demand side.

Kemal (2011) explores that whether IT can be adopted or not in the presence of high external debt and fiscal deficit. Paper used monthly data of interest rate, CPI of Pakistan, exchange rate and US CPI. Study used VAR and OLS to estimate the model. Theoretically any fiscal imbalance creates problem for the CB in controlling inflation in the presence of policy of targeting inflation. Study shows that in the short run real exchange is not significantly related to the interest rate. And also that any fluctuations in interest rate is not transmitted to prices in the scenario of Pakistan, so policy of targeting inflation can be curtailed in Pakistan. But there is a need to explore the relationship between inflation and interest rate. In Pakistan most of the studies evaluates the impact of instruments of monetary policy on target variables. Very few studies are present on monetary policy with rule. Some of the studies are Malik and Ahmad (2010). Tariq (2010) studies focused on the choice of monetary policy, either the policy of exchange rate is suitable or policy of targeting inflation is suitable in the emerging economies. In most of the economies policy of targeting inflation is more suitable as it improves the economic conditions of the economy.

(Minhaj.S,2018) studies the existence of ERPT and different trends in case of Pakistan from the period of 1982-2016. Results disclose that there exist a relationship in pass through of exchange rate and the prices. While the variables of trade and interest rate also affect the inflation positively. (Jaffri,A.A.2010) evaluates the changes in exchange rate influence on the prices of the goods. The study analyzes both the short run and the long run pass through of exchange rate, the findings suggest that the pass through of exchange rate to prices is very little or we may say close to zero.



## **2.6 Literature Gap**

Many studies are conducted to check whether the policy of targeting inflation is suitable for Pakistan or not, and what are the preconditions required to adopt the policy of targeting inflation. Many studies suggest that IT is a good policy choice for Pakistan as it is investigated by several studies that countries that opted the policy of targeting inflation perform better.

No study has been conducted in Pakistan to investigate the policy of targeting inflation and its impact on volatility of the exchange rate. This study will investigate it. This study will analyze that whether the policy of targeting inflation will be appropriate in the present economic situations of distress or not and also the effect of inflation targeting on volatility of exchange rate and vice versa and also the effects on output of the economy.

## Chapter 3

### Data and Methodology

This chapter states the theoretical framework and the model for the empirical investigation. In this section we will also discuss the samples of data, the sources of data, variables and econometric model that will be used in this study.

#### 3.1 Theoretical framework

The key objective of the monetary policy and the macroeconomic policies is stabilizing the aggregate prices and the stabilization of the financial sector and the economic activity. These objectives can be attained by the optimal monetary policy. The monetary policy is optimal if it stabilizes the inflation successfully.

Basic framework for the model includes the fisher effect and the international fisher effect.

##### The fisher effect

Fisher effect is basically theory of economics created by Irving Fisher. It defines the relationship of the real and the nominal interest rate with rates of inflation. The theory states that the real interest rate is equal to the nominal interest rate minus the expected rate of inflation. So, increase in inflation leads to decline in the interest rate.

$$i = (r, \pi^e)$$

We assume that the real interest rate is a constant. Than interest rate will be a function of expected inflation.

$$i = f(\pi^e)$$

We assume in our model that the expected inflation is exactly equal to the inflation in real. So the interest rate directly impacts the inflation in the economy.

## **The international fisher effect**

This theory is developed by Irving Fisher. The difference of the nominal interest rate of the two countries is equals to the changes in their currencies exchange rate at any time is called as international fisher effect.

Eiteman, Stonehill, and Moffett (2007) defined this international fisher effect as "The relationship between the percentage change in the spot exchange rate over time and the differential between comparable interest rates in different national capital markets is known as the international Fisher effect"

It can be written as

$$(i - i_{USA}) = f(\text{exchange rate})$$

This study checks the effect of changes in nominal interest rate on the shifts in the exchange rate.

## **3.2 Variables definitions**

This section defines the variables of the models.

### **Variables for the model of evaluation of inflation targeting**

For this model yearly data is taken. The definitions of the variables that are used in the first model are as follows:

#### **Inflation**

Inflation is basically upsurge in the price level at some time period. I is calculated through CPI.

CPI is the key for measuring the changes in prices at merchandizer's level. It evaluates the variations of the cost of buying the characterized basket of the predefined goods and services and also scales any up rise in the living cost in the current period.

For computing CPI Laspeyer's formula is used:

$$\text{CPI} = \frac{\sum \left( \frac{P_n}{P_o} \right)}{\sum W_i} * 100$$

Where,

$P_n$  = denotes the price of an item in the present time.

$P_0$  = denotes the item price in base period.

$W_i$  = denotes the weight of the  $i$ th item in the base period.

In this study yearly data of CPI from 1970 to 2019 is taken from WB.

### **Call money rate**

“It is the rate of the money market at which borrowing and lending of short term funds is carried out”. Time period is one day for call money loan. It is basically interest rate on short term loan that banks lend to the brokers and they lend money to the investors on margin. These loans don't have any repayment date, they are to pay back on demand. Call money rate is used as a proxy. As also used in many studies as a proxy (Saleem,2010). Yearly data of call money rate is taken from SBP for the period of 1970 to 2019.

### **Exchange rate**

“It is the rate at which one currency is exchanged for the other or value of currency of a country relative to the value of currency of other country”. For example, exchange rate off 150 Pakistani rupees to the United States dollar means that 150 Pakistani rupees will be exchanged for one dollar of United States.

Yearly data of nominal effective exchange rate is taken from WB, IFS from IMF from the period of 1970 to 2019.

### **Output gap**

“It is the difference of actual output and the potential output of the economy. It is said as percentage of the gross domestic product (GDP)”. It can be positive or negative.

In this study data of Gross domestic product is taken to derive the output gap of the economy. Output gap is calculated by finding the difference between the actual output and the potential output. While potential output is generated through hodrick Prescott filter for smoothening the trend. (Saleem, N.2010). Yearly data of Gross Domestic Product is taken from World Bank from 1970 to 2019.

### **Variables for the model of evaluation of exchange rate volatility:**

For this model monthly data is taken to cope with the volatility in a better way. Definitions of the variables used for the second model are as follows.

### **Inflation**

Inflation is a rate of increase of the average prices of the basket of the particulars goods and services in the economy at a specified time period. It is basically increase in the general price levels

where one currency unit becomes unable to buy as much as it buys in the previous periods. It basically leads to decreased purchasing power of the currency.

Inflation is basically calculated through CPI. Log of current CPI is subtracted from log of previous CPI to get the inflation rate.

$$\Pi_t = \log(CPI_t) - \log(CPI_{t-1})$$

For this study monthly data of inflation is taken from IFS from IMF from the period of 2000 to 2019.

## **Output**

“It is the amount of the goods and services produced in an economy in a fixed time period”. The goods and services produced may be utilized fully or may be used for next production process.

For measuring the output of the economy, this study has used Industrial Production Index as a proxy. Monthly data of Industrial Production Index is taken from IFS from International Monetary Fund for the years 2000 to 2019.

## **Exchange rate volatility**

“It is the risk related to the unanticipated activities in the exchange rate. It is measured through the standard deviation of the moving average of the logarithm of the exchange rate”. (Serenis,D.2012)

Monthly data for exchange rate is taken from IFS from International Monetary Fund for the years 2000 to 2019. While real effective exchange rate index is used for obtaining the variable of exchange rate volatility.

### 3.3 Economic channels

#### Interest rate channel

Interest rate has negative impact on inflation and output. when there is an increase in policy rate “ $i$ ”, it increases the cost of capital which hits the investment level negatively that leads to increased savings and a decline in consumption due to which there is a fall in aggregate demand. This fall in aggregate demand will push the inflation down. Smets and Wouters (2002) Interest rate channel affects the consumption, investment and the real output for euro countries. When aggregate demand is lesser than aggregate supply then there is a downward pressure on the prices which leads to decreased inflation.

- $i \uparrow \gg r \uparrow \gg \text{cost of capital} \uparrow \gg I \downarrow \gg C \downarrow \gg Y \downarrow \gg \pi \downarrow$

In a model of open economy inflation is caused by the interest rate through two different networks. First is that when the real interest rate is higher it leads to decreased aggregate demand which decreases the output due to which inflation decreases. Second is that when the real interest rate is high there is a real appreciation which reduces inflation directly and indirectly by the tempted decline in aggregate demand and the output. Blanchard (2004).

#### Exchange rate channel

It explains how the changes in monetary policy affects the currency’s strength. When monetary policy increases the policy rate, it strengthens the domestic currency. As high interest rate attract the investment, it increases the demand of domestic currency which strengthens the exchange rate. There is an appreciation in the currency when the currency strengthens. It impacts the economy in two ways. First one is that domestic goods become more expensive as compared to foreign goods due to which exports decreases while rise in imports. It negatively affects the economy and pressurizes the prices upward. Secondly, inflation is affected by exchange rate through varying

domestic prices of goods for another country trade. These low import prices helps to lower the inflation.

