Role of Monetary Policy in the Transition to a Low-Carbon Economy: A Time-series Analysis of Pakistan

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A Thesis submitted to the School of Economics , Quaid-i-Azam University, Islamabad in partial fulfillment of the requirements of the award of degree of Master of Philosophy in Economics.

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Declaration of Authorship

I, Sameen Khan, hereby declare the authenticity of my work. I take the oath of authorship of my work which is produced for the sole purpose of M.Phil degree completion and is not used or prepared for any other purpose. However, it can be developed for publication after my degree.

I further acknowledge the right of the university to cancel my degree if the thesis is found dubious or if already been published in any journal or by anyone else.

I also solemnly pronounce that it will not be submitted for any other degree in the future from any institution.

Sameen Khan.

Acknowledgement

In the name of Allah, the Most Beneficent and the Most Merciful. Greatly humbled by all those favors that Allah has bestowed upon me with education and learning, being one of the most important and cherished blessings of all.

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Saneen Khan.

Certificate

This is to certify that the thesis titled **"Role of Monetary Policy in the Transition to a Low-Carbon Economy: A Time-series Analysis of Pakistan"** submitted by **Sameen Khan** D/O **Muhammad Khan** is accepted in its present form by School of Economics (SOE), Quaid-i-Azam University, Islamabad, Pakistan as satisfying all the necessary requirements for partial fulfillment of the degree of **Master of Philosophy in Economics**.

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List of Abbreviations

CO_2	Carbon Emissions
MP	Monetary Policy
PR	Policy Rate
CR	Domestic credit
GDP	Gross Domestic Product
FDI	Foreign Direct Investment
EN	Energy Consumption
TR	Trade Openness
EKC	Environment Kuznet Curve

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Abstract

This study probes into the impact of monetary policy on climate change in Pakistan. Carbon emissions has been used a proxy for climate change. Two monetary policy transmission channels, termed as interest rate channel and credit channel, have been selected for the study. Time series data from 1990 to 2020 for Pakistan has been used and FMOLS and GMM estimation techniques have been employed in the study.

The empirical findings of the research study confirm that monetary policy positively impacts climate change (higher carbon dioxide emissions) through both the interest rate channel and the credit channel. On grounds of the empirical findings, the study proposes a proactive role of central banks to make the shift from a high-carbon to a low-carbon economy through monetary policy. Hence, the study recommends directing monetary policy such that low and discounted interest rates are offered for environment friendly projects and higher credit and lending is allocated for green sectors and sustainable investments.

Empirical research has established a number of indicators of environmental degradation of which, carbon dioxide emissions is the most widely used indicator of climate change. It is one of the most appropriate indicators and can gauge climate change accurately as around 76% of greenhouse gas emissions are made up of carbon dioxide emissions.

Carbon dioxide emissions are emitted through a number of ways, primarily as a result of anthropogenic activities. Prior studies have discussed several factors and determinants of climate change some of which are economic growth (Shahbaz et al, 2013; Shobande, 2021, Broni et al. 2020), energy consumption (Shobande, 2021; Broni et al. , 2020) , fossil fuel consumption (Chishti et al. , 2021) remittances (Sharma et al. ,2019; Qingquan et al. , 2020), trade (Shabaz et al. , 2013; Pradeep, 2022; Balogh and Jambor, 2017), foreign direct investment (Shobande, 2021; Pradeep, 2022), and fiscal policy (Cassou and Hamilton, 2004; Halkos and Paizanos, 2016).

In addition to the factors mentioned above, a growing strand of literary works and publications has focused on monetary policy and has advocated the involvement of monetary policy to mitigate the effects of climate change. Over the last decade, communities and economies have made an effort to shift from fossil fuel to climate friendly low-carbon energy usage and central banks and the financial sector has played a moderate role in this shift. This scope of central banks is unprecedented as historically the main objective of monetary policy has been stability of prices, economic growth and high employment level. Other objectives might include interest-rate and exchange rate stability. However, fighting for climate change cause has not been in the list of their objectives or targets. Developed countries have ardently started exploring this in their attempt to combat the effects of climate change with green investments, green bonds and green financing now being a permissible and likely component of their monetary policy.

However, this is a notion relatively new for developing and low-income countries where the financial sector and markets are not yet fully developed and therefore, have not yet been able to identify and avail the financing opportunities that might be available to them to attract climate investments (Glemarec and Connelly, 2011).

The literature on environmental economics is extensive and has highlighted various dimensions of environmental issues and their possible triggers and responses. Several studies have also been conducted to explore the influence of monetary policy on climate change, specifically carbon emissions. However, most of these studies have focused on developed countries. Very limited studies are available that justify the implication of central banks environmental role for developing and low middle income economies. In order to address the gap in literature and study the impact of monetary policy on carbon emissions in the developing world, this research is being conducted. The results of this study may provide the pathway for further studies on the topic with a focus on developing countries. Also bulk of the studies have employed panel data for the analysis. This study employs time series data for the analysis and explain the results of the study in the context of the economic conditions of a single country.

With the growing threat of climate change that poses risk to the people and economy of Pakistan, it is imperative that timely action is undertaken by different sectors of the economy. With monetary sector playing an imperative role in stability and economic growth, its contribution in times of climate emergency is an aspect that a country like Pakistan can benefit from. However, before we decide on the scope of interference of monetary authorities and central bank, thorough research is required to establish the appropriate role of central banks and the financing options available. This is our motivation behind this study. The financial sector of Pakistan is still growing and whether it can have a significant impact on environmental emissions and support environmentalists and government of Pakistan in their effort to reduce the shocks of a changing climate needs to be evaluated and assessed. To the best of our knowledge, no such study has been conducted for Pakistan which has been a motivation for this study.

Several studies have been conducted to discern the role of monetary policy in terms of climate finance and this will be an addition to the existent empirical literature on the subject.

The following question will be addressed in the study:

- Does monetary policy have an impact on carbon emissions?

CHAPTER 2

LITERATURE REVIEW

This chapter reviews literature that considers the relationship between environmental quality and monetary policy. The chapter is structured as follows: section 2.1 is introduction, section 2.2 gives a review of studies that have explained the link between monetary policy and carbon emissions, section 2.3 presents some country specific case studies whereas section 2.4 cites some empirical studies. Section 2.5 refers to some contradictory studies where the authors have raised concerns on the role of monetary policy in climate mitigation. Finally, section 2.6 concludes this chapter.

