Leaning Against the Wind: The Cost-Benefit Analysis of Monetary Policy in Pakistan

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CERTIFICATE

This is to certify that this thesis entitled **"Leaning against the wind: The Cost-Benefit analysis of Monitory Policy in Pakistan"** submitted by **Ms. Zareen Afzaal** is accepted in its present form by the Department of Economics and Finance, Pakistan Institute of Development Economics (PIDE) Islamabad as satisfying the requirements for partial fulfillment of the Degree of Master of Philosophy in Economics and Finance.

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Dedication

This thesis is dedicated to my family, for believing in me, inspiring me, and always encouraging me so that I can achieve my goals. Also, my thesis is dedicated to my supervisor who guided me so that I could complete my research work.

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First of all, I would like to thank Allah Almighty for helping me to go through this tedious work of research and listening to my supplications.

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ZareenAfzaal

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Acronyms

LAW	Leaning against the wind
NL	Non-leaning
Ũ	Unemployment deviation
DSGE	Dynamic stochastic general equilibrium models
RBC	Real business cycle
VAR	Variance autoregressive models
GDP	Gross domestic product
HP-filter	Hodrick-Prescott filter
Un	Unemployment
MC	Marginal cost
MB	Marginal benefit
MB^p	Marginal benefit from a lower probability of crisis
$MB^{\Delta u}$	Marginal benefit from smaller magnitude of crisis
NMC	Net marginal cost
L	Loss function

Abstract

The rising interest rates in Pakistan have become a significant, current issue. Whether these rising interest rates pose a threat to the economy or not, is the basic question at hand. This study aims to determine the numerical values of the costs and benefits of the monetary policy's leaning against the wind (LAW) using sensitivity analysis. The underlying models of this sensitivity analysis are the Dynamic Stochastic General Equilibrium Models (DSGE) and the Variance Autoregressive Models (VAR). The study covers a twenty year time span ranging from 1998-2017. The estimates of probability of a future financial crisis, the crisis duration and magnitude of a crisis were acquired. Thereby, adding the marginal benefit from a lower probability of a crisis and marginal benefit from a smaller magnitude of a crisis, the total marginal benefit was obtained, which was then subtracted from the marginal cost which too was calculated, using certain estimates and assumptions. Impulse response functions were also obtained using various series of variables, such as, the unemployment rate, debt-to-income ratio, real debt and lastly, the probability of a crisis. One unit (positive) shock to the policy rate (interest rate) was given and its impact on all the series mentioned above was gauged. The results of this study indicate that as we move from non-leaning (NL) towards leaning against the wind (LAW), the costs increase and the benefits decrease, respectively. On that basis, it is recommended that the State Bank of Pakistan should avoid leaning against the wind and further tightening of the monetary policy. However, further research is required on the calculation of certain components used in this study, such as, the possibility of a crisis occurring (probability), the magnitude of that crisis and the time duration for which that crisis can persist.

CHAPTER 1

Introduction

1.1 Preamble

This chapter provides an introduction to the study. Section 1.2 discusses the background of the study, section 1.3 discusses about the modelling of monetary policy in the case of Pakistan, section 1.4 states the problem statement, section 1.5 describes the objectives of the study and section 1.6 sheds light on the significance of the study.

1.2 Introduction

Leaning against the wind (LAW), signifies a monetary policy with a higher policy interest rate (tighter monetary policy), than what is justified in case of flexible inflation targeting. It refers to leaning in the periods of high credit booms and asset prices increase. A financial crisis is often associated with one or more of the following phenomena: substantial changes in credit volume and asset prices (IMF, 2018).The benefits of leaning compriseof a lower probability or smaller magnitude of a forthcoming financial crisis and costs include lower inflation and increased level of unemployment in the economy.

Recent research assumes that the primal benefit of LAW is the avoidance of financial crisis, like for instance, the Global Financial Crisis of 2008. A plus point to this definition is that it permits the costs and benefits to be calculated in terms of expected changes in the unemployment rate. On the other hand, there is also a disadvantage of this definition, that it might be too narrow (Saunders &Tulip, 2019).

Monetary policy has a lot left that has to be explored about it. Its benefits have often been overlooked and fiscal policy has been researched throughout. The benefits and losses accrued from the implementation of an effective monetary policy are of considerable importance to the economy. Monetary policy fosters price stability and real stability[1]that elevates the economy to a better position, leaving an impact on the net exports, credit growth, price stability, employment and many other macroeconomic variables (Srithilat& Sun, 2017).

A statement that was in favour of LAW in terms of financial stabilization of the economy was put forward by Stein in 2013; monetary policy gets in all of the cracks [of the financial system] and may reach into corners of the market that supervision and regulation cannot (Stein, 2013). A moderate increase in the policy interest rate would hardly fill the cracks, in order to fill these cracks, such an increment in the policy rate is needed that it might as well kill the economy (Svensson, 2015). If the interest rate is being raised, the cost of borrowing is increased and it increases mortgage interest payments. There is an increased incentive to save rather than to spend. Furthermore, higher interest rates increase the value of currency leading to an appreciation in the exchange rate and increases the cost of government interest payments. Consumption and investment falls. Consumer and business confidence is affected by higher interest rates in the economy (Economics Help, 2017).

If monetary policy is implemented, under flexible inflation targeting; there are certain goals which are to be achieved by it. These goals are, firstly, price stability related to the attainment of inflation around the set inflation target and, secondly, real stability pertaining to maximum employment (full employment) in the particular country around its estimated long-run sustainable rate. These goals are set to be acquired by the monetary policy but what about the financial stability?

[1] Real stability means the financial stability in the country. It can also mean a condition in which the three components of the financial system,that are, financial institutions, financial markets and financial infrastructure, are stable.

The one related to financial markets, lending between them and the interest rates prevalent, mortgages and real estate. Now, for this, another policy, namely, a macroprudential policy has to be deployed. The goal of macroprudential policy is financial stability. Monetary policy is primarily aimed at price stability; and macroprudential policies at financial stability (Smets, 2014).

Therefore, it is now clear that the goals of monetary policy are price stability and real stability whereas the goal of macroprudential policy is financial stability. Therefore, only by employing monetary policy, stabilization of the economy cannot be achieved; macroprudential policy too is a must. When both these policies are implemented, the goals of stabilization are met. Additionally, macroprudential policies, which are targeted, would help in consigning future run-ups in debt (OECD, 2012). Macroprudential policies aim to ward off, or at least to have a capacity for, the buildup of financial imbalances and to make sure that the financial system is able to resist the easing up after stress and be quick to recover from the shocks (Smets, 2014).But should the monetary policy be employed for financial stability purposes? For example, a tighter monetary policy might restrict the growth of household debt and housing prices. This might decrease the probability of a likely future financial crisis. Since a crisis implicates too low an inflation rate and too high an unemployment rate, a tighter monetary policy might have a better expected future outcome. But this furthermore implies that in the future, some years later, the tighter monetary policy will result in a lower inflation and a higher unemployment rate. So, it may have these costs and may result in a worse expected future outcome. Therefore, to have a justification for a tighter monetary policy, the benefits must exceed the costs and for the policy to be optimal, the benefits must equalize the costs (Svensson, 2015).

The goals of these two policies have been described. Now, what are instruments of the two policies is the next basic question. The instruments of monetary policy in normal times are policy rate and communication. Policy rate means the policy interest rate and communication relates to the foretelling of target policy rates[2], inflation rates and unemployment rates. In the times of crisis, the instruments of monetary policy comprise of large-scale asset purchases, balance sheet policies, fixed rate lending and exchange rate floors. In normal times, the instruments of the macroprudential policy, under crisis prevention are supervision, regulation and communication. They contain the financial reports, liquidity and capital requirements, mortgage loan-to-value caps etc. In times of crisis, however during crisis management, the monetary, fiscal and macroprudential authorities cooperate and use all available instruments to reduce the scope and magnitude of crisis, and reinstate financial stability (Svensson, 2018).

Apprehending the aforementioned fact and to be more clear regarding the subject, it is very important to state here that monetary policy does have some effects on the financial stability. Likewise, macroprudential policy also has some effects on price stability and real stability. More specifically, these effects are unsystematic and weak. They are not strong and only affect the goals to a very minute degree.

The authority responsible for administering the instruments and achieving the goals concerning the monetary policy is the central bank. The authorities which take into account the

[2] SBP focuses on achieving monetary stability by controlling inflation close to its annual and medium-term targets set by the government. At the same time, SBP also aims to ensure financial stability, particularly the smooth functioning of the financial market and the payments system. Consensus in literature as well as country experiences suggests that price and financial stability facilitate the achievement of sustained economic growth in the long-run.

macroprudential policy related actions can be any supervisory or regulatory authority of a country, for instance, the central bank, ministry of finance etc.

Asset prices and credit, which are relevant variables for macroprudential policy, are affected by the monetary policy at hand. Likewise, macroprudential policy also has an impact on these variables, and is therefore, most likely to affect the transmission mechanism of monetary policy**(**Angelini, Neri& Panetta, 2011).

After the Global Financial Crisis of 2008, it is accepted that the Central Bank should be transparent in monetary policy implementations, in order to reestablish the credibility of the Central Bank and to reduce inflationary effects (Atgur& Altay, 2017).

1.3 Monetary Policy in the Case of Pakistan

In the case of Pakistan, when a monetary policy is deployed, it aims to achieve the goals of price stability and real stability, whereas, the goal of financial stability remains unattended. To fulfill the objective of bringing financial stability in the economy, a macroprudential policy has to be deployed as well. This creates stability in the economy and brings it to an overall sound level. In the Monetary Policy Experience of Pakistan, it has been mentioned that LAW is opted by the monetary authority in Pakistan i.e., The State Bank of Pakistan (Hanif, 2014). As the relationship between inflation and unemployment is referred to as the Phillips curve (Phillips, 1958), therefore, based on this relationship the monetary authority follows the path of “leaning against the wind.” Furthermore, this relationship gives a message to the policy makers that if they try pro-GDP economic policies, the cost in terms of future inflation would be higher and in the case of prolonging stabilization policies, the cost will be higher in terms of future unemployment (Hanif, 2014).[3]

An ongoing debate nowadays is about bringing the interest rate downwards. There is a lot of pressure on SBP's governor Dr. Reza Baqir to bring the interest rate to a lower level. Pakistan's current situation is such that it is creating problems for Pakistan's economy at this current point in time. But it keeping Pakistan's current situation in mind, it can get difficult to manage Pakistan's interest rate.

A threshold level of the policy interest rate is required to be calculated for Pakistan, so that we can check where the costs and benefits of LAW are exactly equal, which refers to as an optimal monetary policy. The relationship is non-linear.

1.4 Problem Statement

If LAW is implemented, along with its benefits, some losses (costs) are also accrued. A cost and benefit analysis of LAW will be done which presents the costs and benefits accrued by implementing LAW in Pakistan. The costs and benefits are then weighed, to find out, that which of the two exceeds the other.

1.5Objectives of the Study:

The objectives of the study are as follows:

I. To provide a cost-benefit analysis of LAW in order to evaluate whether the costs are greater than the benefits or vice versa.

II. To investigate whether LAW is beneficial for the economyof Pakistan or not.

[3]Implementation of the monetary policy stance, signaled through announcement of the policy rate, entails managing the day-to-day liquidity in the money market by SBP with the objective to keep the short-term interest rates stable and aligned with the policy rate.

1.6 Significance of the study

This study will provide evidence to the financial and advisory authorities and add to the debate on the scope of the monetary policy. This will bear a fruitful outcome as the goals of monetary policy, along with those of the macroprudential policy, will be elucidated. The society will reap benefits from the cost-benefit analysis as solid, empirical estimates of the costs and benefits of LAW will be available to them, through which they will be able to evaluate the monetary policy stance. The enumeration of the costs and benefits of LAW will also enable individual bodies to analyse the monetary policy prevalent in Pakistan and give suggestions referring to the monetary policy at this moment in time.

1.7 Thesis Organization

The rest of the thesis is organized as follows; Chapter 2 contains the Literature Review. Chapter 3 defines the Data and Methodology in detail. Chapter 4 presents the Results and Discussions and lastly, Chapter 5 gives the Conclusion and Policy Recommendations.

CHAPTER 2

Literature Review

2.1 Preamble

This chapter elaborates the literature present on leaning against the wind. Section 2.2 states a definition of LAW, section 2.3 provides a definition of macroprudential policies, section 2.4 provides the details of the monetary policy transmission mechanism and following it the sub-sections 2.4.1 explains the interest rate channel, 2.4.2 describes the asset price channel, 2.4.3 gives details on the credit channel and 2.4.4 describes the exchange rate channel. Section 2.5 gives a brief overview on the background of the Dynamic Stochastic General Equilibrium Models (DSGE). Section 2.6 provides a brief overview of the proponents and opponents of LAW. Section 2.7 provides the theoretical evidence on LAW and section 2.8 gives the empirical evidence. Section 2.9 provides evidence of monetary policy for the case of Pakistan.

2.2 Leaning against the Wind (LAW)

LAW is a countercyclical monetary policy, an economic phenomenon whereby the Central bank tends to counteract the fluctuations in an economic cycle of its country by taking measures to dampen inflationary booms and stimulate growth.

2.3 Macroprudential Policies

Macroprudential policies are those which are related to the financial system and minimize the systemic risk[4] prevalent in the economy. Such policies aim at preventing the risks from exerting a strong influence on the financial system, in a broader context.

2.4 Monetary Policy Transmission Channels

Monetary Transmission Mechanism is a concept which refers to the transmission on inflation of the monetary policy decisions (Taylor, 1995).Monetary policy transmission mechanism is the process through which the economy and the price level of a particular country are affected by the implementation of the monetary policy. It depicts how the change in the policy interest rate by the Central Bank affects the aggregate demand, inflation expectations and the rate of inflation of a particular country. Long and short-term interest rates are affected by the Central Bank's interest rate formation decisions and so is liquidity in the financial system, bank credit and the quantity of money, asset prices, exchange rate, and lastly, the future expectations regarding all these variables in the market. All of these sequentially have an effect on investment and consumption decisions of firms and individuals, thereby affecting aggregate demand, and eventually inflation. The monetary policy transmission involves long and uncertain time lags due to which the prediction of the exact effects of the monetary policy on the economy and price level becomes difficult. Four channels of monetary policy transmission have been found,[5] namely, the interest rate channel, the asset price channel, the credit channel and the exchange

[4] Systemic risk refers to extreme instability occurring in an organization, due to any incident, and thereafter the whole economy is likely to crumble.

[5] Mishkin (1995) examined Monetary Transmission Mechanism channels under four headings as interest rates, exchange rates, asset prices and credit channels.

rate channel. The monetary policy in any country is managed in two ways; either by bringing about a change in the money supply or in the interest rate.

2.4.1 The interest rate channel

a) Interest rate change:

In the interest rate channel, the retail interest rates are affected. The retail interest rates are those which the banks offer to households on deposits or charge on loans to businesses. In the first period, changes in the policy rate influence the money market interest rates, which are, KIBOR[6] and the repo rate which sequentially impact the long-term interest rates. When the interest rates are lower, people are encouraged to save less and consume more and vice versa. The demand for credit decreases as it becomes expensive for the general public as well as the investors to borrow from the commercial banks. Consequently, economic activity is slowed down and a fall in the demand for and prices of goods and services is observed.

b) Money supply change:

An expansionary monetary policy causes the real interest rate to move downwards which, in turn, decreases the cost of capital and boosts investment and consumption and discourages savings. This results in an overall increase in the output level.

$$M \uparrow \Rightarrow r \downarrow \Rightarrow c \downarrow \Rightarrow S \downarrow \Rightarrow I \uparrow, C \uparrow \Rightarrow Y \uparrow$$

Where, M = money supply

r = real interest rate

[6] KIBOR stands for Karachi Interbank Offer Rates. KIBOR is used as a benchmark rate for lending to consumers and businesses. The changes in KIBOR and thus the borrowing cost for consumers and businesses influence decisions of the public to consume, save, or invest.

c = cost of capital

S = savings

I = investment

C = consumption

Y = output

2.4.2 The asset price channel

a) Interest rate change:

The asset price channel’s working is through the price of assets. These can be real as well as financial assets. For instance, an increase in the interest rate causes a rise in the returns of bank deposits in comparison to returns on investing in other assets. Consequently, consumers choose to deposit their cash rather than holding bonds, stocks and real estate.This is a result of decrease in the demand for these assets and this ultimately decreases the price and wealth of the owners of these particular assets.When their wealth decreases, their expenditure falls as well. Thisin turn decreases the demand for goods and services in the economy and subsequently their prices as well.

b) Money supply change:

An expansionary monetary policy puts an upward pressure on the prices of financial assets, which increases the wealth of households. This can be seen as an increase in consumption by households as well as increase in investment by firms. This yields an increase in output altogether.

$$M \uparrow \Rightarrow P_f \uparrow \Rightarrow W \uparrow \Rightarrow I \uparrow, C \uparrow \Rightarrow Y \uparrow$$

Where, M = money supply

P_f = price of financial assets

W = wealth

I = investment

C = consumption

Y = output

2.4.3 The credit channel

a) Interest rate change:

This is also known as the balance sheet channel. This means the channel through which the credit portfolio of financial intermediaries as well as other economic agents affects the monetary policy. The changes in monetary policy affect the availability of loanable funds with the financial intermediaries and other economic agents by making specific changes with regard to their cash flows and net wealth. Such changes in interest income and wealth affect the micro level as well as the aggregate level of expenditure, output and prices in the economy. For example, in a tight monetary policy regime the bank's capacity to extend credit is reduced. This is mainly due to the lesser availability of funds and a lower demand for credit by the consumers and the businesses, because of the decrease in their cash flows and net wealth. By these means, a contractionary monetary policy brings about a fall in the aggregate demand and in the prices of goods and services in the economy.

b) Money supply change:

This channel is related to the assets of commercial banks. An expansion in the money supply and changes in the policy rate by the Central Bank leads to an increase in the overall liquidity of the commercial banks, which increases their reserves and this, in turn, shows an increment in providing credit to the private sector. The liquidity of the private sector increases. The growth of the commercial banks indicates positive effects on investment and household consumption.

$$M \uparrow \Rightarrow R \uparrow \Rightarrow L_p \uparrow \Rightarrow I \uparrow, C \uparrow \Rightarrow Y \uparrow$$

Where, M = money supply

R = reserves kept by the central bank

L_p = overall liquidity of the commercial banks

I = investment

C = consumption

Y = output

2.4.4 The exchange rate channel

a) Interest rate change:

The exchange rate channel is the one that associates the domestic economy with the international economies. For example, with an increase in the interest rates the local currency financial assets, like the rupee denominated bonds, rupee deposits, become relatively more attractive to than the foreign currency denominated assets. This leads to an increment in the relative demand of the local currency in contrast to the foreign currency which in turn results in the appreciation of the local currency. This relative increase in the local currency makes the local goods more expensive as compared to the foreign goods. This causes the net exports to fall and thereby a fall in aggregate demand. Furthermore, changes in interest rate might have a direct effect on inflation by placing an influence on the prices of imported goods and services.

b) Money supply change:

An increase in the money supply would increase the nominal interest rate in the country, the outcome of which would be a negative differential amongst the domestic and international nominal interest rates (i<i*), and depreciation in local currency occurs (increase in the exchange rate), net exports increase (positive effect on balance of payments), thereby increasing output.

$$M\uparrow \Rightarrow i\uparrow \Rightarrow (i < i^*) \Rightarrow E\uparrow \Rightarrow NX\uparrow \Rightarrow Y\uparrow$$

Where, M = money supply

i = domestic nominal interest rate

i* = international nominal interest rate

E = exchange rate

NX= net exports

Y = output

2.5 Dynamic Stochastic General Equilibrium Models (DSGE)

Dynamic Stochastic General Equilibrium (DSGE) models refer to as quantitative models of growth or business cycle fluctuations (Christiano, Eichenbaum, &Trabandt, 2018). The Real Business Cycle (RBC) models, which are a type of DSGE models, were developed by Kydland and Prescott (1982) and Long and Plosser (1983). These primary RBC models assumed an economy represented by a consumer who is driven by a world of perfectly competitive factor, goods and asset markets. A shock to the technology is the main source of uncertainty in the model. These models reflected that fluctuations in the aggregate economic activity is a systematic response to the exogenous shocks by the economy (Kydland and Prescott, 1982). The policy implications were clear that government intervention was not needed. In fact intervention could be welfare-reducing. Then came the New Keynesian DSGE models. These New Keynesian DSGE models allow for nominal frictions in labour and goods market (Christiano, Eichenbaum, &Trabandt, 2018).