Norbin (2000) the demand side channel of exchange rate is: the increased interest rate ( $i$ ) leads to appreciation of the domestic currency. The prices of the domestic goods increases ( $P_{dg}$ ), exports of the country decreases due to which net exports ( $NX$ ) also decreases. This decreased net exports leads the output( $Y$ ) to decline.

- $i \uparrow \gg E \downarrow \gg P_{dg} \uparrow \gg P_{fg} \downarrow \gg NX \downarrow \gg Y \downarrow \gg \pi \uparrow$

The supply side channel of exchange rate is: the central bank chooses loose monetary policy, decreases the nominal interest rate which leads to decreased real interest rate. The decreased real interest rate further depreciates the domestic currency. The exchange rate increases due to depreciated domestic currency which further increases the cost of production of the firms that is further transmitted to the prices of the import goods. This leads to decline in aggregate demand which decrease the output level of the economy, hence there is increased inflation in the economy.

- $i \downarrow \gg E \uparrow \gg r \uparrow \gg P_{dg} \downarrow \gg P_{fg} \uparrow \gg Y \downarrow \gg \pi \uparrow$

### **Inflation and exchange rate**

Inflation affects exchange rate as if the rate of inflation is higher in an economy than others it losses the value of its currency due to which its exchange rate depreciates.

- $\pi \uparrow$  than other countries  $\gg$  losses value of currency  $\gg$  ER depreciates

### **Interest rate and exchange rate**

When interest rate is high than the return on the capitals will be high which will attract the foreign capital due to which exchange rate depreciates



- Interest rate  $\uparrow$  » high returns » foreign capital  $\uparrow$  » ER  $\uparrow$

### **3.4 Econometric methodology**

This section discusses the methodology used for the models of the study. Firstly we will discuss the model built for evaluating the targeting inflation policy. And then will discuss the methodology for the model of exchange rate volatility.

#### **Stationarity test:**

For checking the stationarity of the data unit root test is used as ADF (Augmented Dickey Fuller) test. We will check whether the variables are non-stationary at level or have a unit root. If the variables are not stationary or have a unit root than we will take the difference of the variable to make it stationary. It will make the variables integrated of order one.

#### **3.4.1 Methodology of IT**

For the model of IT we will use the VAR methodology for the estimation of the results. It includes Vector Error Correction Models (VECM) and the cointegration models. This model explains the behavior of the variables and its features. It gives the short run and the long run relationships of the variables. These models allow us to check the significance of the relationships and also checks the policy outcomes effectiveness.

Firstly we will check the cointegration among the variables by using the unrestricted cointegration rank test. The results suggest no integration among the variables, so we move towards the VAR technique.

#### **VAR model**

We take the modified form of Saleem. N (2010) model that has used the modified form of Soderstorm's (1999) that is modified on the base of literature on the open economies and the CBs response of controlling inflation. The CB sets interest rate while regulating the output and the inflation, which is shown in the VAR model. The model will evaluate the relationship of the variables.

$$y_t = A_{10} + \sum_{l=1}^p A_{1s} y_{t-s} + \sum_{l=1}^p B_{1s} \pi_{t-s} + \sum_{l=1}^p C_{1s} i_{t-s} + \varepsilon_{1t} \quad (3.1)$$

$$\pi_t = A_{20} + \sum_{l=1}^p A_{2s} y_{t-s} + \sum_{l=1}^p B_{2s} \pi_{t-s} + \sum_{l=1}^p C_{2s} i_{t-s} + \varepsilon_{2t} \quad (3.2)$$

$$i_t = A_{30} + \sum_{l=1}^p A_{3s} y_{t-s} + \sum_{l=1}^p B_{3s} \pi_{t-s} + \sum_{l=1}^p C_{3s} i_{t-s} + \varepsilon_{3t} \quad (3.3)$$

$$\varepsilon_t = A_{40} + \sum_{l=1}^p A_{4s} y_{t-s} + \sum_{l=1}^p B_{4s} \pi_{t-s} + \sum_{l=1}^p C_{4s} i_{t-s} + \varepsilon_{4t} \quad (3.4)$$

$\pi_t$  is the annual CPI inflation rate,  $i_t$  is the call money rate,  $\varepsilon_t$  is the exchange rate and  $y_t$  is the output gap.  $y_t$  shows the gap of actual and the potential GDP. Hodrick-prescot filter is used to smooth the trend of the series of potential output. It is used to get the leveled estimates of the series components for the long term. In this paper, we have used annual data for the period 1970-2019.

The model assumes that CB is responsible for the price stability and the financial stability of the macroeconomic environment. Data is taken for the period 1970-2019 from the WDI, IMF (IFS), federal bureau of statistics and Pakistan Economic Survey.

### **3.4.2 Methodology for exchange rate volatility due to IT:**

We will use simple GARCH model for the estimation of the volatility in exchange rate due to IT. For this we will use the GARCH (1, 1) methodology. This model explains the time varying behavior of the series and also models and forecast the conditional variance. GARCH (1,1) model is used for modeling the variance and capturing the volatility.

## **GARCH (1,1) Model:**

GARCH is basically the general form of the ARMA model. GARCH was introduced by Tim Bollerslev (1986). GARCH basically stands for Generalized Autoregressive Conditional Heteroskedasticity. The basic equation for the GARCH model is represented as:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i \mu_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2$$

The coefficients of the equations are always positive as they verifies the positivity of the  $\sigma_t^2$ .

For the identification of the lags in the model, it is represented as GARCH (p, q). In case when q becomes equal to zero than the model converts to the ARMA model. In this model the conditional variance of the  $\mu_t$  are dependent on the preceding phases residuals squares and also on the conditional variance of preceding q period. Mostly GARCH (1,1) model is used in the studies with 3 variables included in the equation of the conditional variances, Kozhan.R (2014).

The generalized form of GARCH (p, q) model which includes squared error terms of p lag and lag of the conditional variances of q lags.

$$\text{GARCH (p, q): } h_t = \varphi + \sum_{k=1}^p \theta_k h_{t-k} + \sum_{i=1}^q b_i \mu_{t-i}^2$$

GARCH model can be written as the squared residuals of the ARMA model.  $h_t$  is the conditional variance. Representation of GARCH (1, 1) is illustrated as:

$$\text{GARCH (1, 1): } h_t = \varphi + \theta_1 h_{t-1} + b_1 \mu_{t-1}^2$$

In the GARCH mode, conditional variance is dependent on the squares of the past values and its own lag (conditional variance). All the co-efficient of the conditional variance equations must be positive.

The GARCH model is considered as stationary when  $\theta_1 + b_1$  are less than one. It show the persistency of shocks to volatility.

GARCH model estimated in this study includes exchange rate and the inflation.

The mean and the variance equation used in this study are as follows:

$$\text{C.M.E } \varepsilon v_t = \alpha_0 + \alpha_1 \varepsilon v_{t-1} + \alpha_2 \pi_t + \alpha_3 y' + e \quad (3.5)$$

$$\text{C.V.E } \sigma_t^2 = \gamma_0 + \gamma_1 \sigma_{t-1}^2 + \gamma_2 \varepsilon_{t-1}^2 \quad (3.6)$$

Where  $\varepsilon v$  represents volatility of exchange rate,  $\pi$  represents the inflation rate and  $y'$  is the output for which industrial production index is used as a proxy. This study estimates both the equations of conditional mean and conditional variance and diagnose the volatility spillover effect in the variables of the model.

### 3.5 Data and description

In this study the interrelationship between the exchange rate and the IT policy of monetary policy is examined. Monthly data from 2000 to 2019 is taken from IFS in the (IMF) International Money Fund. The data includes the nominal effective exchange rate for calculating the volatility of exchange rate (EX), industrial production index (IPI) as a proxy of output and for constructing the inflation rate consumer price index (CPI) is used. Inflation is constructed by finding the difference in price levels of the current month and previous month as shown below,

$$\Pi_t = \log(CPI_t) - \log(CPI_{t-1})$$

For measuring the performance of targeting inflation output and the inflation indicators are used. The main objective of targeting inflation is to accomplish constancy in low inflation and the output

growth. We will get better understanding of the association of the exchange rate flexibility and the IT by studying the analysis of the relationship of output, inflation and exchange rate volatility.

## **Chapter 4**

### **Results and discussions**

#### **4.1 Overview of Chapter**

In this study two models are analyzed. First model is for evaluation the policy of inflation targeting in Pakistan and the second model is for analyzing the exchange rate volatility due to inflation targeting. In this chapter estimations of the models and the empirics are discussed.

Firstly we will discuss the model of inflation targeting in Pakistan.

#### **4.2 Model for inflation targeting**

This model evaluates the policy of inflation targeting in Pakistan. The study see's the behavior of the variables and their relationships.

