

# **The role of carbon taxation in mitigation of carbon emissions in energy sector of Pakistan**



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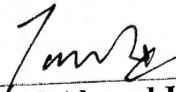
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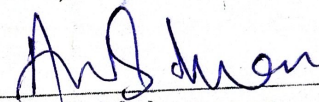
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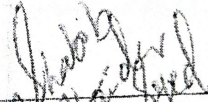
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## Key words

ADB	Asian development bank
ARDL	Autoregressive Distributed Lag
BAU	Business as usual
CDIAC	Carbon Dioxide Information Analysis Center
CDM	Clean Development Mechanism
CGE	Computable General Equilibrium
CO <sub>2</sub>	Carbon dioxide
COP	Conference of parties
CPEC	China–Pakistan Economic Corridor
CPEIR	Climate Public Expenditure and Institutional Review
DID	Difference in difference approach
EPA	Environmental Protection Agency
EPI	Environmental performance index
ETS	Emission trading system
FBR	Federal Board of Revenue
FFE	Fossil Fuels Energy utilization
GCEC	Global Commission on the Economy and Climate
GCISE	Global Change Impact Studies Centre
GIS	Geographical information system
GDP	Gross domestic product
GHG	Greenhouse gas
GOP	Government of Pakistan
GWP	Global warming potential

IMF	International monetary fund
INDC	Intended nationally determined contributions
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producers
IRF	impulse response function
IUCN	International Union for Conservation of Nature
JCT	Joint committee on taxation
LMDI	Log Mean division Index
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MMCFD	Million Cubic Feet per Day
NASA	National Aeronautics and Space Administration
NCCP	National climate change policy
NCS	National Conservation Strategy
NWFP	North-West Frontier Province
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PEPA	Pakistan Environmental Protection Act 1997
REDD+	Reducing emissions from deforestation and forest degradation
SAM	Social accounting matrix
TOE	Tone of oil equivalent
UNFCCC	United Nations Framework Convention on Climate Change



# **The Role of Carbon Taxation in Mitigation of carbon Emissions in Energy Sector of Pakistan**

## **Abstract:**

*Carbon emissions have devastating impacts on environment as well as on human health. The severity of these is getting worst day by day with continuous rise in the level of carbon emissions. Current study aimed to investigate the effect of carbon tax on carbon emissions and economic growth of the provinces of Pakistan. The methods for instance panel unit root test, panel co-integration test and Autoregressive Distributed Lag (ARDL) test were used to find the relationship between carbon tax, carbon emissions and economic growth. Moreover, impulse response function (IRF) was used to project the dynamics of carbon emissions and economic growth till 2050. A carbon tax of \$8 has applied to check its effect on carbon emissions and economic growth. Study concluded that carbon tax and carbon emissions are negatively associated while carbon tax and economic growth are positively associated. Besides, Impulse response function illustrated that increasing carbon tax by 2% every year will significantly reduce the carbon emissions and increase the economic growth. Correspondingly, study will pave the way for the formulation of comprehensive policy for the reduction of carbon emissions. While on the other side shifting their energy mix towards renewable/clean energy resources can make a fruitful policy to cope with over all emissions level.*

*Key words: carbon tax, carbon emissions, ARDL, IRF, economic growth,*

# Chapter No.1

## Introduction

### 1.1. Background:

Carbon Emissions including methane gas emissions, nitrous oxide, and other greenhouse gases (GHGs) emissions lead to increase temperature of the whole world. However, their drastic impact faces by all over the world which includes raise in the sea level, rainfall pattern shifting, number of heavy storms incident increase, the acidification of ocean increase by raising the temperature which effects aquatic life. The consequences of GHGs emissions have very severe impacts on human as well as on environment (EPA<sup>1</sup> 2017; NASA<sup>2</sup> 2018). According to the World Bank, the most vulnerable region in the whole world, which are effected by carbon dioxide emissions, are Asian countries. East Asian countries are more dominant upon the south Asian countries in edict to emit the  $CO_2$  emissions and highly effected by those emissions. East Asia emit 6.2 Mt of carbon dioxide each year and south Asia emit 1.46 Mt each capita of carbon dioxide per year. Korea, japan and china are the largest emitter of East Asia. On the other side, Sri Lanka India, Bangladesh and Pakistan are the dominant emitter of south Asia. (CDIAC 2014)

Carbon emissions from the burnings of petroleum by-products normally deliberated as the main consideration of change in climate. From expected conclusions, the decrease capability of carbon dioxide emissions in Pakistan are estimated, utilizing extraordinary intended situation analysis. Researches demonstrate that discharges will be reached at 251.5 Mt carbon dioxide in year 2025 according to Business As Usual (BAU) situation. Decrease

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<sup>1</sup> The **Environmental Protection Agency** (EPA) was established in December 1970 by the executive order of President Richard Nixon. It is an agency of the United States federal government whose mission is to protect human and environmental health.

<sup>2</sup> **NASA stands** for National Aeronautics and Space Administration. **NASA** was started on October 1, 1958, as a part of the United States government. **NASA** is in charge of U.S. science and technology that has to do with airplanes or space.

impending for the 2025 is measured as 28.94 Mt carbon dioxide and 55.02 Mt carbon dioxide according to direct and forceful outflow decrease situation, separately. (Lin & Ahmad. 2017).

Pakistan repetitively influenced by offensive climate happenings (Kreft et al. 2016). Meanwhile 2010, nation has encountered exceptional and offensive events of environment, bringing about a monetary damage of 6 billion dollars (CPEIR, 2015). Despite the fact that Pakistan contributes 1 % (0.8%) of worldwide emissions of carbon, the Pakistan's government resolve just before reacting to environmental change, together through adjustment strategies just as via decreasing greenhouse gas emissions. The energy, transport, agribusiness and livestock, forestry, town arranging and energy sector (modern divisions) are the key zones that should have been mediated to improve the impacts of climate change. In November 29<sup>th</sup>, 2015 in the event of 21<sup>st</sup> (COP-21<sup>3</sup>), Pakistan signed and presented Intended Nationally Determined Contributions (INDC) on environment and also apart of Pakistan 's Vision (2025) and NCCP (Intended Nationally Determined Contributions policy 2012).

While checking the emissions of different sectors of Pakistan, the dominant area that plays a vital role in producing the carbon emissions is energy sector of Pakistan. Total emissions from energy sector of Pakistan are 157 million per ton according to the scenario of 2007-2008, which are 51% of the total emissions of country (0.45% of overall world). Not only energy sector, also all other sector contributed in carbon emissions which includes 39% of livestock and agriculture, industrial sector is of 6% and only 1% of wastes. Thus 90% of greenhouse gases emissions come from agriculture, livestock and energy sector. Therefore, the energy sector is the area where the carbon emissions mitigation strategies need to be attentive. (Khan, 2010).

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<sup>3</sup> **COP 21**: COP stands for Conference of the Parties, referring to the countries that have signed up to the 1992 United Nations Framework Convention on Climate Change.

Pakistan is generating 39% of emissions from different sectors specifically energy sectors but Pakistan is not achieving much advantage from those emissions, the carbon emissions will lead to generate revenue for country plus perform a key role in increasing the GDP of country. The world is highly underestimating the advantages of following up on environmental change. Research done by Global Commission on the Economy and Climate (GCEC<sup>4</sup>) finds that strong action on climate might convey at any rate \$26 trillion in financial advantages through 2030 (UNFCCC<sup>5</sup>, 2018). This essential research, delivered by the Global Commission and in excess of 200 specialists, features verification purposes of the worldwide move to de-carbonization economy, and recognizes tactics to quicken activity in five parts: energy, urban areas, nourishment and land use, water and industry. (UNFCCC 2018).

Problems of Climate change and the GHG emissions resolve by implementing punishment on those sectors which polluted the environment e.g. energy and agriculture sector. To control those emissions put some price on those emissions which is called as carbon tax. As well as to Encourages peoples and industrialist to produce less greenhouse gas emissions. (Marron et al. 2015). The market failure can be overcome due to taxation on carbon as all the other tax do and carbon tax takes part in economic efficiency. One side, a lot of benefit can be achieved by consumption of energy but with this consumption societal cost with the people are not paying off is also high specially when energy is producing and consuming. Societal cost includes air and water pollution, variation in temperature which leads to climate change. Most of the economists recommended a long tax on those sectors which are creating all these problems. It is the better solution to overcome this problem. (William 2013)

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<sup>4</sup> The Global Commission on the Economy and Climate is a major new international initiative to analyze and communicate the economic risks and opportunities, which arise from climate change.

<sup>5</sup> The United Nations Framework Convention on Climate Change is an international environmental treaty adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it.

Taxes on carbon could increase revenue significantly. Congress Budget Bureau and Joint Committee on Taxation (JCT) estimated the revenue collected from carbon tax. If the initial level of carbon tax is \$25 in 2017 and then increased up to 2 % more than inflation would have generated revenue of \$1 trillion terminated its first span. (Congressional Budget Office 2016).

## **1.2. State of environment in Pakistan:**

Climate issues are land pollution, soil erosion, increases in global temperature, air and water pollution, and least but not last natural disaster. Pakistan is facing all these types of climate and environmental issues. Poor air quality is too much high in Pakistan which is also reported by latest global environmental performance index (EPI). As change in climate and raising of temperature are the most serious and alarming issues in all over the world. The major factors behind all these problems are emissions producing by carbon, cut down of trees and increases in number of populations. (EPI 2018).

A worldwide climate change is the fundamental aspect of environmental change, the UNFCCC is endeavoring stiff for not permitting worldwide normal temperature to ascend past 2°C over the pre-industrial level to forestall unmanageable unfavorable effects of climate change. In such manner Kyoto Protocol, with restricting duties by industrialized nations to diminish their GHG (greenhouse gas emissions), was marked in 1997 and came into power in 2005. During the primary duty time frame (2008-2012), 37 industrialized nations and the European Community resolved to decrease GHG emanations to a normal of 5 percent against 1990 levels. Though these targets were not adequately accomplished (Grunewald and Martinez-Zarzoso 2016; Aichele and Felbermayr 2013).

As of late, the UNFCCC at its 21st Conference of Parties (COP-21), have produced a universal agreement which is called the Paris Climate Agreement promising to hold

temperature beneath 2°C, and endeavoring to constrain it to 1.5°C (Rogelj 2016). Without doubt, this is a stage forward and the aggressive idea of the understanding is estimable, yet the genuine work presently cannot seem to start. The United Nations Framework Convention on Climate Change address the issues of global warming in late 1980's so UNFCCC developed the Kyoto protocol framework.

Climate change problem also discourses UNFCCC (United Nations Framework Convention on Climate Change). In late 1980's, which was held in United Nations Headquarters in New York on 9<sup>th</sup> May, 1992. Meeting was held at city of Japan named as Kyoto on 11, December 1997. Kyoto protocol was adopted on 11, December 1997 at city of Japan, Kyoto. This protocol was based on the international agreement on greenhouse gas emissions mitigation. Global warming is the risk for all the life exist on earth especially for human being that's why global warming has been great concern. United Nations Organization in late 1980's emphasize to solve the environmental related issue happening by global warming because of that, in 1992 special framework was adopted which is called UNFCCC (United Nations Framework Convention on Climate Change) and it adopted in Headquarters of United Nations. Kyoto protocol has two mechanism with CDM (Clean Development Mechanism) and joint implementation.

Although Pakistan is contributing very low ratio of GHG emissions in all over the world. Which are only 0.4% to 0.5% that are not too much high that's why there is no strict binding on Pakistan to reduce its emissions but still Pakistan is developing plans to mitigate their carbon emissions because of lots of reasons and also for the safety of their own people. One important sector in emissions generation is energy sector. From July 1993 to June 1994, the highest carbon emitter sector is energy sector when shared 81% of whole emissions. (GOP 2006). Energy sector emissions raised up to 94.1% between the eras of 1990 to 2005. (World Bank 2010). According to World Bank report, per capita emissions of Pakistan were 0.8 tons

per head in 2005. (World Bank 2010). Total emissions of Pakistan were 2.4 billion metric ton between the eras of 1850-2005. Before 1971, collective emissions are centered on east and West Pakistan's data. In energy related carbon emissions, Pakistan have just 0.45% share in global emissions. (GOP 2006). International community has a specific platform with the help of UNFCCC (United Nations framework convention on climate change) to cope with climate change and to take precautionary measure for climate change. REDD+ <sup>6</sup>is risen as a motivator-based relief component to find the possible job of forestry up to 17 - 25 % revealed share in the direction of greenhouse gases emissions.

Pakistan is a low timberland spread nation however has a critical potential for REDD+ for which it has not insignificant rundown of attempts to go into the worldwide standard so as to bring future REDD+ into its training and to support local community along with worldwide commitment towards moderation reaction. Pakistan is very late for REDD+ activity and the degree of exercises so far done can just recommend the equal exercises to be done on need premise so as to accomplish the worldwide frequency and meet the fundamental prerequisite of REDD+ status. Notwithstanding different difficulties, the lawful circumstance is likewise basic in choosing national versus common settings keeping in see the 18<sup>th</sup> amendment in the constitution at national level, decentralization of government ecological service and the specific counsel in Cancun Agreements for national level strategy/situations. (Iqbal & Ahmad 2011).

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<sup>6</sup> **REDD+** (or **REDD-plus**) refers to "reducing emissions from deforestation *and forest degradation* in developing countries, and the role of *conservation, sustainable management of forests, and enhancement of forest carbon stocks* in developing countries" (emphasis added); the most recent, elaborated terminology used by the COPs.