2.6 Brief Overview

The supporters of LAW state that, even though interest rate may not be the best tool for dealing with financial risks, but it has the mastery "to get into all the cracks" (BIS, 2014, Stein, 2013, 2014). On the contrary, the opponents of LAW argue that the benefits of LAW are greatly outweighed by its costs (Svensson, 2014, 2015, 2016, 2017, Pescatori&Laseen, 2016, Saunders & Tulip 2019). However, coming into the field with a neutral result IMF (2015) suggests that specific characteristics of each country brings about a variation in the calculation of the benefits and costs of LAW and the accuracy in measuring costs and benefits for each and every country should be paid special attention to.

2.7 Theoretical Evidence

Stability in exchange rates, financial stability, price stability all had become important components which were being talked about. Tosini (1977), in his paper, placed his focus on managed floating. Managed float is an exchange rate in-between the pegged and flexible exchange rate regimes. In this paper, the problems dealt by floating currencies were addressed to. One deduction presented in the study was that if leaning against the wind is allowed in spot and forward exchange markets, it would yield protection against both potential difficulties and managed floating. Furthermore, as interest rates and exchange rates are interrelated, monetary policy is generally a strong means of influencing exchange rates. The final assertion, in this paper, was in the favour of LAW (leaning against the wind), in the exchange market.

When research on LAW started, a major policy rule was required through which the policy could be defined algebraically, numerically and graphically. Therefore, Taylor (2000) gave out a monetary rule known as the Taylor rules for monetary policy, that emerging economies accrue almost the same benefits, as described in research by the developed countries, although with certain modifications. He asserted that a stable monetary policy rule is based on the concoction of an inflation target, a monetary policy rule and a flexible exchange rate.

Furthermore, when disruptions in the financial markets occurred, market makers and specialists had no idea what to do in order to correct the frightful situation. So, Weill (2007) postulated, in his paper, that during financial disturbances, liquidity is provided by the market maker by absorbing the outward selling pressure. They purchase when the pressure hikes up, hoard the inventories and sell when the pressure lessens. He showed that if the market makers have adequate access to capital, an optimal amount of liquidity can be provided in a competitive market scenario. Hence, if raising capital requires a cost to be borne, an easy-going policy of the central bank lending should be followed during financial disturbances.

After 2000, the Taylor rules were frequently used for assessing the monetary policy. Gambacorta and Signoretti (2014) used the Taylor rules to test in terms of macroeconomic stabilization and agent's welfare using asset prices and credit, respectively. His contention included the fact that LAW policies are desirable in case of supply side shocks, whereas strict inflation targeting and a standard rule are less effective. Robustness tests were also performed by them which testified strong effects between financial frictions and debt-deflation.

The 2008 global financial crisis shook the economies of several countries and debates on it started. Smets (2014) answered the basic question being raised that to what degree the price-stability-oriented monetary policy framework helps in fulfilling the objectives of financial stability. He postulated that macroprudential policy should be the main mechanism which should drive financial stability. He further proposed that the monetary policy authorities should also ensure financial stability, in the economy, on an overall basis. This would, in turn, grant permission to the central bank to lean against the wind, if needed, while keeping its prime focus on the financial stability in the medium-run period.

In a later period, questions regarding the differences and similarities amongst themonetary and macroprudential policies started to bubble up. Whether they should be interrelated or should they be used distinctly? Svensson (2018), discussed in his paper, that firstly, how monetary and macroprudential policies can be differentiated from one another, secondly, that whether they should be used distinctly orjointly as complements and thirdly, whether they should be coordinated by similar or different authorities. Moreover, a contrast between institutional structures in Canada, Sweden and the U.K. was presented in this paper.

2.8 Empirical Evidence

Interest rates were being focused as elements which could be brought up or down in order to achieve specific economic goals. Taylor (1999) in his working paper discussed that using interest rates as a monetary policy rule renders a useful structure through which the monetary history of the U.S. can be studied. He used the quantity equation of Freidman and Schwartz (1963) and discussed that overtime the monetary policy rules in the U.S. have been changed and they, as a result, bring about a drastic change in the economic stability of the U.S. economic system. He further proclaimed that if a monetary policy rule acknowledges the changes in inflation and real output more aggressively, it is thereby a good policy rule. Furthermore, if deviations from such a good policy rule are regarded as policy mistakes, then committing such mistakes is interconnected with either high and extended inflationary periods or endless periods of low capacity utilization.

Svensson (2013 a) also stated that the effecton real debt, of higher policy rate, is presumably small and could be of either sign. He stated that if a policy rate decelerates the nominal mortgages' growth rate, consequently, it also decelerates the price levels' growth rate. Hence, both the numerator as well as the denominator of real debt are affected in a similar manner by the policy rate, due to which the resulting overall ratio tends to be smaller.

Moreover, as studies regarding LAW progressed even further, Svensson (2014) and Ajello,Laubach, Lopez-Salido& Nakata (2015) evaluated the numerical estimates of the costs and benefits of LAW. They examined a two-period setup. Here, the costs were measured in terms of higher unemployment in the first period and a benefit is assessed in the form of lower probability of a crisis in the second period.

Diaz et al. (2015) following the same lead also calculated the cost and benefit and then suggested that the cost incurred goesabove the benefit accrued for some years but then, later on, in the long-run, cost is tantamount to the benefit.

And then came studies which were anti-LAW in nature.Svensson (2015) stated such a case. According to his findings, the costs always exceed the benefits of LAW, may it even be the case of an ineffective macroprudential policy. He assumed that the crisis can take place anytime, so, whether or not the monetary policy is considered neutral, the costs always go beyond the benefits in every way. Therefore, if a higher policy interest rate would lead to a lower debt growth and a lower probability of crisis for a couple of years, it would eventually lead to a higher debt growth and a higher probability in the times to come.

Additionally, the cost-benefit analysis was also done by Gerdrup et al. (2016). They stated that the benefits of monetary policy during a crisis exceed its costs. The costs being in terms of higher volatility in output and inflation in normal times, when agents miscalculate the crisis risk and the intensity of crisis is endogenous, whereas benefits being lower frequency of crisis and lower volatility during the crisis. The study affirmed that the severity of crisis [higher unemployment] can be associated with the amount of accumulated credit established on a sample of 22 OECD countries. The LAW policies can be enacted by placing lesser weight on lagged interest rate and putting positive weight on credit in the Taylor rule. Lastly, LAW policies can cause more output volatility when agents are able to identify crisis risk accurately.

Svensson (2016) enquire into the fact that existing factual (empirical) estimates show that in a weaker economy, if the loss of crisis is larger, the policy rate effects are too little to make benefits exceed costs of LAW. Similarly, Svensson (2017) provided the cost and benefit analysis of LAW where the benefit is a lesser probability of future crisis and the cost is a weaker economy if the crisis does not occur and a second cost, left unnoticed by earlier literature, is a fragile economy if a crisis befalls. The outcome was that the costs of LAW outdid the benefits by a considerable amount. Along with that, the losses of macroprudential policy, that are, a higher probability, a higher magnitude and longer duration of crisis, all add to the costs incurred. This makes the costs outclass the benefits in every possible way. Benchmark estimates had also been used.

Filardo and Rungcharoenkitkul (2016) also stated the costs and benefits of a systematic LAW policy with a repeatedly occurring financial cycle with costly crises in booms and busts. The policy's primary benefit arose from the reduced impact left by thefinancial cycle. They further affirmed that previous literature underestimates the benefits of leaning by placing all the focus on, firstly, the strong self-correcting financial cycles, and secondly, a one-off policy action to address an approaching financial crisis.

Pescatori&Laseen (2016) postulate that by increasing the interest rates, it is implausible for the benefits to outweigh the costs in the case of Canada. They further state that although a reduction is observed in thegrowth of real household credit and house prices and the ratio of household debt to GDP, by bringing an increment in the interest rate, the probability that a crisis can occur reduces after about eight years and is slightly small. In turn, the costs are amplified by tighter economic conditions. Their main finding is that, for Canada, the monetary policy should not be tightened to reduce risks to the financial stability as the total costs are greater than the total benefits accrued.

Gourio et al. (2017) addressed the question that whether or not should the monetary policy lean against the wind. They performed a quantitative analysis in a small New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model, whereby the risk is dependent on the "excess credit.” One powerful result derived from the study was that the case of LAW presumably lies in the fact of accepting higher volatility in inflation and output reciprocated for reduction in the risk of crises.

In the IMF working paper, Choi and Cook (2018), worked on the annualized data of 23 different countries and performed a quantitative analysis on it. They talked about the Central bank inflation targeting monetary policies devised by advanced economies and emerging-market economies. They further assert that a policy mix of monetary along with macroprudential policies is a solution to the disputes among goals including financial and price stability. Accordingly, policy rates may respond to deviations from expected rather than actual inflation from the set inflation target. Price stability and inflation targeting was basically discussed in the paper. For robustness checks, both sides of the constrained monetary policy were accounted for, in each regression.

Saunders & Tulip (2019) state that the evaluation of LAW is conditioned to uncertainty. It is further said that empirical evidence regarding the key assumptions are thin or missing. However, the research done by them on Australia is narrow in the sense that only credit is given due consideration and not debt and asset prices. Keeping these shortcomings in mind, the current research regarding Australia suggests that the costs outweigh the benefits. But LAW cannot be considered as not being beneficial if the benefits cannot be quantified properly. Further research on the topic is necessary.

2.9 Evidence from Pakistan

Malik (2006) investigates that whether high inflation is an outcome of the monetary policy actions of Pakistan. The Near-VAR model has been used in this study to represent real GDP gap, inflation and reserve money after which the impulse response functions are calculatedby imposing constraints consistent with economic theory [Enders (2004); Sims (1986)]. The results of this study show a standard hump-shaped function of inflation and output in response to a monetary policy shock. Granger Causality test is also applied.

Ahmed and Malik (2011) study the research objective of estimating a monetary policy reaction function for Pakistan. Data for the period 1992Q4–2010Q2 has been used. Results reveal that the State Bank of Pakistan responds to the changes in the economic activity and the inflation rate in a way that it follows the Taylor rule (1993) with the objectives at hand of interest rate smoothing and exchange rate management. Evidence of non-linearity in the production function was also found as a response to the inflation rate above 6.4% is found to be more aggressive than those in low inflationary periods.

Asghar&Hussain (2014) examine the need to understand the monetary policy transmission mechanism to derive a better monetary policy which yields a better outcome. The results of this study discards Friedman’s view and affirms that monetary policy affects prices significantly after a nine months lag. The study suggests that in order to protect the economy from inflationary shocks, a tight monetary policy needs to be adopted.

To the best of my knowledge, no work regarding monetary policy’s “Leaning against the Wind” is done here in Pakistan and no work till date is being done. Therefore, the cost-benefit analysis of LAW will be conducted in this study.

2.10 Research Gap

The cost and benefit analysis of the monetary policy’s leaning against the wind (LAW) has not yet been reported in Pakistan. Therefore, there is an obvious need, keeping in mind the current situation of Pakistan, to calculate the numerical estimates of the costs and benefits of LAW in order to evaluate that, whether or not, LAW is an appropriate policy measure for Pakistan's economy.

CHAPTER 3

Data and Methodology

3.1 Preamble

This chapter provides the data and the framework used in the study. Section 3.2 lists the variables and their data sources. The time span of the study is mentioned as well. Section 3.3 explains in detail, with all the equations and steps, the theoretical framework of the study. Ten steps are given in the section 3.3 below.

3.2 List of Variables and Data Sources

Variables	Definition	Data Source
Unemployment rate (%)	Unemployment refers to the number of people actively seeking jobs, but currently they are not employed. We take the deviation of the unemployment rate from its threshold rate.	The data for unemployment rate has been extracted from the World Bank.
Inflation (%)	Inflation tells the overall movement in prices in the respective country.CPI is used as a proxy for prices.	The data for inflation has been obtained from the World Bank.
Debt (%)	Debt is the variable that the governments have to pay, that is, external debt.	The data for debt has been extracted from the World Bank.
Credit (%)	We take credit as the loan given out to private investors by the banks, which the borrower has to return later on.	The data for credit has been obtained from the World Bank.
Real debt(debt deflated by CPI)	Real debt is the ratio of debt to CPI.	The variable of real debt ratio has been constructed by deflating debt to CPI.
Debt to income ratio(DTI)	Debt-to-income ratio is the public debt divided by the nationalincome of the country.	Debt to income ratio has been constructed by taking a ratio of debt to income.
Interest rate (%)	The policy interest is the rate at which private banks acquire money from the central bank. The commercial banks then offer financial products to their clients at an interest rate that is based	The discount rate has been used as the policy interest rate and has been taken from the State Bank of Pakistan.

	on the policy rate. SBP Policy Rate (Target for overnight money market Repo Rate) is used. Through this policy rate, the state bank targets the overnight money market repo rate that signals the monetary policy stance.	
GDP(million rupees)	GDP is the final market value of all the goods and services produced within a country in a specific time period.	The data for GDP has been taken at constant prices from Pakistan Economic Survey.
Asset prices(PKR)	Asset prices refer to the price of financial instruments (bonds, shares, real estate prices etc.) that increase with respect to ordinary goods and services in the country. We take housing prices and new mortgages as a proxy for asset prices.	House rent has been used as a proxy for asset prices and has been taken from Pakistan Economic Survey.

Table 3.1: List of variables, definitions and their sources.

3.3 Theoretical Framework

This study applies the sensitivity analysis of Svensson (2017) for the case of Pakistan for the time span of 20 years ranging from 1998-2017.

Step 1: Say, u_t is the unemployment rate in year $t \geq 1$ and u_t^* is the optimal unemployment rate (optimal unemployment rate) in case of flexible inflation targeting.

u^*, the optimal rate of unemployment, is calculated through the Hodrick-Prescott filter. Therefore, u^* is the trend series obtained after applying the HP-filter.

Step 2: $\tilde{u}$ is the unemployment deviation, calculated as the difference of the optimal unemployment rate from the actual unemployment rate series:

$$\tilde{u}_t = u_t - u_t^*$$

Applying the HP-filter to compute the unemployment gap:

Unemployment gap refers to the deviation of the actual unemployment rate from its optimal rate.

HP filter is used for smoothing the data, which is, breaking it down into the trend (g_t) and cyclical (c_t) components.

$x_t = g_t + c_t$ (a)

The objective function for the filter has the form:

$min[\sum_{t=1}^{m}(x_t - g_t)^2 + \lambda \sum_{t=2}^{m-1}((g_{t+1} - g_t) - (g_t - g_{t-1}))^2]$ (b)

The most appealing traits of this filter are its transparency and computational simplicity. However, the HP-filter is also criticised by many (Hamilton 2018, Bouthevillain, et al. 2001, etc.). A common drawback of this filter is its personal choice of the smoothing parameter (lambda). Secondly, it has the structural breaks problem. That is, that the HP-filter is not able to identify sudden breaks in trend in real-time data (Bouthevillain, et al., 2001). These drawbacks can sometimes result in spurious outcomes in the computation of the output gap.

As we are using annual data for our study, the value of the smoothing parameter lambda will be set at 100 in our analysis and the potential level of output and the optimal rate of unemployment is found. Furthermore, using this, we also compute the output gap for the GDP series and the unemployment gap of our unemployment rate series.

Step 3: The loss accrued from the unemployment rate differing from the optimal unemployment rate is shown by the indirect loss function (quadratic);

Suppose, a loss function (quadratic) of inflation and unemployment;

$Ł(\pi_t, u_t) \equiv {\pi_t}^2 + \lambda(u_t - \bar{u})^2$ (i)

Where:

π_t= deviation between the inflation rate and the fixed inflation target

$u_t - \bar{u}$ = deviation between the unemployment rate and its long-run sustainable rate

$\lambda > 0$ = a given number (fixed) on unemployment gap stabilization with respect to inflation gap stabilization.

Accompanied by the positive weights, on unemployment and inflation stabilization, the loss function depicts flexible inflation targeting.

Presuming an elementary Phillips Curve;

$$\pi_t = -\kappa(u_t - \bar{u}) + z_t \qquad \text{(ii)}$$

Where, z_t, with zero unconditional mean, it is an exogenous stochastic process. z_t denotes cost-push shocks which a cause of tradeoffs between the stabilization of inflation (near to the inflation target) and unemployment (near to its long-run sustainable rate).