##### **4.2.1 Descriptive analysis**

The analysis depends on the generating process of the data and it's very important for organization of the data and the research design. It gives important information and also the understanding of the data without any process or in a raw form. In statistical analysis we have mean, mode and median that are used for measuring the central tendency, while variance and range are used for measuring dispersion in the data set. Statistical analysis informs about the normality of the variables, extreme values present in the data and the presence of outliers. If the data have higher values of standard deviation it means that data has high volatility, and if value of Jarque Bera are high it means data is good fit and vice versa. If the probability values of the data are less than 0.05 it means that data is not normally distributed so we will have to take natural log of the variables.

And if Jarque Bera test indicates non normality of the data than we need to take difference of the variables to make them normally distributed.

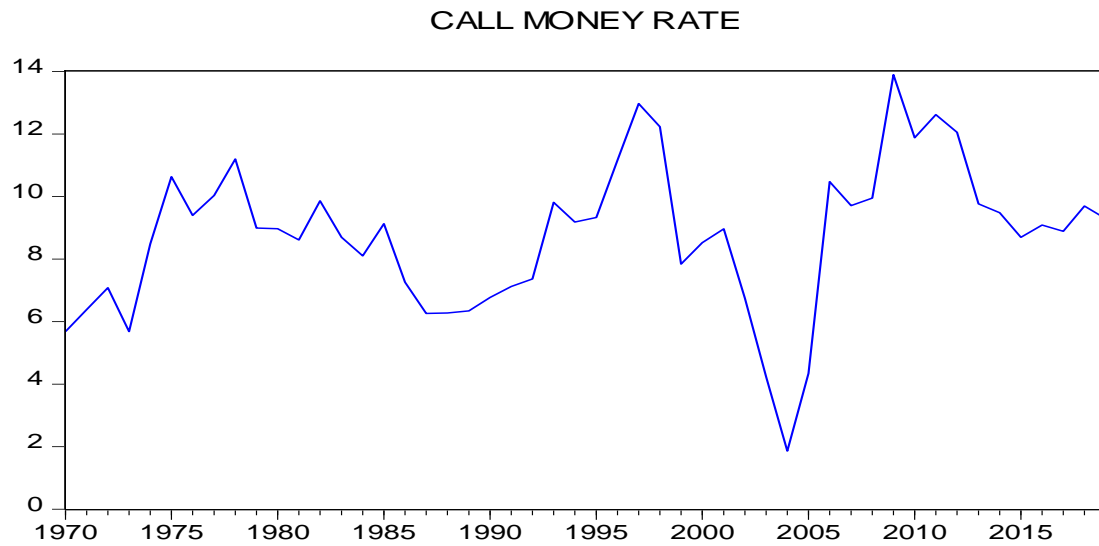
**Table 4. 1 Summary Statistics**

	<b>Consumer Price Index</b>	<b>Exchange rate</b>	<b>Call Money Rate</b>	<b>Output Gap</b>
<b>Mean</b>	49.11	143.58	8.73	-2.17438E-05
<b>Standard deviation</b>	7.27	6.943	0.33	10.52
<b>Kurtosis</b>	0.28	-1.43	0.70	7.55
<b>Skewness</b>	1.23	0.63	-0.35	1.52
<b>Minimum</b>	2.89	95.27	1.86	-1.74
<b>Maximum</b>	182.32	231.41	13.89	33096

Table 1 shows the summary statistics of the variables of the model.

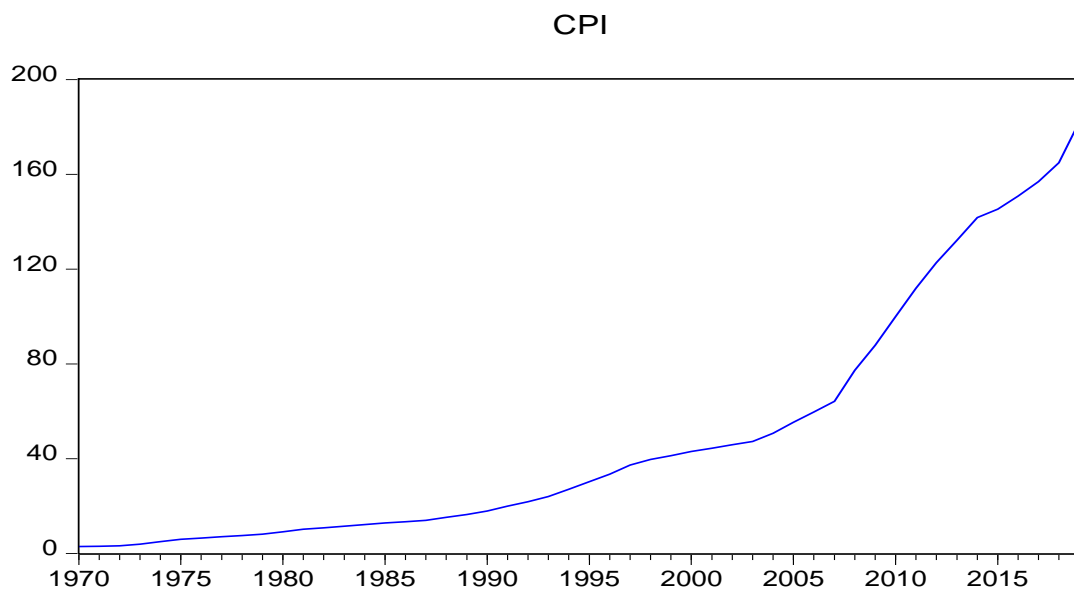
## **4.2.2 Graphical representation of the data**

**Figure 4. 1 Call Money Rate**



Call money rate is announced on daily basis that's why it has a lot of deviation in the series. From 1970 to 1990 it has normal trends but after 1995 it has high peak values but in 2005 it crashes down to almost near to zero percent. After 2005 there is a sudden rise in call money rate and average afterwards.