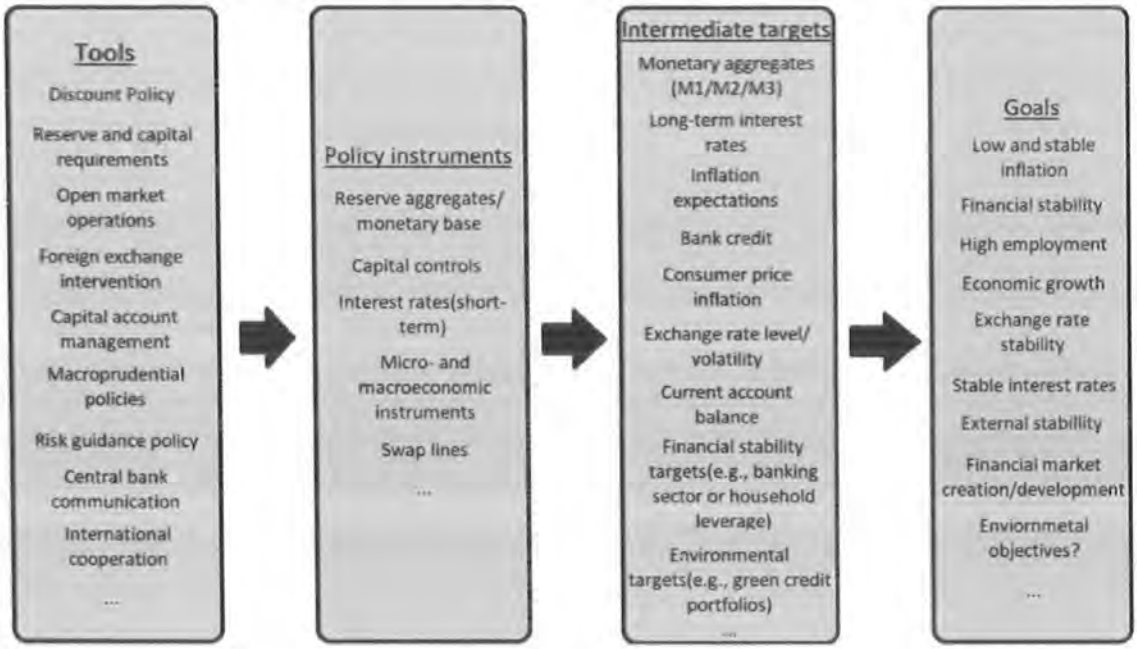
2.1 Prelude

Calls have been made for central banks to assist in the switchover to a low-carbon economy. Given the independence that central banks have, monetary mechanism can be put in place to effectively curb greenhouse gas emissions. Monetary policy tools may play a proactive and a pivotal role to achieve this objective. A number of case studies and empirical studies have been conducted in recent years to analyze the appropriate role of central banks in the context of climate change and how monetary policy mechanism may be exercised to find the ideal policy.

2.2 Climate Change and the Role of Monetary Policy

In United Nations Inquiry working paper (2017), Volz studies the role central banks can play in the convergence towards green financing. By investing and allocating resources towards sustainable projects and having environmental objectives, monetary policy may bring a radical change. Conventionally, the objective of monetary policy and central banks has been price stability, high employment level in the economy and maintenance of long-term interest rates that would all contribute towards economic growth. Although, environmental and sustainability goals are not in their list of objectives, the incorporation of sustainability into its goals may prove congruent in achieving price stability.

Figure 2.1: Monetary policy tools, instruments, intermediate targets and final goals



Source: UN Environment Inquiry Working Paper, 2017

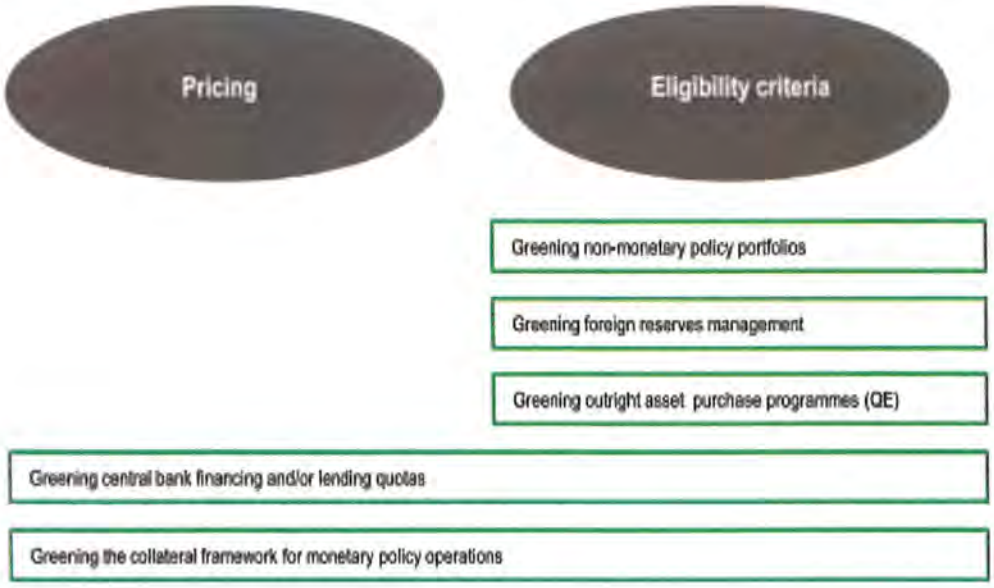
The author also discusses how overstretching central banks mandates by adding sustainability to the list of their targets and objectives may cause threefold risks. These risks could include objectives conflicting with the central bank's main objectives, second could be the risk of designating authority to unaccountable institutions and the third risk could be the resistance that central banks would have to face internally from within their own banking community. Any such additional goals that central banks add to their list and fail to achieve might be a setback to their credibility.

Though sustainability and environmental objectives are not yet a part of central banks mandate, but given that central banks have a series of strong and powerful instruments that can address climate change threat, their role can be explored further to provide guidance and support towards limiting dangerous levels of environment degradation.

communicating the risk to the public and financial markets by discussions, conferences and seminars. One of the frameworks in this respect that has already been adopted by some central banks is the Task Force on Climate related Financial Disclosures (TCFD) which specifies the information that companies have to disclose for investors, insurance underwriters and lenders to take the correct pricing strategy which would incorporate risks that might prevail due to climate change into the pricing too. Moreover, central banks can support the initiatives of their respective governments to finance sustainable growth.

The third measure where central banks role in a proactive manner is being explored may be controversial. Since directing their strategies specifically towards mitigation of climate risk and promoting the convergence to a carbon neutral economy is not in their legal mandate, it may lead to criticism. A proactive measure would consist of central banks changing their pricing or changing the eligibility criteria which is explained in the following figure by the authors:

Figure 2.2: Greening central banks portfolio via pricing strategy or eligibility criteria



Source: Boneva et al. (2022)

By changing the eligibility criteria, central banks would be taking initiatives for greening their non-monetary portfolios, foreign reserves and their asset purchase. Similarly, by changing

kinds of bonds was measured before and after the policy. This policy had a significant effect on the yields of both type of bonds. A study by Macaire & Naef (2021) to examine the consequences of this policy on the yield spread between green and non-green bonds concluded that central banks can significantly effectuate market rates for green projects. Results of the study revealed that the yield of green bonds further reduced by 46 basis points as compared to the non-green ones and this further increased the yield spread between both kinds of bonds. This study provides an insight into how collateral policy of a central bank can be leveraged to impact asset values and hence achieve their desired objective.