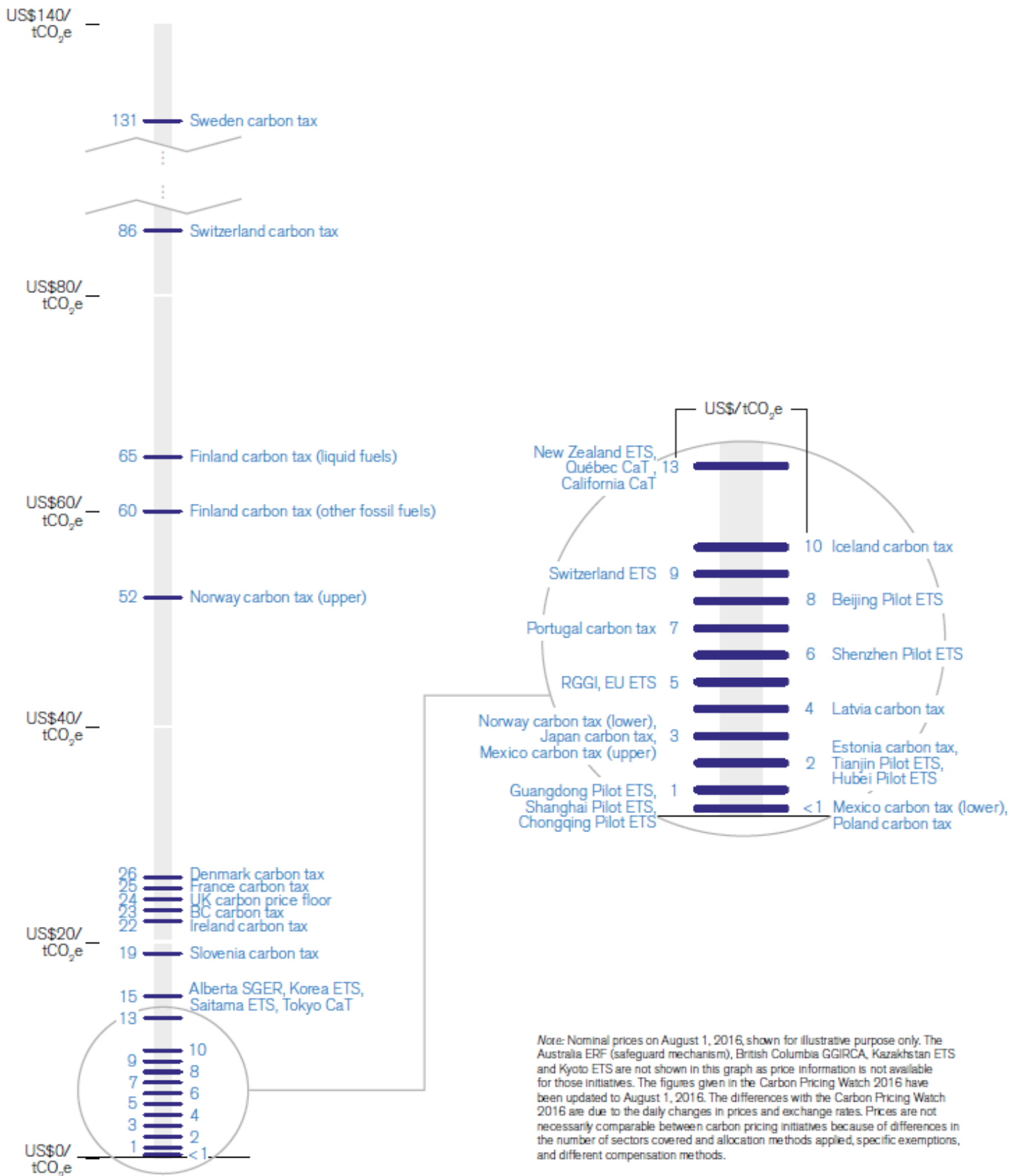
### **1.3. World carbon tax implication:**

Most effective tools to mitigate the global climate change is setting price on carbon which is also assembled the goal of Paris agreement.

While the key policy for mitigation of carbon emissions are carbon trading and taxation on carbon. Reusing incomes as singular amount profits tends to the greater part of the political and social obstructions. In any case, there is no "one size fits all" arrangement: In certain political atmospheres other reusing techniques, for example, green spending, directed exchanges or tax reductions could be progressively proper. Eventually, structuring income recycling components with an eye on behavioral visions and as per the political setting can help make carbon tax assessment a political achievement. (Funke, Mattauch 2018). World Bank shows the graph of carbon pricing on different countries below in figure no.1.1.



**Figure 1.1: Prices in existing carbon pricing initiatives**



Source: World Bank (“State and Trends of Carbon Pricing, 2016”).

World Bank report stated that, Most of the countries in world implementing carbon tax, doing carbon trading and using ETS to reduce their emissions level as per IPCC, Kyoto protocol and REDD+ restricted. All over the world. Tax rate is defining on the bases of their emissions level and IPCC carbon tax scenario. Above diagram demonstrates the carbon tax rate in different countries. IPCC have given a specific tax rate for developing countries. Pakistan is also included in developing countries. Although its emissions are very low but Pakistan, also need to implement carbon tax according to under the framework of IPCC<sup>7</sup>. Still there is no carbon tax or green tax policy of Pakistan but most of the idea are under observation for mitigation of carbon emissions. Like national environmental quality standard is a rule made by PEPA<sup>8</sup> act 1997 under the federal agency clause (e) of sub section (1) of section (6). According to this rule there is some plenty on every industry who is violating the emissions standard settled by PEPA act 1997. Plenty on violation of rule for sure make some contribution in economic development but it is not actually a carbon tax.

#### **1.4. Pakistan Energy Mix:**

As indicated by energy year book 2018, the primary energy source to more than 86 TOE which is 8.4% higher than 2016-2017 in view of significant increment in the flexibly of coal, LPG, LNG and nuclear energy. Oil and gas are by a long shot the overwhelming sources with a portion of 65.8%. Middle East primarily Saudi Arabia is exported oil to Pakistan, importing gas from Iran. Also, Pakistan is consuming Liquefied National Gas (LNG), Liquefied Petroleum Gas (LPG) and coal.

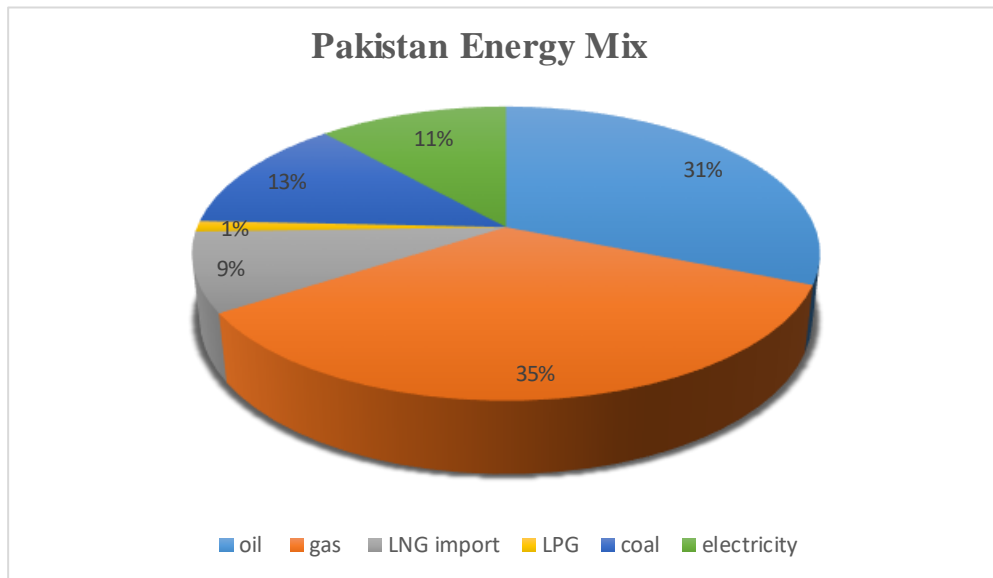
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<sup>7</sup> The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

<sup>8</sup> The National Assembly of Pakistan passed the Pakistan Environmental Protection Act 1997 on September 3, 1997, and by the Senate of Pakistan on November 7, 1997. The Act received the assent of the President of Pakistan on December 3, 1997 and an executive agency of the Government of Pakistan managed by the Ministry of Climate Change.

Share of oil is 31.2% and natural gas has 34.6% share. Likewise, coal has 12.7% share long with LNG of 8.7% and LPG of 1.2%. Total share of electricity is 11.6% out of 100%. Graphical presentation of Pakistan energy mix is given below in figure 1.2. (Energy yearbook 2018).

**Figure 1.2: Pakistan Energy Mix**



Source: Pakistan economic survey 2018

Consumption on petroleum products during fiscal year of 2016-2017 was round about 26 million annually. Imported the crude oil of 60.4 million barrels during July 18, while locally extracted crude oil was 21.8 million. Total country requirement full filled by indigenous crude oil was only 15%. While crude oil and petroleum produced were imported, up to 85% that full filled the country’s requirement. Natural gas of 3,837 million cubic feet per day consumed during July 2017-2018, which includes 632 million cubic feet per day (MMCFD) volume of real LNG, which is higher than previous year. Previous year LNG was amount of 3,205 MMCFD. Largest consumption of gas is by energy sector, which used by the domestic sector. Domestic coal production of Pakistan increased due to new coal-based power plant. During the fiscal year 2017-2018, the coal production is increased by 1,022,821 TOE. Total supply of coal

is 4,639,478 TOE which is larger than previous year. (Ministry of Energy, Petroleum Division 2018).

### 1.5. Share by sectors:

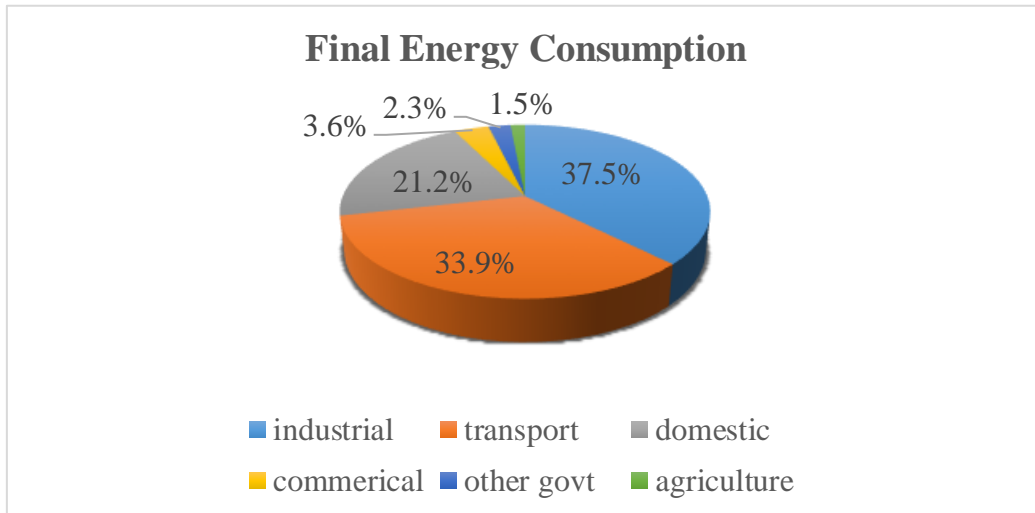
In energy yearbook 2018, the total final energy consumption in 2017-2018 by different sectors of Pakistan is 55 million TOE, which is 9.7% higher than previous year of 2016-2017. The most dominant sector is industrial, transport and domestic sector. Industrial sector shared 37.5%, transport sector shared 33.9% and domestic sector shared 21.2% of 100%. The other sectors include commercial, agriculture and other government sectors. Commercial sector only contributes 3.6%, agriculture sector contributes 1.5% and other government sector contain only 2.3% share in consumption. (Energy yearbook 2018).

<b>Table 1.1</b>		<b>Projected emissions by sectors (MtCO<sub>2</sub>)*</b>			
<b>Sectors</b>	<b>1994</b>	<b>2008</b>	<b>2012</b>	<b>2020</b>	
Energy	86	157	169	358	
Agriculture	72	120	165	245	
Industrial	13	18	14	26	
Land use change and forestry	7	9	10	16	
Wastes	4	6	10	7	
Total national emissions	182	309	369	650	

MtCO<sub>2</sub> = million ton of carbon dioxide equivalent. \*

Source: Energy yearbook 2018

**Figure No.1.3: Final Energy Consumption**



Source: Energy yearbook

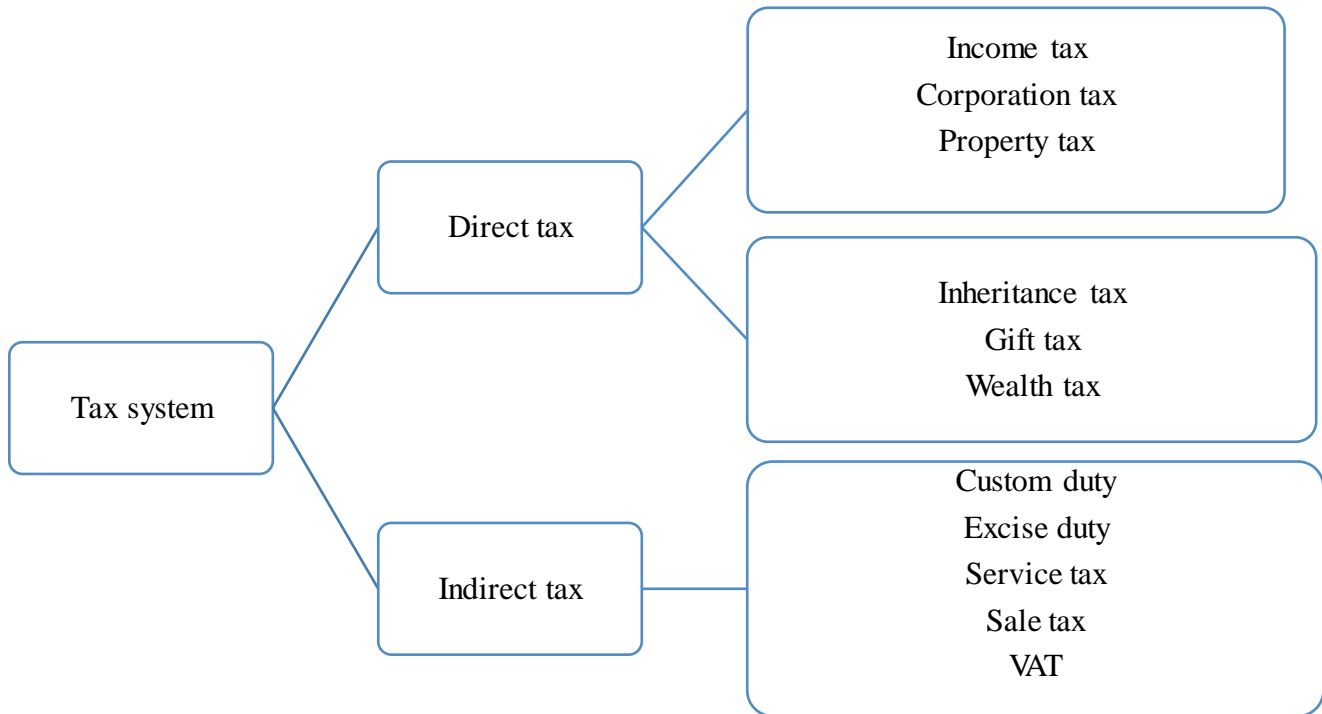
The reasons behind gas emissions in Pakistan can generally be credited to rising carbon emissions, which have developed by 123% since 1994, and with the given emphasis on monetary development is anticipated to rise multiple times in the following 15 years. In the energy sector, the fundamental benefactors were power and transportation, while in the rural segment creation of fertilizer and expanded domesticated animals can clarify raised emissions. Final report on climate change by GCISE (global climate impact studies center) describes the sectorial projected emissions scenario of Pakistan up to 2020 and 2050. The trend of emissions are increasing with the passing year. The total emissions are 650MtCO<sub>2</sub> in 2020 which is much higher than in 1994. As energy sector emitting highest emissions in 2020 means that highest sector of emissions production in energy sector. (Mir and M. Ijaz 2015).