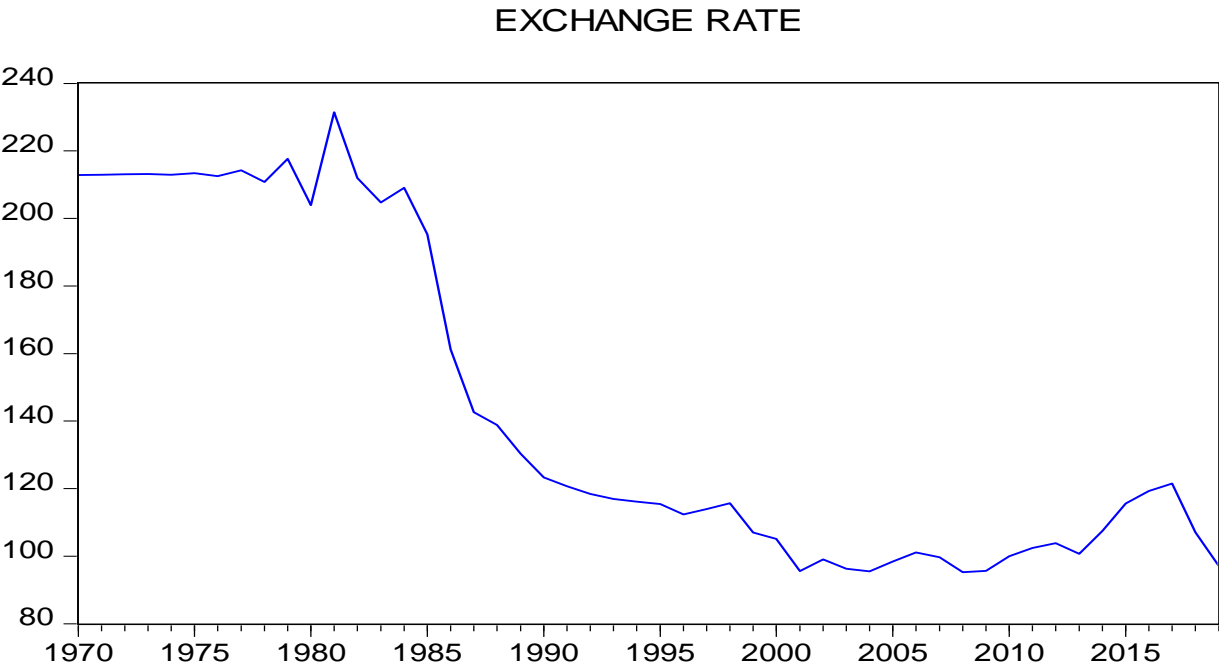
**Figure 4. 2 Consumer Price Index**





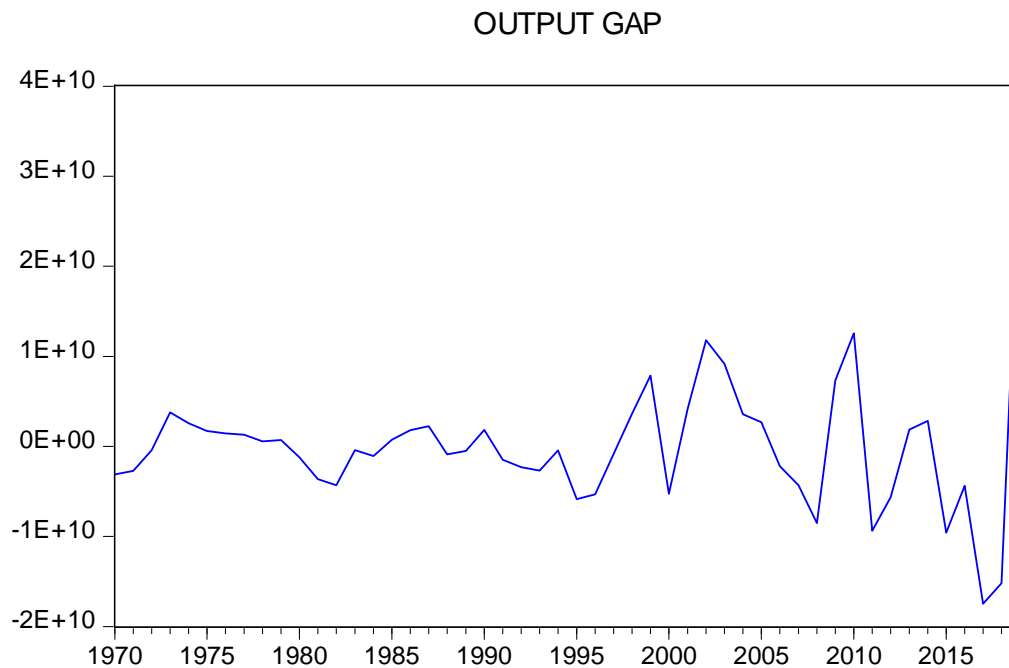
Consumer Price Index is calculated monthly, there is almost 12.6 percent growth in inflation in every year. In the data CPI has an increasing trend from 1970 to 2019, but this trend is more rapid after 2010 as compared to the previous era. In the current year CPI is at it's highest.

**Figure 4. 3 Exchange Rate**



Exchange rate is the price of a currency in terms of other currency. It deviates in different circumstances. In 1970 to 1985 exchange rate of Pakistan has almost linear trend but after 1985 it started to decline which continued till 2003 but after 2004 it started to increase slowly till 2017 but now it's again in its depreciation phase.

**Figure 4. 4 Output Gap**



Output gap is basically the difference between actual GDP of the economy and the potential GDP of the economy. It varies from positive to negative values. Sometimes it becomes positive and sometimes it becomes negative under different circumstances. Output gap has highest negative peak in 2017 and highest positive peak in 2019.

From the above figures we have seen that there is a need of taking first or second difference as there are lots of time trends and also the effects of seasons. We have to make them stationary for making the estimation of the series. So we will take differences for making the mean and variances persistent with time.

### 4.2.3 Empirical results

#### Jarque Bera test for normality

Table 4. 2 Results of normality test

	<b>CPI</b>	<b>ER</b>	<b>CMR</b>	<b>OUTG</b>
<b>Jarque Bera</b>	11.90 P(0.00)	7.33 P(0.02)	1.54 P(0.46)	87.15 P(0.00)

We will check the probability of the Jarque Bera test for checking the normality of the series.

Null hypothesis for the Jarque Bera test is that series is normally distributed.

H1: not normally distributed

If probability is less than 5% we reject the null.

If the series is not normal than we take log of the series to make it normal.

- In table 1 CPI has probability of 0.0026, which means 0.26% that is less than 5%. It means we can reject the null that is series is normal. It means that series of CPI is not normally distributed. So we will take log of the series to make it normally distributed.
- Exchange rate has probability of 0.0256, which means 2.56% that is less than 5%. It means we can reject the null that is series is normal. It means that series of ER is not normally distributed. So we will take log of the series to make it normally distributed.
- Call Money rate has probability of 0.4629, which means 46.29% that is greater than 5%. It means we can accept the null that is series is normal.

- Output Gap has probability of 0.00, which means 0.00% that is less than 5%. It means we can reject the null that is series is normal. It means that series of OG is not normally distributed. So we will take log of the series to make it normally distributed.

#### 4.2.4 Unit root testing for stationarity

Unit root test is used to check the stationarity of the data. We will check stationarity of all the variables through augmented dickey fuller test.

Null hypothesis for unit root test is series has unit root which means data is not stationary.

If the probability value is less than alpha value than we will reject the null.

It means that if probability value is less than 5% it means we will reject the null and series does not have the unit root. Than for making the series stationary we will take the first difference of the series. The other guideline is if the absolute test statistics is greater than absolute critical value than we will reject the null and if absolute critical value is greater than absolute test statistics than we will accept the null.

**Table 4. 3 Results of Augmented dickey fuller test**

<b>ADF</b>	<b>T-statistics</b>	<b>C.V(5% level of significance)</b>	<b>Prob*</b>
<b>Call money rate</b>	-3.01	-2.92	0.04
<b>Exchange rate</b>	-1.07	-2.92	0.72
<b>Inflation</b>	-21.33	-2.92	0.00
<b>Output gap</b>	-4.29	-2.92	0.00

- The absolute test statistics is 3.006 which is greater than the critical value at 5% which is 2.922. It means that we can reject the null which is that series has a unit root or data is not stationary, or we can say that as probability value is less than 0.005 so we will reject the null. As we are rejecting the null it means the series does not have unit root which means that series is stationary. So there is no need to take the difference.
- The absolute test statistics is 1.7071 which is smaller than the critical value at 5% which is 2.922. It means that we can accept the null which is that series has a unit root or data is not stationary. Or we can say that as probability value is greater than 0.05 so we will accept the null. As we are accepting the null it means the series has unit root which means that series is not stationary. So there is a need to take the difference for making the series stationary.
- The absolute test statistics is 21.3328 which is greater than the critical value at 5% which is 2.9225. It means that we can reject the null which is that series has a unit root or data is not stationary. Or we can say that as probability value is less than 0.05 which is 0.0001 so we will reject the null. As we are rejecting the null it means the series does not have unit root which means that series is stationary. So there is no need to take the difference for making the series stationary.
- The absolute test statistics is 4.2915 which is greater than the critical value at 5% which is 2.9225. It means that we can reject the null which is that series has a unit root or data is not stationary. Or we can say that as probability value is less than 0.05 which is 0.0013 so we will reject the null. As we are rejecting the null it means the series does not have unit root

which means that series is stationary. So there is no need to take the difference for making the series stationary.

#### 4.2.5 Lag selection criteria

For the estimation of the Vector Auto regressive model we need the appropriate lag length. In econometrics there are many criteria's for the selection of lag length, like AIC, HQ, SC and LR. For the selection of lag length we have taken vector autoregressive model with different lag lengths and then compared their AIC (Akaike Information Criteria) the lags of the model that have the lowest AIC is selected for the estimation of the VAR model. According to the economic theory if too many lags are incorporated in the model than the standard error of the estimates of the coefficients will inflate. So the error in forecasting will be higher. While in case if the important lags are excluded from the model it will create biasness in the estimates. The AR(pp) model has the tendency of producing models with too many lags. Where BIC has tendency to produce a model with very low lag length.

**Table 4. 4 Selection of Lag length**

<b>Lag length</b>	<b>1 lag</b>	<b>2 lags</b>	<b>3 lags</b>	<b>4 lags</b>
<b>AIC</b>	0.121	0.1907	-0.556	-0.426

The table 3 shows the AIC value for models with lag length of 1, 2, 3 and 4.

For the lag length 1 value of AIC is 0.121989, for lag length 2 value of AIC is 0.19078, for lag length 3 and 4 AIC value is negative. So the smallest positive AIC value is for lag length 1 that is 0.121989. So it will be appropriate to take model with lag length 1 for the estimation of the VAR model.

#### 4.2.6 Autocorrelation test

The test of autocorrelation shows the results of coefficients and the Durbin Watson statistics. Durbin Watson shows the 1<sup>st</sup> order correlation. If the value of Durbin Watson is between 1.7 to 2.3 than there is no autocorrelation. In our model value of Durbin Watson is 2.0030 it means that there is no first order autocorrelation in the model.

**Table 4. 5 Breusch-Godfrey Serial Correlation LM Test:**

<b>F-statistic</b>	0.085238	<b>Prob. F(2,41)</b>	0.9185
<b>Obs*R-squared</b>	0.198755	<b>Prob. Chi-Square(2)</b>	0.9054

Breusch Godfrey Series Correlation LM test is for diagnosing higher order correlation.

Null hypothesis for this test is no autocorrelation. We check the probability of Chi square for confirming autocorrelation. If the probability is greater than 0.05 than we accept the null, which means no autocorrelation. So our model is best fit for the estimation of the Vector Autoregressive model.

#### 4.2.7 Cointegration test

As one of our variable was not stationary, we first checked the cointegration in the model. But results of cointegration in appendix found no cointegration in the variables. So we move towards the VAR model.