Monnin and Barkawi (2015) discuss the impact of monetary policy and its sustainability impacts in case of Bangladesh. The central bank of Bangladesh, has various instruments and tools that are used to take the best decisions regarding the economic growth of the economy. It has the ability to drive the financial market through the interest rate channel and accordingly, interest rates may be the key to direct investment towards a greener economy. Moreover, differentiated interest rates can have a significant effect on environmental emissions too. This is why one of their tools, targeted refinancing lines, is being explored and has been extensively put into use in Bangladesh. The targeted use of refinancing lines is considered as an important one to help the Bangladeshi economy respond to some of the issues such as poverty, food insecurity and unemployment., The same tool when put to use for sustainability objectives means that commercial banks would be scrutinizing the loans keeping in view whether the loan is being provided for environmentally sustainable projects. Discounted rates are offered after careful review and consideration once it is established by the bank that the loans will cater to the market that practices and aims for a greener economy. According to the author, refinancing lines have a great future prospect for providing a solution to Bangladesh's environmental goals, provided these loans are granted for long-term as the transition from carbon-intensive to low-carbon projects cannot happen immediately and can only be met in the long run with long-term funding and maturity.

While some experts are in favour of using this tool, others believe that the use of refinancing lines may lead to "rent-seeking". With the rising use of Bangladesh's refinancing lines in several sectors and markets such as agriculture, entrepreneurship, and now environment, concerns for unintended use of discounted loans and refinancing lines have risen. This requires monitoring as well as evaluation of the projects for which these loans are being granted.

Schoenmaker et al. (2015) discuss a macroprudential policy framework in a study to discuss the role of financial supervisors, referring to the central banks, in the fight towards mitigation of carbon emissions. The role of macro prudential authorities (i.e central banks) is about careful calculation and judgment of risks and rewards. Climate change is not just an environmental issue, but has deep impact on other sectors too, including the monetary sector of any economy and a timely response and action from the financial sector is required to meet climate change targets. According to the authors, ecological dimension has to be envisaged to assess the financial risks that arise due to ecological imbalances. Any credit rating models that do not take into consideration the ecological factor are hence incomplete.

Banks, therefore, have started assessing the risks they might have to face when they grant loans or finance facilities for projects. Credible macroprudential policy may support in reducing the ecological imbalances as expectations and financial risks would be incorporated into the pricing.

2.4 Review of Empirical literature

Some empirical studies on the influence of monetary policy are also reviewed hereafter.

Eyraud et al. (2011) have studied trends and determinants of green investment and have also suggested the design of policies to promote green investment. They are of the view that macroeconomic policies that are in general implemented for expanding private investment will also work for increasing green investment. Hence, just as higher interest rates would discourage investment, the same will be applicable for green investments, with an increase in interest rates raising the cost of capital and leading to a lower investment in green projects. The authors believe that the general determinants of green investment are the same as traditional determinants of investment that are interest rates, economic growth and production costs.

The authors conducted a panel study of 35 countries from 2000-2010 to identify the determinants of green investment. In their study, green investment includes investment in renewable and energy-efficient technologies, capacity investment in nuclear sector and research and development in green technologies. The econometric result of their study shows that the cost of capital or interest rate has a significant negative impact on green investment with a lag. Green investment decreases by 10 percent when real interest rate increases by 1 percentage. Another

aggregate consumption to assess the link with the environment. According to their study, contractionary monetary policy leads to decrease in carbon emissions. The increase in borrowing rates as a result of contractionary monetary policy does not work in favor of both producers and consumers as both do not wish to get loans from commercial banks with higher interest payments. With an increase in the prime rates, producers are not in the position to increase their plant size and they tend to decrease production level, consuming lesser fossil fuels, which ultimately leads to lower levels of carbon emissions. Similarly, from consumer's perspective, higher interest rate shrinks income and aggregate consumption. A decreased level of aggregate consumption drives a reduction in the industrial production and lowers fuel usage which ultimately lower level of carbon emissions. The authors have employed OLS, DOLS, FMOLS and ARDL econometric approaches to estimate the long-run coefficients and ECM to estimate the short-run coefficients. Their results establish a long-run association between expansionary monetary policy and carbon dioxide emissions (CO_2). With every 1% increase in expansionary monetary policy (i.e a decrease in interest rates), CO_2 increase by 0.4 %, 0.518%, 0.186%, 0.222% and 0.251% in Brazil, Russia, India, China and South Africa respectively. Another result of their study is the increase in CO_2 as a result of increased aggregate domestic consumption spending per capita. They also observed a uni-directional causal relationship from expansionary and contractionary monetary policy to CO_2. As a policy recommendation, the authors are of the view that promoting green technologies, both fiscal and monetary policy can effectively, reduce the level of CO_2.

Shahbaz et al. (2013) have conducted an empirical study of the impact of financial development on environmental quality in South Africa in parallel with economic growth, coal consumption and trade by employing ARDL approach for estimation. Their results show a statistically significant negative impact of financial development on carbon dioxide emissions. By financial development, the authors refer to domestic credit provided to the private sector by banks and other financial institutions. The negative impact is explained by the authors in terms of maturity of the financial sector of South Africa. The authors believe that since the financial sector of the country is strong enough, it can allocate resources and funds for environment friendly projects. As a policy recommendation, the authors are of the view that financial development may be used as an instrument for improving environmental quality. Accordingly, an efficient capital market may be a good policy option, which if adopted will ensure that firms have enough liquidity

74 in Western Europe, oil embargo of 1973, the global financial crisis of 2008, riots in Greece that have had repercussions in US. During eras of crisis and instability, a positive impact of lending rate on carbon emissions was observed as high lending rates put extra burden on economic agents who act rationally and tend to neglect environmental concerns in such crisis.

Further, the authors are of the view that the negative relationship between lending rate and CO_2 in real means that only those individuals and firms that are financially stable would be able to borrow when the interest rates are high. Such firms already have the economies of scale and hence, the capability to invest in environment friendly technologies and machinery. On the other hand, firms and individuals who are not financially stable would be unwilling to borrow at high-interest rates, thus limiting their operational activities.

In a study, Annicchiarico and Dio (2017) study how monetary and environmental policies are associated using the New Keynesian model extended to incorporate pollutant emissions, abatement technology and environmental damage. They examine different policy combinations. One of the results of their study reveals that in case of a positive technological shock, an optimal monetary policy, which emphasizes on strict price stability, may not work as held by previous studies.