Substituting (ii) in (i) for π_t;

$$Ł(-\kappa(u_t - \bar{u}) + z_t, u_t) \equiv [-\kappa(u_t - \bar{u}) + z_t]^2 + \lambda(u_t - \bar{u})^2 \qquad \text{(iii)}$$

Selecting u_t to minimize (iii), under flexible inflation targeting, results in the optimal unemployment rate, u_t^*, which conforms to;

$$u_t^* = \bar{u} + \frac{\mathrm{K} z_t}{\lambda + \mathrm{K}^2} \text{(iv)}$$

Using (iv) to replace z_t in (iii) gives, after simplification, the indirect loss function$\acute{L}(u_t - u_t^*)$, which satisfies;

$$\acute{L}(u_t - u_t^*) = Ł\left(-\kappa(u_t - \bar{u}) + \frac{\lambda + \mathrm{K}^2}{\mathrm{K}} u_t^*, u_t\right) \equiv (\lambda + \mathrm{K}^2) L(u_t - u_t^*) + \frac{\lambda(\lambda + \mathrm{K}^2)}{\mathrm{K}^2}(u_t^* - \bar{u}) \qquad \text{(v)}$$

Where, the loss function, $L(u_t - u_t^*)$, is represented by,

$L(u_t - u_t^*) \equiv (u_t - u_t^*)^2$(vi)

u_t^* is the optimal unemployment rate,in the situation of flexible inflation targeting, also referred to as the benchmark unemployment rate. Unemployment deviation is the difference between actual unemployment rate series and the benchmark unemployment rate series (u_t - u_t^*). Hence, this finally yields,

$$L_t = (\tilde{u}_t)^2 \tag{3.1}$$

Step 4: For the monetary policy, the intertemporal loss function is;

$$L_1 = E_1 \sum_{t=1}^{\infty} \delta^{t-1} L_t = \sum_{t=1}^{\infty} \delta^{t-1} E_1 L_t \tag{3.2}$$

Where:

E_1 = expectations based on information existing in year 1

δ = discount factor, ($0 < \delta < 1$)

E_1L_t = expected year 't' loss for $t \geq 1$

Hence, the expected year 't' loss is:

$$E_1L_t = E_1 (\tilde{u}_t)^2 = (1- p_t) E_1 (\tilde{u}_t^n)^2 + p_t E_1 (\tilde{u}_t^c)^2 = [(1- p_t) E_1 (\tilde{u}_t^n)^2 + p_t E_1 (\tilde{u}_t^n + \Delta u_t)^2] \tag{3.3}$$ [7]

Where, it is presumed that in the year $t \geq 2$, there can be one of the two situations of the economy, either it can be in a non-crisis (n) state or in a financial crisis (c). It is also assumed that a crisis cannot take place in year 1.

p_t= probability of a crisis occurring in year t, based on the existing information in year 1

[7] A crisis is assumed to be connected with a possible random crisis increase in the unemployment rate $\Delta u_t > 0$, so, the crisis employment deviation becomes $\tilde{u}_t^c = \tilde{u}_t^n + \Delta u_t$, and the crisis loss becomes $L_t^c = (\tilde{u}_t^c)^2 = (\tilde{u}_t^n + \Delta u_t)^2$.

$(1- p_t)$ = probability of no crisis occurring

Δu_t = the unemployment rate increase associated with the incorporation of demand shock and any other shock to the monetary policy transmission mechanism linked with a crisis. Equation (3.3) can be written down as:[8][9]

$$E_1L_t = E_1 (\tilde{u}_t^n)^2 + p_t [E_1 (\tilde{u}_t^n + \Delta u_t)^2 - E_1 (\tilde{u}_t^n)^2] = E_1 (\tilde{u}_t^n)^2 + p_t [E_1 (\Delta u_t)^2 + 2E_1\tilde{u}_t^n E_1\Delta u_t] \quad (3.4)$$

Step 5: A Markov Process for calculating the probability of a crisis;

Take into account a situation where the (annual) probability of a crisis start is 'q' and the duration for which the crisis persists is 'n'. It is assumed, for bringing clarity into the analysis that, another crisis cannot take place in the course of an ongoing crisis. Therefore, the probability of a crisis start is dependent on the assumption that a crisis had not occurred in the preceding year. This condition can be shaped as a Markov process with (n+1) states and where state 1 pertains to non-crisis and state j for $2 \leq j \leq n+1$ amounts to a crisis in its $(j-1)^{th}$ year.

Suppose, the $(n+1) \times (n+1)$ transition matrix be $P^{transition} = [P_{kj}]$, wherein P_{kj} = Prob (j in (t+1)|k in t) is the probability of transition from state 'k' in year 1 to state 'j' in year (t+1). The probabilities in the transition will be zero apart from $P_{11} = 1-q$, $P_{12} = q$, $P_{k,k+1} = 1$ for $2 \leq k \leq n$ and lastly, $P_{n+1,1} = 1$. For instance, for n=3 the transition matrix is 4×4, that is:

$$P^{transition} = \begin{bmatrix} 1-q & q & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

[8] It is assumed that $E_1 (\tilde{u}_t^n \Delta u_t) = E_1\tilde{u}_t^n E_1\Delta u_t$, i.e., $\tilde{u}_t^n$ and Δu_t are uncorrelated based on the information available in quarter 1.

[9] The expression in the square bracket is the expected cost of crisis.

Let the row vector $\Omega_t = (\Omega_{tk})_{k=1}^{n+1}$ represent the probability distribution of the states in year t, and let, $\Omega_1 = (1,0,\dots,0)$, indicating a non-crisis in year 1. Then the probability distribution in year t ≥ 1, subject to a non-crisis in year 1, is:

$$\Omega_t = \Omega_1 P^t$$

Thereby, the probability of a crisis occurring in year t, p_t, is given by;

$$p_t = 1 - \Omega_{t1} \; for \; t \geq 1 \tag{a.1}$$

If a linear approximation is considered for this model, the probability of crisis is simply the sum of the probabilities of a crisis start over the last n years:

$$p_t = \sum_{\tau=0}^{n-1} q_{t-\tau} \tag{a.2}$$

The greatest convenience achieved from this linear approximation is that the policy rate effect on the probability of crisis is simple to calculate. Given the effect of probability on a crisis start, dq_t/di for t ≥ 1, it clearly satisfies:

$$\frac{dp_t}{di} = \sum_{\tau=0}^{n-1} \frac{dq_t}{di} \tag{a.3}$$

But for the markov process, the computation is somewhat more complex. Say, $P_t^{transition} = [P_{kj}]$, for t ≥ 1, represent the transition matrix from states in year t to states in year t+1, where $P_{t-1,11} = 1 - q_t$, $P_{t-1,12} = q_t$, and $P_{t-1,kj} = P_{kj}$ for (k,j) ≠ (1,1), (1,2). We obtain the following equation:

$$\Omega_t = \Omega_{t-1} P_{t-1} for \; t \geq 2 \tag{a.4}$$

The policy rate effect on the probability distribution, thus, gives:

$$\frac{d\Omega_t}{di} = \frac{d\Omega_{t-1}}{di} P_{t-1} + \Omega_{t-1} \frac{dP_{t-1}}{di} for \; t \geq 2 \tag{a.5}$$

Where, $d\Omega_1/di = 0$, $dP_{t-1,11}/di= -dq_t/di$, $dP_{t-1,12}/di= dq_t/di$ and $dP_{t-1,kj}/di= 0$ for $(k,j) \neq (1,1), (1,2)$. Lastly,

$$\frac{dp_t}{di} = -\frac{d\Omega_{t1}}{di} for\ t \geq 2 \tag{a.6}$$

The exact derivative used in this study is from the equations (a.4) to (a.6).

Step 6: The effect on the intertemporal loss function (3.2), of a policy rate increase (policy tightening), during a year, is represented by di>0.

The Cumulative NMC is described as the derivative of the intertemporal loss with regard to the policy rate (during each year):

NMC= $dL_1/di = (d/di)\ E_1 \sum_{t=1}^{\infty} \delta^{t-1} L_t \ = \ \sum_{t=1}^{\infty} \delta^{t-1}\ dE_1 L_t\ /di$

Step 7: When the derivative of (4) is taken in accordance to the policy rate, 'i', the result is:

$NMC=MC_t - MB_t$

Where,

$$MC_t = 2(E_1\tilde{u}_t^n + p_t\ E_1\ \Delta u_t)\ dE_1u_t^n/di = 2E_1\tilde{u}_t\ dE_1\tilde{u}_t/di\ |p_t,E_1\ \Delta u_{t\ constant.} \tag{3.5}$$

$$MB_t^p = [E_1\ (\Delta u_t)^2 + 2E_1\tilde{u}_t^n\ E_1\Delta u_t]\ (-dp_t/di) \tag{3.6}$$

$$MB_t^{\Delta u} = 2p_t\ E_1\ (\tilde{u}_t^n + \Delta u_t)\ (-dE_1\Delta u_t\ /di) \tag{3.7}$$

$$MB_t = MB_t^p + MB_t^{\Delta u} \tag{3.8}$$

Step 8: Corresponding to non-leaning (NL), for ($E_1\tilde{u}_t^n = 0$) a zero non-crisis unemployment deviationor Lt = 0, the MC and MB is given by:

$$MC_t = 2p_t\ E_1\Delta u_t\ dE_1u_t^n/di \tag{3.9}$$

$MB_t^p = E_1 (\Delta u_t)^2 (-dp_t/di)$ (3.10)

$MB_t^{\Delta u} = 2p_t E_1\Delta u_t(-dE_1\Delta u_t /di)$ (3.11)

Corresponding to leaning against the wind (LAW), for ($E_1\tilde{u}_t^n = 1$) or Lt = 1, the MC and MB is given by:

$MC_t = (2 + 2p_t E_1\Delta u_t) dE_1u_t^n/di$ (3.12)

$MB_t^p = [E_1 (\Delta u_t)^2 + 2E_1\Delta u_t] (-dp_t/di)$ (3.13)

$MB_t^{\Delta u} = [2p_t + 2p_t E_1\Delta u_t] (-dE_1\Delta u_t /di)$ (3.14)

Corresponding to a stronger case of leaning against the wind (LAW), for ($E_1\tilde{u}_t^n = 2$) or Lt = 2, the MC and MB is given by:

$MC_t = (4 + 2p_t E_1\Delta u_t) dE_1u_t^n/di$ (3.15)

$MB_t^p = [E_1 (\Delta u_t)^2 + 4E_1\Delta u_t] (-dp_t/di)$ (3.16)

$MB_t^{\Delta u} = [4p_t + 2p_t E_1\Delta u_t] (-dE_1\Delta u_t /di)$ (3.17)

Step 9: In order to find out whether the costs exceed the benefits or vice versa when all the years are taken into account, the sign of the net marginal cost (NMC) is then seen:

$$NMC = \sum_{t=1}^{\infty} \delta^{t-1} NMC_t = \sum_{t=1}^{\infty} \delta^{t-1} MC_t - \sum_{t=1}^{\infty} \delta^{t-1} MB_t \gtreqless 0 \quad (3.18)$$

Where, $MC_t$is provided by (3.5) and MB_t by (3.6), (3.7), and (3.8).

Step 10: To find the estimates of costs and benefits, and assess which of the two is greater, numerical estimates or assumptions are needed about the components of MC and MB in (3.5) to (3.7). Firstly, the unemployment deviation is set at 0 in the above stated equations, or putting it differently, the loss function is assigned the value 0, which indicates non-leaning and thereby, the equations (3.9) to (3.11) are derived and the required components are calculated. Next, the loss function is assigned the value 1, which indicates leaning against the wind and the components in equations (3.12) to (3.14) are calculated. Subsequently, the loss function is assigned the value 2, which indicates more leaning than the previous case and thereby, the components in equations (3.15) to (3.17) are calculated.

CHAPTER 4

Results and Discussions

4.1 Preamble

This chapter provides the results of the study conducted. Section 4.2 illustrates the descriptive statistics of each and every variable used in the study and a brief explanation of each of these. Section 4.3 gives the estimates of the HP-filter used to compute the output gap and the unemployment gap. Section 4.4 gives details on the calculations required for the MC of LAW, section 4.5 gives details on the calculations of $MB^{p}$and section 4.6 provides the calculations done for calculating the $MB^{\Delta u}$. Section 4.7 explains about the net marginal cost which has sub-sections,sub-section 4.7.1 which tells the net marginal cost when L=0, sub-section 4.7.2 tellsthe net marginal cost when L=1 and sub-section 4.7.3 explains the net marginal cost when L=2.

4.2 Descriptive Statistics

We begin our methodology by first calculating the descriptive statistics of our variables in order to observe their trend. We calculate the arithmetic mean (AM), standard deviation (SD) and stability ratio (SR) for all our variables[10]. The descriptive statistics are presented in table 1 below.

Variables	Years	AM	SD	SR
GDP (million rupees)	1998-2004	4088700	1045466	25.57
	2005-2011	11403874	4253759	37.30
	2012-2017	25996964	4361314	16.78

[10] The data was sectioned into 3 total sections and the mean was calculated by adding the values and dividing them by the total number of observations. The standard deviations are found out using the standard deviation formula and the stability ratio is the ratio of standard deviation to the particular mean value multiplied by 100.

Unemployment rate (%)	1998-2004	6.83	0.94	13.81
	2005-2011	6.14	1.11	18.07
	2012-2017	6.01	0.11	1.88
Inflation (%)	1998-2004	4.50	1.71	38.03
	2005-2011	12.04	4.46	37.06
	2012-2017	5.82	2.77	47.56
Interest rate (%)	1998-2004	12.49	3.02	24.18
	2005-2011	12.11	1.93	15.92
	2012-2017	10.26	1.81	17.67
Real debt (debt deflated by CPI)	1998-2004	1.05	0.22	20.91
	2005-2011	0.39	0.09	23.21
	2012-2017	0.17	0.02	11.82
Debt to income ratio (debt divided by income)	1998-2004	0.10	0.02	23.78
	2005-2011	0.03	0.006	19.76
	2012-2017	0.02	0.002	10.61
Credit (%)	1998-2004	42.63	5.68	13.33
	2005-2011	45.85	2.99	6.52
	2012-2017	49.70	2.91	5.85
Asset prices (%)	1998-2004	63.05	5.37	8.51
	2005-2011	110.85	25.17	22.71
	2012-2017	178.36	18.74	10.51

Table 4.1: Descriptive Statistics. (Source: Author’s own estimation)

As we can see that the mean values for GDP are showing an upward trend. An increase in the GDP is seen overtime. The standard deviations are close to their means demonstrating that the data is near to the mean value. For the period 2005-2011, the coefficient of variation shows the highest percentage, that is, 37.3%, which conforms that the data points of GDP are greatly spread out in this time period. The stability ratio shows the lowest value for 2012-2017, which shows that data is closer to the mean in this period. The stability ratio is seen to be increasing, showing a peak in 2005-2011, and then going downwards.

The highest value of the arithmetic mean in unemployment rate series is observed in the period 2005-2011. Overall, the lower values of standard deviation show that the values are closer to the mean. The stability ratio indicates the same as well. An increment and then a decline after a peak is observed in the graph. Various fluctuations are present in the unemployment rate.

Inflation in Pakistan shows both increasing and decreasing trend. The lowest mean is seen in 1998-2004 period and highest mean is seen in the 2005-2011 phase. Pakistan experienced an upsurge in prices over the years and inflation is still increasing. Standard deviation overall shows lower values. The stability ratio generally shows higher values for the inflation data, indicating the greater spread of data values. Overall, a mixed trend in inflation is observed showing peak values in 2012-2017.

A trend of higher interest rates has been observed for Pakistan’s data. The average values in the years have remained consistent throughout the years with average values ranging from 10% to 13%. The values of standard deviation are also very low pointing towards the fact that the data points are near to the mean values. The highest stability ratio is observed in the period 1998-2004. However, the stability ratio too shows lower values conforming to the fact that the data values are close to the mean. A declining trend is seen in the stability ratio graph for interest rate.

The average values of real debt are fairly close to each other. The lower values of standard deviation and the stability ratio indicate that the data is not much spread out. A relatively stable trend in the values are observed. A little increase and then a sharp decline is observed.

The average values of debt to income ratio are also close to each other. The standard deviations are low too indicative of the fact that the data is clustered near to its mean values. The value of the stability ratio is a bit higher for the phase 1998-2004 then declining trend is seen.

The average values of credit in the years are also fairly close to each other. The standard deviation values are also low showing that the values are clustered close to the mean values. The stability ratio is also low indicating that the values are clustered close to the mean value. Starting from a higher value the graph of stability ratio declines throughout.

For the asset prices, the values of the mean are greatly diverse. The highest mean value is that of the period 2011-17. The values of standard deviation are also low showing that the values are close to the mean. The stability ratio values are also on the lower side, again conforming to the data points being clustered close to the mean.

As we can observe that the mean value and the standard deviation (S.D) for none of the variables is equal. If, for example, the stability ratio, which is calculated as S.D divided by the mean value multiplied by 100, becomes 100 in value or in other terms when not multiplied by 100 becomes equal to one, it would be interpreted in the way that the series of that particular variable is not stable, that is, the data points are far away from the mean. As none of the values of mean and S.D are equal for any variable, we can thus conclude that the data series of all our variables are stable.

4.3 Applying HP-filter for the computation of Output Gap and Unemployment Gap

We apply the Hodrick-Prescott filter on theGDP series with the purpose of estimating the potential level of output and the output gap. Output gap means the deviation of the actual GDP values from its potential level.The graphs (figures 1 &2) of potential level of output and output gap are given below.