For making the variables stationary study takes difference of the variables. As there is no long run relationship existing in the model (no cointegration found) we can go for VAR model to check the short run relationship.

#### 4.2.8 Vector autoregressive model

The table 4 shows the results of the VAR model for the variables of our study.

**Table 4. 6 VAR analysis results**

	<b>DCMR</b>	<b>DLER</b>	<b>LINF</b>	<b>OUTPUT GAP</b>
<b>DCMR(-1)</b>	-0.119073 P(0.14974)	-0.001868 P(0.00520)	-8.39E-05 P(0.03650)	-0.018150 P(0.00766)
<b>DLER(-1)</b>	1.542 P(4.619)	0.1567 P(0.01603)	-2.1082 P(1.12622)	0.21153 P(0.23645)
<b>LINF(-1)</b>	2.52056 P(0.0067)	0.014606 P(0.0933)	0.83855 P(0.016)	0.0484 P(0.0344)
<b>OUTPUTGAP(-1)</b>	2.9907 P(3.191)	-0.1014 P(0.1107)	-0.14082 P(0.7780)	0.7215 P(0.1633)
<b>Akaike AIC</b>	3.990904	-2.731023	1.167860	-1.953871

#### 4.2.9 Results and discussions



- The results of VAR for equation 3 are for the output gap. It shows the relationship of the output gap with call money rate, exchange rate, inflation rate and its own lag. The results shows that output gap is negatively related to the growth rate of call money rate as it has a coefficient of -0.01815 and it is also significant as it has the probability value of 0.00766 which is 0.76 percent which is less than 5 percent. While with growth rate of exchange rate it has positive relationship as it has a coefficient of 0.21153 with the probability of 0.236 which means 23 percent. It means that output gap does not have significant relationship with the growth rate of the exchange rate. The results are consistent with the results of Chaudhry *et.al* (2012). The next variable is inflation, the coefficient of inflation is 0.048 with the probability of 0.034 which means 3 percent that is less than 5 percent it means output gap is positively related to the inflation and their relationship is significant. At last we will see the relationship of output gap with its lag term. It has the coefficient of 0.7215 with the probability of 0.16 which mean 16 percent that is greater than 5 percent it means that it is not significantly related to its lag term.
- The results of equation 4 for the VAR equation shows the relationship of inflation with growth rate of call money rate or short term interest rate , growth rate of exchange rate, its own lag value and the output gap. The results of the VAR model is showing that inflation is negatively related to growth rate of call money rate but its effect is very low. But it has a significant impact as it has a probability value of 0.036 which means 3.6 percent that is smaller than 5 percent. While the growth rate of exchange rate has negative coefficient of -2.108 with the probability value of 1.12 that is 112 percent it means that inflation rate does not have significant relationship with the growth rate of exchange rate. The results are somehow consistent with Bilquees *et.al* ( 2012). Inflation is positively related with its own

lag value with a coefficient of 0.8385 with a probability of 0.016 which means 1.6 percent it means that inflation is positively and significantly related with its lag value. It means inflation is also affected by its previous or past values. At last we will see the output gap, which has coefficient of -0.1408 with probability of 0.7780 which means 77.8 percent that is greater than 5 percent. It means that output gap is not significantly related to the inflation rate. Khalid(2005) have the same results instead the variable of output gap.

- The results of equation 5 for the VAR equation shows the relationship of growth rate of call money rate or inflation with its lag value, growth rate of exchange rate, inflation and the output gap. The results of the VAR model is showing that growth rate of call money rate is negatively related to it lag term as it has a coefficient -0.1190 with a probability of 0.1497 which is 14.9 percent that is greater than 5 percent it means that it is insignificant or growth rate of call money rate is not affected by its lag values. Growth rate of Call money rate has positive but insignificant relationship with growth rate of exchange rate as it has coefficient of 1.542 with probability of 4.619 that is 461.9 percent. “It means that *International fisher effect* do not hold as exchange rate is not affecting the call money rate significantly, keeping the assumption of only one country”. The coefficient of inflation is 2.520 with the probability value of 0.0067 which means 0.67 percent that is less than 5 percent it means that the coefficient of inflation is significant. “As inflation is positively related so, we can say that *fisher effect* do not hold in our study. As according to fisher effect when there is high inflation the policy rate or interest rate declines but in our study it will rise”. It displays that growth rate of call money rate affects the inflation rate positively. Lastly the output gap has the coefficient of 2.990 with the probability value of

3.191 that means 319 percent. It means that output gap is not affected by the growth rate of call money rate.

- The results of equation 6 shows the relationship of growth rate of exchange rate with growth rate of call money rate, its own lag value, inflation rate and the output gap. The results are showing that growth rate of exchange rate has negative coefficient of -0.00186 of growth rate of call money rate with probability value of 0.0052 which means 0.52 percent it means that growth rate of call money rate significantly affect the growth rate of exchange rate. The growth rate of exchange rate is positively related to its lag term as it has a coefficient of 0.156 with the probability of 0.0163 which means 1.6 percent that is less than 5 percent it means that it is significant. It demonstrates that growth rate of exchange rate is positively affected by its lag values. The coefficient of inflation is 0.0146 with probability value of 0.0933 which means 9.3 percent that is greater than 5 percent it means that inflation does not affects the growth rate of exchange rate. These results are consistent with the results of (Jaffri.A.,2010) as they also suggest almost zero pass through effect to prices. At last the coefficient of output gap is -0.1014 with probability value of 0.110 which means 11 percent that is greater than 5 percent. It means that output gap is not significantly related with the growth rate of exchange rate. Chaudhry *et.al* (2012) shows the same output and exchange rate relationship, according to the study it's a bidirectional relationship.

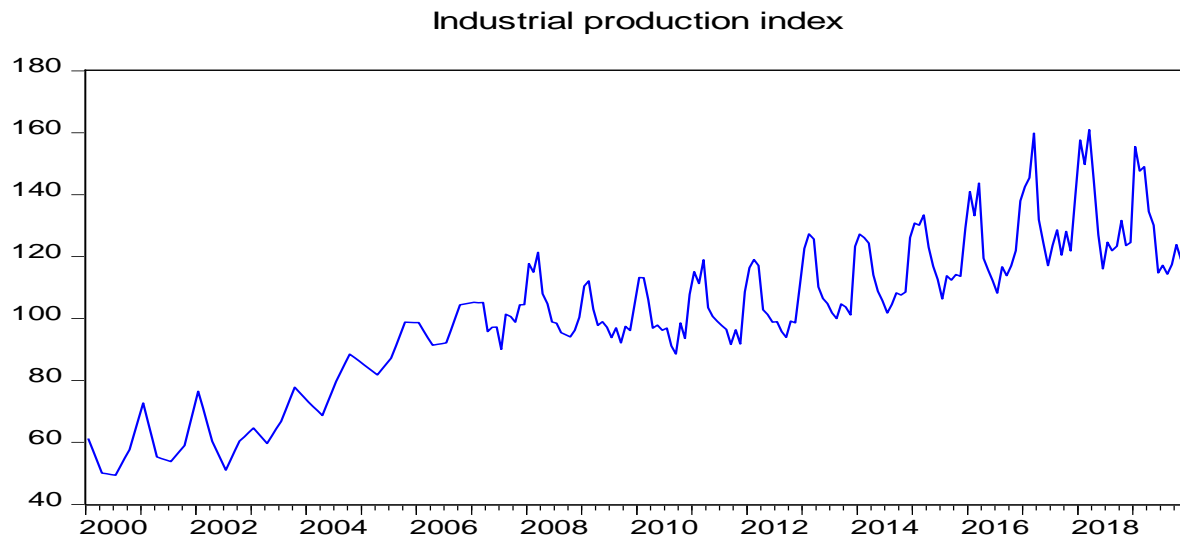
### **4.3 Model of exchange rate volatility**

This model analyzes the exchange rate volatility due to inflation targeting. We used the GARCH (1, 1) model. For this first we developed the mean equation and then by using the residuals obtained by the mean equation are used for the derivation of the variance equation.