The authors discuss two environmental policy instruments: carbon tax and cap-and-trade arrangement. While carbon tax is a tax imposed on carbon emissions to be paid by emitters, under a cap-and-trade regulation, governments set a cap on the level of emissions and gives permits for each unit of emissions under that cap. In case of a productivity shock, the optimal monetary policy is affected in different ways under these two environmental regimes. According to the results of the study, with a 1% positive productivity shock, only carbon emissions increase under a carbon-tax regulation. However, for a cap-and-trade program, due to the abatement effort and permits, deviations from central banks price stability objective are expected and observed, with a significant price increase. Hence, the strict inflation targeting optimality of central bank is compromised. With a cap-and-trade program, there is a trade-off between inflation and emissions control and a temporary deviation from the optimal policy is required. The optimal monetary policy would now be to bring about a reduction in the inflation rate. Only when environmental regulation is devised to incorporate a carbon-tax, an optimal price stability policy may prevail.

monetary policy has distributional effects and so with another objective of sustainability added to their list, central banks might have to keep adding more to their list of responsibilities which can become overwhelming and not easy to tackle. According to the authors, though proactive measures taken by central banks have the potential to make an impact, there are concerns and several trade-offs that need to be looked into too.

2.6 Concluding Remarks

As evident from various studies, a number of monetary policy instruments and tools can be chosen as a proxy for monetary policy to study how monetary policy may influence environmental emissions. These studies have included interest rates, lending rate, deposit rates, discount rates, domestic credit to the private sector, total commercial banks' lending as proxy variables. The most widely used proxy for climate change is carbon emissions which seems an accurate and relevant proxy given that carbon emissions account for around 76% of greenhouse gas emissions (EPA 2017) and can be used to study the overall impact in terms of climate change.

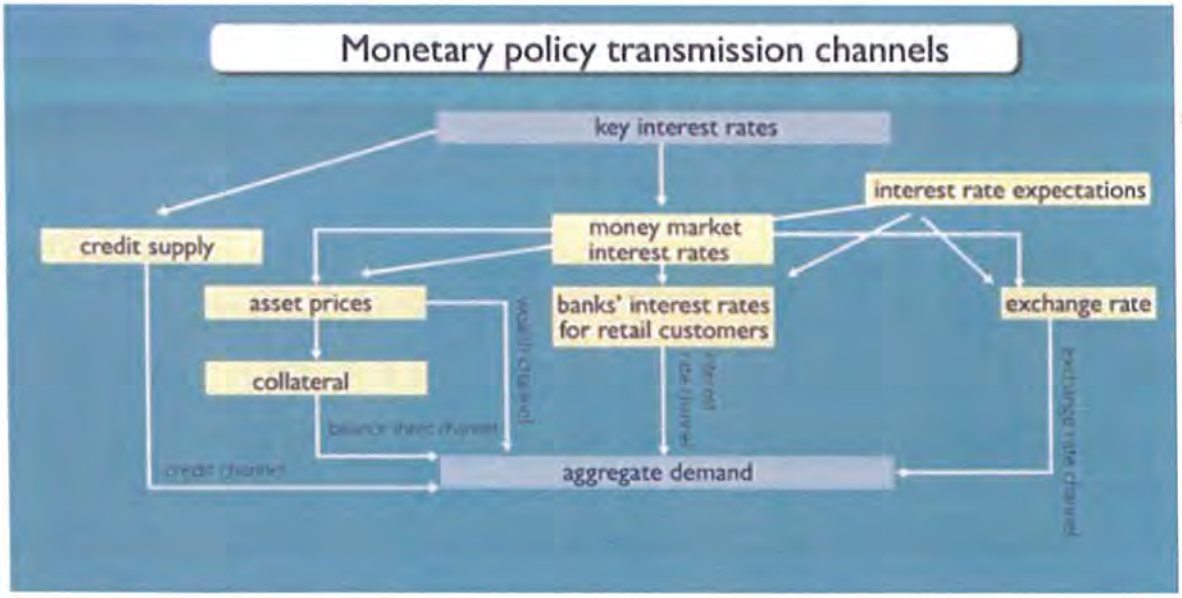
Studies over the years have established the basis on which central banks may engage in the drive for climate mitigation. They have instruments and tools that can be employed to achieve the desired targets related to environment and sustainability. Hence, central banks may broaden their scope to support their respective governments and environmental agencies, domestic as well as international, to collectively find the solution to climate crisis.

Though most of the earlier studies conducted are for a panel of countries, the differentiated and contrasting economic, socio-political conditions and trade environment of countries make it necessary to study the impact of a single country.

differentiated interest rates for green vs non-green projects, subsidized loan rates, direct budgetary subsidies, accepting carbon certificates as legal reserves and issuance of green finance guidelines (Voz, 2017; Fry, 1995; Chandavarkar, 1988). These studies suggest how and in what capacity monetary policy can function to address environmental concerns.

Monetary policy has different transmission channels through which it impacts the economy: interest rate channel, exchange rate channel, credit channel, asset price channel and the expectations channel are the most import mechanisms or channels through which monetary policy influences aggregate demand, output and the economy. The following figure 3.1 summarizes transmission channels of MP.

Figure 3.1: Monetary policy transmission channels



Source: Oesterreichische NationalBank (OeNB) (2020)

In this study, we aim to study two main monetary policy channels as described below, which may provide a solution to the existing climate change challenge. We build our econometric model accordingly.

1. ***Interest rate channel***

   This is the mechanism through which a change in the key interest rate, which usually refers to the policy rate determined by the central bank of a country, a corresponding change in

3.2.1 Carbon Dioxide emissions (CO_2)

Carbon dioxide emissions (CO_2) is the main dependent variable in this study and is an indicator of climate or environment degradation. Carbon emissions are primarily emitted from fossil fuel burning and cement manufacturing. The effect of both fossil fuel burning and manufacturing of cement on the climate and our ecosystem is tremendous. Fossil fuel when burnt, discharges carbon dioxide along with other greenhouse gases. Fossil fuels are a significant part of Pakistan's energy mix and with continued use of fossil fuel, environmental concerns cannot be looked over. Similarly, cement industry is one of the main producers of carbon dioxide. In Pakistan, the cement industry is a significant sector contributing to the economy and with the expansion of this industry and other likes, significant carbon emissions in future can be expected.

In this study, we aim to analyze how carbon emissions may be influenced by the monetary policy. For this purpose, we will introduce some proxy for MP in our model. Therefore, the main independent variables in the study are the ones that present monetary mechanism, the impact of which on environmental performance and environmental emissions is to be studied. For monetary policy, the two proxy variables that have been selected are:

- Policy Rate
- Domestic credit

3.2.2 Policy Rate (PR)

Policy Rate is State Bank of Pakistan's (SBP) Reverse Repo Rate. This is the key interest rate that is announced by SBP. As discussed in the previous chapter, a number of research studies have discussed the potential policy tools that Central Bank has at its disposal to impact investment towards green projects. In UN's working paper, Volz (2017) has stressed the emerging role of central banks and how they can respond to environmental and sustainability challenges by putting into action their credibility and independence and using the policy instruments and tools that it has

3.2.3 Domestic Credit (CR)

The second proxy variable for monetary policy used in the study is via the credit channel. Monetary policy tool for the credit channel indicates the domestic credit provided to the private and public sector by banks and other financial corporations in the country. This is another monetary policy variable available to the banking sector and has the potential to effectively impact environmental emissions.