### **1.6. Pakistan’s taxation system:**

Pakistan follows a mix of direct and indirect methods of taxation to raise revenue with the lion’s share tilted profoundly towards “indirect taxes”. As evident from the name, indirect taxes are regressive in nature as they usually target consumption. On the other hand, direct

taxes are levied on salaries, profits, dividends according to their scale as a share of percentage.  
(Feltenstein et al. 2017)

**Figure 1.4: Carbon tax hierarchy:**



Pakistan's tax system based on two type of tax. One is direct tax and other is indirect tax. Direct tax includes inheritance tax, gift tax, wealth tax, income tax, corporation tax and property tax. On the other hand, indirect tax include custom and excise duty, services and sale tax and value added tax (VAT). Pakistan's tax to GDP ratio is very low. There are a lot of problems in collection of taxes in Pakistan. The institutional behavior and the public burglar are the main problems in tax collection. With all these problems, federal board of revenues is struggling to make tax collection system strong.

## Taxes for companies:

Companies	Tax rate
Banking companies	35%
Public/private companies	29%
Small companies	24%

Source: Pakistan Tax Year 2019

Tax rate on companies putted by “Division II substituted by the Finance Act, 2002”. Taxes on banking companies are “the substituted clause (i) of the Substituted by the Finance Act, 2007”. Taxes on public/private companies are imposed according to the finance act 2013. And small companies’ taxes are imposed of 24% which is described in Section II of the Income Tax Ordinance, 2001. (FBR 2019).

Federal revenue board (FBR) is accountable for the assortment of all type of federal based tax implemented in Pakistan. Direct and indirect taxes are the two main type of federal taxes. Income tax, workers welfare fund, workers profit participation and capital value taxes are direct type of taxes and other like sales tax, custom duty and federal excise duty are types of indirect taxes.

**Table 1.2** Percentage change in federal taxes over the year

Description	(Rs. In Billion)		
	2017-18	2016-17	Change (%)
Direct Taxes	1,537	1,344	14.4
Sales Tax	1,485	1,329	11.7
Federal Excise	214	198	8.1
Customs Duties	608	497	22.3
<b>Total Taxes</b>	<b>3,844</b>	<b>3,368</b>	<b>14.1</b>

The tax collection during fiscal year 2017-18 exhibited a growth of 14.1% as compared to last year's collection. This growth has been achieved mainly due to significant growth of 22.3% by customs duties.

<b>Description</b>	<b>Rs. In million*</b>		
	<b>2017-2018*</b>	<b>2016-2017*</b>	<b>% Growth</b>
Without holding tax	1046917	944068	10.9
Sale tax(domestic)	661087	626400	5.5
Sale tax (imports)	824219	702565	17.3
Custom duty	608373	496773	22.5
Federal excise duty	213493	197911	7.9

The present degree of taxes, estimated as a portion of GDP, is underneath the assessed limit level of charges in every nation with ever-changing degree, which demonstrates the powerlessness of this district to raise duty to GDP proportion up to obligatory level. (ul Husnain, Haider, A., Salman, A., & Shaheen, F.2015).

The tax revenue performance largely depends on the performance of the economy. Thus, healthy economic activities generate ample opportunities leading to higher tax collection as well. The tax revenue collection has improved significantly in the recent years. Above table illustrates the different type of taxes implemented in Pakistan which is implemented on the bases of income. Very important type of tax is still missing in these types which can perform a vital role in the economic growth of country. Our country is generating emissions which are increasing with the passage of time (DP, C. 2018). so, it is important to control these emissions by using appropriate solution. Carbon emissions can be reduced by applying indirect policy knows as taxation on carbon.

Many of the economist accepts that the most effective tool or efficient way to combat the carbon emissions problem is carbon tax. Furthermore, they expect carbon taxes would address what many see as externalities of utilizing carbon-based powers. Apparently, Carbon tax would reduce the externality if the carbon-based fuel usage will be low. And after that,



wellbeing will improve and surely carbon tax will generate revenue for the country and the part on economic development of that country.

<b>Table 1.4</b>		<b>Environmental governance in Pakistan (from 1971-2018)</b>
<b>Year</b>	<b>Party</b>	<b>Environmental status</b>
<b>1971</b>	Pakistan People's Party (PPPP)	Planting of forest and wood lands will be distributed all over the country and where forest will be grown may be given on lease as compensation
<b>1983</b>	Pakistan People's Party (PPPP)	Pakistan Environmental Protection Ordinance enacted. Environmental Protection Council, established.
<b>1987</b>	Pakistan People's Party (PPPP)	Pakistan Ratified the Convention on Migratory Species in December
<b>1988</b>	Pakistan People's Party (PPPP)	The NWFP Salinity Control and Reclamation Act
<b>1989</b>	Pakistan People's Party (PPPP)	EPAs Established. Vienna conference on the safety of ozone layer signed in January. Montreal Protocol on ozone layer Depleting substance signed in January. Sindh EPA established.
<b>1991</b>	PML (N)	Indus River Water Apportionment Accord <sup>9</sup>
<b>1992</b>	PML (N)	National Conservation Strategy by IUCN. Pakistan and World Summit <sup>10</sup> Vienna Convention on the protection of ozone layer ratified in December. Montreal Protocol on ozone layer depleting substance ratified in December. Basel convention on the transportation of hazardous substances signed in 1992. Convention on Biological Diversity signed in June. UNFCCC signed in June. EPA-NWFP established.
<b>1993</b>	Pakistan People's Party (PPPP)	Pakistan Environmental Quality Standards notified. Pakistan Environmental Protection Act drafted. Eighth Five-Year Plan (1993-1998.) Statutory
<b>1994</b>	Pakistan People's Party (PPPP)	Supreme Court took up the public interest interrogation for the first time gave a judgment on Environmental rights. Basel convention on transportation of hazardous substances ratified in July. Convention on Biological Diversity ratified in July. United Nations convention to combat desertification signed by Pakistan in October. UNFCCC ratified in June.
<b>1997</b>	PML (N)	PEPA Act.

<sup>9</sup> (1991) Statuary Notification S.R.R.742 (1993).

<sup>10</sup> Pakistan attended the Earth Summit in 1992 at Rio-De Janeiro and became a party to several international conventions and protocols

		Standing Committees on Environment of various Chambers of Commerce. Framework for implementation of NCS <sup>11</sup> Convention on law of Seas ratified in February. United Nations convention on COMBAT desertification ratified in February. Kyoto protocol to UNFCCC signed in December.
<b>1999</b>	Military rule	Delegation of powers under PEPA, 1997 to Provincial EPA's. Environmental Tribunals established (Karachi & Lahore). NWFP fertilizer Control Act enacted.
<b>2001</b>	Military rule	Hydro-power project vision 2025 (WAPDA 2001)
<b>2002</b>	Military rule	NEAP-SP initiated for implementation of NEAP. National Action Program to combat desertification. GCISE were established
<b>2005</b>	Military rule	National Environmental Policy. Hospital waste management Rules. Pakistan Biosafety Rules. National Biosafety Guidelines. Kyoto Protocol to UNFCCC ratified in January 2005. <sup>12</sup> AJK- EPA established.
<b>2006</b>	Military rule	National energy conversation policy Policy for development of renewable energy for power generation (AEDB 2006) National disaster management commission
<b>2008</b>	Pakistan People 's Party (PPP)	Stockholm Convention on POPs ratified in April. <sup>13</sup> State Forest Policy and Strategic Plan (2008-17.)
<b>2009</b>	Pakistan People 's Party (PPP)	National impact assessment program (GOP 2009) National sustainable strategies draft GHG inventory for Pakistan (ASAD- PAEC 2009).
<b>2011</b>	Pakistan People 's Party (PPP)	National economic and development studies' preparation (NEEDS). (GOP 2011) ENERGCON act 2011 Glaciers monitoring research center under WAPDA '(GOP 2012)
<b>2012</b>	Pakistan People 's Party (PPP)	National Climate Change Policy. Wildlife Acts and Rules of Pakistan. National Sustainable Development Strategy (Draft.) National Disaster Management plan (2012- 22) approved.
<b>2013</b>	(PML-N)	Ministry of Climate Change established. Eleventh Five-Year Development Plan (2013-18) approved. National Disaster Risk Reduction Policy approved. National Power Policy Approved. National Mineral Policy.

<sup>11</sup> Establishment of Provincial Sustainable Development Fund, protection & conservation of species, conservation of renewable resources, establishment of Environmental Tribunals, & appointment of Environmental Magistrates, IEE and EIA.

<sup>12</sup> Rotterdam Convention on Prior Informed Consent (PIC) for certain hazardous chemicals and pesticides ratified in July.

<sup>13</sup> See: [https://en.wikipedia.org/wiki/Stockholm\\_Convention\\_on\\_Persistent\\_Organic\\_Pollutants](https://en.wikipedia.org/wiki/Stockholm_Convention_on_Persistent_Organic_Pollutants)

2017	(PML- N)	Climate Change Act. Climate Change Council. KP Hydro-Power Policy got implemented.
2018	Muttahida Qaumi Movement (MQM)	Undertaking emergency campaign for plantation of tree, protecting sea cost from waste especially of industry. Incorporating environmental protection in planning urban projects. For safe disposal of sewage and industry produced wastes it promises to construct Combined Effluent Treatment Plants. (MQM, 2018)
	PML-N (Pakistan Muslim League Nawaz)	PML (N) prioritizes ecosystem preservation in Pakistan and take steps to fight waterlogging and salinity.  It promises a comprehensive strategy to address environmental concerns and form a bulwark against natural disasters such as floods, droughts and earth-quakes by constructing model towns and villages (PML-N, 2018)
	Awami National Party (ANP)	ANP promises to emphasize environmental protection. It declares environment as a national asset and focuses on forests and rivers and issues like pollution (ANP, 2018).
	PML-Q (Pakistan Muslim League Quaid-e-Azam)	Party claims to promote “greener and cleaner” environment in Pakistan. It pledges to undertake such projects that ensures so and make environmental protection a necessary component of all developmental projects. Plantation of trees is promised in order to promote re-forestation (PML-Q, 2018).
	Jamiat-e-Ulema-i-Islam (JUI- F)	Has used the word in the context of mitigation of damages caused by flood and disaster.
	Pakistan Tahrik-e-Insaf (PTI)	The PTI launched an environmental policy for Khyber Pakhtunkhwa province of Pakistan during PTI government tenure (2013- 2018).  At national level, a comprehensive National Climate Change Policy will be launched.  It will start “Green Development Agenda” that combines true environment costs in economic decision making” and promises protection of natural re-sources, reducing pollution and emphasizes green energy projects.

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It promises smart storage of rainwater and usage of organic fertilizers and pest control.

It aims 100% increase in forest covered area.

It aims to constitute national parks to preserve the flora and fauna of Pakistan.

It aims to increase awareness about environmental issues and solutions but incorporating such aspects in education at primary and secondary level.

It promises legislation through relevant ministries about “Environmental rights” and making them part of constitution as a basic human right (PTI, 2018).

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Pakistan People’s Party (PPP)

It has highlighted its achievement of planting more than one million mangroves in Sindh.

The mangroves are declared vital for ecosystem of Sind and Balochistan as it help in promoting related flora and fauna and provides safety against natural disasters such as cyclones, windstorms, flooding, and soil erosion (PPP, 2018).

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Jamaat-e-Islami (JI)

Environmental concerns are absent from their manifesto (JI, 2018)

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## **1.7. Problem statement:**

Although Pakistan is contributing very low in carbon emissions globally but recent profile of Asian development bank (ADB) describes that Pakistan is expected to be affected by climate change in future. Climate change effects its agriculture productivity, availability of water and also increased the frequency of extreme event related to climate. (Chaudhry 2017). Pakistan's contribution is very low in emitting the greenhouse gas emissions in environment, which changes the climate scenario. Globally, Pakistan is at 135th in ranking on per capita base of emissions and only contribute 0.8% of GHG emissions of the whole world. (Malik et al. 2010). Moreover, the cumulative carbon emissions and the consumption of energy on per capita bases of Pakistan are very small. But Pakistan's energy consumption on per unit level are comparatively high. Total greenhouse gas emissions of Pakistan are 310 million tons of equivalents of  $CO_2$  on 2008. Carbon dioxide is 54%, carbon monoxide is 1%, methane is 36%, non-methane volatile organic compound is 0.3% and nitrous oxide is 9%. These all are total emissions and percentage contribution of all gases included in emissions. (Irfan and Attari 2011).