#### **4.3.1 Descriptive statistics**

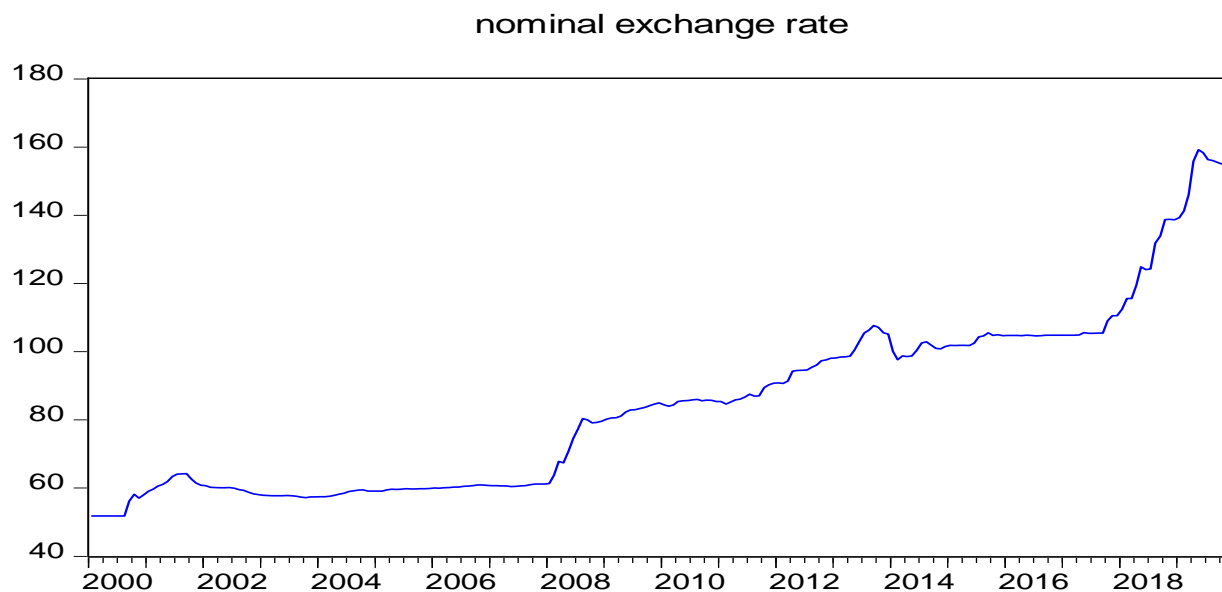
It is important for getting the information about the data and understanding of the data in a raw form. We check the trends and shocks present in the data. In statistical analysis we have mean, mode and median that are used for measuring the central tendency, while variance and range are used for measuring dispersion in the data set. Statistical analysis informs about the normality of the variables, extreme values present in the data and the presence of outliers. If the data have higher values of standard deviation it means that data has high volatility, and if value of Jarque Bera are high it means data is good fit and vice versa. If the probability values of the data are less than 0.05 it means that data is not normally distributed so we will have to take natural log of the variables. And if Jarque Bera test indicates non normality of the data than we need to take difference of the variables to make them normally distributed.

#### **Figure 4. 5 Industrial production index**



The graph shows the data of the industrial production index that is used as a proxy of the output in the model. There is an increasing trend in the index of industrial production but there is a lot of volatility among the monthly production as we can see in the graph there are lots of variations.

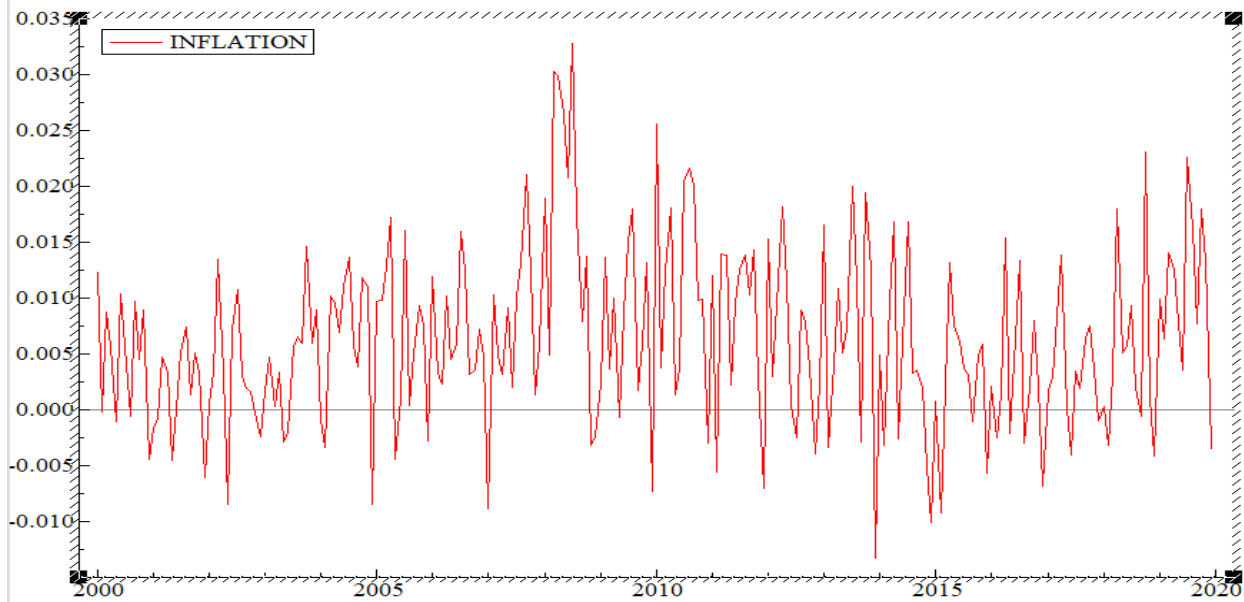
**Figure 4. 6 Nominal Exchange rate**



In the figure 1.6 of the nominal exchange rate index there is almost constant trend from 2000 to 2007 as the exchange rate was held fixed but this trend has changed after 2007 as there is an

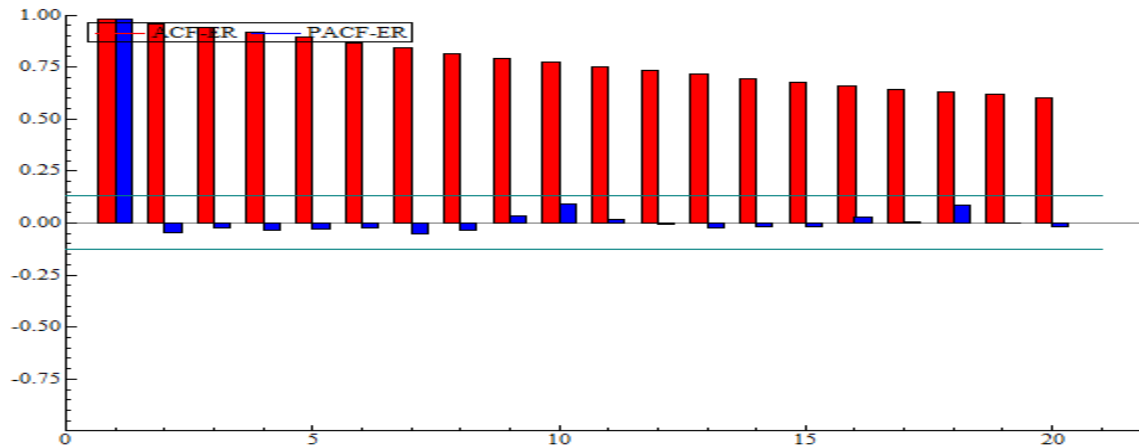
increasing trend in the exchange rate as the regime was shifted to the managed floating exchange rate. After 2013 there was a minor decline in the exchange rate but again it started to move upward but it includes a lot of fluctuations.

**Figure 4. 7 Inflation**



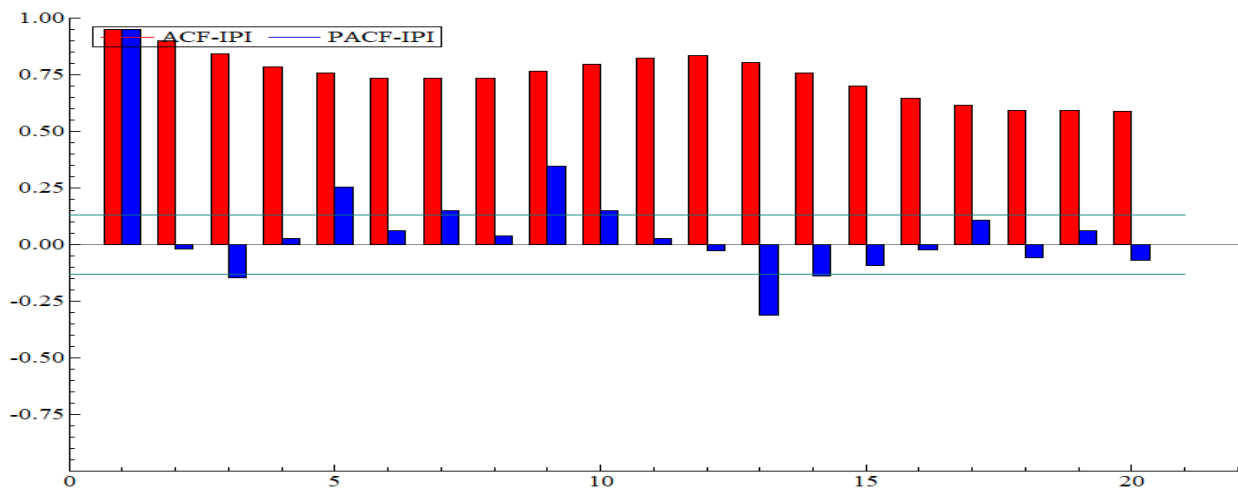
The graph shows the data of the prices level in Pakistan. From 2000 to 2005 there is increasing trend with fluctuations of the prices. In 2008 there were huge fluctuation in the inflation level but in 2009 it normalized. After 2011 there was a minor decline in the level of inflation that does not stayed for a long time and after wards the inflation level continued to increase with fluctuation's in the inflation level.