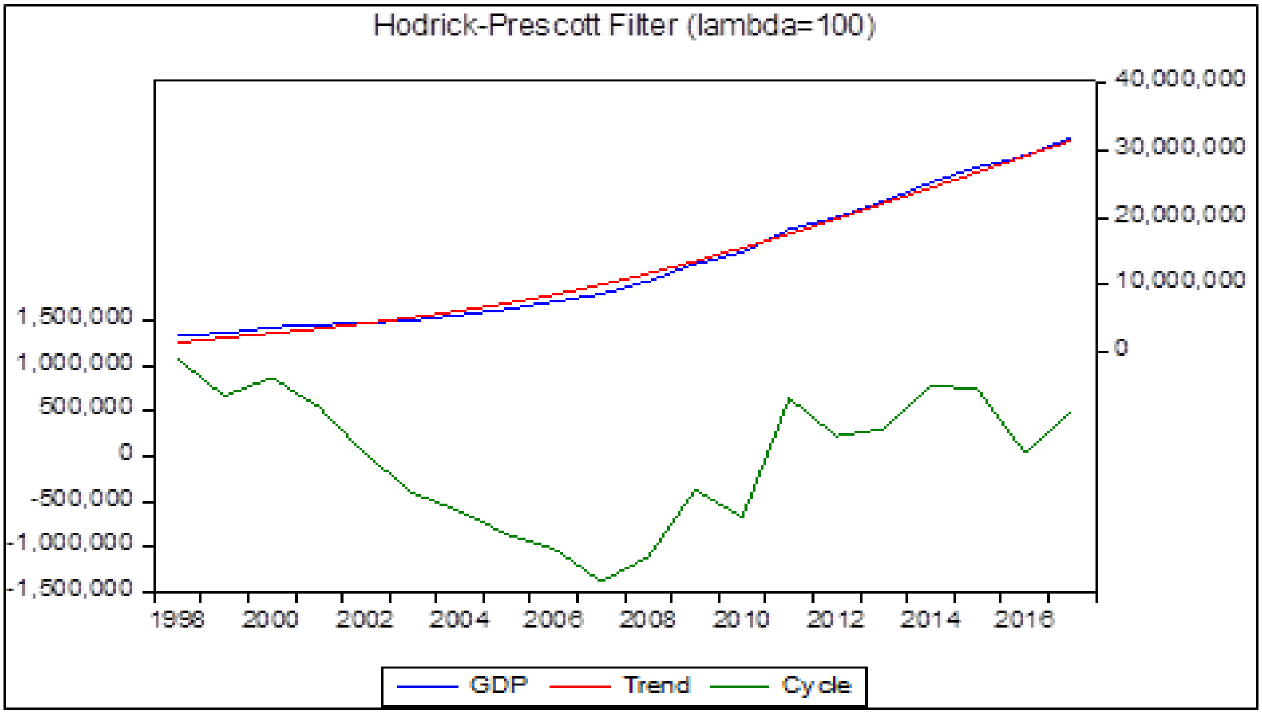

Figure 4.1: Hodrick-Prescott filter for measuring the output gap. (Source: Author's own estimation)

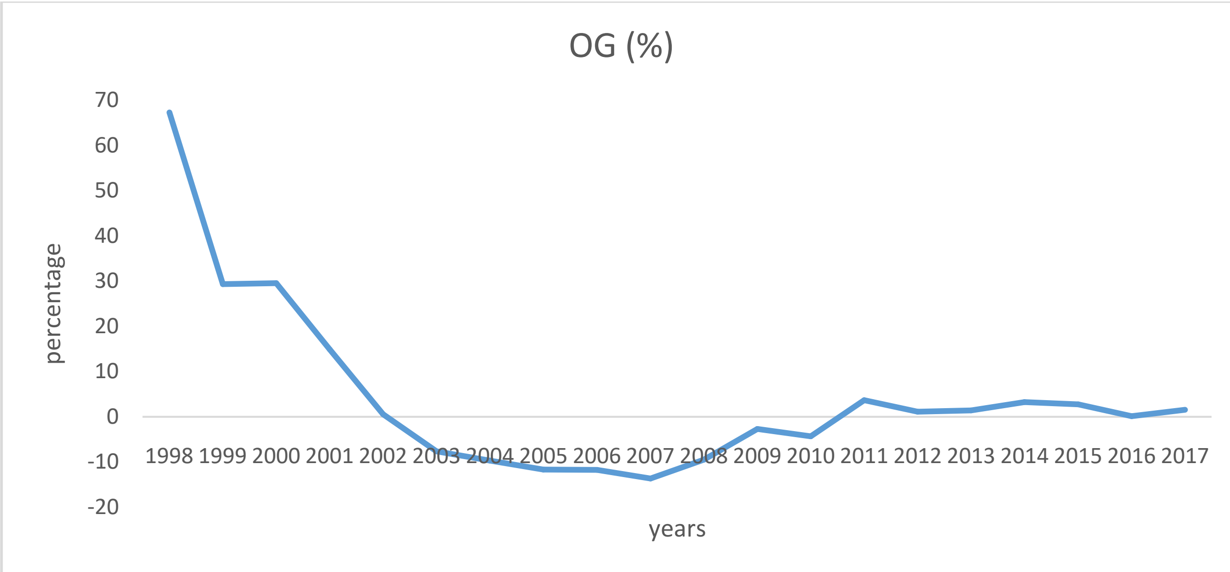

Figure 4.2: Output Gap (OG). (Source: Author's own estimation)

A major downfall in GDP occurred in 2007-08 when the Global Financial Crisis hit the world. In 2013, when the new government came into power, its primary focus was the revival of the economy and reinstating economic stability. In a short span of time considerable gains pertaining to economic stability were achieved. After taking into account the macroeconomic stability, next the government set its focus on higher GDP growth which would increase the living standards of individuals residing in Pakistan through increment in per capita incomes, numerous job opportunities and much more. Since 2014-15, an upward trend in the economy has been observed. Real GDP growth was more than 4% in 2014-15 and has shown a smooth trend in the last four years to come to 5.28% in 2016-17, which is the highest in ten years (GOP, 2017).

Next, we apply the HP-filter to estimate the optimal rate of unemployment and to compute the unemployment gap. The graphs (figures 3 & 4) of optimal unemployment and unemployment gap are given below.

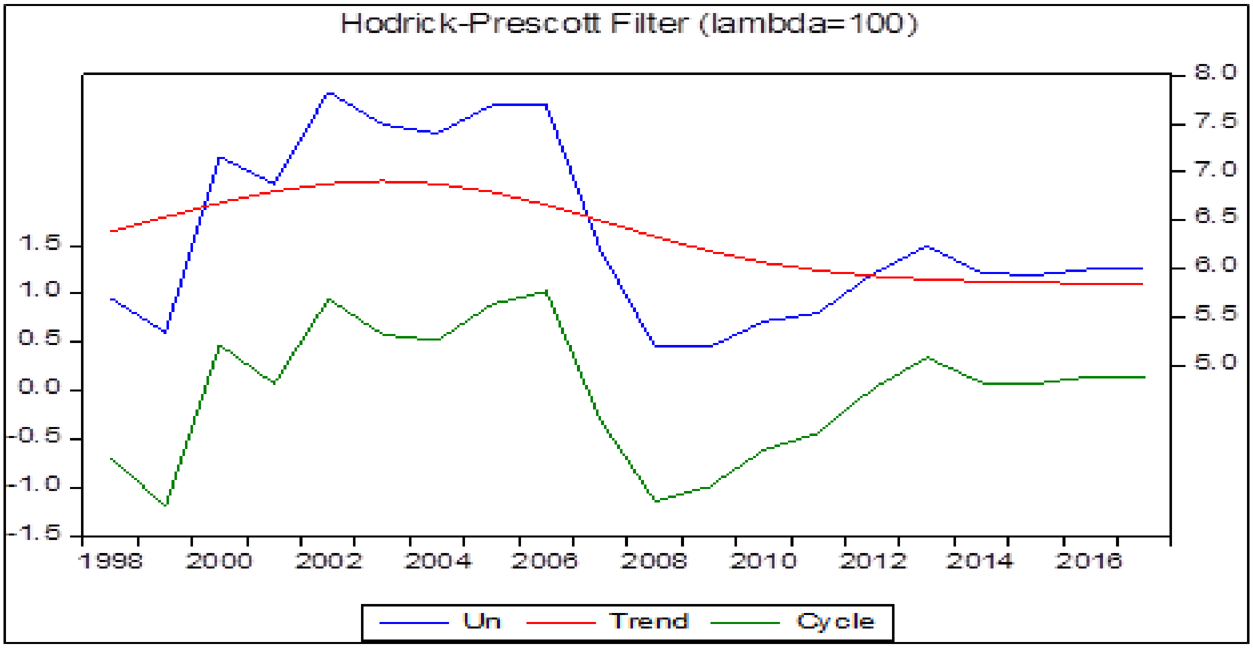

Figure 4.3: Hodrick-Prescott filter for measuring the unemployment gap. (Source: Author's own estimation)

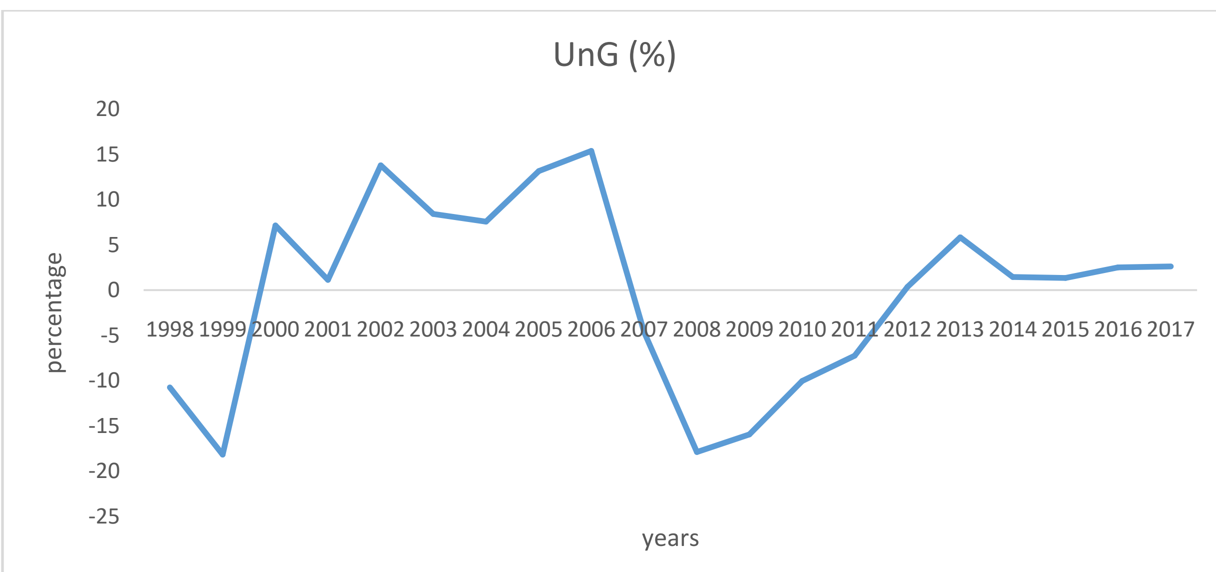

Figure 4.4: Unemployment Gap (UnG). (Source: Author's own estimation)

From the 90’s up to the 2000’s Pakistan faced an upsurge in the unemployment rate. This was due to many reasons; firstly, political instability was at its peak as several governments were changed in this period which created a sense of uncertainty and no prediction regarding the future could be correctly made. Apart from that, there occurred exogenous shocks to the economy, for example the nuclear testing in 1998 that shattered investors’ confidence, the flight of capital from Pakistan gained momentum, economic sanctions were imposed and external economic assistance was disrupted. After 2000, the unemployment rate remained fairly high up to 2008, after which it fell and a rise was observed in 2010, after which it fluctuated approximatelyaround 5%-6% till 2107. However, after 2006 a decline in the unemployment rate was observed. The highest unemployment rate faced by Pakistan was in 1991 which was 1.86% and lowest in 1990 which was -1.81%.

Both the series of GDP and unemployment rate show a trend with some fluctuations. The unemployment rate is more unstable than GDP. The trend line of the GDP is closer to the actual data points in contrast to the unemployment rate trend line which is estimated. GDP is smoother relative to the unemployment rate in which greater fluctuations are observed.

Policymakers use the potential output to measure inflationary pressures in the economy and define it as the level of output conforming to no rise or fall in the prices in the economy (Jahan& Mahmud, 2013). In this context, the output gap gauges the level of demand and supply of the economy. If the output gap is positive (actual > potential), prices will start rising and, on the contrary, if the output gap is negative (actual < potential), prices will begin to decline. Unemployment gap is closely related to the output gap. Both are essential to the conduct of the monetary and fiscal policies (IMF, 2013). Deviations of the unemployment rate from it optimal or natural rate is referred to as the unemployment gap.

The output gap and the unemployment gap are almost showing the same trend and both are volatile. When actual unemployment equals natural unemployment it pertains to full employment in the economy and hence, real GDP, also equals potential GDP. Therefore, there is no unemployment gap. When actual unemployment is greater than natural unemployment it refers to a below full employment situation for the economy. Real GDP is less than the potential GDP resulting in a negative output gap and a positive unemployment gap. This is also referred to as the recessionary gap. Lastly, When actual unemployment is less than natural unemployment it refers to an above full employment situation for the economy. Real GDP is greater than the potential GDP resulting in a positive output gap and a negative unemployment gap. This phenomenon is also called an inflationary gap. Operating above potential is only possible for a short while, since it corresponds to workers working overtime.

4.4 The Marginal Cost of LAW (MC)

To obtain the numerical estimates of the MC of leaning against the wind, the estimates of or, in other words, some realistic assumptions about the policy rate effect on the expected non-crisis unemployment rate ($dE_1u_t^n/di$), the expected magnitude of a crisis (Δu) and the probability of a crisis (p_t).

For the numerical estimate of the policy rate effect on the expected non-crisis unemployment rate ($dE_1u_t^n/di$), the impulse responses of non-crisis unemployment rate are calculated by giving 1 unit shock in the policy rate. We obtain the graph shown in figure 4.6 below.

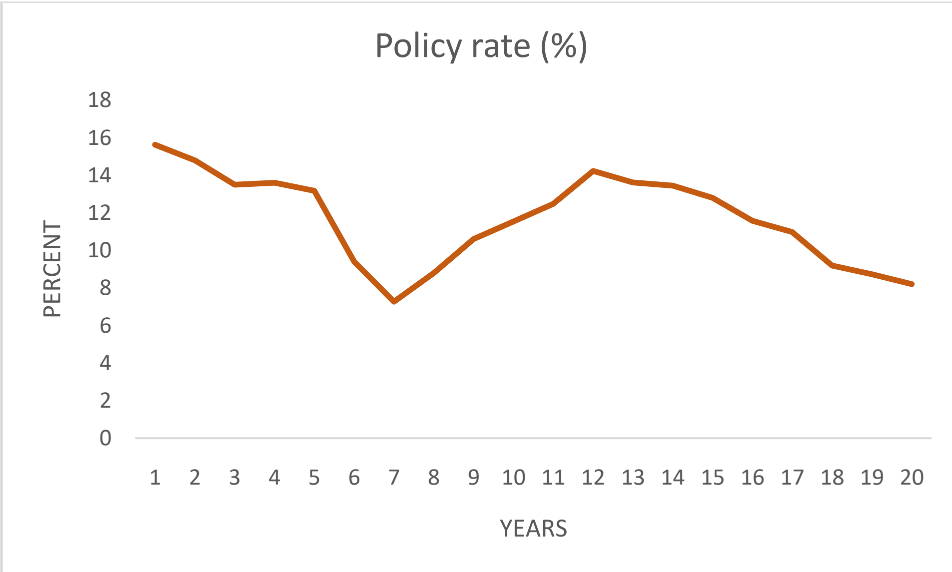

Figure 4.5: The policy rate. (Source: State Bank of Pakistan)

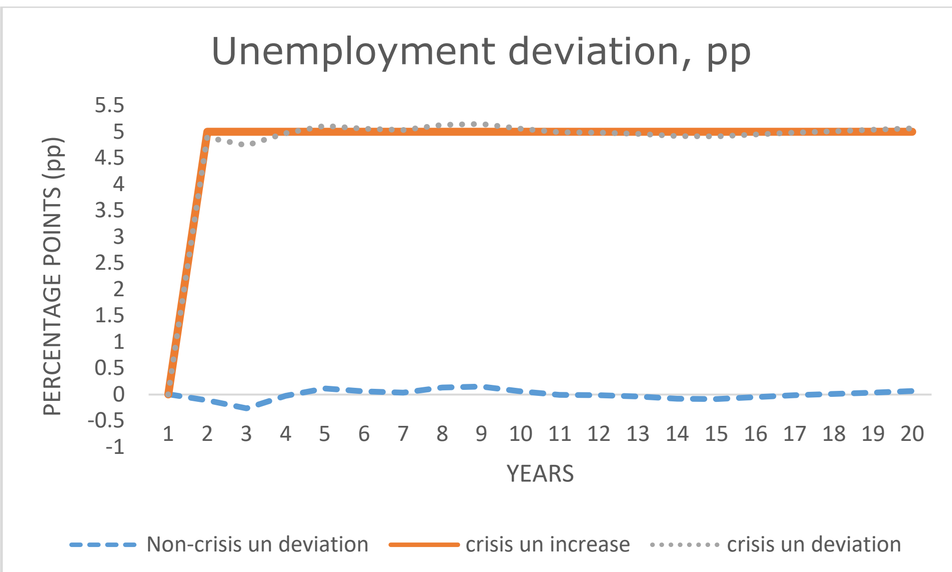

Figure 4.6: The policy rate effects on crisis and non-crisis deviations and the crisis unemployment increase. (Source: Author's own estimation)

The unemployment rate shows a declining trend first. Gives an extreme low of -0.26 pp in the third year and then starts rising. A positive peak is observed in the fifth year and still staying in the positive space another peak is observed in the ninth year of up to 0.14 pp and again a declining trend is observed. After the eleventh year, the unemployment rate becomes negative again and rises above the baseline after the eighteenth year. A clearer picture of the graph of non-crisis unemployment deviation is shown below.

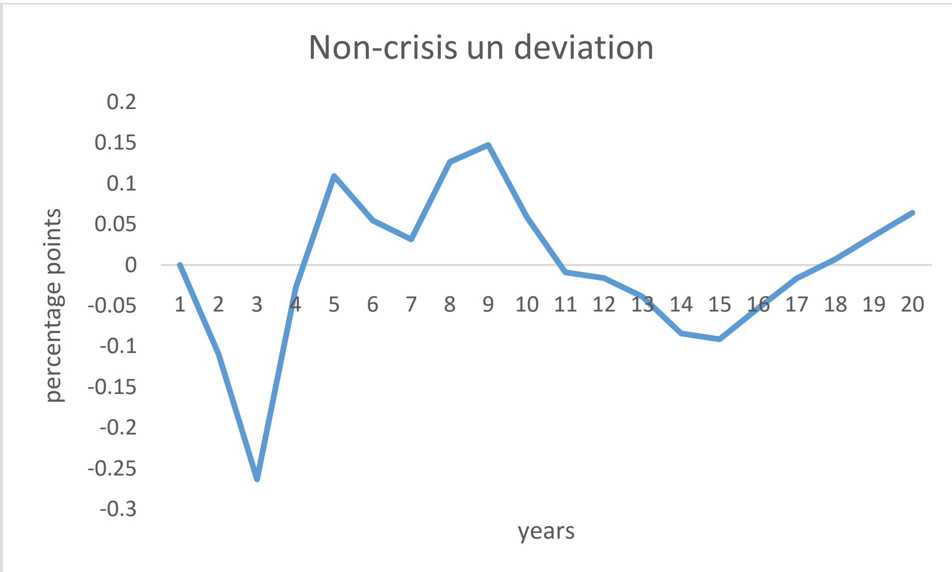

Figure 4.7: The non-crisis unemployment deviation. (Source: Author's own estimation)

Due to the fact that the economy acknowledges with lags to policy (interest) rate changes, the primary outcome is almost zero and the major consequences can be observed approximately after two years.