Pakistan want to minimize the environmental impact, which caused by the human activity. For this purpose, Pakistan believes in the collaborative effort at global level to minimize these effects. This study is going to address the impact of carbon tax on future carbon emissions from Pakistan's energy sector at provincial level. The idea is to establish a conclusion with proof, on whether enforcing carbon taxes can actually reduce carbon emissions in Pakistan as well as either the carbon taxation better for economic growth of Pakistan and also try to find out that which province of Pakistan has higher emissions scenario and which have low emissions because of this we can give a better policy recommendation for high vulnerable province. If so, the same ideology can be proposed for use globally to reduce the global climate change scenario.

### **1.8. Objectives of the study:**

- To visualize the data of total emissions for all provinces by using GIS technique
- To investigate the impact of carbon tax on carbon emissions in energy sector at the provincial level of Pakistan.
- To investigate the impact of carbon tax on economic growth at provincial level of Pakistan.

### **1.9. Research questions:**

- What is the trend/variation in the data of total emissions for each province of Pakistan?
- What is the impact of carbon tax on carbon emissions in energy sector at provincial level of Pakistan?
- What is the impact of carbon taxation on economic growth at provincial level of Pakistan?

### **1.10. Significance of study:**

Carbon taxation plays vital role in reduction of Greenhouse gas emissions specifically carbon emissions. This study will find out the ratio of mitigation of Greenhouse gas emissions by using carbon tax in every province of Pakistan. In order to which better policy would recommend for future. Furthermore, this study will also visualize the trends and variation of total emissions in all provinces of Pakistan. Moreover, study will also describes that how much the carbon taxation leads to generate the revenue for each province of country. For researcher, this study will help them to uncover the critical area in energy sector of Pakistan that many researchers were unable to find out.

### **Research gap:**

Even for developed countries, research on carbon taxes is of recent origin (see e.g. Jorgenson and Wilcoxon 1990, Poterba 1991, Pearce 1991 and Goulder 1991) and still largely in progress. Carbon taxes and tradeable permits figure prominently in proposed economic policy responses.

A careful analysis of carbon taxes in terms of their impacts on efficiency, economic growth, government revenues and environmental protection, is needed for an informed debate on policy development. The area of carbon tax is completely eliminated from research as well as tax documents so this research takes a first step in this direction by quantifying the efficiency and economic growth of carbon taxes for a Pakistan at provincial level.

**Organization of Study:**

This study organized as follows: section 2 contains literature review. Section 3 is research methodology section. Results will be discussed in section 4. Section 5 includes discussion and at last section 6 contains policy recommendation.

## **Chapter No.2**

### **Literature review**

The basis indicator for the people's living standard is the energy consumption. Thus the energy is the vital component for the development and the sustainable growth of economy today the shortage of energy exist because the energy is the main indicator of technological and industrial development and due to this reason the energy demand in Pakistan is escalating day by day more than the sum of energy supply. Therefore, the energy deficit is the main issue of Pakistan hence government should concentrate on the security of energy and take some serious action against the development and producing of renewable resources of energy.

#### **2.1. Role of carbon taxation in reduction of Greenhouse Gas emissions:**

Tax on carbon emissions plays a vital role in reduction of greenhouse gas emissions. Most of the literature reflects the effect of taxes on reduction of hazards gases which pollutes the environment up to dangerous level. Implementation of taxes is useful to protect the environment and create continuity in sustainable production of energy. (Jawed Anwar 2014) discovered the impact of carbon taxation and supply portfolio on the energy resources diversification, supply side technology mix and the demand side of technology mix. The data used for this purpose was from the sector of Energy efficiency, conservation of energy and energy security during the planning year of 2005-2050. A MARKAL-based least cost energy model was developed to find out the objective of this study for an integrated energy system of Pakistan (Loulou, et al. 2004). This paper suggested two policy implications to improve the energy security. One was renewable portfolio supply and other was carbon tax. Both may lead to improve the energy security of Pakistan.



Study was led to set up a connection between newborn child mortality and carbon emissions in four South Asian nations to be specific: Pakistan, India, Sri Lanka and Bangladesh. The outcomes show that high carbon outflows lead to higher pace of baby mortality and found indirect connection instead of direct. Carbon emissions must be diminished to improve newborn child wellbeing in any event over the long run. Measure to check population growth are essential to stop newly born baby mortalities. The reduction of carbon dioxide emissions can bring down the number of child deaths in the long run. This could be achieved in several ways, for instance, moving the countries towards a greener economy, could be one of the options. (Husnain, M. I. U., Haider, A., Salman et., Al 2016)

Tax policies on carbon was used to reduce the emissions of future which is produce from energy sector of Pakistan by using three type of cases (No carbon tax, Carbon tax from 20\$-30\$, Carbon tax from 150\$-250\$). The carbon emissions are performed over the year of 2040 to check out the greenhouse gas reduction by applying carbon tax. PAK-IEM (Pakistan Integrated Energy Model) model which was developed by using the time modeling framework. The Results of this study declared that the industry and transport sector producing highest level of emissions which has shown through three different cases: Case 1: there will be 398mt carbon dioxide emissions when there is no carbon tax policy. Case2: the emissions will be reduce up to 389mtcarbon dioxide when lower carbon tax will be imposed Case3: the emissions will continuously reducing up to 381mtcarbon dioxide when high tax will be imposed. (Saleem, et al 2015).

Taxation concept on carbon emissions used to reduce the greenhouse gas production in Pakistan. Ahmad and Stern's (2009) objective was to earmark the way to effective taxation's concept and the theory of reform to guide the carbon taxes design in India and Pakistan. Household survey data on consumption and estimated demand response was used for this purpose which is based on Ahmad and Stern (1991). Model used to find effective tax policy

for India and Pakistan is based on previous Ahmad and Stern's (1991) optimal pattern of tax rate. This paper observed to the manners by which the idea of "actual taxes" and the hypothesis of Reform can be utilized to control the plan of carbon taxes. In this way those commodities on which the taxes should be implement will be determined. (Ahmad & Stern 2009).

Carbon dioxide emissions have reduced due to implementation of taxes on energy sector of Ireland. Aggregated Social accounting matrix of 1998 for Irish economy was used to find out this effect. The Applied general equilibrium model was used to estimate the consequence of carbon energy tax on the Irish economy. Results indicated that the carbon reduction target of 25.8% compared to 1998 can be reduced in order to implement tax between 10-15 euro/ton of carbon as well as the macroeconomic impact of carbon dioxide is not very resilient. The consumption pattern would change due to change in the relative price. (Wissema & Dellink 2007).

A coordinated framework was given to wide investigation of elements of Pakistan frameworks, all the while representing both the market interest side's key factor. The data was taken from Pakistan energy book (2012) from the year of 1995 to 2011. The existing dynamic MDES RAP model (modeling the dynamic of electricity supply, resources and pollution) is used. With some modification: the nuclear power generation and the electricity related to carbon dioxide,  $SO_2$  and  $NO$ . This model was developed in late 1990's. At the end of this decade, Pakistan will bear maximum shortfall of electricity. With the passage of time the demand for the electricity will be so high due to increase in the production activities but the delay in the construction of hydro and nuclear power plant lead to shortfall of electricity. Pakistanis will keep on paying higher rates during the time of this appraisal by 2010-2030. The electricity rates rise essentially because of the expansion of costly, professional oil thermal age. The expanding limit of thermal generation by IPPs is the hugest change in the stock blend during this decade: it expanded its offer from 62% to 75%, assuming a key job in the ascent of

electricity rates just as in the expanding natural contamination. Of the all-out electricity related carbon dioxide emanations, 81% is the commitment of IPPs. IPPs' offer in other damaging pollutants,  $SO_2$  and NO, additionally increments from 60% in 2010 to 81% in 2030. (Quadrat-Ullah, H 2015).

The investigation of capability of carbon dioxide discharge depended on yearly perception covering the period 1990-2014. The factors incorporated carbon dioxide discharge, FFE (Fossil Fuels Energy utilization), TOE (Total Energy Consumption), Gross Domestic Product, Pop (Population). LMDI (Log Mean division Index) technique was applied to discover the adjustments in carbon dioxide emanations from the burning of Fossil powers as this was an ideal deterioration approach with no remaining. The expansion in GDP per capita and populaces was the main considerations Responsible for the expansion in energy related carbon dioxide emissions. Carbon intensity added to the decrease of emissions. The decomposition impact is likewise utilized in anticipating future carbon dioxide Emissions for the period 2015-2025. In view of the anticipated outcomes, the decrease capability of carbon dioxide Emissions in Pakistan was assessed, utilizing extraordinary structured situation examination. The discoveries addressed that emissions will arrive at 251.5 Mt carbon dioxide in 2025 according to BAU (Business as usual) situation. (Lin & Ahmad 2017)

By using CGE model the carbon tax policies was helped to reduce the carbon emissions of the South African countries. Secondly, other type of taxes could be reduced by the revenue generated from the taxes which will be implemented on the carbon and other energy resources in South Africa. The study was based on the social accounting matrix (SAM) of 2003 which was developed by World Bank. Study used the general equilibrium model of South African economy. This paper found that the welfare expenses of accomplishing noteworthy decreases in carbon dioxide emissions are genuinely little. When all was said in done, the more focused on the tax to carbon emissions, the better the welfare results. The out came affirm the customary

contention that the applicable dead weight reduction will by and large be little for vitality related taxes. Besides, labor market mutilations, for example, labor market division or joblessness will probably rule the welfare and value ramifications of a carbon tax for South Africa. (Devarajan et al. 2009)

An income and distributional impartial way to deal with decreasing U.S. ozone harming substance emissions that uses a carbon tax. Information was gathered by consumption data from 2003, Data from the Consumer Expenditure, Data from EPA's Emissions and Generation Resource Integrated Database and Survey for 2003. Concentrate dependent on displaying utilizing the Massachusetts Institute of Technology's (MIT's) Emissions Prediction and Policy Analysis (EPPA) model. This article has contended that solid economic, regulatory, and effectiveness contentions could be made for a carbon tax. Building a distributional and income nonpartisan change has tended to a large number of the worries raised by adversaries to carbon pricing. It was be apt to the negative effect of carbon pricing on low pay family units and abstains from conflating carbon arrangement with banter over the proper size of the government spending plan. (Metcalf 2009)

## **2.2. Revenue from emissions reduction or carbon taxation:**

Growth rate is so important for any developing country. By implementation of taxes on greenhouse gas emissions can generate a lot of revenue which will partially increase the growth rate of country. Pakistan is a developing country so there is a need of increasing his growth by using his internal factors. Carbon taxation in energy sector of Pakistan will play an important role for increasing of growth rate as many developed countries are achieving.

Study demonstrated the demand elasticity of transport fuel (gasoline) in context of environmental threat by using various models. The cross-sectional data for the gasoline price elasticity were taken from 21 OECD countries from 1960-1985. Different models were used

for estimation of elasticity of gasoline which include Lagged endogenous model (preferred model), Simple statistical model (give price elasticity below -0.3) and Simple vehicle model. The lagged endogenous estimates of long run gasoline elasticity average approximately -0.8 for price and 1.2 for income. According to results, the consumption of gasoline was continued to growing with the increased in the income elasticity, while on the other hand the implementation of tax policies which suggested by the positive price elasticity decreased by the consumption of gasoline could be effective Under the assumption of growth rates of income and population of the study having no tax differences found that OECD consumption of gasoline and emissions from carbon would increase by 47 % from the year 1987 to 2000. (Sterner, Dahl, & Franzen 1992).

Focusing on gross domestic product, GDP did not have any adverse effect of carbon tax implemented in British Columbia using difference-in-difference analysis of different provinces of Canada from the time period of 19909 to 2016. Results described that carbon tax have positive impact on GDP from 1985 to 2017 using panel of EU countries. (Metcalf 2019)

Vector auto regression (VAR) was used to find the impact of carbon tax of British Columbia on provincial gross domestic product. Results revealed that there was no impact of carbon tax on gross domestic product. (Bernard et al. 2018). Another study found the employment effects of the British Columbia carbon tax and found modest positive impacts on employment in the province. While total effects were little, he secured huge position moving from carbon escalated to non-carbon concentrated segments. (Yamazaki 2017).

Climate change happening due to various gas emissions. These gas emissions are high generated by fuel and oil stock. Oil taxation considered this as an instrument of climate change which subsidize the local demand of oil as a counteract taxation. This study used a game model which includes two type of agents one is oil exporter (OPEC) and other is oil importer (OECD).

Model included two type of stock which was OPEC oil's deposit stock and carbon stock gathering in the global atmosphere. This paper has break down oil tax assessment (by oil merchants, played by OECD) as an instrument of climate policy with regards to a game, in which oil exporters (played by OPEC) sponsor nearby request deliberately to neutralize taxation. The fundamental commitment of this paper was to present the plausibility of value segregation by oil makers. (Wei, et al. 2012).

This paper included the gasoline tax policy and greenhouse gas emissions tax, water, waste tax policy of overall Europe, which demonstrated the environmental taxation and all tax policy in whole Europe. The model in this study distinguished the environmental tax between the countries and firms as well as discussion was being held about environmental tax revenue. Environmental taxes played a vital role in order to protect the environment in Europe yet at the same time, environmental taxation appears to play some degree more unmistakable job in Europe than in different mainland. This is incompletely however defectively reflected in higher environmental tax income as a portion of GDP. Environmental taxes ought to anyway be isolated into two classifications. In the primary we have taxes identified with vitality and transportation and inspired at any rate halfway by worldwide concerns, for example, environmental change. The other classification of environmental taxes is to some degree less noticeable both to services of account and accordingly to the political world. (Stern & Köhlin 2003).