Some studies have related domestic credit to financial development of a country. Shehbaz et al. (2013) and Lee et al. (2015) have reported a negative impact of financial development on environmental emissions. Accordingly, when the financial sector of a country is developed, strong and mature, it serves as a channel for investment into environment friendly projects (Birdsall and Wheeler, 1993; Frankel and Rose, 2002). On the contrary, studies by Tamazian and Rao (2010), and Ayeche et al. (2016) have reported a positive impact of domestic credit on carbon emissions via growth channel. Similarly study by Komal and Abbas (2015) has shown that financial development significantly affects energy consumption via the economic growth channel which ultimately leads to higher environmental emissions.

Domestic credit is selected as the second explanatory variable to check the influence of monetary policy on carbon emissions in the context of Pakistan.

In a time series analysis of six East African countries, Shobande (2021) has used two transmittal channels of monetary policy, interest rate transfer path and credit transfer path, to study the impact of monetary policy on environmental emissions. We employ the same channels for a time series analysis of Pakistan's data.

The following two models are the base models where Model 1 uses SBP Policy Rate (PR) as the monetary proxy variable and Model 2 uses Domestic credit (CR) as the monetary proxy variable.

$CO_2 = \beta_0 + \beta_1 PR$ Model 1

$CO_2 = \beta_0 + \beta_1 CR$ Model 2

friendly investments and projects. Studies focusing on EKC Hypothesis have shown mixed results. With GDP per capita included in this research study as a control variable, the existence of EKC will be checked in case of Pakistan.

3.2.5 Foreign Direct Investment (FDI)

Foreign Direct Investment taken as a share of GDP is selected as a control variable in the model. Nguyen et al. (2021) have discussed the mixed impact of FDI on carbon emissions from three dimensions: pollution haven, pollution halo and scale-effect hypothesis. The premise of the pollution haven hypothesis is that large industrialized nations seeking investment in countries with cheap labor and resources not only shift the industrial production from their own country to the country where labor is cheap but also where the environmental control standards are non-existent or really weak. In doing so, they get cost-effective production and this also leads to a shift of industrial pollution from their own country to foreign countries. Since developing nations do not have strict environmental regulations, countries looking to opt for cheaper options would invest in these developing countries that do not have any effective environment standard which would ultimately observe a positive result of FDI on environmental emissions and pollution. In contrast pollution-halo hypothesis implies foreign investments bringing in green technology into a country along with FDI and has a negative impact on the environmental emissions. The scale-effect FDI hypothesis implies an indirect impact where foreign direct investment pilots an increase in industrial production which leads to increased level of pollution and ultimately, deterioration of the environment. In order to observe which effect dominates in case of Pakistan, FDI is included as a control variable in the model.

-

3.2.6 Energy consumption (EN)

Energy consumption is considered to be one of the major drivers of environment deterioration. Carbon emission is one of the direct consequences of energy production. Air pollution, water pollution, and ultimately climate change are the after-effects of energy production and energy consumption. The data for energy consumption in our model refers to the use of primary energy

l policy rate (PR) represents the monetary policy proxy and in model 2 domestic credit represents the monetary policy proxy:

$$CO_{2t} = \beta_{0t} + \beta_{1t} PR_t + \beta_{2t}\, GDP_t + \beta_{3t} FDI_t + \beta_{4t} EN_t + \beta_{5t} TR_t \quad \text{equation 3.1}$$

$$CO_{2t} = \beta_{0t} + \beta_{1t} CR_t + \beta_{2t}\, GDP_t + \beta_{3t} FDI_t + \beta_{4t} EN_t + \beta_{5t} TR_t \quad \text{equation 3.2}$$

The equation is transformed by taking log of variables to make the analysis and interpretation of the results easier in terms of percentage changes. The logarithmic version of the models are as follows:

$$lnCO_{2t} = \beta_{0t} + \beta_{1t}\, PR_t + \beta_{2t}\, lnGDP_t + \beta_{3t}\, lnFDI_t + \beta_{4t}\, lnEN_t + \beta_{5t}\, lnTR_t \quad \text{equation 3.3}$$

$$lnCO_{2t} = \beta_{0t} + \beta_{1t}\, lnCR_t + \beta_{2t}\, lnGDP_t + \beta_{3t}\, lnFDI_t + \beta_{4t}\, lnEN_t + \beta_{5t}\, lnTR_t \quad \text{equation 3.4}$$

The expected sign of β_1 is uncertain as existing literature shows positive as well as negative impacts on CO_2 emissions through the interest rate passage (Eyraud et al. 2011; Pradeep 2021; Broni et al. 2020; Chishti et al. 2021; Qingquan et al. 2020). Similarly for credit passage, some studies have found out a positive impact while others have shown a negative impact on CO_2 emissions (Shehbaz et al. 2013; Lee et al. 2015; Tamazian and Rao 2010 and Ayeche et al. 2016). However, expected sign of β_2 is positive as discussed earlier. The expected sign of β_3 is not clear as it can be positive or negative in case of Pakistan. β_4, the co-efficient of trade is expected to be negative. β_5, the co-efficient for energy consumption is expected to be positive.

3.3 ESTIMATION TECHNIQUES

In this study two econometric regression techniques are applied to check the influence of monetary policy on environmental emissions.

- Fully Modified Ordinary Least Square (FMOLS)
- Generalized Method of Moments (GMM)

The GMM model in our study employs both internal and external instruments.

Internal instruments are those that have been taken from within the model. Hence, lagged values of control variables have been used in the GMM model as internal instruments. The idea of using lagged values is to address endogeneity issues in an empirical analysis. The lagged values are only capable of influencing the dependent variable through the control variable itself in the model. Results of the estimation were seen to be stronger and better with the use of first lag of control variables in the model. This is attributed to the fact that the impact of control variables on monetary policy proxy variables appears after a lag of one period.

Two external instrumental variables have been carefully selected for the GMM model by checking their validity. F statistics is used to check the relevance of the instruments chosen and Hansen's J Chi square test is used to check the exogeneity of the instruments. Both instrumental variables chosen in the model are found to be relevant and exogenous. These instrumental variables are:

- Saving (as a ratio of GDP)
- Debt (as a ratio of GDP)

In their study on six South East Asian economies, Sharma & Gounder (2012) reported a significant positive effect of bank deposits on domestic credit growth. Promoting domestic saving is essential to ensure the provision of domestic credit to the private sector. Greater the savings in the economy, greater will be the availability of funds for providing loans to the domestic sector. Generally, lower interest rates imply that people would be encouraged to save less and consume or invest more. Since domestic savings has an impact on domestic credit, it is taken as an instrumental variable in GMM estimation.