Next, for the expected crisis increase in the unemployment rate ($E_1\Delta u_t$), which represents the magnitude of a crisis, the crisis assumptions used in IMF (2015, paragraph 41) and SverigesRiksbank (2013) are considered. Although, this adds to the limitations of the study that the assumptions of a developed country's economy are being taken, the actual underlying problem is that the magnitude of a crisis, and its persistence in Pakistan, if it occurs, has not been calculated. The assumptions for the crisis scenarios discussed in the above mentioned papers are that the crisis increase in the unemployment rate is constant, deterministic and is equal to 5 pp. If a crisis occurs, then, for a zero non-crisis ũ, the unemployment deviation would rise to a crisis ũ of 5 pp as shown in figure 4.6 represented by the horizontal green line.

Additionally, with leaning and alongside having a positive non-crisis unemployment deviation, if for instance a crisis takes place, the unemployment deviation would rise to a 5 pp higher level. On the contrary, in case of LAW with a negative non-crisis unemployment deviation, if a crisis takes place, the unemployment deviation would decrease to 5 pp lower level than its value before as illustrated by the grey line in figure 4.6 above.

We can also calculate Lt and ML, with respect to the unemployment deviation. They will be:

Loss: $L_t = (\mu_t - \mu_t^*)^2 = (\tilde{u}_t^2)$

Marginal Loss: $ML_t = \frac{dL_t}{d\tilde{u}_t} = 2\tilde{u}_t$

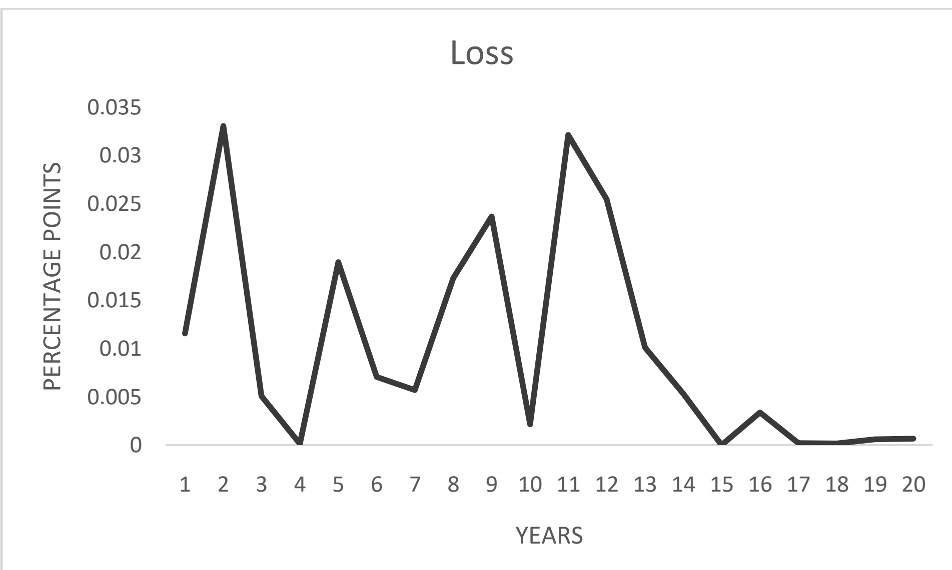

Figure 4.8: The loss incurred with respect to the unemployment deviation. (Source: Author's own estimation)

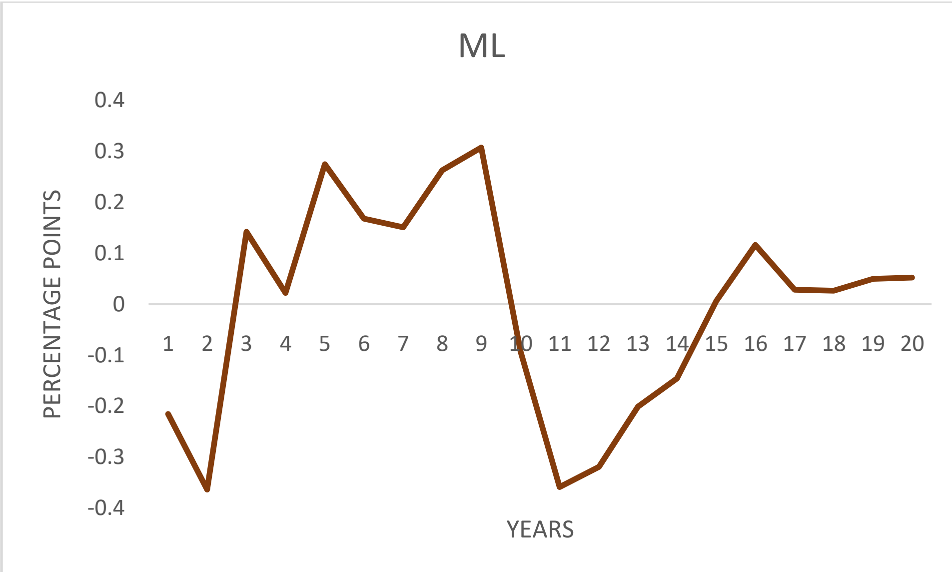

Figure 4.9: The marginal loss (ML) with respect to the unemployment deviation. (Source: Author's own estimation)

Pertaining to a zero non-crisis unemployment deviation, the marginal loss incurred from increasing the non-crisis unemployment deviation will be equal to zero. For a positive crisis unemployment deviation, which is equal to Δu = 5 pp, by increasing the crisis unemployment deviation,the marginal loss becomes positive, not zero. That is, $ML^c = 2\Delta u = 10$, which is shown in the above figure. This furthermore leads to the result that $dL^c/di = ML^c dE_1 u_t^c/di = 2\Delta u dE_1 u_t^n/di$ is a series containing positive numbers. When the product of this series is taken along with p_t, it gives the MC of LAW, as in equation (3.9).

For the calculations regarding the probability of a crisis (p_t), this study considers the assumptions that the benchmark annual probability of a crisis start is 3.2% (0.032), correlating with a crisis occurring usuallyover every 31 years. Furthermore, the duration for which a crisis persists (n) is assumed to be 2 years, that is, n=2 (Svensson, 2017).

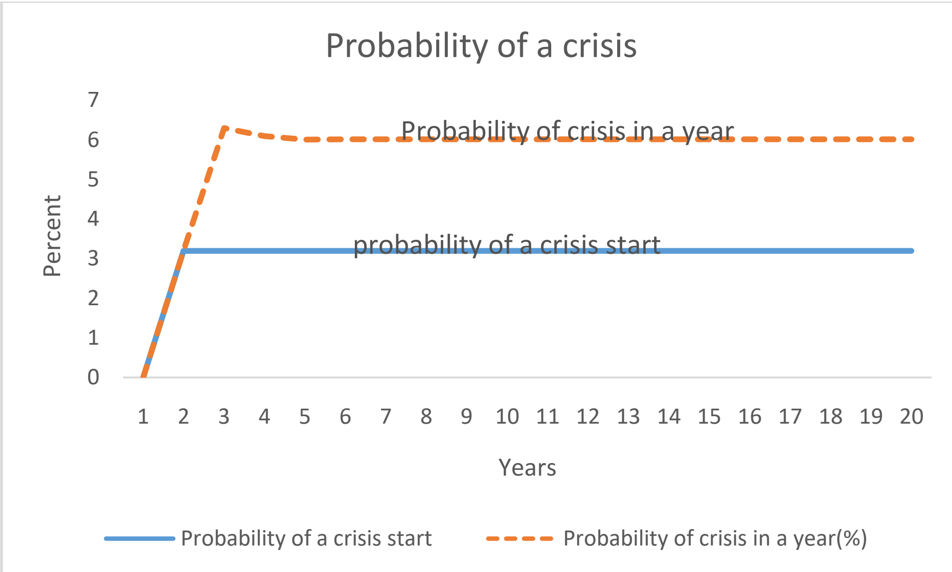

Figure 4.10: The benchmark probabilities of a crisis and a crisis start. (Source: Author's own estimation)

The figure above illustrates the benchmark p_t and the probability of a crisis start, respectively. This is conditional on the assumption that no crisis can occur in year 1. Then, the probability of a crisis (p_t)occurring equals to the $p_t$in the last 'n' years. The benchmark $p_t$of a crisis start is illustrated in the figure above by the horizontal blue line indicating that it is constant throughout the years at 3.2% except for year 1. The probability of a crisis, which is calculated using the Markov process, shows an increased peak in year 3 which is at 6.29%, after which it starts to decrease gradually and eventually becomes constant at approximately 6.01%.

In this case, for LAW to be optimal, when the magnitude of a crisis and probability of a crisis are exogenous, the marginal benefits of LAW have to be sufficiently larger in comparison to its costs. The estimates needed in (3.9) have now been identified. It is given by $MC_t = 2p_t \Delta u_t dE_1 u_t^n/di = 10p_t dE_1 u_t^n/di$.

4.5 The Marginal Benefit of LAW from a lower probability of a crisis(MB_t^p)

For the sake of obtaining the estimate for the marginal benefit from a lower probability of a crisis (MB_t^p) by equation (3.10), we require checking thathow the probability of a crisis is affected by the policy rate (dp_t/di). This depends on the probability of a crisis start which is found out by the policy rate effect on real debt. The impulse response functions were calculated by giving 1 unit shock to the policy rate and then checking its impact on the real debt. This input was to be used in the calculation of the probability of a crisis.

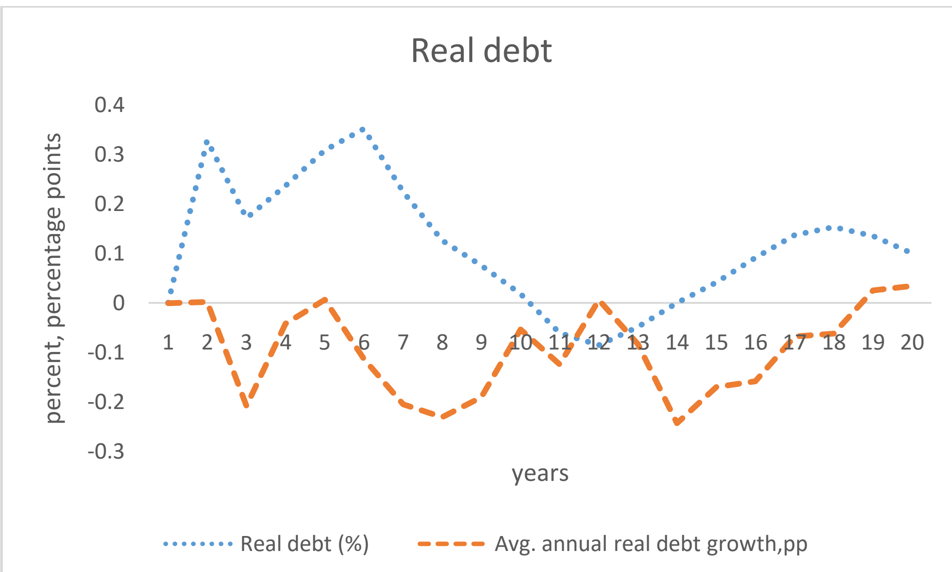

Figure 4.11: The effect on real debt and average annual real debt growth of policy rate. (Source: Author's own estimation)

The graph of real debt tends to be volatile throughout the years. It is in the positive space up to the 10th year after which it turns negative. The highest peak is observed in year 6. After remaining negative for 4 years real debt again becomes positive in year 15. The average annual real debt growth graph shows volatility as well but remains mostly in the negative quadrant throughout the years. It turns positive and a small peak can be seen in year 12 but mostly remains on the negative side, the lowest peak observed in year 14.

The probability of a crisis (p_t) which has been previously calculated by the Markov process gave 'dp' in the code made in Matlab as well. Next, 1 unit shock in the policy rate was given and its impact was assessed on 'dp'. From here we obtain the estimates for dp_t/di, respectively.

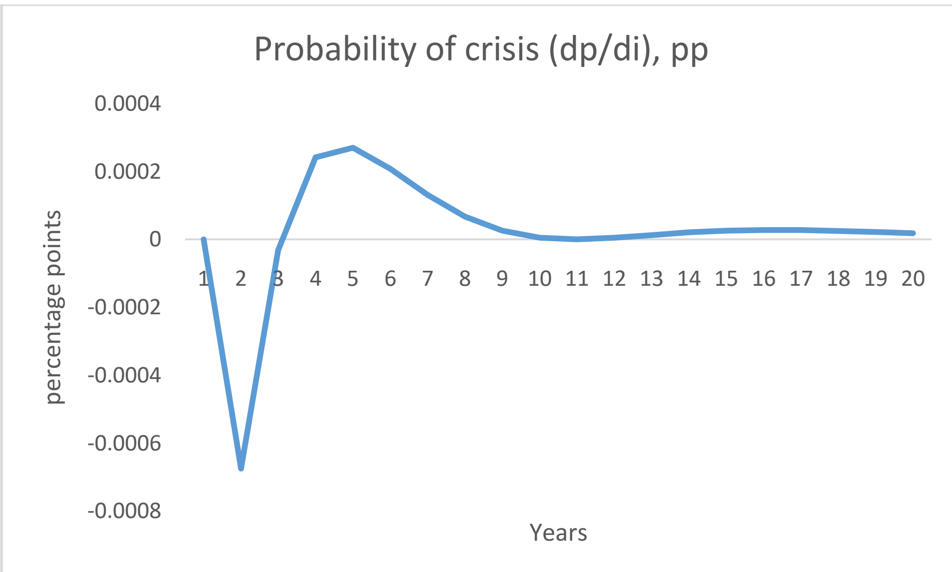

Figure 4.12: The policy rate effect on the probability of a crisis. (Source: Author's own estimation)

The probability of a crisis (dp_t/di) shows its minimum point in year 2 being -0.00067 pp and after the 3rd year moves to the positive space and shows its maximum in year 5 after which it starts converging towards the baseline. Thus, a higher policy rate brings about a reduction in the probability of a crisis for approximately 3-4 years and upsurges it after about 5 years. As a component of marginal benefit from a lower probability of a crisis, the negative of the series (dp_t/di) is required, therefore, it is multiplied by the negative sign in order to get the desired result.

Each and every constituent of marginal benefit from a lower probability of a crisis (MB_t^p) specified in (3.10) have been calculated, given by $MB_t^p = (\Delta u_t)^2 (-dp_t/di) = 25 (-dp_t/di)$.

4.6 The Marginal Benefit of LAW from a smaller magnitude of a crisis($MB_t^{\Delta u}$)

With the aim of finding the marginal benefit of LAW from a smaller magnitude of a crisis ($MB_t^{\Delta u}$)in accordance to equation (3.11) we need to calculate how the policy (interest) rate affects the magnitude of a crisis. This channel can be through the effect debt has on the magnitude of a crisis. For this purpose we take the ratio of debt to income and obtain a series of debt to income ratio, respectively.

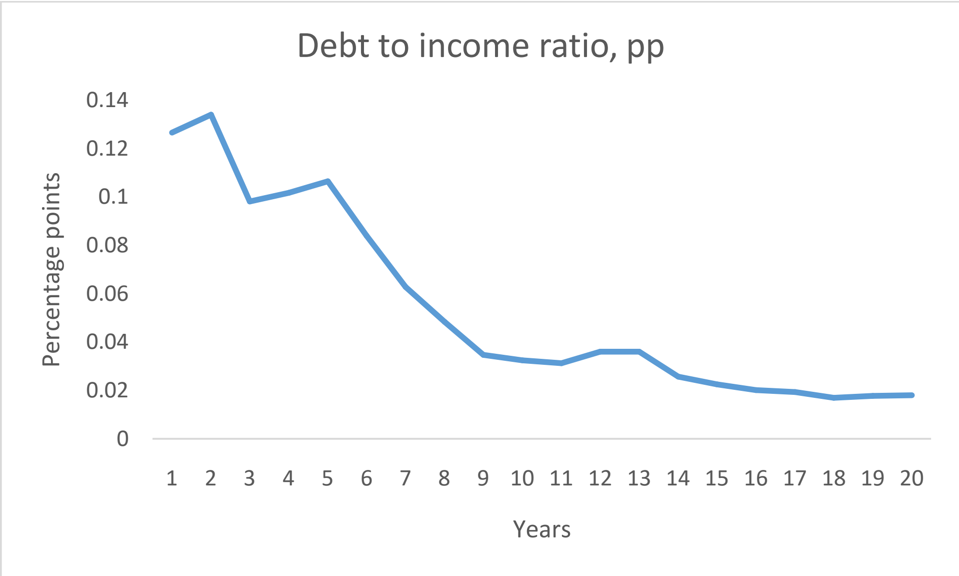

Figure 4.13: The policy rate effect on debt to income ratio. (Source: Author's own estimation)

The above graph shows the policy rate effect on debt to income ratio. All the values lie in the positive quadrant declining and converging towards the baseline in future years. A downward trend is observed.

Next, pertaining to the effect debt has on the magnitude of a crisis, Floden (2014) states, for OECD countries, that a lower household debt to income ratio is connected with a lower increase in the unemployment rate for the years 2007-2012. In other words, 1 pp lower debt to income ratio is linked with a 0.02 pp smaller increase in the unemployment rate (Floden, 2014). This comes forth as a limitation to this study yet again. Pakistan is not an OECD country. Such numerical estimates for Pakistan's economy have not been calculated till date and there is a dire need for them to be calculated, as the current situation prevails in the country where interest rates are increasing day by day and Pakistan's economy is moving towards monetary policy tightening even more, at a greater pace.

So, the policy rate effect on the magnitude of a crisis, ($dE_1\Delta u_t$ /di), is 0.02 times the policy rate effect on debt to income ratio.

Figure 4.14: Magnitude of a crisis. (Source: Author's own estimation)

The above figure illustrates the magnitude of a crisis, respectively. The minimum point observed for the crisis unemployment increase is in year 6. It then increases above the baseline goes down again after year 15 and can be predicted to go above the baseline again in the future years after year 20.

All the elements required for calculating the marginal benefit of LAW from a smaller magnitude of a crisis given by equation (3.11) have now been collected. This is given by $MB_t^{\Delta u} = 2p_t\, \Delta u_t(-dE_1\Delta u_t /di) = 10p_t\, (-dE_1\Delta u_t /di)$ which is shown in the figure below.