Changing in prices, taxes on carbon and all other final goods and services used to estimate the revenue cycle for Ireland. To find out revenue cycle, micro data was used which was based on 2005 HBS (household budget survey) across population. The SWITCH model for Irish economic and ESRI (social research institute) was used to estimate the tax benefit and compare the three-tax revenue cycle which rebalance the distribution of household income. Ireland needs to reduce the greenhouse gas emissions from major non-emission tax system

(ETS). Likewise, the administration should present a carbon tax, which: (1) would be income impartial; (2) ought to be collected uniquely in the non-ETS area; and (3) ought to be near EU ETS cost of carbon. This paper investigations the distributional ramifications of a €20/carbon dioxide tax with such qualities. The immediate effect of the tax was assessed to go somewhere in the range of €3 and €4 every week, per household, over the household population. The circuitous effect of the tax was evaluated to extend somewhere in the range of €0.5 and €1.5 every week, per household, over the household population. (Verde and Tol 2009).

Firstly, climate change factor will be felt and foremost at the household level. In Pakistan meeting this test will require an assortment of strategy approaches including technological advancements, engaging local community with the apparatuses and data they have to adjust, and setting up components to give alleviation from the impacts of climate change. Adapting to climate change is progressively testing and will turn out to be an ever-increasing number of troublesome as worldwide temperatures rise. This study concentrated on adjustment to environmental change as opposed to on mitigation procedures. (Gowdy & Salman 2007).

While tending to environmental change by diminishing ozone-harming substances, carbon taxes can likewise produce progressively quick natural and medical advantages, especially by declining deaths that outcome from nearby air contamination. They can likewise raise noteworthy income for governments, income they can use to check monetary mischief brought about by higher fuel costs. For instance, governments could utilize carbon tax revenue to facilitate the weight of tax collection on laborers by bringing down close to personal pay and finance charges. Carbon tax income could likewise support profitable speculations to help accomplish the United Nations Sustainable Development Goals, including diminishing hunger, poverty, imbalance, and ecological damages. (Ian Parry 2019)

Taxes on emissions could significantly increase the revenue naturally (cost-advantage), e.g. if \$10 tax implements on per capita emissions could increase the revenue of united state up to \$60 billion and decreased the emissions by 5% to 10% in near term. Based on assumption given by literature, if US government used this revenue as an income tax than carbon tax could save the cost up to \$20 billion per year by using equivalent trade-cape system which did not damage the recycling revenue approach. (Burtraw et al 2002)

### **2.3. Possible hypothesis for environment and growth rate:**

Whenever the discussion come on environment and growth rate, the involvement of environment Kuznets curve is mandatory. The relationship between growth rate and environmental factor is called environmental Kuznets curve. Kuznets curve having a U-shape relationship of environmental degradation and economic growth. Many studies were done under the shadow of this environmental Kuznets curve.

Complication of raising taxes on gasoline determined by using variables of gasoline taxation. Data sample was consisting of 21 rich OECD countries from 1978 to 2000. The data was of price, taxes and variables which was related to transport sector from international road federation. Standard OLS model and 2SLS model was used to estimate the two-heuristic model for taxation (STATA- 2003). The results showed that the main problem while implementing the taxes on gasoline was the political pressure which has influences by the political parties. Not exclusively low expenses and in this way low costs empower high utilization, yet elevated levels of utilization additionally lead to broad weight against raising the taxes. This study also points out the significance of other factors e.g. government debt. (Hammar, Löfgren, & Sterner 2004).

The fundamental target of this study was to represent the welfare expenses of exclusions in environmental policy together with the issue of one-sided carbon taxes in an open economy.



Study incorporated both energy and export concentrated enterprises. Study took 58 segments of West Germany dependent on the most as of late accessible steady financial and energy information for 1990. It was a benchmark information for a benchmark year of 1990. Static general balance model was utilized to study the economic ramifications of CO charge exclusions for vitality and fare concentrated enterprises in the West German economy. One-sided carbon decrease in a solitary nation did not prompt critical changes of carbon emissions somewhere else. On the off chance that leakage rates are low, tax exceptions of energy and export concentrated enterprises did not give an effective arrangement to one-sided action. In the instance of high leakage rates halfway expense exclusions of ventures may expand effectiveness of worldwide carbon dioxide decrease. (Böhringer & Rutherford 1997).

There was a strong relationship between economic growth and carbon dioxide emissions due to some major aspect included environmental degradation and global warming. Kuznets curve better elucidated the causality between economic growth and carbon dioxide emissions. Kuznets curve have inverted U shaped relationship between both degradation of environment and economic growth which mean that due to economic development the environment degrades and after the specific level of that development, the environmental degradation started to decrease which means to improve the environment. (Shahbaz and Feridun, Soytaş, 2006).

Given literature illustrates that the greenhouse gas emissions lead to the serious climate change which effects the ozone layer as well. Major emissions from greenhouse gases is carbon emissions which creates pollution in the environment. For reduction of greenhouse gas emissions and their harmful effects a carbon taxation is a better option. Carbon taxation leads to reduce the carbon emissions and generate revenue for government. Review also tells about the supply portfolio mechanism and the revenue recycling across the income distributions. The most vulnerable sector by these emissions are energy sector and agriculture sector of Pakistan.

## Chapter No.3

### Research Methodology

#### 3.1. Study area:

Pakistan's carbon emissions were not much high in 2006. It was only 200 Mt in 2006 but carbon emissions of Pakistan are continuously increasing which lead to increase up to 482 MT in 2018 (Atlas 2017). Due to increase in coal power plant, Pakistan's carbon emissions are increasing annually up to 6% says 18.5Mt. Main reason behind this is Pakistan do not have capacity to store and capture those emissions. That's why it is generally increasing which is dangerous for now and future prospective as well. In energy and agriculture sectors, high rate of **CO<sub>2</sub>** emissions demand instant under consideration. (W. Malik et al. 2012). Total **CO<sub>2</sub>** emissions were probably increased after 2018 due to large scale coal power plants underneath manufacture in all provinces in Pakistan.

Provinces	Punjab	Sindh	KPK	Balochistan
Total emissions (percentage)	27.4%	54.6%	6.7%	11.12%

Source: Author

Because of increasing level of emissions, it is essential to discover some way to mitigate the emissions which is generating by energy, transport and agriculture sector at provincial level, so this study address the impact of carbon tax on emissions and economic growth of Pakistan. The study is based on the provinces of Pakistan which includes Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan. The determination of this study is to investigate the impact of carbon tax on GHG emissions specifically carbon dioxide emissions of provinces in Pakistan

and investigate the impact of carbon taxation on economic growth of every provinces of Pakistan.

### 3.2. Data sources:

The study uses panel data from 1997 to 2018. Gross value added data which is the proxy of gross domestic product (GDP) is collected from public expenditure review 2012 and public expenditure review 2017 which is published by World Bank and data for natural gas, coal and crude oil is collected from Pakistan statistical review 2007 and Pakistan statistical review 2018 for all these variables. Data of electricity collected from energy yearbook of Pakistan. Study is also based on interviews of some experts related to carbon tax and environmental law which make study more authentic and reliable. Thus, due to both quantitative and qualitative data, study makes a triangulation between both types of data.

Previously emissions were calculated by using (Tetzlaff, A. 2004, Litschke, T., 2005, Jing, R et., al 2014, Hong, J et., al 2015, Nava, P. 2009) method. But these methods were calculating emissions for other sectors like steel production, metal mining and emissions from building construction. Different formulas for emissions calculation given in the below table 3.1.

Table 3.1 Emissions calculation formula	Author
$CO_{2e} = AD * EF * GWP$ <p>product of activity data (AD) emissions factor (EF)</p>	Hong, J., Shen, G. Q., Feng, Y., Lau, W. S. T., & Mao, C. (2015)
$E_{TOTAL} = \left(\frac{E_{CO_2}}{R_1}\right) * GWP_{CO_2} + E_{CH_4} * GWP_{CH_4} + E_{N_2O} * GWP_{N_2O}$ <p>GWP= global warming potential</p>	Jing, R., Cheng, J. C., Gan, V. J., Woon, K. S., & Lo, I. M. (2014).
$CE_e [g \text{ of } CO_2] = EC [KJ] * CES [g \text{ of } \frac{CO_2}{KJ}]$ <p>The carbon emitted (CEe) energy consumed (EC) Carbon Emissions Signature (CES)</p>	Nava, P. (2009).

This study is using the formula of (vandijk 2011) to find the carbon emissions which was also used by (N. Fatima, A. Salman 2017) which is quite similar to previous literature and (vandijk 2011) formula is emissions generated form energy resource. The formula is as following

$$\text{Carbon emissions (eq)} = \text{Amount of Coal} \times \text{CO}_2 \text{ emissions} + \text{Amount of Coal (0.3\%} \\ \times \text{CO}_2 \text{ emissions} \times \text{GWP for CH}_4 \text{ of 21)}$$

These numbers are based on the IPCC method for greenhouse gas emissions calculation, using a default Tier 1  $\text{CO}_2$  emissions factor reflecting the full carbon content of the fuel less any non-oxidized fraction of carbon retained in the ash, particulates or soot. Since this fraction is usually small, the IPCC Tier 1 default emissions factors neglect this effect by assuming a complete oxidation of the carbon contained in the fuel (carbon oxidation factor equal to 1) (IPCC 2006). For methane, the default IPCC emissions factor for residential coal combustion was selected, as this factor assumes a significant fraction of incomplete combustion. This factor is about 0.3% of the value of the default  $\text{CO}_2$  emissions factor (uncertainty range 0.1–0.9%). Including the GWP of methane, the uncertainty range for the residential coal combustion factor indicates that  $\text{CH}_4$  emissions may increase the  $\text{CO}_2$  emissions by about 2 to 18%.

Formula contains emissions factor of  $\text{CO}_2$  which collects from Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment, 2018. GWP is global warming potential for  $\text{CH}_4$  of 21 (i.e. 1kilogram  $\text{CH}_4 = 21$ -kilogram carbon dioxide equivalent).

<b>Table 3.2</b>		<b>Carbon Emission Factor</b>	
Name	Emissions factor (kg $\text{CO}_2$ per standard cubic foot)		
Natural gas	0.05 kg $\text{CO}_2$ per scf		
Coal	2.71 kg $\text{CO}_2$ per scf		
Crude oil	10.29 kg $\text{CO}_2$ per scf		

Source: IPCC (Intergovernmental panel for climate change) Fourth Assessment Report (AR4), 2007.

We find the emissions of natural gas, coal and crude oil with this formula and at the end, added all those emissions in order to find total emissions.

$$\text{Carbon emissions (eq)} = \text{Amount of natural gas} \times \text{CO}_2 \text{ emissions} + \text{Amount of natural gas} \\ (0.3\% \times \text{CO}_2 \text{ emissions} \times \text{GWP for } CH_4 \text{ of 21})$$

$$\text{Carbon emissions (eq)} = \text{Amount of Coal} \times \text{CO}_2 \text{ emissions} + \text{Amount of Coal} (0.3\% \\ \times \text{CO}_2 \text{ emissions} \times \text{GWP for } CH_4 \text{ of 21})$$

$$\text{Carbon emissions (eq)} = \text{Amount of crude oil} \times \text{CO}_2 \text{ emissions} + \text{Amount of Crude oil} (0.3\% \\ \times \text{CO}_2 \text{ emissions} \times \text{GWP for } CH_4 \text{ of 21})$$

$$\text{T.C.E} = \text{Emissions of coal} + \text{Emissions of natural gas} + \text{Emissions of crude oil}$$

### 3.3. Panel unit root test:

Panel unit root test is applied to check the stationarity of the data series (TE, NG, GDP, coal, electricity and CO). Three type of panel unit root test applied to check the stationarity of data which includes LLC, IPS and Breitung unit root tests. According to the Pedroni (1999), when the data set has exceeded from fifteen year, the panel data characteristics converted into time series nature so it is essential to check the integration order of the data series. Furthermore, the co-integration test is used to check the long run relationship among the variables. If the results reject the null hypothesis i.e. H0, which means that there is co-integration amongst variables. On the other hand, if it accepted than there is co-integration exist between the variables.

**Table 3.3 Results of Panel Unit Root Tests**

Variables		I(0)			I(1)		
		LLC	IPS	Breitung	LLC	IPS	Breitung
<b>TE</b>	Constant	0.65270	0.75746	-0.97852	-6.20294*	-5.32242*	-6.11210*
	and Trend	(0.7430)	(0.7756)	(0.1639)	(0.000)	(0.000)	(0.0000)
<b>NG</b>	Constant	0.50695	-0.70260	-0.17440	-3.37973*	-3.89198*	-3.10515*
	and Trend	(0.6939)	(0.2412)	(0.4308)	(0.0004)	(0.0000)	(0.0010)
<b>GDP</b>	Constant	2.22602	2.52484	0.39788	-6.25942*	-4.33470*	-6.45215*
	and Trend	(0.9870)	(0.9942)	(0.6546)	(0.0000)	(0.0000)	(0.0000)
<b>Coal</b>	Constant	-0.01977	-0.63150	-1.14279	-7.31898*	-8.17160*	-3.82842*
	and Trend	(0.4921)	(0.2639)	(0.1266)	(0.0000)	(0.0000)	(0.0001)
<b>CO</b>	Constant	0.24506	-0.61501	-1.20903	-7.75403*	-5.36044*	-6.98096*
	and Trend	(0.5968)	(0.2693)	(0.1133)	(0.0000)	(0.0000)	(0.0000)
<b>Electricity</b>	Constant	0.12301	2.50688	-0.81627	-2.96671*	-3.50599*	-1.73232*
	and Trend	(0.5489)	(0.9939)	(0.2072)	(0.0015)	(0.002)	(0.0416)

All variables are significant at 1% level

Pervious Literature used different unit root tests to check the stationarity of the data for panel data, but this study used Levin-Lin-Chu (2002), Im, Perasan and Shin (2003) and Breitung (2000) for panel unit root tests. Table 3.3 shows the results of three different panel root tests with constant and trend. The results describe that all the data are statistically insignificant at level but statistically highly Significant at first difference level.