**Figure 4. 8 ACF and PACF plot of exchange rate**



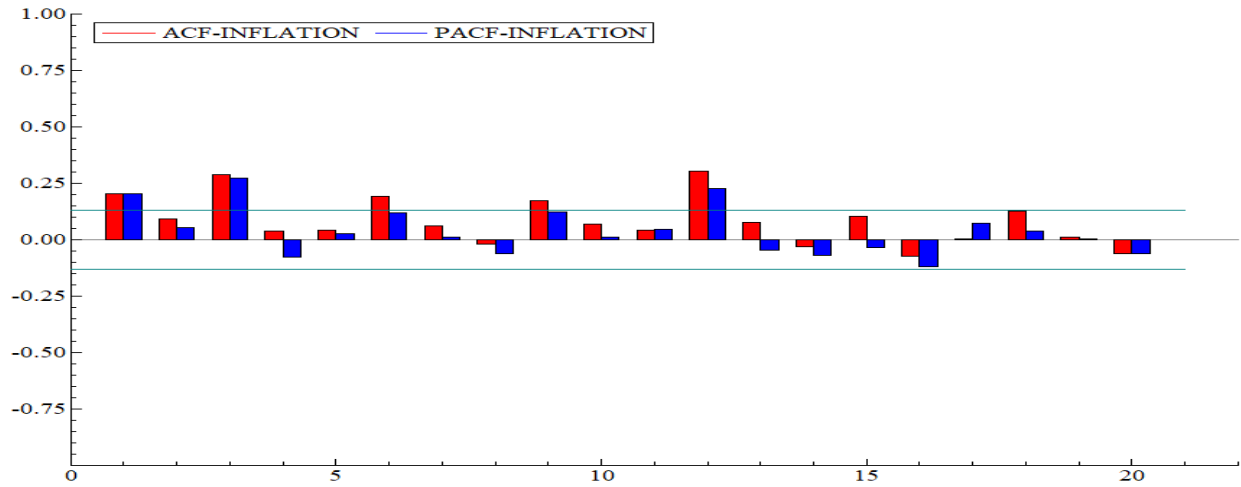
The figure shows the ACF and PACF plot of the SDER. ACF and PACF gives us the idea about the presence of the effect of the previous autoregressive terms. But it does not give the exact idea about how much lag terms are present in the series. The plot shows that SDER is highly auto correlated. It means that AR is present. It means we have to include the autoregressive term.

**Figure 4. 9 ACF and PACF plot of IPI**



The figure shows the ACF and PACF plot of the industrial production index. There is high level of autocorrelation present in it. It means we have to include the autoregressive term.

**Figure 4. 10 ACF and PACF plot of Inflation**



The figure shows the ACF and PACF plot of the inflation. It shows that there is autocorrelation present in the data. It means we have to include the autoregressive term.

**Table 4. 7 Statistical analysis of variables**

	<b>Consumer price index</b>	<b>DLIPI</b>	<b>DLEV</b>
<b>Mean</b>	0.00627	0.0033	-0.0199
<b>Standard deviation</b>	0.0078	0.062	1.0556
<b>Minimum</b>	-0.0133	-0.1917	-6.789
<b>Maximum</b>	0.032	0.2222	8.773
<b>Kurtosis</b>	0.392	0.9090	25.951
<b>Skewness</b>	0.473	0.1811	1.473



The table shows the statistical results of the variables included in the model.

### 4.3.2 Empirical analysis:

#### Test for normality

For checking the normality of the data we will use the Jarque Bera test.

Null hypothesis for the Jarque Bera test is that series is normally distributed.

H1: not normally distributed

If probability is less than 5% we reject the null.

If the series is not normal than we take log of the series to make it normal.

It means that if probability value is less than 5% it means we will reject the null and series does not have the unit root. Than for making the series stationary we will take the first difference of the series. The other guideline is if the absolute test statistics is greater than absolute critical value than we will reject the null and if absolute critical value is greater than absolute test statistics than we will accept the null.

#### Jarque Bera test

**Table 4. 8 Normality test statistics**

	<b>Consumer Price Index</b>	<b>Exchange Rate volatility</b>	<b>Industrial production index</b>
<b>Jarque Bera</b>	10.489 P(0.005)	27.71218 P(0.001)	9.9563 P(0.008)

- In table 3 CPI has probability of 0.005, which means 0.005% that is less than 5%. It means we can reject the null that is series is normal. It means that series of CPI is not normally distributed. So we will take log of the series to make it normally distributed.
- The exchange rate volatility has probability of 0.001, which means 0.001% that is less than 5%. It means we can reject the null that is series is normal. It means that series of exchange rate volatility is not normally distributed. So we will take the log of the series for making it normally distributed.
- The industrial production index has probability of 0.008, which means 0.008% that is smaller than 5%. It means we cannot reject the null that is series is normal. It means that we will reject the null which means that the series of industrial production index is not normally distributed. So we will take the log of the series for making it normally distributed.

### **Test for stationarity**

For checking the stationarity in the data of the variables unit root test is used. We will check stationarity of all the variables through augmented dickey fuller test.

Null hypothesis for unit root test is series has unit root which means data is not stationary.

If the probability value is less than alpha value than we will reject the null. It means that if probability value is less than 5% it means we will reject the null and series does not have the unit root. Than for making the series stationary we will take the first difference of the series. The other guideline is if the absolute test statistics is greater than absolute critical value than we will reject the null and if absolute critical value is greater than absolute test statistics than we will accept the null.

We have taken the log of the series of the industrial production index and the volatility of exchange rate to make them normal and then estimated the augmented dickey fuller test.

**Table 4. 9 Stationarity test statistics**

<b>ADF</b>	<b>t-statistics</b>	<b>C.V(5% level of significance)</b>	<b>Probability*</b>
<b>LEV</b>	0.54	-2.87	0.98
<b>LIPI</b>	-1.79	-2.87	0.38
<b>Inflation</b>	-5.89	-2.87	0.00

- For LEV the absolute test statistics is 0.54 which is smaller than the critical value at 5% which is 2.87. it means that we cannot reject the null which is that series has a unit root or data is not stationary, it means we will accept the null or we can say that as probability value is greater than 0.005 that is 0.98 so we will accept the null. As we are accepting the null it means the series has unit root which means that series is not stationary. So there is a need to take the difference for making the series stationary.
- For LIPI the absolute test statistics is 1.79 which is smaller than the critical value at 5% which is 2.87. it means that we cannot reject the null which is that series has a unit root or data is not stationary, it means we will accept the null or we can say that as probability value is greater than 0.005 that is 0.38 so we will accept the null. As we are accepting the null it means the series has unit root which means that series is not stationary. So there is a need to take the difference for making the series stationary.
- For inflation the absolute test statistics is 5.89 which is greater than the critical value at 5% which is 2.87, it means that we can reject the null which is that series has a unit root or data is not stationary, or we can say that as probability value is less than 0.005 that is 0.00 so

we will reject the null. As we are rejecting the null it means the series doesn't have unit root which means that series is stationary. So there is no need to take the difference for making the series stationary.

For stationarity of the variables difference of the variables is taken. By differencing the variables they become stationary and can be used in the model.

### 4.3.3 Pre estimation test

Before estimation of the GARCH model we will estimate the presence of ARCH effect in the series. It is estimated through ARCH LM test.

#### ARCH LM test

ARCH LM test was performed to check the presence of ARCH effect in the series.

The null for ARCH LM test is that there is no ARCH effect.

**Table 4. 10 Test statistics for ARCH LM test**

<b>LM ARCH test</b>	<b>Coefficient</b>	<b>Probability*</b>
<b>DLIPI</b>	2.36	0.013*
<b>DLEV</b>	2.92	0.0001*
<b>Inflation</b>	21.43	0.000*

- For DLIPI the probability value is 0.01 that is greater than 0.05 or 5% it means we will reject the null. As we are rejecting the null it means that there is ARCH effect present in the series of DLIPI.

- For DLEV the probability value is 0.0001 which is smaller than 0.05 it means we will reject the null. As we are rejecting the null it means that the ARCH effect is present in its series.
- For inflation the probability value is 0.00 which is smaller than 0.05, it means we will reject the null. As we are rejecting the null it means that the ARCH effect is present in the series.

As ARCH effect is present in DLEV, DLIPI, and inflation, so we can apply the GARCH model to them. As it necessary to have ARCH effect for the implication of the GARCH model. We will use the simplest version of GARCH that is GARCH (1,1).