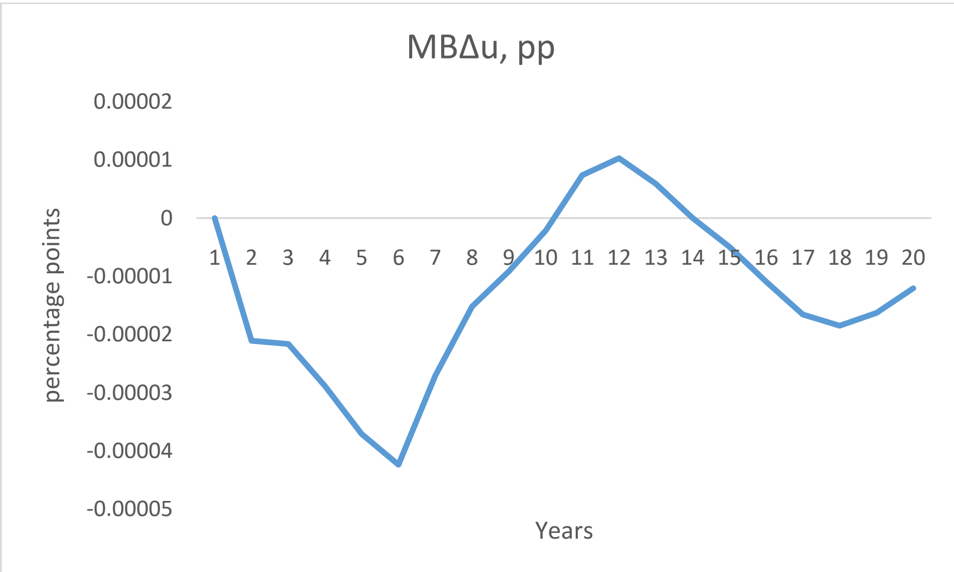

Figure 4.15: Marginal benefit from a smaller magnitude of a crisis. (Source: Author's own estimation)

4.7 The Net Marginal Cost

This section is further split up into sub-sections which define the net marginal cost (NMC) in three different cases. Sub-section 4.7.1 gives the NMC when the loss function (L) is '0', which refers to a case of non-leaning. Next, the sub-section 4.7.2 tells the NMC when L=1 which is a case of leaning against the wind and lastly, sub-section 4.7.3 gives the NMC when L=2 which pertains to a stronger leaning scenario.

4.7.1 The Net Marginal Cost when L=0 (Non-leaning)

We will discuss three different scenarios. In the first one we will consider the loss function equal to zero, that is, L=0. By taking the loss function (L) equal to zero means that the unemployment deviation which is, $L_t = (\mu_t - \mu_t^*)^2 = (\tilde{u}_t^2)$, is also zero. This reflects non-leaning where the government does not lean against the wind at all. The second would be a case of leaning against the wind (LAW) where the loss function would be assigned the value of one, that is, L=1. Here the unemployment deviation will be 1. The third case would relate to a stronger degree of leaning where the loss function has the value of 2, that is, L=2, where the unemployment deviation equals to the value of 2.

In the first case, when L=0, the situation refers to non-leaning. We calculated the marginal cost (MC) and marginal benefit (MB) keeping the non-crisis unemployment rate equal to 'zero' in equations (3.5) to (3.7). The resulting equations were (3.9) to (3.11), respectively. These resulting set of equations refer to non-leaning. After performing calculations regarding these equations the result obtained was;

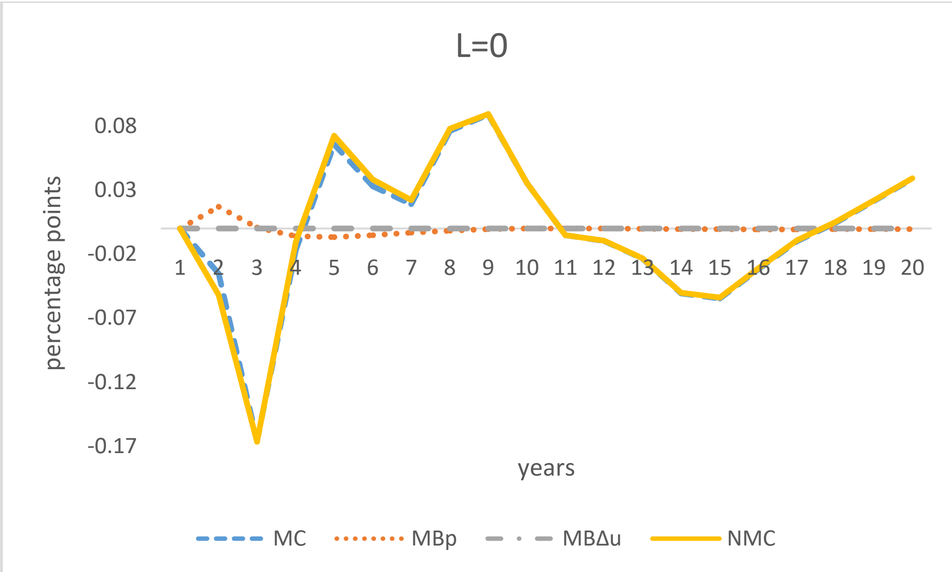

Figure 4.16: Marginal cost (MC), marginal benefit (MB^p&$MB^{\Delta u}$) and the net marginal cost (NMC) when L=0.(Source: Author's own estimation)

The figure above shows the MC, MB (MB^p&$MB^{\Delta u}$) and the NMC, over a period of 20 years when the non-crisis unemployment deviation is 'zero'. The MC first falls low in year 3, up to -0.17 pp, where the benefit exceeds the cost. After year 4, the MC begins to rise above the baseline and exceeds the MB by a great degree. Its first maximum point is reached in year 5, where the cost exceeds the benefit, after which a drop is observed in the MC but here too the cost is still greater than the benefit, and again a rise is seen in year 9. The costs are still greater than the benefits. MC falls below the baseline again after year 11, here some benefits are reaped but they are very small in amount. The MC then stoops low, and crosses the baseline again after year 17, where the cost outdoes the benefit by a great margin again. This is barely visible in the near end of the graph as the graph of NMC overtakes the graph of MC at many points. Even if assessed roughly from the graph, one can tell that the costs exceed the benefits and even where the benefits are more they are small in amount and stay greater than the costs for a short time span, say 2 to 3 years only.

The NMC is described as the marginal cost minus the marginal benefit, therefore, a negative NMC indicates a greater benefit and a positive NMC indicates a greater cost. Up to year 4 the benefit accrued is greater than the cost, but immediately after the 4^{th} year, the NMC becomes positive, indicating higher costs. It remains positive for, approximately 6 years, after which it turns negative once again in year 11. NMC remains negative for the next 6 years, which means that in this time period the benefits are greater than the costs incurred. After year 17, it begins to rise and the cost increase the benefits once again.

Precisely, the behaviour of the NMC is that it first shows a greater benefit than cost for approximately 4 years after which cost becomes greater than the benefit for almost 6 years. The benefit takes over the cost again for a time period of 6 years and then the cost exceeds the benefit again.

4.7.2 The Net Marginal Cost when L=1 (Leaning against the wind)

Pertaining to the second case, when L=1, the situation refers to leaning against the wind. This refers to monetary policy tightening, that is, increasing the interest rate (policy rate) in the economy, than what it was before. The marginal cost (MC) and marginal benefit (MB) were calculated, keeping the non-crisis unemployment rate equal to 'one' in equations (3.5) to (3.7). The resulting equations were (3.12) to (3.14), respectively. These set of equations refer to leaning against the wind. After doing the required calculations the result obtained was;

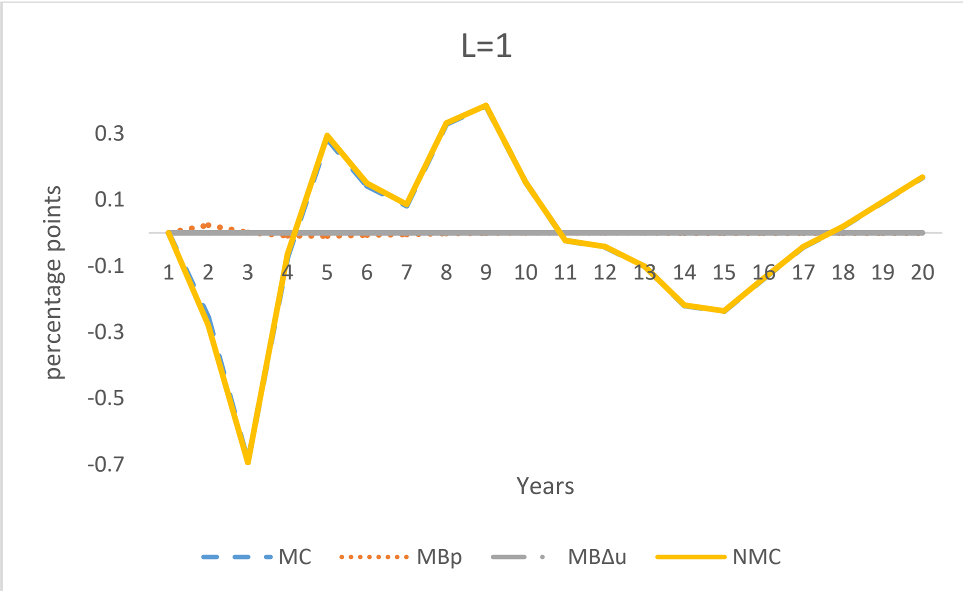

Figure 4.17: Marginal cost (MC), marginal benefit (MB^{p}&$MB^{\Delta u}$) and the net marginal cost (NMC) when L=1.(Source: Author's own estimation)

The figure above shows the marginal cost (MC), marginal benefit (MB^{p}&$MB^{\Delta u}$) and the net marginal cost (NMC), when the non-crisis unemployment deviation is 'one'. The shape of the marginal cost graph looks similar to the one illustrated in case 1, when L=0. But with scrutiny, it can be seen that the scales of both the graphs are different.

The marginal cost stooping low in year 3 goes down to -0.7 pp, whereas, in the previous case it went down to -0.17 pp. The maximum point of MC in figure 4.16 (the previous graph), was 0.08 pp in year 9, while, the maximum point in figure 4.17, in year 9, is 0.38 pp. This vividly indicates that the cost of leaning is significantly greater as compared to that of non-leaning. The benefit gained in this case has also decreased than that in the preceding case. Likewise, we can see as the graph portrays, the next low observed in year 15 in the preceding graph was -0.05 pp, whereas, in this graph, the low observed in year 15 is -0.23 pp. This points to a significantly high difference in the cost relating to the two situations at hand. The cost for LAW is sufficiently higher than that of non-leaning. Whereas, the benefit has decreased in case of LAW.

The behaviour of MC and MB is the same as in the previous graph. The MB is greater in the first years, then the MC increases showing its first peak in year 5 and remaining positive showing its second peak in year 9, gives a drop again, minimum at year 15, then rises up again. The only difference is in the greater amount of costincurred and lesser benefit accrued in leaning against the wind than in non-leaning.

The net marginal cost (NMC) goes low to -0.16 pp in year 3, in the case of non-leaning while, in the case of leaning it goes down to -0.69 pp. The behaviour of NMC is the same thatup to year 4 the benefit accrued is greater than the cost, but immediately after the 4th year, the NMC becomes positive, indicating higher costs. It remains positive for, approximately 6 years, after which it turns negative again in year 11. NMC stays negative for the next 6 years, which means that in this time period the benefits are greater than the costs incurred. After year 17, it begins to rise and the cost increase the benefits once again.

In short, the NMC illustrates that a greater benefit is seen than the cost accrued for approximately 4 years after which cost becomes greater than the benefit for almost 6 years. The benefit becomes greater than the cost again for a period of 6 years and then the cost exceeds the benefit again. The difference in both the graphs is the amount of costs and benefits incurred, which are greater in the case of leaning.

4.7.3 The Net Marginal Cost when L=2 (Stronger leaning)

Finally, in the third case, when L=2, the situation refers to a stronger case of leaning. In this case monetary policy tightening is greater than that done in the second case. We calculated the marginal cost (MC) and marginal benefit (MB) keeping the non-crisis unemployment rate equal to 'two' in equations (3.5) to (3.7). The equations obtained were (3.15) to (3.17), respectively. These equations refer to stronger leaning than equations (3.12) to (3.14). After calculations the result was;

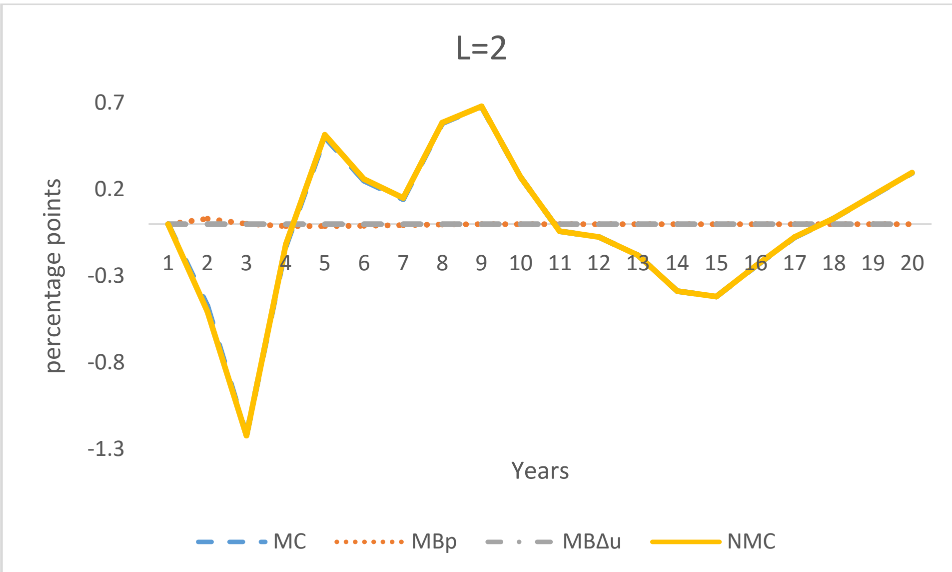

Figure 4.18: Marginal cost (MC), marginal benefit (MB^p&$MB^{\Delta u}$) and the net marginal cost (NMC) when L=2.(Source: Author's own estimation)

The figure above illustrates the marginal cost (MC), marginal benefit (MB^p&$MB^{\Delta u}$) and the net marginal cost (NMC), when the non-crisis unemployment deviation is 'two'. The shape of the marginal cost graph looks similar to the one illustrated in case 1 and 2. Again, the difference lies in the amount of costs and benefits gained. In this case, the costs incurred are even greater than those incurred in the previous case when L=1.

In the second case the MC stooped low to -0.69 pp in year 3 while, it goes down to -1.22 pp in this case. The shape is similar to the two cases above but the amount of costs and benefit vary largely. The costs being the greatest in this case. The benefits were a little bit greater in the first case, lessened in the second and went down a little more in the third case. This was the opposite of what happened to the MC, which had increased with policy tightening.

The maximum point reached in year 9 was 0.38 pp in the second case whereas, in this case it goes up to 0.67, almost three times the previous one. Then again in year 15, it goes down to -0.41 pp whereas, it went to –0.23 pp in the previous case. This means it is almost 2 times greater fall in this case than the previous one.

The behaviour of MC and MB is the same as in the previous graph. The MB is greater in the first years, then the MC increases showing its first peak in year 5 and remaining positive showing its second peak in year 9, gives a drop again, minimum at year 15, then rises up again. The difference lies again in the greater amount of costincurred and lesser benefit accrued in stronger leaning than in leaning against the wind or in non-leaning.

The net marginal cost (NMC) goes low to -0.69 pp in year 3, in the case of LAW while, on the other hand, in stronger leaning it moves down even further to -1.22 pp. The behaviour of NMC is the same thatup to year 4 the benefit accrued is greater than the cost, but immediately after the 4th year, the NMC becomes positive, illustrating higher costs. It remains positive for, approximately 6 years, after which it turns negative again in year 11. NMC stays negative for the next 6 years, which means that in this time period the benefits are greater than the costs incurred. After year 17, it begins to rise and the cost increase the benefits once again.

In other words, the NMC indicates that a greater benefit is observed than the cost accrued for approximately 4 years after which cost becomes greater than the benefit for almost 6 years. The benefit becomes greater than the cost again for a period of 6 years and then the cost exceeds the benefit again. The difference in all the three graphs (figures 4.16, 4.17&4.18) is the amount of cost and benefit incurred, which is tantamount to an increasing marginal cost and a decreasing marginal benefit as we move towards stronger leaning starting from no leaning at all.

Therefore, it can be stated, that cost for stronger LAW is higher than that of LAW and non-leaning. Whereas, the benefit has decreased in case of LAW and decreased even further in case of stronger LAW.

4.8Comparison of the results

a) No Leaning:

As we can see in the figure below that on the left side the scale is that which measures the interest rate and the right scale conforms to the measurement of the NMC in case of no leaning. As we can see clearly that after year 2003 when the interest rate begins to rise, the NMC is also in the positive quadrant above the baseline. As we have taken our NMC to be MC minus the MB, the graph lying in the positive quadrant indicates a greater cost than the benefit. Even after 2017 when the interest rate begins to rise again the NMC also tends to rise, thus conforming to our results.

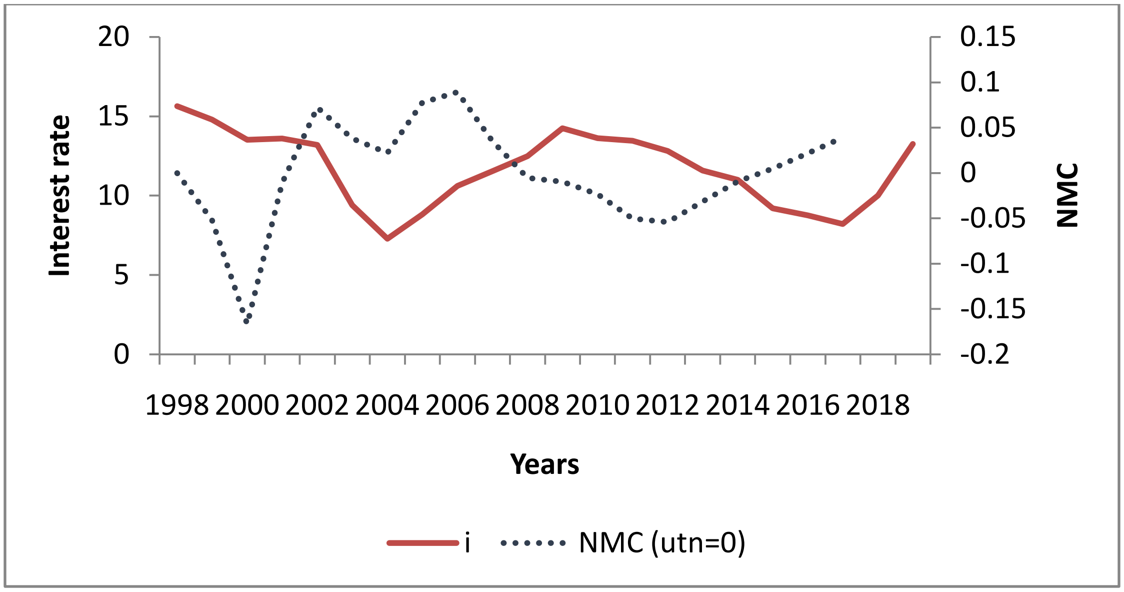

Figure 4.19: Interest rate and NMC in the case of no leaning[11].(Source: Author's own estimation)

b) LAW:

The left scale is that which measures the interest rate and the right scale conforms to the measurement of the NMC in case of LAW. Again, we can see clearly that after year 2003 when the interest rate begins to rise, the NMC is also in the positive quadrant above the baseline. If we scrutinize the numbers on the scales, we get to know that the MC above baseline is higher than in the case of no leaning. This means that the MC for LAW has increased and the MB goes even closer to the baseline indicating that the benefits have deceased even further in this case.