Central banks oversee monetary policy and announce the policy or cash rate to accomplish their objectives of price stability, maximum employment and economic growth and prosperity of the country. Given these objectives, gross domestic saving is an indicator that might impact State Bank of Pakistan's policy rate. Bernanke (2005) indicated global saving glut to be the main cause of low interest rates in the USA. Further according to Tasar (2017), when national savings are inefficient, governments mostly increase the interest rates in order to attract foreign capital to

CHAPTER 4

DATA AND VARIABLES DESCRIPTION

This chapter will present a detailed discussion of the data and the variables that have been used for this study. The chapter is structured as follows: section 4.1 is introduction, section 4.2 gives description of the data, section 4.3 presents summary statistics of the variables selected, section 4.4 presents the correlation matrix, section 4.5 gives the data source, and section 4.6 presents pre-estimation results.

4.1 INTRODUCTION

This study investigates the prospective scope of monetary policy in controlling environmental emissions in Pakistan and employs annual time series data for Pakistan from 1990 to 2020. Very limited research studies are available for the participatory role of monetary policy on climate change in the context of Pakistan. By focusing on Pakistan, this study aims to investigate whether monetary policy and central bank in Pakistan have a scope and the capacity to check carbon emissions in Pakistan. This study employs quantitative research method to study whether monetary policy can support and achieve the objective of switchover to a carbon resistant and environment friendly economy. For this purpose, the study includes carbon dioxide emissions as the dependent variable, policy rate and domestic credit as focused variables and a set of controlled variables. Variables included in the model are described in the next section.

4.2 DATA DESCRIPTION

This section describes the variables that have been used in the study.

4.2.1 Dependent Variable

Carbon Dioxide Emissions

Carbon dioxide (CO_2) emissions is the dependent variable in our study that captures climate change or environmental emissions. Though there are other proxy variables for measuring

i. Gross Domestic Product (GDP) Per Capita

GDP per capita is gross domestic product of Pakistan divided by the total population. GDP is the gross value of domestic output of Pakistan. This also includes taxes on production but does not include the value of any subsidies. This variable represents economic activity in our study. Data is in constant 2015 U.S. dollars and has been obtained from World Development Indicators (WDI) by World Bank.

ii. Foreign Direct Investment

Foreign direct investment are the net inflows of investment in Pakistan from foreign investors. It is shown in the balance of payment as the aggregate value of foreign capital, both long-term and short-term. This series is measured as a ratio of GDP.

iii. Trade Openness

Trade is the total value of exports and imports of goods and services of Pakistan. It is calculated in percentage form of GDP. It represents trade openness in our framework of this study.

iv. Energy Consumption

Energy consumption refers to the use of primary energy before being converted to other end-use fuels. This includes local production plus imports, less any exports and fuels used for ships and aircrafts engaged in international conveyance. It is measured in terms of energy use per capita where energy use is measured by kilogram of oil consumed.

4.2.4 Instrumental Variables

i. Saving to GDP ratio

Gross domestic saving is a variable that affects both of the explanatory monetary policy variables in the model. Data for saving to GDP ratio has been collected from different editions of Economic Survey of Pakistan.

Positive correlation implies that an increase in a particular variable will cause an increase in the other variable too. From the correlation matrix above, it can be seen that policy rate and credit, our main policy variables are negatively correlated to the dependent variable, CO_2. This implies that an increase in both the policy rate and the domestic credit will lower the level of carbon emissions. Control variables in the model, Gross Domestic Product, Foreign direct investment and Energy are positively related to carbon emissions whereas trade is negatively correlated with carbon emissions.

4.5 DATA SOURCE

Data for this study has been acquired from the following sources:

World Development Index (WDI), Economic Survey of Pakistan (various editions), Handbook of Statistics on Pakistan Economy 2020, State Bank of Pakistan website www.sbp.org.pk. A detailed description of the data and the source of the data is given in Appendix A.

4.6 PRE-ESTIMATION TESTS

The following pre-estimation tests have been conducted to check the relevant properties of the data:

- Multicollinearity test
- Normality test

4.6.1 Multicollinearity Test

Multicollinearity was checked for all the estimation models using the Variance Inflation Factor (VIF) Test. As a rule of thumb, a VIF value of 10 or greater than 10 indicates problem of multicollinearity. VIF Test was performed for all estimation models and the VIF value was observed to be less than 5 for all models. Hence, the data does not suffer from the problem of multicollinearity.

Chapter 5

EMPIRICAL RESULTS AND DISCUSSION

The purpose of this research study is to investigate whether monetary policy can contribute towards the goal of mitigating the impacts of climate change. For this purpose, carbon emissions are taken as a proxy for climate change and for monetary policy, two proxies are used: SBP policy rate and domestic credit. Two estimation techniques have been employed for data analysis: Fully Modified Ordinary Lease Square (FMOLS) and Generalized method of Moments (GMM). In this chapter, estimation results are presented along with discussion of the results. The chapter is sectioned as follows: section 5.1 presents results of the unit root test, section 5.2 presents results of co-integration test, section 5.3 cites results of FMOLS estimation, section 5.4 cites results of GMM estimation technique and section 5.5 discusses estimation results in detail.

5.1 Unit Root test – Augmented Dickey Fuller Test

We start the estimation process by first running the unit root test with results presented in Table 5.1 below:

Table 5.1: Summary of Unit Root Test – Augmented Dickey Fuller (ADF)

Variable	ADF Test statistics		Order of integration
	Level	First difference	
CO2	-1.9462 (0.308)	-3.5136** (0.017)	I (1)
Policy Rate	-2.4419 (0.143)	-9.8297*** (0.000)	I (1)
Domestic Credit	-1.3048 (0.614)	-4.2140*** (0.003)	I (1)
GDP per capita	-0.5912 (0.858)	-3.1483** (0.034)	I (1)
FDI	-2.0675 (0.258)	-4.8330*** (0.001)	I (1)
Energy	-2.3677 (0.159)	-3.7852*** (0.008)	I (1)
Trade	-1.7288 (0.407)	-5.3735*** (0.000)	I (1)

Note: t-statistics significant at 1% , 5% and 10% level of significance are given by ***, ** and * respectively
Probabilities in parentheses.

Table 5.2: FMOLS estimation results

Variables	Column 1	Column 2
	Equation 3.3	Equation 3.4
Policy rate	0.0202*** (0.0066)	
Domestic Credit		0.1869** (0.0640)
GDP per capita	0.7028*** (0.0638)	0.5146*** (0.0625)
FDI	0.0436** (0.0190)	0.0171 (0.0155)
Energy Consumption	0.7285*** (0.2133)	1.2063*** (0.2477)
Trade Openness	-0.1394* (0.0716)	-0.1763* (0.0616)
Constant	-9.2439*** (1.3615)	-11.3852*** (1.4903)
R-squared	0.9357	0.9392
Engle Granger tau statistics Probability Value	-5.4153 0.06	-5.1011 0.07
Engle Granger z statistics Probability Value	-22.0340 0.05	-44.3923 0.02

Note: Standard error in parentheses
***, ** and * denote signifcance level at 1%, 5% and 10% respectively

The results for equation 3.3 are reported in column 1. The proxy for monetary policy in this equation is policy rate. The results show that policy rate has a significant positive effect on carbon emissions. With a unit percentage increase in SBP policy rate, CO_2 emissions increase by 0.0202%.