#### **3.4. Panel Co-integration test:**

After checking the stationarity of all the variables. The Pedroni co-integration test has applied to test the long run relationship. (Pedroni, 1999, 2004) suggested that seven different co-integration panel tests and the results of co-integration tests for all data sets are report in below table 3.4. The co-integration tests are statistically significant; eight tests are significant out of eleven tests. It means that the variables are highly co-integrated with each other. There is long run relationship exists between the variables.

**Table 3.4 Panel Co-integration Test**

<b>Panel statistic</b>	<b>Statistic</b>	<b>Prob.</b>	<b>Statistic</b>	<b>Prob.</b>
Panel v-Statistic	1.659052	0.0486*	1.106778	0.1342***
Panel rho-Statistic	0.235800	0.5932	0.327362	0.6283
Panel PP-Statistic	-0.903222	0.1832***	-0.775053	0.1329***
Panel ADF-Statistic	-2.491375	0.0064*	-1.524974	0.0636*
<b><u>Group statistic</u></b>	<b><u>Statistic</u></b>	<b><u>Prob.</u></b>		
Group rho-Statistic	1.033522	0.8493		
Group PP-Statistic	-0.598385	0.1804***		
Group ADF-Statistic	-2.015673	0.0219*		

\*, \*\* and \*\*\* indicate level of stationarity 1%, 5% and 10%.

Different studies used various methods to find the relationship of carbon tax with different economic and environmental indicators given in table 3.5. Most of the studies used CGE model to find the impact of carbon tax from different prospective. This study is using ARDL model to find the results.

**Table 3.5 Econometric models**

<b>Models</b>	<b>References</b>
<b>CGE model</b>	(Sam Meng et al. 2011; Daniel J. A. Johansson et al. 2013; Joshua Elliott Don Fullerton 2013; Christoph Bohringer, Thomas f. Rutherford 1997; W Wissema, R Dellink 2007; Maia King, Bassel Tarbush, Alexander Teytelboym 2019; Meng, S. et al. 2011)
<b>SAM based price model</b>	(Sebastian Renner 2017; Chapa, J., & Ortega, A 2017)
<b>DiD approach</b>	(Julius J. Andersson 2019)
<b>OLS method</b>	(Gilbert e. Metcalf and james h. Stock 2020; Erick Lachapelle 2011)
<b>Static CGE</b>	(Thomas f. Rutherford 1997)

<b>MDESRAP</b>	(Hassan Qudrat-Ullah 2015)
<b>LMDI (Log Mean division Index) method</b>	(Boqiang LINa, Izhar Ahmad 2017).
<b>Gravity model</b>	(Yu-huan zhao 2011)
<b>TIMER</b>	(Johansson, D. J., Lucas, P. L., Weitzel, M., Ahlgren, E. O., Bazaz, A. B., Chen, W., & Peterson, S 2015).
<b>Treasury distribution model</b>	(Horowitz, J., Cronin, J. A., Hawkins, H., Konda, L., & Yuskavage, A 2017).
<b>HERMES</b>	(Conefrey, T., Fitz Gerald, J. D., Valeri, L. M., & Tol, R. S 2013).

### 3.5. Descriptive Statistics:

Descriptive statistics is the revolution of raw data in useful intuition for better understanding of the data. This study has two different equation to investigate the emissions reduction and revenue generation. The dependent variable is Gross domestic product and total emissions. Rest of others are independent variables.

**Table 3.6 Descriptive statistics**

<b>Variables</b>	<b>TE</b> (Tons)	<b>NG</b> (Metric ton)	<b>GDP</b> (Million Rs)	<b>COAL</b> (Metric ton)	<b>CO</b> (Metric ton)	<b>Electricity</b> (MWh)
<b>Mean</b>	6.579576	4.817733	6.090142	5.724105	3.633528	16.20372
<b>Median</b>	6.531093	5.321798	6.014449	5.941050	3.917954	16.10686
<b>Maximum</b>	8.164619	6.022223	6.746139	6.345257	7.230815	18.05997
<b>Minimum</b>	4.876718	0.000000	5.482896	4.379668	0.000000	14.32594
<b>Std. Dev.</b>	0.775537	1.603084	0.351426	0.519011	2.313435	0.960568
<b>Observations</b>	88	88	88	88	88	88



Descriptive statistics shows the mean, median, maximum, minimum and standard deviation of all the variables. The mean and median of all the variables are similar to each other. This study is provincial based so the minimum value shows the lowest value of the province in panel and maximum value show the highest value of province in panel. The average value of TE is 6.5 along with the standard deviation of 0.77 and GDP has average value of 6.09 along with the standard deviation of 0.35. Total number of observations are 88 in numbers.

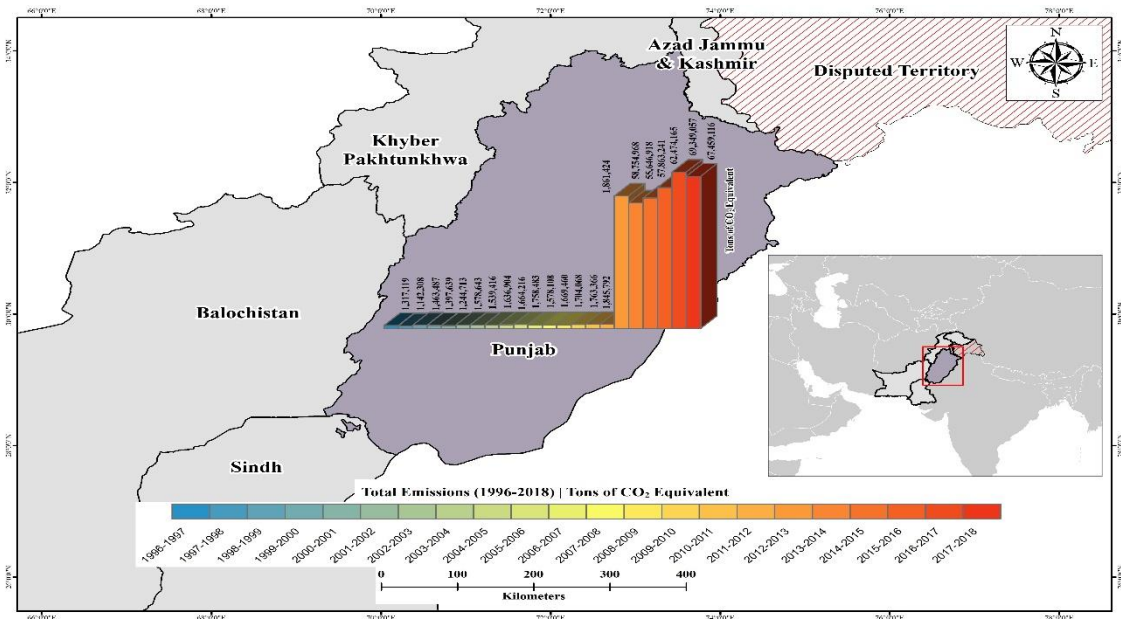
### **3.6. Graphical presentation of data:**

Graphical presentation of the variables is given in Appendix II. Bar chart shows the variation in the data sets of all variables from 1997 to 2018. Graph of coal shows that balochistan has highest level of coal in Pakistan. Sindh has 2<sup>nd</sup> rank, 3<sup>rd</sup> one is Punjab and at last KPK has lowest coal production from all the four provinces of Pakistan. Sindh has biggest production of natural gas among the provinces. Balochistan, Punjab and KPK are the after Sindh. Punjab's growth rate are highest among all he provinces. Sindh has 2<sup>nd</sup> in number, KPK comes after Sindh and balochistan is at last number. Punjab is at 1<sup>st</sup> number in electricity production. Sindh has 2<sup>nd</sup>, KPK has 3<sup>rd</sup> and balochistan has 4<sup>th</sup> in electricity production.

### **3.7. Graphical presentation by using GIS:**

Geographical information system is a unique system, which is design to visualize the data, manipulate, manage and analyze the data. Geography means that data which is present somewhere in the world. This study uses the GIS arc map to visualize the total emissions of all the four provinces of Pakistan. Arc Map is a simple software used to draw maps through different tool. Data visualization is the main characteristics of Arc Mapping. Arc Map is the vital module of Arc GIS. Arc Map allows the user to explore data within a data set, symbolize features accordingly, and create maps.

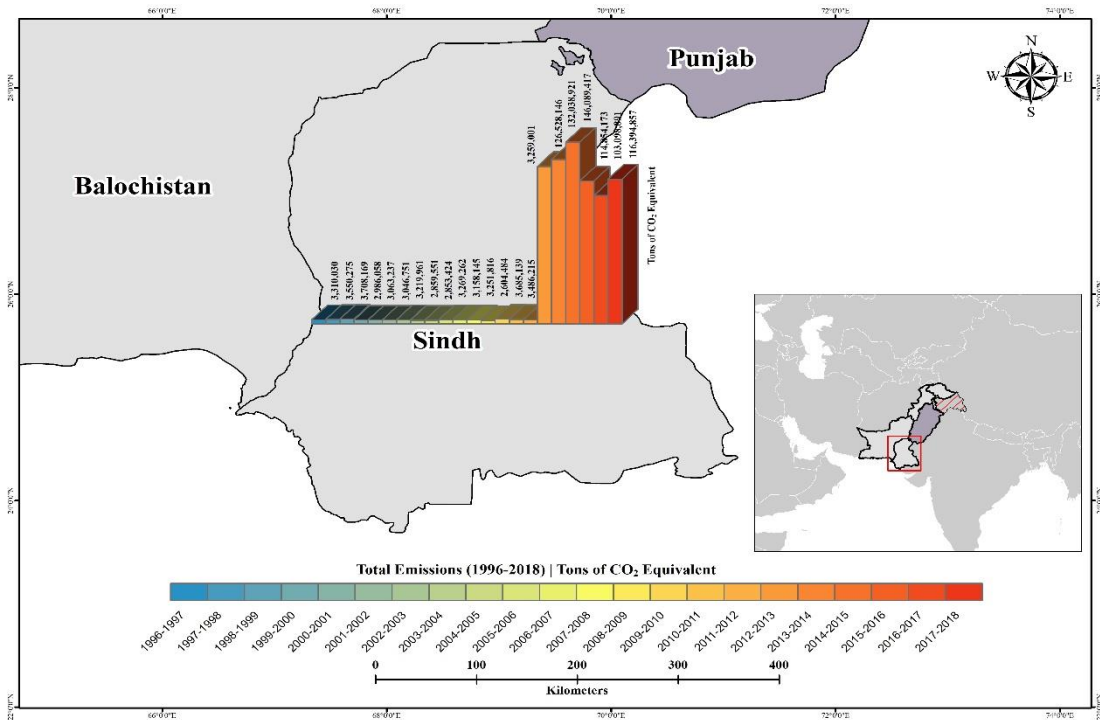
**Figure 3.1: Map of Punjab:**



**Source: Author**

Above map shows the total emissions of Punjab province of Pakistan from 1997 to 2018. Map shows the gradually increases in the total emissions (Tons of CO<sub>2</sub> equivalent) of Punjab from 2010 to 2018. The reason behind that much increase in the total emissions is the contently increase in the production of crude oil and coal. Due to increase in the non- renewable energy resources, the total emissions are increasing annually.

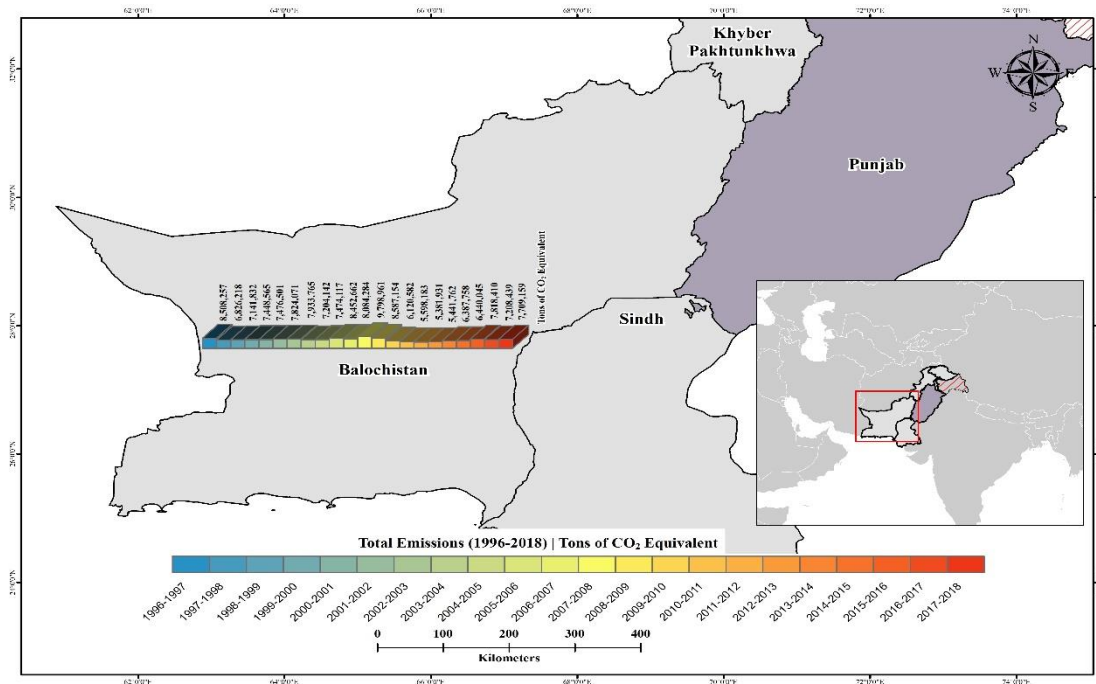
**Figure 3.2: Map of Sindh:**



Source: Author

Sindh total emissions has shown in above map drawn by Arc Map. The map shows the trend of total emissions of Sindh from the time period of 1997 to 2018. Sindh’s total emissions also shows the increasing trend after 2012. Crude oil production was increase in Sindh after 2012 and coal production were increase as well. The number of coal power plant were established due to which the total emissions of Sindh are high.