[11] U_t^n =0 refers to no leaning, u_t^n =1 means LAW and u_t^n =2 corresponds to stronger LAW.

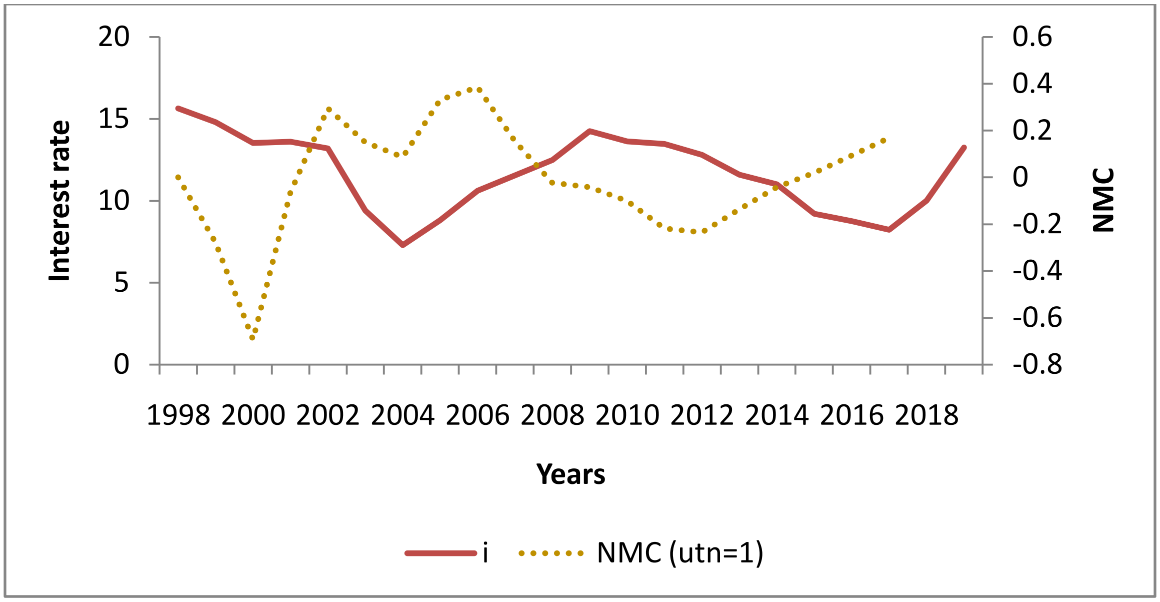

Figure 4.20: Interest rate and NMC in the case of LAW.(Source: Author's own estimation)

c) Stronger Case of LAW:

Once again, the left scale measures the interest rate and the right scale conforms to the measurement of the NMC for a stronger case of LAW. Again, we can see clearly that after year 2003 when the interest rate begins to rise, the NMC is also in the positive quadrant above the baseline. Again, upon scrutinizing the scales, we can observe that the MC has gone even higher for the stronger case of LAW and the MB has decreased even further. This means that MC in case of LAW was greater than that of no leaning and in the case of stronger LAW it was the highest. Therefore, we can conclude that as we move from no leaning towards leaning, the MC increases and the MB decreases.

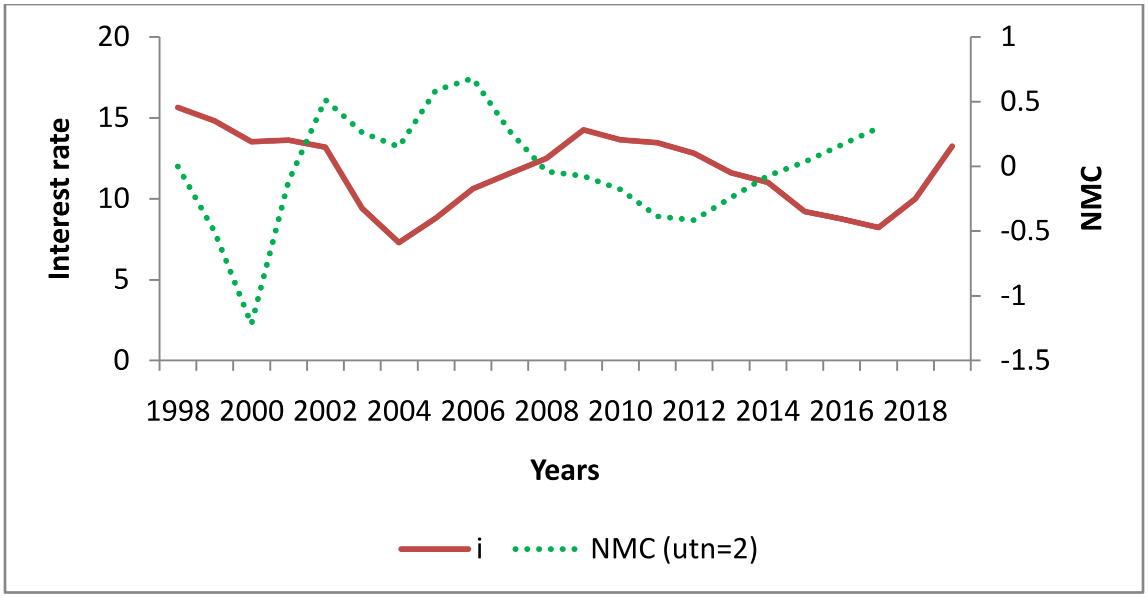

Figure 4.21: Interest rate and NMC in the case of stronger LAW.(Source: Author's own estimation)

Now, putting all the three graphs of NMC for no leaning, LAW and stronger LAW in the same plane along with the interest rate on left scale and NMCs on the right one brings clarity to our results. This is illustrated in the figure below:

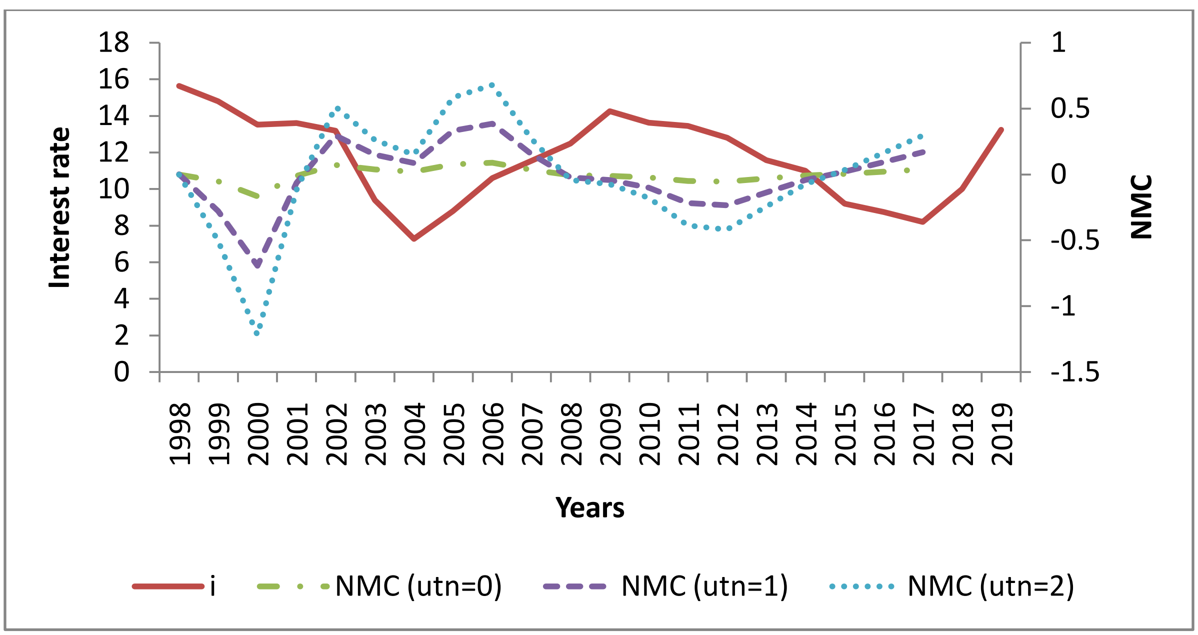

Figure 4.22: Interest rate and NMC for all the three cases.(Source: Author's own estimations)

In the graph presented above, it is now evident that the NMC is greater for LAW after 2003 when the interest rate is beginning to increase and is the greatest for stronger LAW at this point. Therefore, if we move from no leaning towards leaning our costs increase and benefits decrease.

CHAPTER 5

Conclusion and Policy Recommendation

5.1 Preamble

This chapter gives the conclusion of the study and recommendations. Section 5.2 summarizes the work done in each chapter and further discusses the results and findings of this research. Section 5.3 gives the policy recommendation and section 5.4 states the limitations of this study and future directions.

5.2 Summary and Conclusion

This analysis of finding the numerical estimates of the costs and benefits associated with increasing the interest rate (policy rate) is a simple, transparent analysis which is much needed now. Currently, the situation in Pakistan is such that the policy rate is increasing day by day, and at a fast pace. Therefore, it has become imperative to assess the costs and benefits arising from this increment in policy rates. That being the case, certain assumptions and benchmark estimates were taken into account and the costs and benefits arising from a loose policy as well as policy tightening were calculated.

In chapter 1, an introduction to leaning against the wind (LAW) has been given. The background to the monetary policy of LAW has been provided. The monetary policy in case of Pakistan has been elaborated. Furthermore, the objectives, significance of the study have also been stated.

In chapter 2, some explanation regarding LAW and macroprudential policies has been stated. A brief background of the DSGE models has been provided and the four monetary policy transmission channels have been explained in detail. Later on, the theoretical and empirical evidences have been provided and evidence from Pakistan has been provided as well.

Moving ahead, in chapter 3, the variables used, data regarding those variables, its sources and the time span of the study is described. The descriptive statistics for all the variables used in the study have been calculated and explained further with the help of graphs of the stability ratio of each variable. The arithmetic mean, standard deviation and the stability ratio (coefficient of variation) have been calculated in the descriptive statistics portion. Next, the theoretical model has been specified. Details and equations regarding the model have been described.

In chapter 4, firstly, we calculated the marginal cost (MC) by calculating the estimates of policy rate effect on the expected non-crisis unemployment rate ($dE_1u_t^n/di$), the expected magnitude of a crisis (Δu) and the probability of a crisis (p_t). Next, we calculated the marginal benefit (MB) by combining the marginal benefit accrued from a lower probability of a crisis and a smaller magnitude of a crisis. The former was calculated by finding the estimate of the policy rate effect on the probability of a crisis (dp_t/di) and the latter was calculated by estimating the policy rate effect on the magnitude of a crisis ($dE_1\Delta u_t /di$) and the channel was through the effect of debt on the magnitude of a crisis.

The results obtained exhibit that as we move from a loose policy, whereby, we do not lean against the wind at all (NL), to a much tighter policy (LAW), the costs incurred increase and the benefits decrease. Moreover, tightening the policy even further (stronger LAW), adds to the costs and a decline in benefits is observed. It is observed that, for a first few years, say approximately 3-4 years, benefits are accrued, after which the cost overtakes the benefit and loss is incurred for about 6-7 years. Thereafter, for a period of approximately 6 years the benefit becomes greater than the cost, and subsequently the costs exceed the benefits once again.

Additionally, when there was a situation of non-leaning (NL), the minimal point that the marginal cost fell to, was observed to be -0.16 pp whereas, in the case of leaning against the wind (LAW), it was observed to be -0.69 which tends to be a huge difference and for a stronger case of leaning against the wind (stronger LAW), it was -1.22 pp. Moreover, the peak of net marginal cost observed in year 9 was 0.08 pp for NL, 0.38 pp for LAW and 0.67 pp for a stronger LAW. Besides that, it is observed that the MC for NL is lesser than it is for LAW and is the most for a stronger LAW. Conversely, it is seen that the MB accrued from NL is greater as compared to LAW and goes down even further when we move towards a stronger LAW.

On that account, it can be concluded, that policy tightening or moving towards LAW leads to higher costs and lower benefits than accrued in the case of NL.

5.2 Policy Recommendation

The State Bank of Pakistan should try not to lean against the wind, according to the calculated estimates of this study, as moving from non-leaning (NL) towards LAW (policy tightening), increases the overall costs and decreases the benefits. As it is evident from the graphs illustrated above, the costs of LAW have been seen to be greater than the costs of NL and on the contrary, the benefits of LAW are smaller than the benefits of NL. Furthermore, the costs of a stronger LAW have been observed to be greater than the costs of LAW and on the other hand, the benefits of a stronger LAW are smaller than the benefits of LAW. Precisely, moving from NL towards LAW increases the costs and decreases the benefits.

5.3 Limitations and Future Directions

However, this study has certain limitations and they should be given due consideration. Previously, no research has been conducted on calculating the numerical estimates of the costs and benefits for monetary policy in case of Pakistan. It has been done for several other countries but not for Pakistan, in particular. Despite the fact that, monetary policy and the continuous increment in Pakistan's interest rate, day by day, is of great significance at this point in time. Therefore, many measures, for instance, the magnitude of the occurrence of a crisis in Pakistan which has not been numerically calculated, should be calculated now. Likewise, many others like the probability of the occurrence of a crisis, the duration for which that crisis can persist have not been calculated for Pakistan and research regarding these issues can be conducted in the future.

References

Ahmed, A. M., & Malik, W. S. (2011).The Economics of Inflation, Issues in the Design of Monetary Policy Rule, and Monetary Policy Reaction Function in Pakistan*. The Lahore Journal of Economics.16:* SE (September 2011), 215-232.

Ajello, A., Laubach, T., Lopez-Salido, D., & Nakata, T. (2016).Financial Stability and Optimal Interest Rate Policy. *Finance and Economics Discussion Series 2016-067, Board of Governors of the Federal Reserve System (US).*

Angelini, P., Neri, S., & Panetta, F. (2011).Monetary and macroprudential policies. *Bank of Italy*.

Arby, M. F., & Ali, A. (2017).Threshold Inflation in Pakistan.*SBP Working Paper Series No. 94.*

Asghar, N., &Hussain, Z. (2014).The Lags in Effect of Monetary Policy: A Case Study of Pakistan. *Pakistan Economic and Social Review. 52* (1) (Summer 2014), 1-14.

Atgur, M., & Altay, N. O. (2017).Examination of the exchange rate and interest rate channels of the monetary transmission mechanism during the inflation targeting: Turkey and Mexico countries examples. *Theoretical & Applied Economics, Winter 2017, 24(4)*, 137-160.

Bank for International Settlements (2014).*84th BIS Annual Report, 2013/14*.*Bank for International Settlements.*

Bouthevillain, C., Cour-Thimann, P., Van den Dool, G., Hernandez de Cos, P., Langenus, G., Mohr, M., Momigliano, S., &Tujula, M. (2001). Cyclically adjusted budget balances: an alternative approach. *European Central Bank Working Paper series no 77.*

Carbonari, L. (2009). *Transmission Mechanism of Monetary Policy (Encyclopedia)*.http://www.bankpedia.org/index.php/en/128-english/t/23385-transmission-mechanism-of-monetary-policy-encyclopedia

Choi, W. G., & Cook, D. (2018). Policy Conflicts and Inflation Targeting: The Role of Credit Markets. *IMF Working Paper No. 18/72.*

Christiano, L. J., Eichenbaum, M. S., &Trabandt, M. (2018).On DSGE Models.*Journal of Economic Perspectives, 32(*3), 113-140.

Claessens, S. &Kose, M. A. (2013). Financial Crises: Explanations, Types, and Implications. *IMF Working Paper No. 13/28.*

Diaz, Kalan., F. S. Laséen., D, Vestin., & A, Zdzienicka. (2015). Leaning against the Wind: A Note on Costs and Benefits. *Working Paper, International Monetary Fund, forthcoming.*

Economics Help. (2017). Retrieved from https://www.economicshelp.org/macroeconomics/monetary-policy/effect-raising-interest-rates/

Enders, W. (2004.)*Applied Econometric Time Series.*John Wiley & Sons, Inc.

Filardo, A., &Rungcharoenkitkul, P. (2016).A quantitative case for leaning against the wind. *BIS Working Papers 594*, Bank for International Settlements.

Floden, M. (2014).*Should We Be Concerned By High Household Debt?*http://www.martinfloden.net/files/hhdebt_en_2014.pdf

Friedman, M., & Schwartz, A. (1963).*A Monetary History of the United States*.1963 Princeton University Press.

Gambacorta, L. &Signoretti, F. M. (2014) Should Monetary Policy Lean against The Wind? An Analysis Based on a DSGE Model with Banking. *Journal of Economic Dynamics & Control 43*, 146-174.

Gerdrup, K. R., Hansen, F., Krogh, T., &Maih, J. (2016).Leaning Against the Wind When Credit Bites Back.*Norges Bank Working Papers, 9*(2016).

Gourio, F., Kashyap, A. K., &Sim, J. (2017). The Tradeoffs in Leaning Against the Wind. *IMF Economic Review, Palgrave Macmillan;International Monetary Fund, 66*(1), 70-115.

Hamilton, J., D. (2018). Why You Should Never Use the Hodrick-Prescott Filter. *The Review of Economics and Statistics, 100* (5), 831-843.

Hanif, M. N. (2014). Monetary Policy Experience of Pakistan. *MPRA Paper 60855,* University Library of Munich, Germany.https://mpra.ub.uni-muenchen.de/60855/

Hodrick, R. J., & Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking,* 29, 1-16.

International Monetary Fund (2015).Tackling Challenges Together.*IMF Annual Report 2015.*www.imf.org.

International Monetary Fund (2015).Monetary Policy and Financial Stability.*Policy Papers, August 28, International Monetary Fund.*www.imf.org.

Jahan, S., & Mahmud, A., S. (2013). What is the Output Gap? *Finance and Development, IMF.50* (3).

Kydland, F. E., &Prescott, E., C. (1982). Time to Build and Aggregate Fluctuations.*Econometrica.50* (6), 1345-1370.

Long, J., B., &Plosser, C., I. (1983).Real Business Cycles.*Journal of Political Economy. 91*(1), 39-69.

Malik, W., S. (2006). Money, Output, and Inflation: Evidence from Pakistan. *The Pakistan Development Review. 45* (4) Part II, 1277–1286.

Mishkin, F. (1995).Symposium on the Monetary Transmission Mechanism.*Journal of Economics Perspective. 3(9)*, 3-10.