The results of equation 3.4 are presented in column 2. The proxy for monetary policy in this model is domestic credit. The results indicate a highly significant positive impact of domestic credit on carbon emissions. The parameter estimate shows that a unit percentage increase in domestic credit leads to a 0.1869% increase in carbon emissions. This is consistent with the study by Shobande (2021) where the results show that credit transmission channel Granger causes carbon emissions.

The control variables included in the model all show significant impact on carbon emissions, except FDI. GDP per capita, energy consumption and FDI have a positive impact on carbon emissions whereas trade openness has a negative influence on carbon emissions. The same

Results in column 1 of Table 6 correspond to equation 3.3 where our monetary policy proxy variable is policy rate. The results show that policy rate has a significant positive effect on carbon emissions. With a 1% increase in SBP policy rate, carbon emissions increase by 0.026%. This result is in line with previous studies (Shobande, 2021) that have estimated a positive impact of interest rate on carbon emissions.

Results in column 2 of Table 6 correspond to GMM estimation of equation 3.4 where domestic credit is taken as a proxy for monetary policy. The findings indicate that domestic credit has a significant positive impact on carbon emissions. With a 1% increase in domestic credit, carbon emissions tend to increase by 0.1948%.

The control variables included in the model all show significant impact on carbon emissions, except FDI. GDP per capita and energy consumption have a positive impact on carbon emissions whereas trade openness has a negative impact on carbon emissions. The same results were reported for FMOLS estimation using policy rate as a monetary policy proxy. The results of FDI estimates are insignificant for both monetary policy proxy variables.

Hansen J test results for both GMM models indicate that the instruments are valid and there is no potential problem of endogeneity in the model.

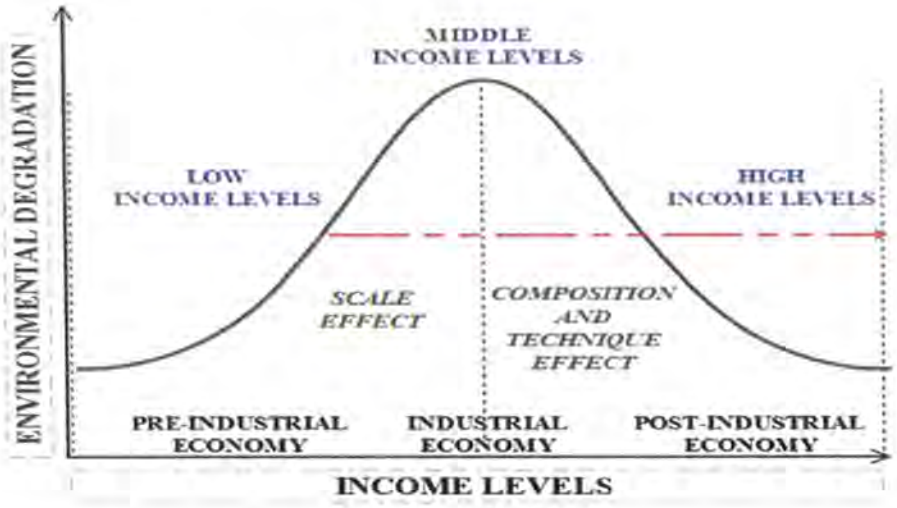
5.5 Discussion of Results

Policy rate as monetary policy proxy

The results for equation 3.3 are reported in column 1 of Table 5.2 and 5.3. The proxy for monetary policy in this equation is policy rate. The parameter estimates from both FMOLS and GMM estimations show that policy rate has a significant positive effect on carbon emissions. With a 1% increase in SBP policy rate, carbon emissions increase by 0.0202% when FMOLS estimation is used and 0.02673 % when GMM estimation technique is employed.

The positive impact of policy rate on carbon emissions in case of Pakistan can be explained by discussing both the consumption and production channels. Carbon emissions are generated by various channels where consumption and production activities are most profound and understanding the pattern of both channels will help interpret and justify results of this study.

Figure 5.1 Environment Kuznet Curve



Source: Sarkodie and Strezov (2018)

From production point of view, the additional cost from higher lending rates puts extra pressure on producers and manufacturing firms specially the ones that tend to adopt cost-cutting measures. These measures would include using inputs that are cheaper but potentially harmful to the environment (Broni et al. 2020). Instead of opting for high-cost environmental friendly products, even consumers would opt for buying low-cost products.

Summing up, conservation of resources or protecting the environment would not be the priority actions or objective for both producers and consumers at high interest rates in developing low and middle income economies. It is the environment that the economic agents tend to sacrifice in such economic conditions. And so increase in carbon emissions and environmental deterioration is the result.

In the context of Pakistan, policy rate determined by the State Bank can play an important role in mitigation of carbon emissions. Since policy rate announced by the State Bank is passed on to other interest rates in the economy, this relationship can be further explored to specifically finance projects with a focus on sustainability and environment protection. Lower the policy rate,

economic activity is accompanied by greater use of energy and that is why higher levels of CO_2 emissions are observed as a result of higher levels of domestic credit.

In the context of Pakistan, domestic credit provided to the private sector seems to play an important role in carbon emissions. Providing loans, funds and trade credits to private corporations that are high carbon emitters means they have access to funds that they can use to expand production facilities and plants but at the same time, contribute more towards environmental damage in the form of higher levels of CO_2 emissions.

Similarly, availability of higher credit to individuals implies greater consumer finance and greater spending on carbon-emitting activities. With higher available credit, individuals tend to increase spending on consumer goods like vehicles, new appliances and electronics, which emanates greater use of fuel and electricity.

Another possible explanation of the positive relationship can be that the financial sector of Pakistan has not yet achieved the maturity level where funds can be specifically allocated by financial institutions and banks towards environment-friendly advanced technology. As explained by Shahbaz et al. (2013), the financial industry in South Africa has developed due to which a favorable impact on carbon emissions has been observed in their analysis.

Domestic credit to the private sector has been associated with financial development in various studies. Some studies have reported that financial development reduces levels of CO_2 emissions whereas some other have argued that it leads to environmental degradation. Komal and Abbas (2015) and Tamazian and Rao (2010) have reported positive impact of financial development on environmental emissions. According to a study by Jensen (1996), financial development may enhance economic growth but it would also lead to industrial pollution and environmental deterioration. The results of our study in case of Pakistan are in line with the studies mentioned above.