#### 4.3.4 Estimation of the GARCH mean equation of exchange rate

This section comprises of the process of data generation of the exchange rate and the test of diagnostics for inspection of the presence of auto correction. And at last we will also check the presence of ARCH effect.

##### Process of data generating for series of exchange rate:

First we will establish the mean equation and the variance equation of volatility of exchange rate for the GARCH (1, 1) model.

$$\text{C.M.E } \varepsilon v_t = -0.00 + 0.21 \varepsilon v_{t-1} + 0.06 \pi_t + 0.01 y' + e$$

**Table 4. 11 GARCH mean equation of Exchange rate**

	<b>Coefficient</b>	<b>p-value</b>
<b>Constant</b>	-0.000081	0.752
<b>AR-1</b>	0.62	0.007
<b>MA-1</b>	0.31	0.02

AR and MA together equals to 0.93, it means less than 1. And also both AR and MA are significant as they have t-value less than 0.05.

Now for checking the validity of the mean equation we will compute the residual analysis.

### **Residual analysis of the mean equation:**

In GARCH model residual analysis is performed for the estimation of the stationarity of residuals for the validity of the mean equation. We will check for any autocorrelation and ARCH effect left or not. The model is good if there is no autocorrelation and ARCH effect left.

**Table 4. 12** Test statistics of residual analysis of mean equation

<b>Test statistics</b>	<b>Residuals</b>	<b>p-value</b>
<b>Q (5)</b>	0.75	0.86
<b>Q (10)</b>	1.23	0.99
<b>Q (20)</b>	3.05	0.99
<b>Q<sup>2</sup> (5)</b>	0.11	0.99
<b>Q<sup>2</sup> (10)</b>	0.16	0.99
<b>Q<sup>2</sup> (20)</b>	0.22	1.00
<b>ARCH (1-2)</b>	0.02	0.97
<b>ARCH (1-5)</b>	0.02	0.99
<b>ARCH (1-10)</b>	0.03	1.00

The null hypothesis of the Q-stat Ljung-Box statistics is that the serial has no auto correlation. If the p value is greater than 5% than we will accept the null. The null hypothesis for the ARCH LM test is that there is no ARCH effect. If the p value is greater than 5% than we will accept the null.

The results in the table shows that there is no autocorrelation present in raw data as well as the data that is squared as there p values are higher than 5 percent. Also the results of ARCH LM represent no ARCH effect left. As all the p values are greater than 5 percent.

### 4.3.5 Estimation of the GARCH variance equation of exchange rate

This model will estimate the conditional variance of the variables in the model.

$$\sigma_t^2 = 0.003 + 0,09 \sigma_{t-1}^2 + 0.79 \varepsilon_{t-1}^2$$

The conditional variance equation shows that the conditional volatility is persistent and also the means are reverting.

**Table 4. 13 Variance results of GARCH estimation**

	<b>Coefficient</b>	<b>P value</b>
<b>Constant</b>	0.005	0.00
<b>ARCH-1</b>	0.09	0.00
<b>GARCH-1</b>	0.79	0.00

In this model the sum of alpha and beta is 0.89. It shows the shocks persistence for a larger time period. ARCH and GARCH are also significant.

### **Residual analysis of the variance equation:**

GARCH models has the post estimation test of residual analysis for checking the model. We will check whether there is any autocorrelation and ARCH effect left or not. The model is good if there is no autocorrelation and ARCH effect left.

**Table 4. 14 Test statistics of residual analysis of variance equation**

<b>Test statistics</b>	<b>Residuals</b>	<b>p-value</b>
<b>Q (5)</b>	3.92	0.88
<b>Q (10)</b>	4.28	0.54
<b>Q (20)</b>	5.8	0.62
<b>Q<sup>2</sup> (5)</b>	2.35	0.50
<b>Q<sup>2</sup> (10)</b>	2.79	0.94
<b>Q<sup>2</sup> (20)</b>	4.88	0.99
<b>ARCH (1-2)</b>	0.54	0.58
<b>ARCH (1-5)</b>	0.41	0.84
<b>ARCH (1-10)</b>	1.22	0.91

The null hypothesis of the Q-stat Ljung-Box statistics is that the serial has no auto correlation. If the p value is greater than 5% than we will accept the null. The null hypothesis for the ARCH LM test is that there is no ARCH effect. If the p value is greater than 5% than we will accept the null.

The results in the table shows that there is no autocorrelation present in raw data as well as the data that is squared as there p values are higher than 5 percent. Also the results of ARCH LM represent no ARCH effect left. As all the p values are greater than 5 percent.

The results of the models shows that the policy instrument that is call money rate affects the volatility of exchange rate, in the economy positively, also these objectives were also discussed by Malik (2007) And also that the inflation do impacts the exchange rate volatility positively. The result is consistent with the Sek,S.K. (2012). The study also suggest that there exist a volatility spillover effect from inflation to volatility of exchange rate. This result is consistent with the results of Shah et. Al,(2009).



## Chapter 5

### Conclusion and Recommendation

#### 5.1 Conclusion

The findings show that the channel between interest rate and the prices do exist in Pakistan. As during the period of 1970 to 2019 the inflation and the output are interrelated with each other negatively. Which clears the path for IT. The suggestions for Pakistan for the adoption of IT is that it should start with flexible IT, in which it can control the interest rate and the volatility of exchange rate as required depending on the situation.

Our findings also proposes that the adoption of the IT will decrease the volatility of the exchange rate, as it will control the inflation rate so there will be less volatility in rate of inflation which would than lead to low volatility in exchange rate. The empirical analysis of the volatility of exchange rate, inflation and the output gap for Pakistan using the GARCH model shows the significant variance spillover effect from the inflation to the volatility of the volatility of the exchange rate. It means that any change or volatility in the inflation creates volatility in the volatile nature of exchange rate. This shows that by opting the policy of targeting inflation in Pakistan we can somehow control the volatility of the exchange rate and also boost the output for the economy.

CB of Pakistan has control over the inflation by means of the interest rate, as interest rate and the exchange rate has negative relation. It also depicts that prices have extensive memory of influencing the interest rate, it shows that it can be used in targeting inflation. The findings directs the CB to chase more varied objective when the rate of inflation is prioritize through the rate of interest. It has become important to inspect movements in exchange rate volatility and the output gap. Whenever any shock appears, nominal anchor (that is interest rate) should act in a way to resist that shock and force the economy towards equilibrium as the disequilibrium brings losses in

the economy and also produces volatility that is harmful for the economy. CB needs to give reaction as these tremors in the economy are sudden. The policy of the CB may vary from loose to aggressive monetary policy but it depends on the uncertainty conditions and the volatility of the gap of inflation-output. In case of high volatility CB can opt aggressive policy, so IT will be beneficial for stabilizing the relationship of inflation-output.

## **5.2 Recommendations**

Based on the empirical findings and the discussion following recommendations are made for the monetary policy and the economic growth. Inflation is termed as a monetary phenomenon by many studies, it means that monetary policy should be tighten by the SBP. Countries like Pakistan are inclined to sequences of shocks that may include oil shocks, flood, export prices and many others that affect the economy adversely. Also the volatility in the exchange rate is too much volatile which affects the economic indicators badly. So such a monetary policy should be opted that targets inflation in a way that prevents the drift of the rate of inflation and the volatility of exchange rate would decrease. Empirics of the study suggest the policy of inflation targeting as the best policy as it controls the inflation level and exchange rate volatility hence it promotes growth in the economy. This will probably lead the economy towards growth.

## **5.3 Limitations**

Limitations of the study are that for the GARCH model we have to use high frequency data for better results so we have used monthly data rather than yearly as used in the VAR model.

And for the fisher effect we do not have the real interest rate in our model so we assume it to be constant and check the relation of interest rate and inflation directly.

In the international fisher effect that is related to the exchange rate, there is interest rate and exchange rate of the second country also but we only have one country. So the study only verifies the relation of interest rate and exchange rate of Pakistan.

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## Appendix

Date: 10/13/20 Time: 15:38  
Sample (adjusted): 1973 2019  
Included observations: 47 after adjustments  
Trend assumption: Linear deterministic trend  
Series: CALL\_MONEY\_RATE INFLATION LER  
Lags interval (in first differences): 1 to 1

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### Unrestricted Cointegration Rank Test (Trace)

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Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.319662	29.66553	29.79707	0.0518
At most 1	0.200162	11.56275	15.49471	0.1791
At most 2	0.022415	1.065507	3.841466	0.3020

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Trace test indicates no cointegration at the 0.05 level  
\* denotes rejection of the hypothesis at the 0.05 level  
\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

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Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.319662	18.10278	21.13162	0.1261
At most 1	0.200162	10.49724	14.26460	0.1813
At most 2	0.022415	1.065507	3.841466	0.3020

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Max-eigenvalue test indicates no cointegration at the 0.05 level  
\* denotes rejection of the hypothesis at the 0.05 level  
\*\*MacKinnon-Haug-Michelis (1999) p-values