Nademi, Y., Zare, E., &Rahimi, M. (2011).Threshold Unemployment Rate, Labor Force Growth and Economic Growth; New Evidence from Iran and Pakistan Economies.*Australian Journal of Basic and Applied Sciences, 5*(9): 1372-1375.

OECD (2012).Debt and Macroeconomic Stability.*OECD Economics Department Policy Notes, No. 16 January 2013.*

Pakistan Economic Survey (2016-17). *Ministry of finance*.Economic Adviser's Wing Economic Adviser's Wing, Finance Division, Government of Pakistan, Islamabad.

Papademos, L. (2006). *Price Stability, Financial Stability and Efficiency and Monetary Policy.*https://www.ecb.europa.eu/press/key/date/2006/html/sp060707.en.html

Pescatori, A. &Laseen, S. (2016). Financial Stability and Interest-Rate Policy: A Quantitative Assessment of Costs and Benefits. *IMF Working Paper WP/16/73.*

Saunders, T. & Tulip, P. (2019).Cost-benefit Analysis of Leaning against the Wind. Research Discussion Paper: RDP 2019-05. *Economic Research Department Reserve Bank of Australia.*

Sims, C. (1986). Are Forecasting Models Usable for Policy Analysis? Quarterly Review.*Federal Reserve Bank of Minneapolis*.2-16.

Smets, F. (2014). Financial Stability and Monetary Policy: How Closely Interlinked? *Economic Review (SverigesRiksbank) 2013:3*, Special Issue, 121–59.

Srithilat, K., & Sun, G. (2017). The Impact of Monetary Policy on Economic Development: Evidence from Lao PDR. *Global Journal of HUMAN-SOCIAL SCIENCE: E Economics. 17* (2).

Stein, J. C. (2012). Monetary Policy as Financial Stability Regulation.*Quarterly Journal of Economics 127 (1)*, 57–95.

Stein, Jeremy C., (2013). Overheating in Credit Markets: Origins, Measurement, and Policy Responses.*Speech given at the "Restoring Household Financial Stability after the Great Recession: Why Household Balance Sheets Matter" research symposium sponsored by the Federal Reserve Bank of St. Louis, St. Louis, Missouri.*

Stein, Jeremy C., (2014). Incorporating Financial Stability Considerations into a Monetary Policy Framework.*Speech given at the International Research Forum on Monetary Policy, Washington, D.C., March 21, 2014.*

Svensson, L. E.O. (2013a). 'Leaning Against the Wind' Leads to a Higher (Not Lower) Household Debt-to-GDP Ratio. *Working Paper, Stockholm School of Economics*, available at www.larseosvensson.se.

Svensson, L. E.O. (2014). Inflation Targeting and 'Leaning against the Wind'.*International Journal of Central Banking 10*(2), 103–114.

Svensson, L. E.O. (2015). *Inflation Targeting and Leaning Against the Wind*. Presented in Fourteen Years of Inflation Targeting in South Africa and the Challenge of a Changing Mandate: South African Reserve Bank Conference Proceedings 2014, South African Reserve Bank.p.19–36, available at www.larseosvensson.se.

Svensson, L. E. O. (2015). *A simple cost-benefit analysis of using monetary policy for financial-stability purposes.*https://larseosvensson.se/files/papers/a-simple-cost-benefit-analysis-of-using-monetary-policy-for-financial-stability-purposes.pdf

Svensson, L. E. O. (2016). Cost-Benefit Analysis of Leaning Against the Wind: Are Costs Larger Also with *Less Effective Macroprudential Policy?*IMF Working Paper WP/16/03.Retrieved from www.imf.org.

Svensson, L. E. O. (2017). Cost-Benefit Analysis of Leaning Against the Wind. *Journal of Monetary Economics 90 (October 2017)* 193–213.

Svensson, L. E. O. (2018). Monetary Policy and Macroprudential Policy: Different and Separate?" *Canadian Journal of Economics. 51* (3), 802-827.

SverigesRiksbank (2013). *Annual Report for SverigesRiksbank 2013.*

Taylor, J. B. (1993). Discretion versus policy rules in practice. *CarnegieRochester Conference Series on Public Policy, 39*, 195–214.

Taylor, J.B. (1995). The Monetary Transmission Mechanism: An Empirical Framework. *Journal of Economic Perspectives. 4(9)*, 11-26.

Taylor, J.B. (1999). A Historical Analysis of Monetary Policy Rules.*Monetary Policy Rules, University of Chicago Press,* 0-226-79124-6.

Taylor, J.B. (2000). *Recent Developments in the Use of Monetary Policy Rules.* Paper presented at the Central Bank of the Republic of Indonesia, Jakarta, Indonesia, July 13-14, 2000.

Tosini, P., A. (1977). Leaning Against the Wind: A Standard for Managed Floating.*Essays In International Finance.* No. 126, December 1977. Princeton University, New Jersey.

Weill, P.O. (2007). *Leaning Against the Wind* (Unpublished PhD dissertation). Stanford University, California.

Annexure

a) The VAR (Vector Autoregression) analysis:

The underlying methodology of the DSGE models is the VAR model .Considering a two-variable case for the VAR model, say y_t is affected by the current and past realizations of sequence z_t and $z_t$is affectedby the current and past realizations of sequence y_t. So, the bivariate system obtained is:

$$y_t = b_{10} - b_{12}z_t + \alpha_{11} y_{t-1} + \alpha_{12} z_{t-1} + \varepsilon_{yt} \quad \text{(b.1)}$$

$$z_t = b_{20} - b_{21}y_t + \alpha_{11} y_{t-1} + \alpha_{22} z_{t-1} + \varepsilon_{zt} \quad \text{(b.2)}$$

Where:

a) y_t and z_t are stationary,

b) $\varepsilon_{yt}$and ε_{zt} are white noise disturbances,

c) $\varepsilon_{yt}$and ε_{zt} are uncorrelated.

The above mentioned set of equations refer to a first-order vector autoregression because the maximum lag length is 'one'. In the equations (b.1) and (b.2), $-b_{12}$ is the contemporaneous effect of a 1 unit change in z_t on y_t. Similarly, α_{12} is the effect of 1 unit change in z_{t-1} on y_t. Furthermore, ε_{yt} and ε_{zt} are shocks or innovations in $y_t$and z_t.

Since, $y_t$has a contemporaneous effect on $z_t$and z_t has a contemporaneous effect on y_t, therefore, this system of equations cannot be solved using OLS. The results would otherwise suffer from simultaneous equations bias due to the fact that the regressors and error term would be correlated. Consequently, we can rewrite the equations (b.1) and (b.2) in the matrix form:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Where:

$$B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}, x_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix}, \pi_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}, \pi_1 = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Therefore, the equation becomes:

$$Bx_{t=}\pi_0 + \pi_1 x_{t-1} + \varepsilon_t$$

$$x_{t=}B^{-1}\pi_0 + B^{-1}\pi_1 x_{t-1} + B^{-1}\varepsilon_t$$

$$x_{t=}C_0 + C_1 x_{t-1} + e_t$$

The last equation above represents VAR in the standard form. Using the new notation, the last equation derived above can be written as:

$y_t = c_{10} + c_{11}\, y_{t-1} + c_{12}\, z_{t-1} + e_{1t}$ (b.3)

$z_t = c_{20} + c_{21}\, y_{t-1} + c_{22}\, z_{t-1} + e_{2t}$ (b.4)

Since, $e_t = B^{-1}\varepsilon_t$

$$e_t = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}^{-1} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

So,

$$e_{1t} = \frac{\varepsilon_{yt} - b_{12}\varepsilon_{zt}}{1 - b_{12} b_{21}} \quad \text{(A)}$$

$$e_{2t} = \frac{\varepsilon_{zt} - b_{21}\varepsilon_{yt}}{1 - b_{12} b_{21}} \quad \text{(B)}$$

Here, e_{1t} and e_{2t} (A & B) are white noise processes with zero mean, constant variance and are individually serially uncorrelated. First, applying expectation on (A), we get:

$$E[e_{1t}] = E\left[\frac{\varepsilon_{yt-b_{12}\varepsilon_{zt}}}{1-b_{12}b_{21}}\right] = 0$$

Hence, the mean is zero.

Next,

$$Var[e_{1t}] = E\left[\frac{\varepsilon_{yt-b_{12}\varepsilon_{zt}}}{1-b_{12}b_{21}}\right]^2$$

$$Var[e_{1t}] = \frac{\sigma_y^2 - (b_{12})^2\sigma_z^2}{1-b_{12}b_{21}}$$

The variance is time-independent or a stationary process.

$$Cov[e_{1t}, e_{2t}] = E\left[\frac{(\varepsilon_{yt-b_{12}\varepsilon_{zt}})(\varepsilon_{zt-b_{21}\varepsilon_{yt}})}{(1-b_{12}b_{21})^2}\right]$$

$$Cov[e_{1t}, e_{2t}] = E\left[\frac{(\varepsilon_{yt}.\varepsilon_{zt}) + (\varepsilon_{yt}.-b_{21}\varepsilon_{yt}) + (-b_{12}\varepsilon_{zt}.\varepsilon_{zt}) + \left(-b_{12}\varepsilon_{zt}.-b_{21}\varepsilon_{yt}\right)}{(1-b_{12}b_{21})^2}\right]$$

$$Cov[e_{1t}, e_{2t}] = \left[\frac{0 + \left(-b_{21}\sigma_y^2\right) + (-b_{12}\sigma_z^2) + 0}{(1-b_{12}b_{21})^2}\right]$$

$$Cov[e_{1t}, e_{2t}] = \left[\frac{-[\left(b_{21}\sigma_y^2\right) + (b_{12}\sigma_z^2)]}{(1-b_{12}b_{21})^2}\right]$$

The above given covariance suggests that the two shocks are correlated.

The mean and variance for e_{2t} are calculated in a similar manner.

If, for instance, $b_{12} = b_{21} = 0$, which pertains to no contemporaneous effect of y_t on z_t and z_t on y_t, then the shocks will be uncorrelated. The var-cov matrix of e_{1t} and e_{2t} can be defined as:

$$\Sigma = \begin{bmatrix} Var(e_{1t}) & Cov(e_{1t}, e_{2t}) \\ Cov(e_{1t}, e_{2t}) & Var(e_{2t}) \end{bmatrix}$$

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}$$

Where:

$Var(e_{it}) = \sigma_i^2$ and $Cov(e_{1t}, e_{2t}) = \sigma_{12}$ and σ_{21}.

b) Impulse response functions:

i) The impulse response generated of the unemployment rate series by giving a 1 unit shock to the policy rate.

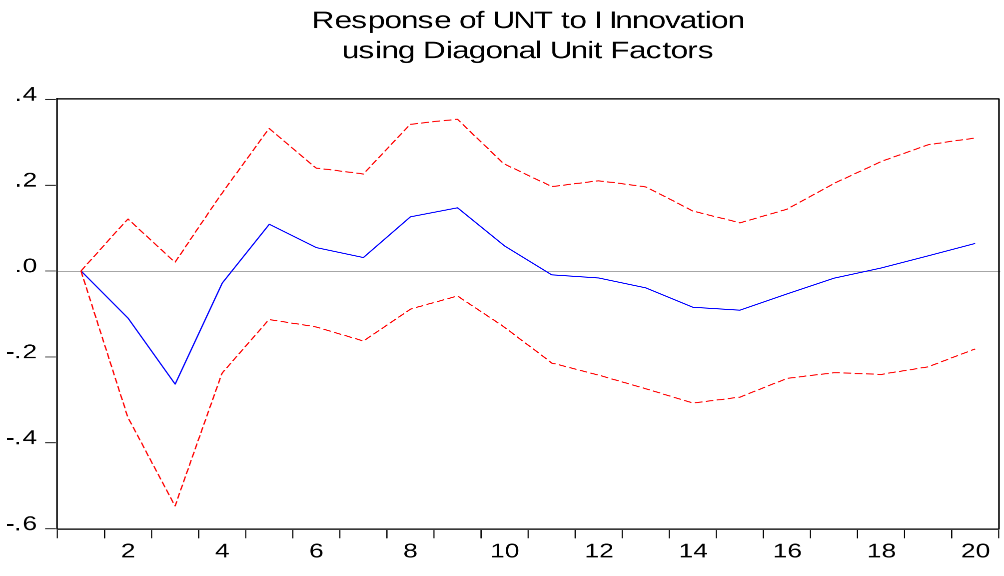

Figure 4.23: Impulse response of a unit shock in the policy rate on the unemployment rate. (Source: Author's own estimation)

ii) The impulse response generated of the real debt series by giving a 1 unit shock to the policy rate.

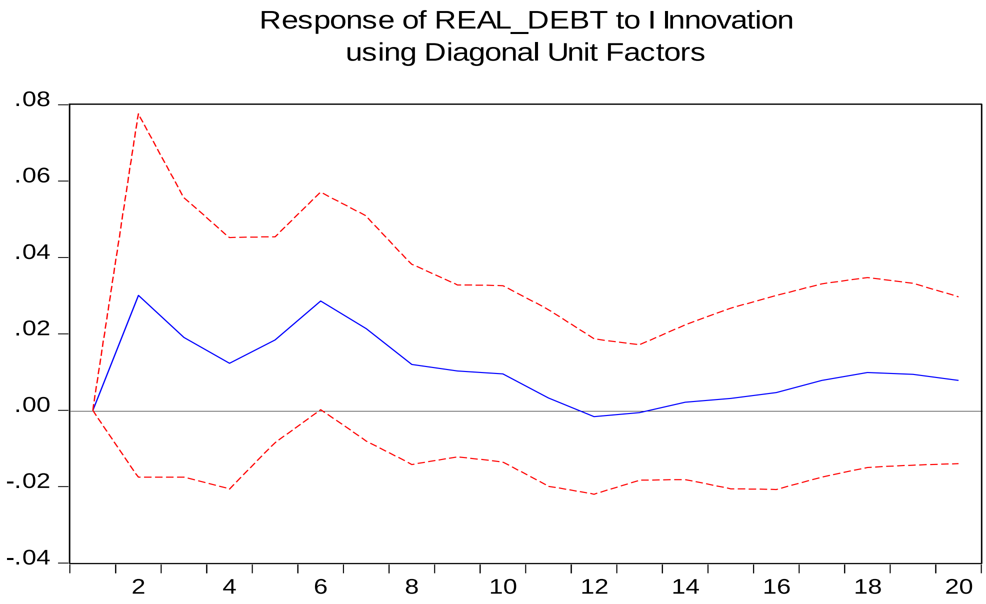

Figure 4.24: Impulse response of a unit shock in the policy rate on real debt . (Source: Author's own estimation)

iii) The impulse response generated of the debt-to-income series by giving a 1 unit shock to the policy rate.

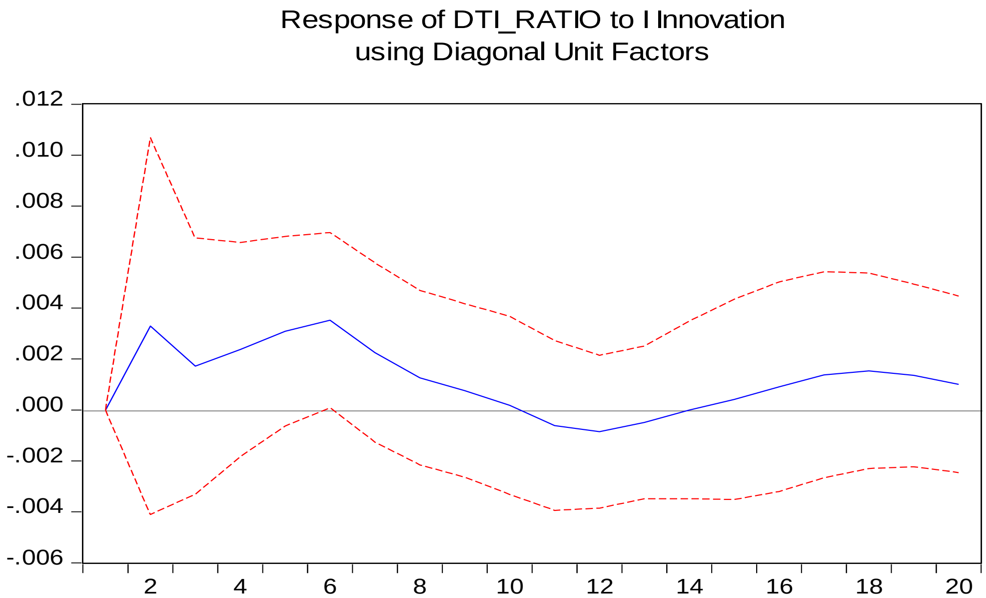

Figure 4.25: Impulse response of a unit shock in the policy rate on the debt-to-income ratio. (Source: Author's own estimation)

iv) The impulse response generated of the probability of crisis series by giving a 1 unit shock to the policy rate.

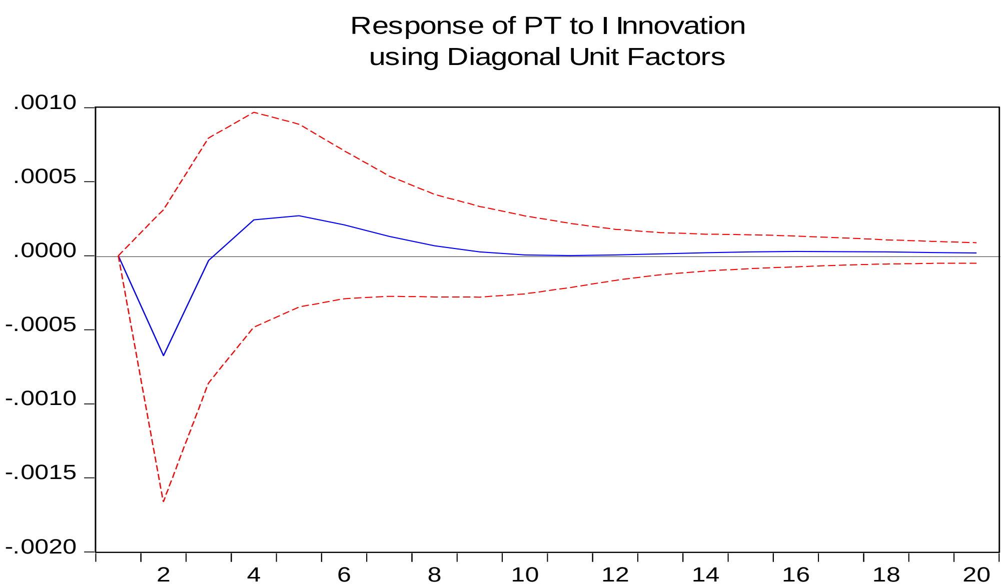

Figure 4.26: Impulse response of a unit shock in the policy rate on the probability of a crisis. (Source: Author's own estimation)