Implications of Monetary Policy Channels

Our empirical findings require us to differentiate between the two channels, Interest Rate Channel and Credit Channel of monetary policy to understand what stance the central bank should adopt to mitigate the impacts of climate change. If central bank conducts expansionary monetary policy, the rate of interest will be lower and credit provision by commercial banks will be higher.

In the context of EKC hypothesis, it can be inferred that Pakistan lies on the upward sloping part of the EKC, where an increase in income and earnings intensifies pollution level. Since no consistent effort has been put into sustainable production activities in Pakistan, and producers do not take sustainability and environmental impact into consideration, increased industrial activity along with economic growth has contributed to increased levels of CO_2 emissions.

The results for FDI are positive and significant only for equation 3.3 where the model uses policy rate as a monetary policy proxy. With a 1% increase in FDI, carbon emissions increase by 0.0436%.

Significant positive impact of FDI indicates scale-effect prevalent in Pakistan where an indirect impact of foreign investment can be seen in the form of increased industrial production where increased industrial activities contribute to environmental deterioration.

The results are insignificant for other estimations and hence, FDI may not be a very significant variable that leads to environmental disruption or degradation in case of Pakistan.

With a unit change in percentage of energy consumption, carbon emissions increase by 0.7285% using FMOLS estimation and by 0.8428% using GMM estimation for equation 3.3 where interest rate channel is the chosen monetary policy channel being studied. With a 1% increase in energy consumption, carbon emissions increase by 1.2063% using FMOLS estimation and by 1.2264% using GMM estimation for equation 3.4 using credit channel as the focused variable.

Energy consumption has been reported to increase carbon emissions. Energy consumption is one of the major drivers of environment deterioration. Carbon emissions are one of the direct consequences of energy production as well as energy consumption. The harmful impact of energy combustion appears in the form of environment deterioration via a considerable increase in carbon emissions. Energy affects carbon emissions through the growth channel as well with higher economic growth seeing greater demand for energy.

Trade shows a negative and statistically significant impact on carbon emissions. With a 1% increase in trade, carbon emissions decrease by 0.1394% using FMOLS estimation and by 0.0636% using GMM estimation for equation 3.3 where interest rate channel is the monetary policy channel being studied. With a 1% increase in trade, carbon emissions decrease by 0.1763%

CHAPTER 6

CONCLUSION AND POLICY RECOMMENDATIONS

The main objective of this research study is to analyze and check whether monetary policy can respond to the climate change crisis by influencing and abatement of carbon emissions. The implications of monetary policy in supporting the economy towards convergence to a green economy has been the motivation of the study. For this purpose, the effect of monetary policy on carbon emissions in the presence of gross domestic product, foreign direct investment, energy consumption and trade openness as control variables is investigated in this study. Time series data from 1990 to 2020 for Pakistan has been used and FMOLS and GMM estimation techniques have been employed in the study.

Our findings confirm a positive significant impact of monetary policy on carbon emissions through both interest rate channel and credit channel in the case of Pakistan. Central banks can design monetary mechanism and steer monetary policy tools to propel investment decisions and direct credit towards green projects that can help in the transformation towards low-carbon emissions.

As a policy recommendation, the foremost action that central bank may take to respond to the climate crisis is to adopt a proactive approach and that would be to add climate and sustainability objectives to its list of targets and central banks directed response towards the challenge by using its monetary policy tools and instruments can be then launched.

In the context of Pakistan, interest rate channel can serve to provide a vital contribution towards mitigation of carbon emissions. Since policy rate announced by the State Bank is passed on to other interest rates in the economy, this relationship can be further explored to specifically finance projects with a focus on sustainability and environment protection. Lower the policy rate, lower can be environmental emissions. Announcing discounted and reduced interest rates for environment-friendly projects and by giving incentives to commercial banks for offering lower rates for green projects lending, monetary policy can help in achieving the desired target of low carbon emissions. Even when in general a contractionary monetary policy is in place, offering

there is a need to decouple environmental degradation from economic growth in order for economies to converge to a greener and socially inclusive economy. Monetary policy can play an important role in this regard by their credit channel mechanism as discussed earlier.

However, given that climate change and sustainability are not a part of central banks mandate, assigning the responsibility to central banks may be met with negative and resisting response. Central banks might risk losing its credibility if it is unable to deliver the desired objective or if their environmental policy actions are met with adverse results. The limits of monetary policy are confined and the approach central banks take towards the climate change crisis needs to be justified by them. Hence, central banks will have to clearly state the motive for their involvement and financing of green investments through communication via open public forums and seminars and conferences.

This research study gives the direction and path for further research and study to identify the exact scope and level of interference that central banks may consider before embarking on this emerging and global issue in order to effectively provide the much needed action to combat climate change. Future research may focus on the type of industries and projects that could benefit exceedingly from monetary policy strategy that is especially focused towards green lending.

Climate change poses a global threat to future generations who will have to bear the brunt of activities of the current generation. Environmentalists are at the frontline to tackle this global issue and governments have joined in hands to include climate change into their development plans. As both are jointly making an effort to reduce the risks of climate change and provide sustainable economies for the future generations, additional coordinated effort from other sectors is required due to the vastness of this challenge. At this stage, the capacity and potential of financial sector cannot be overlooked. Central banks have the credibility and authority that can be put into use to consider what role they can play by directing monetary policy tools to achieve environmental objectives.

The empirical results of this study reveal that monetary policy may be able to play a role in supporting governments and environmental agencies in the fight against climate change. Some concerns do emerge when the role of central banks in this capacity is discussed and therefore, a prudent and well-researched strategy and pathway has to be considered for Pakistan and other developing countries to involve central banks to make the transition towards a greener economy.

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APPENDIX B

Table B1: Johansen co-integration test results for equation 3.3

Maximum Rank r ^	Trace Statistics	5% Critical Value	Maximum Eigen Value	5% Critical Value
r = 0*	167.8495	83.9371	71.3008	36.6301
r <= 1	96.5487	60.0614	45.7126	30.4396
r <= 2	50.8360	40.1749	37.4223	24.1592
r <= 3	13.4136	24.2759	8.3371	17.7973
r <= 4	5.0766	12.3209	3.2158	11.2248
r <= 5	1.8607	4.1299	0.0982	4.1299

^ r stands for number of co-integrating equations

* denotes rejection of the null hypothesis at 0.05 value

Table B2: Johansen co-integration test results for equation 3.4

Maximum Rank r ^	Trace Statistics	5% Critical Value	Maximum Eigen Value	5% Critical Value
r = 0*	90.1164	83.9371	34.8076	36.6301
r <= 1	55.3087	60.0614	18.7349	30.4396
r <= 2	36.5737	40.1749	14.4721	24.1592
r <= 3	22.1016	24.2759	11.1092	17.7973
r <= 4	10.9923	12.3209	7.8795	11.2248
r <= 5	4.1299	4.1299	3.1128	4.1299

^ r stands for number of co-integrating equations

* denotes rejection of the null hypothesis at 0.05 value