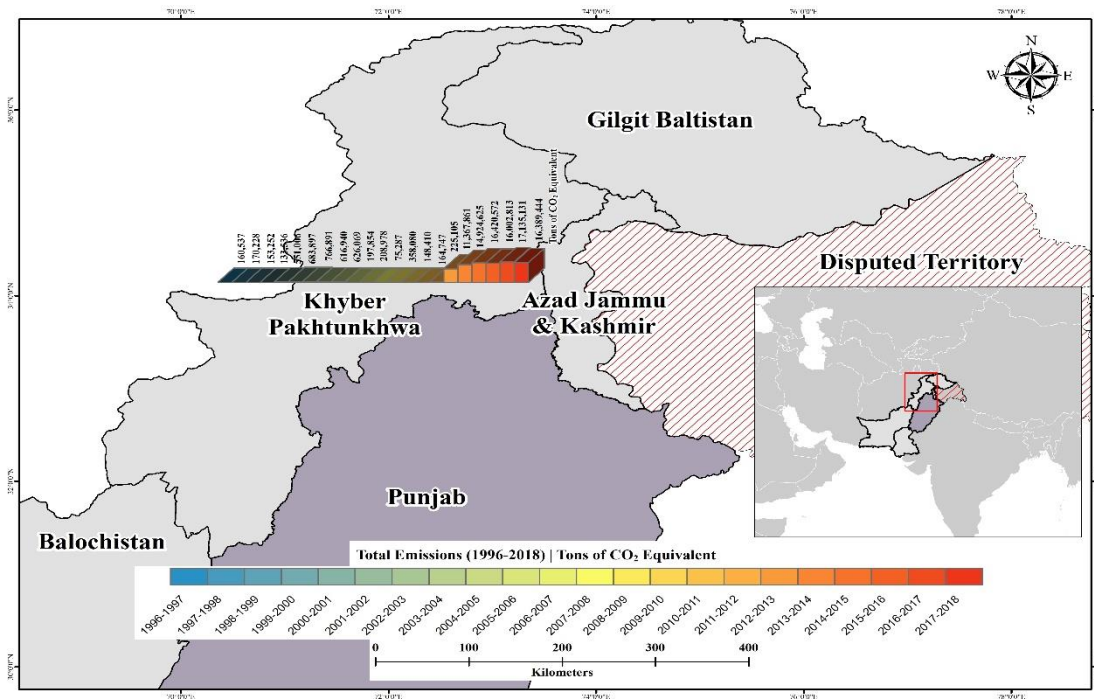
**Figure 3.3: Map of Balochistan:**



**Source: Author**

The Balochistan Plateau is a vast wilderness of mountain ranges in the southwest of the country with an average altitude of about 600 m. Some seasonal rivers cross this region but most of its northwestern part is a wide expanse of desert like the deserts found in the central part of the country, such as Thar and Cholistan. Above map shows the total emissions of Balochistan. Balochistan total emissions are relatively lower than the emissions of Punjab and Sindh. Only 11% emissions are generated by Balochistan province. Map shows the total emissions of Balochistan from 1997 to 2018.

**Figure 3.4: Map of KPK:**



Source: Author

From all the four provinces of Pakistan, KPK province has lowest level of emissions. Only 6% emissions are generated by KPK province. Above map shows the total emissions of KPK province from 1997 to 2018. KPK is doing some familiar projects regarding environment, like billion tree tsunamis due to which emissions are very low in KPK. KPK is at fourth number from all the provinces of Pakistan in total emissions.

In summary, maps show the total emissions of all the Punjab, KPK, Sindh and Balochistan from 1997 to 2018. All map shows the trend of total emissions at annual bases. In comparison, the highest emissions are coming from Sindh, after that Punjab and then Balochistan and lastly KPK. The increases in the emissions are due to increase in the production of non-renewable resource over the time and secondly increase in the energy projects in both provinces.

### 3.8. Empirical framework:

Empirical framework describes the dependent and independent variables, which is used in this study for estimation. The functional form of those two models which is used in this study are as given below

Model I:

$$\text{Carbon emission} = f(\text{natural gas, crude oil, coal, electricity, carbon tax})$$

Model II:

$$\text{GDP} = f(\text{natural gas, crude oil, coal, carbon emission, electricity, carbon tax}).$$

### 3.9. Econometric modeling:

Econometric model has based on the results of panel root tests and co-integration tests. The result shows that the entire series are stationary at **first level** and highly co-integrated with each other. Therefore, the study used ARDL estimator for the analysis. Autoregressive Distributed Lag “ARDL” approach (also known as bound testing approach) is used to estimate the relationship between variables after finding the stationarity of data set. ARDL approach is discovered by Pesaran and Shin (1995). This technique is generally used to find out the long run relationship between variables. Model is nominated through model assortment process like Akaike, Schwarz, Hannan and Quinn, and  $R^2$  (Pesaran and Pesaran, 1997). Like all the other techniques, ARDL approach has some specific qualities.

As this approach can be applied either the variables are  $I(0)$  or  $I(1)$  process or a combination of both, however this approach does not work if the variable is  $I(2)$  process (Pesaran and Pesaran, 1997). Another benefit of the approach is that it is more efficient in small or finite data size as is the case of this study. It is possible in ARDL approach that different

variables have different optimal lags. The time series is the function of his own particular lag terms and also the function of lag terms of one or more than one explanatory variables.

### 3.10. Mathematical model:

According to pervious literature the carbon emissions is the function of natural gas, crude oil, coal. This study used the following equation to analyze the linkage between carbon emissions, economic growth and carbon taxation.

$$\text{Equation \#1: } \ln(TE_{it}) = \beta_1 \ln NG_{it} + \beta_2 \ln CO_{it} + \beta_3 \ln COAL_{it} + \beta_4 \ln electricity_{it} + \beta_5 carbon\ tax_{it} + DV + \mu$$

$$\text{Equation \#II: } \ln(GDP_{it}) = \beta_1 \ln NG_{it} + \beta_2 \ln CO_{it} + \beta_3 \ln COAL_{it} + \beta_4 \ln electricity_{it} + \beta_3 \ln TE_{it} + \beta_4 carbon\ tax_{it} + \mu$$

*NG=natural gass*

*CO=crude oil*

*TE=total emissions*

*GDP=gross domestic product*

*Electricity= Electricity consumption*

*DV= Dummy variable for check the government laws for environment from 1997-2018*

Where LN is the log of variables, I indicate number of cross sections and t shows the time period.

### 3.11. Variables description:

#### Natural gas:

Natural gas is defined as the fossil energy resources which contain high amount of methane gas ( $CH_4$ ). Sometimes it contain non-hydro carbon gases contain water vapors and

carbon dioxide. The data of variable of natural gas used in this study is in metric tons which is collected from Pakistan statistical book 2007 and from Pakistan statistical book 2018.

### **Coal:**

Coal contain high amount of carbon and hydrocarbon. Coal is black combustible and dark brown sedimentary rock beneath the earth surface. The data of coal used in this study is in metric tons which is collected from Pakistan statistical book 2007 and from Pakistan statistical book 2018.

### **Electricity:**

Electricity is a vital factor when we are discussing about emissions and growth. According to Pakistan energy mix 11% of energy is coming from electricity. The unit of electricity is megawatt/hours and data are collected from Pakistan energy year book.

### **Crude oil:**

Some unrefined petroleum products are naturally occurring which contain some organic material and particles of hydrocarbon. Those petroleum products are known as crude oil. Data is in metric ton form used in this study and data is collected from Pakistan statistical book 2007 and from Pakistan statistical book 2018.

### **Gross domestic product:**

Gross provisional value added is used in this study as the proxy of provisional Gross domestic product which is also used by office of national statistics in “A guide to interpreting monthly gross domestic product (2018)”. The unit of data for Gross provisional value added at factor cost, at 1s999/00 prices is PRs million. This data is collected from public expenditure review 2012 and public expenditure review 2017 published by World Bank.



**Dummy variable:** Dummy variable is used to check the previous government environmental laws. If any government did something regarding environmental laws than on that year the dummy will be one other wise it will be zero. If any of the provincial government did not do anything regarding mitigations of emissions than we will use that area as references sign. So, we are using Balochistan as a reference sign area. And in our results, we are comparing governmental laws at provincial level.

**Carbon tax scenario:**

**CO<sub>2</sub> Content in fuel:**

Below table 3.7 describes the amount of carbon content in every natural resource. Coal has high-test amount of carbon dioxide content.

<b>Table 3.7:</b>		<b>Amount of carbon content</b>	
<b>Fuel</b>	<b>CO<sub>2</sub> content<sup>14</sup></b>	<b>Tax @ \$49/mt CO<sub>2</sub>-e</b>	
<b>Natural gas</b>	53.12 kg/mcf	\$2.60/mcf	
<b>Sub-bituminous</b>	1,685.51 kg/short ton <sup>15</sup>	\$82.59/short ton	
<b>Gasoline</b>	8.89 kg/gallon <sup>16</sup>	\$0.44/gallon	
<b>Crude oil</b>	432 kg/bbl <sup>16</sup>	\$21.17/barrel	

Source: U.S energy information administration (EIA)

**Where carbon is taxed:**

To eradicate carbon emissions, an instrument is used independently, which is carbon tax or carbon tax also happen with instrument of carbon pricing. Like tax on energy. Carbon tax is indirect instrument till now, but the new phenomena of direct carbon tax is relatively new. Such type of tools is being designed at fast planetary. Below table 3.8 provides the list of some countries where carbon tax exists. The price of carbon tax is also given in table below.

<sup>14</sup> Source: [http://www.eia.gov/environment/emissions/CO2\\_vol\\_mass.cfm](http://www.eia.gov/environment/emissions/CO2_vol_mass.cfm). CO<sub>2</sub> content parameters represent OTA’s assessment of tax-relevant emissions and should not be considered definitive for any carbon tax that may be enacted.

<sup>15</sup> For natural gas and coal, upstream and midstream approaches differ in the point in the supply chain at which the fuel is taxed but not the form of the fuel or the per-unit fuel tax at the point of taxation.

<sup>16</sup>Source: <https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references>

<b>Table 3.8</b>		<b>Carbon Tax Rate</b>	
<b>Country</b>	<b>Type</b>	<b>Year</b>	<b>Carbon tax per tCO<sub>2</sub> e</b>
British Columbia	Subnational	2008	CAD30 (2012)
Chile	National	2014	USD5 (2018)
Costa Rica	National	1997	3.5% tax on hydrocarbon fossil fuels
Denmark	National	1992	USD31 (2014)
Finland	National	1990	EUR35 (2013)
France	National	2014	EUR7 (2014)
Iceland	National	2010	USD10 (2014)
Ireland	National	2010	EUR 20 (2013)
Japan	National	2012	USD2 (2014)
Mexico	National	2012	Mex\$ 10 -50 (2014) *
Norway	National	1991	USD 4-69 (2014) *
Portugal	National	2014	€5 (2015)
South Africa	National	2016	R120 (2016)
Sweden	National	1991	USD168 (2014)
Switzerland	National	2008	USD 68 (2014)
United Kingdom	National	2013	USD15.75 (2014)
Vietnam	National	2011	VND 6-30 (2011)
Malaysia	National	2019	\$8.08 (2019)
Sri lanka	National	2005	\$0.7-\$8.3 (2010)

Source: Carbon tax center, New York Times (April 2, 2019)

IPCC suggested a gradual implementation of a per-ton carbon price, namely between US\$40 and US\$80 by 2020 for developed countries and \$1 to \$10 for developing countries.

(Carbon Pricing Leadership Coalition 2019). Share of emissions covered per province of Canada is 47% to 90% which is like Pakistan's provincial emissions. Canadian government starts at \$15 per ton of carbon dioxide in 2019 and will rise to \$30 per ton by 2022. Individual provinces can opt out of the federal program by designing their own local climate policies. British Columbia, for instance, has its own higher carbon tax in place, which rose to \$30 per ton this year, but four provinces, including Ontario, refused to create their own plans, and the federal tax went into effect in those places. (Plumer & Popovich 2019).). In the same way emissions level of Pakistan and Vietnam is similar. Vietnam is putting carbon tax ranging between 6 VND to 30 VND. (Willenbockel, D 2011). Malaysia and Sri Lanka are also putting carbon tax to mitigation carbon emissions. The economic structure of Sri Lanka and Malaysia are quite similar with Pakistan. The energy growth rate of Sri Lanka and Malaysia are 5.3% and 3.2% (Tan, C. 2013, ADB 2013) which is similar with Pakistan having the energy growth rate of 5.8%. The emissions generated from energy sector of Malaysia and Sri Lanka are 43.4% and 55% (USAID. 2016, Nor, N. et al. 2016) which is also alike with Pakistan's energy sector emissions of 46% (WRI CAIT 2015). The GDP of Pakistan are alike with Malaysia and higher from Sri Lanka. Due to all these similarities we choose our tax base scenario on the bases of Malaysia and Sri Lanka's carbon tax. We are applying \$8/ton of  $CO_2$  tax rate on Pakistan's energy sector which will increase by 2% every year. The carbon tax rate changes with the change in the economy of country. In May 2013 the South African government published a policy paper for public comment on introduction of a carbon tax. The paper proposes a fuel input tax based on the carbon content of the fuel. Tax is proposed to increase by 10% per year until end- 2019 (National Treasury. 2013). As (Metcalf & Stock 2020, May) illustrates that the tax rate will be changes when the economy is booming. Once the economy is in booming state then experts and policy makers think that they can afford the huge rate for carbon tax.

## Chapter No.4

### Results and discussion

Global warming is commonly believed to be one of the biggest challenges of this century. It is caused by emissions of greenhouse gases into the atmosphere. Carbon dioxide (CO<sub>2</sub>) is the most important greenhouse gas, and therefore it is crucial to reduce the CO<sub>2</sub> emissions. Energy taxes or CO<sub>2</sub> taxes are instruments that are believed to reduce CO<sub>2</sub> emissions. so, this study will find the impact of carbon tax on GHGs emissions reduction and how much carbon tax generates revenue for wellbeing of country. Below tables shows the results of Equation #1 using ARDL model.

**Table 4.1 Results of ARDL**

**Dependent Variable: D(LN\_TE)**

	Natural gas	Coal	Crude oil	Electricity Consumption	Carbon tax (\$/ton of CO <sub>2</sub> )	Dummy
<b>Punjab</b>	0.003320 (0.009)	0.499701 (0.00)	0.505580 (0.00)	0.478618 (0.00)	-0.034478 (0.00)	0.021239 (0.00)
<b>Sindh</b>	0.096180 (0.01)	0.570397 (0.00)	0.552624 (0.00)	0.236401 (0.015)	-0.068923 (0.02)	0.023952 (0.00)
<b>KPK</b>	0.394177 (0.00)	0.886685 (0.00)	0.535332 (0.00)	0.811805 (0.016)	-0.027012 (0.00)	0.077440 (0.00)
<b>Balochistan</b>	0.023470 (0.00)	0.983745 (0.00)	0.007409 (0.00)	0.002932 (0.00)	-0.005184 (0.00)	-0.000257 (0.00)

**Source: Author**

Result shows the significant relationship between dependent and independent variables.

Dependent variable is total emissions and independent variables are natural gas, crude oil, coal,

electricity consumption, carbon tax and one dummy variable. The most important variable is a carbon tax which is theoretical variables. And at last we added dummy variable which describes that how much previous government were pro-active regarding to environmental laws. All the variables have significant relationship at 1% level. Natural gas, coal, crude oil and electricity consumption have positive relationship with total emissions in all the four provinces which means that increases in energy resources will lead to increase in emissions of all provinces. Results of our finding are related to (Khan et al. 2020, Awodumi, O 2020, Bruvoll, A 2004), their finding also describe the significant and positive relationship between carbon emissions and non-renewable resources. One of climate expert said:

*With the increase in the population and increase in natural resources, our carbon emissions increase because carbon is a main component in all these natural resources. Other sources of carbon emissions are affluent waste which covered lot of area in Pakistan. Like in industries, that waste or hazardous material also generated carbon emissions. Sea and forestry are two main sources to eradicate carbon emissions. The sea capacity is almost at its last stage which means no more carbon absorption by sea. Because of increase of carbon content in sea, aquatic life is in danger and the production of mangroves are also declining. Forestry is another option but due to structural collapses and fiscal deficit, bowing trees are not on its perfect stage so carbon tax is a better solution which will eradicate the carbon emissions and take part in economic growth. Government is not very much concern related to environment laws and environmental problem (Khalid Mahmood, 55, Karachi).*

Vertically, Sindh has highest in ranking which is generating large number of emissions from all these resources. Punjab scored Second, KPK is at third number and Balochistan is at

last. According to carbon tax scenario, the emissions and carbon tax has negative and significant relationship which means that if carbon tax has applied, the total emissions will be reduced. In Punjab, if 8\$ carbon tax is applied, 3% carbon emissions will be reduced. 6% carbon emissions will be reduced will \$8 carbon tax will be applied. KPK will reduce 2% of carbon emissions by applying \$8 carbon tax. Balochistan has low carbon emissions so it will reduce only 0.5% of carbon emissions by applying \$8 carbon tax. Thus, all the provinces will reduce their emissions if \$8 carbon tax will be applied on their energy sector. A lot of previous studies also reveals the negative relationship between carbon emissions and carbon tax which means that by applying carbon tax, carbon emissions leads to reduction. (Bruvoll, et al 2011). After the 18<sup>th</sup> amendment, responsibilities were divided upon provinces, so this study used dummy variables to find how much all political parties worked for environment at provincial level. Dummy variable explains that, environmental laws are made by all the governments in previous era. The results show that except Balochistan, all the other provinces have environmental laws. An environmental lawyer said,

*“Different laws made by government for environmental protection. After 18<sup>th</sup> amendment, provincial government also consider climate change problem very seriously and made laws regarding environment. But the main problem is the implementation of these laws. Implementation of these laws were very weak. There is no implementation seen in last five or six year of any law regarding environment. The UNFCCC and many other NGOs have played a great role in some successful project which were linked with environment. Government were pro-active for environment only on paperwork. Physically completion of all those law and projects were never on screen”. (Ahmad Rafay Alam, 47, Lahore)*

Dummy shows positive and significant results for Punjab, Sindh and KPK but negative and significant relationship with Balochistan which means that Balochistan government did not take any measures concerning environment. (Khan et al. 2018) describes the current political party's attraction towards the environmental law. Other study also reveals the Summary of Major Laws Relevant to Environmental Mainstreaming and Efforts of Successive Pakistani Governments. (Qayyum, M. 2019).

**Table 4.1a** Dependent Variable: D(LN\_GDP)

<b>Provinces</b>	Natural gas	Coal	Crude oil	Electricity Consumption	Total emissions	Carbon tax (\$8)
<b>Punjab</b>	-0.187917 (0.0018)	-0.548447 (0.0446)	-0.257555 (0.0462)	0.347151 (0.1439)	0.507298 (0.1979)	0.035583 (0.0110)
<b>Sindh</b>	0.166450 (0.0143)	0.489828 (0.0005)	0.030184 (0.1839)	0.199519 (0.1341)	-0.029251 (0.6571)	0.04848 (0.0470)
<b>KPK</b>	-0.151192 (0.0000)	0.217122 (0.0017)	0.160930 (0.0001)	0.173582 (0.0196)	-0.305351 (0.0007)	0.041271 (0.0699)
<b>Balochistan</b>	-1.150793 (0.0364)	-9.706642 (0.1061)	-0.088265 (0.0000)	1.145963 (0.007)	0.04063 (0.7866)	0.014736 (0.0003)

**Source: Author**

Carbon tax substantially generates the revenue which will significantly contributes in the GDP of country. The ARDL model applied to find the relationship between GDP, natural gas, crude oil, electricity consumption, total emissions and carbon tax. Results shows that the growth will increase by applying carbon tax on emissions. Applying carbon tax is not the killer of economic growth of country. GDP will lead to increase by applying carbon tax in the country (Metcalf & Stock 2020, May). Main purpose of carbon tax is to reduce emissions but likewise the revenue will also be generated by applying carbon tax. As results shows the positive and

significant relationship between carbon tax and growth variable. One of the taxation lawyers said,

*Pakistan's taxation system is based on income. Every sector has different type and amount of tax. Tax implementation are on the bases of different rule and ordinance which were pass by federal government in different years like finance ordinance 2007, income tax rule 2001 etc. If we compare Pakistan's taxation system with other countries, Pakistan's tax to GDP ratio is very low. Still, there is no such a word like carbon tax in taxation system of Pakistan. Government have never thought about this type of tax ever. According to my opinion, Carbon tax will lead to increases economic growth and will play major role in financial condition of Pakistan. This tax would improve the economic condition of Pakistan as well as will play a vital role in make technologies green instead of normal machinery (Farrukh zulfiqar, 37, Lahore).*

In Punjab, the revenue will increase up to 3% by applying carbon tax of \$8. In Sindh revenue will be 4% and KPK revenue will lead to increases up to 4% as well. In Balochistan the emissions produce by energy resource were not too high so revenue of that area will also be increasing not too much. It will be just 1%. Lot of studies shows the positive and significant relationship between carbon tax and economic development. Our finding is closely related to (Fang et al. 2013, Loganathan et al. 2014, Sam Meng 2011, Joana chapa 2017, W Wissema, R Dellink 2007) which show positive impact of carbon taxation on economic development. Furthermore, the relationship of GDP with total emissions in all the provinces except Balochistan have positive and significant. Only Balochistan have insignificant relationship with GDP which means that with the increases in the economic development, the carbon



emissions will increase continuously. The empirical evidence from 28 countries indicates significant positive impact of CO<sub>2</sub> emissions on energy consumption for four global panels.

Economic growth has also a positive impact on energy (Saidi & Hammami s2015).

**Table 4.2 Projections**

Variables	2020	2025	2030	2035	2040	2045	2050
<b>Total emissions</b>	-0.318854	-0.131752	-0.035154	-0.003899	-0.003114	-0.002671	-0.001011
<b>GDP</b>	0.007324	0.039734	0.103933	0.141311	0.188320	1.975794	6.226735

All values are significant are 1%, 5% and 10% level

By using impulse response function, projections is up to 2050 to check the long run relationship between carbon tax, total emissions and growth. The result shows the significant relationship between carbon tax, total emissions and GDP, as one of climate scientist said:

*In present situation if we compare Pakistan's carbon emissions even on provincial level with other countries, we have seen that emissions are very low. Climate conditions suggest the country could produce enough power to both cover domestic needs and to export, along with associated equipment and technology. In future, Carbon emissions will increase due to the increasing projects in Pakistan like CPEC so putting carbon tax on carbon emissions is feasible option. It is a good indirect policy option which will control carbon emissions in future. (Dr Fahad saeed, 42, Austria)*

One side projection shows the reduction of emissions and on the other side, increases in growth of country by applying carbon tax of \$8. According to the scenario the rate of carbon tax will continue to increase by 2% every year up to 2050. The results show that as carbon tax

is increases yearly bases by 2%, the total emissions will also decreases. In 2020 the emissions are 31% but continuously increasing in carbon tax lead to decrees the emissions s in 2050 up to 0.01%. (Saleem, M 2015) shows similar relationship of carbon tax and carbon emissions (Saleem, M. 2015) also did projection till 2040. Revenues will be increase by increasing the rate of carbon tax. Results shows that revenues will continuously increasing as in the above table by increasing carbon tax every year by 2%. (Fang, G et al. 2013) find the impacts of carbon tax on energy intensity and economic growth in china which verifies our results. (Loganathan, N 2014) also discussed the link between green taxation and economic growth on CO2 emissions in Malaysia, which also shows the positive relationship between economic development and carbon tax.

## **Chapter No.5**

### **Conclusion**

The study addresses the impact of carbon tax on economic growth and reduction of carbon emissions in all the four provinces of Pakistan: Punjab, Sindh, KPK and Balochistan from 1997 to 2018. The study established the relationship between carbon tax, carbon emissions and economic growth. For this instance, this study uses different econometric techniques to check the relationship between variables. The study uses GIS Arc map technique to visualize the total emissions of each province of Pakistan. GIS Arc map shows total emissions of every single year. Panel Unit root test were applied to find out the stationarity of data than panel co-integration test was applied to plaid the relationship between all variables by using different tests. ARDL model is used to find out the impact of carbon tax on both, carbon emissions and economic growth. Projection up to 2050 were calculated by using impulse response function.

Total emissions are visualized by using Arc map GIS technique. Data shows the trend and variation of total emission in all the four provinces of Pakistan. The reasons behind the variation in total emission are clearly shows in the maps and shows the increasing, decreasing and constant trend of emissions in all four provinces of Pakistan as well.

All the variables of 1<sup>st</sup> model are significant at 1% level. Results of model 1<sup>st</sup> demonstrates that carbon emissions from all the provinces lead to reduction when carbon tax of \$8 was applied on that. The positive and significant relationship was shown between the dependent and independent variables. By applying \$8 carbon tax, Punjab's emissions was declining by 3%, Sindh's carbon emissions lessening by 6%, carbon emissions of KPK was

decreased up to 2% and Balochistan's carbon emissions declined by 0.5%. Results shows that major Laws Relevant to Environmental Mainstreaming and Efforts of Successive Pakistani Governments exists in all provinces except Balochistan. Dummy shows positive and significant relationship of Punjab, Sindh and KPK with carbon emissions but Balochistan did not ensure a lot of effort for environment.

Results of 2<sup>nd</sup> model reveal that economic growth, carbon emissions and carbon tax have significant and positive relationship. Results demonstrates that revenues generated in all the provinces by applying carbon tax. 3% revenue generated in Punjab by applying carbon tax. 4% in Sindh, 4% in KPK as well and 1% in Balochistan. Moreover, result shows positive impact of carbon taxation on economic development. Furthermore, the relationship of GDP with total emissions in all the provinces except Balochistan have positive and significant.

Base year for tax case scenario for carbon tax is 2020. \$8 carbon tax applied in 2020 which will increase by 2% every year. The projection was investigated up to 2050 for carbon emissions reduction and revenue generation by using impulse response function. The result shows the significant relationship between carbon tax, total emissions and growth. The result shows that as carbon tax will be increasing by 2% every year, the emissions will be reduced, and revenue will increase as well.

In conclusion, the carbon tax is indirect policy to reduce carbon emissions as per the motto of UNFCCC and sidewise revenue is also generated through carbon taxation. It is a better way to solve the emissions problem which can be seen in the results of this study. With increase in the demand of energy with the passage of time, the emissions will also be increases. Although Pakistan is not emitting but over the time and with the construction of CPEC project its emissions will also increases. After 18<sup>th</sup> amendment, it is provincial responsibility to deal with all these matters. The economic growth of all provinces is critically important but the

preservation of environment is also important which the responsibility of provincial government is as well. For protection of environment provinces needs sustainable growth to require economic development. Although dummy variables show that provincial level government made rules for environment but its implementation seems very rare.

## **5.1. Policy recommendation:**

After 18<sup>th</sup> amendment all the responsibilities were shifted to provinces government, so it is now provincial government responsibility to make proper policy for the reduction of carbon emissions. Carbon tax is an indirect and effective policy option to reduce carbon emissions in present as well as in past. Every province should have its own policy plan to reduce emissions according to their energy resources. This study provides comprehensive policy recommendation for reduction of carbon emissions at provincial level. The suggestions and recommendation at provincial level are following.

### **5.1a. Policy recommendation for Sindh:**

It is highly recommended that Sindh's carbon emissions are more than all other province which were calculated as 54% so Sindh government should make an appropriate plan to reduce its emissions. Most of the coal power projects are located in Sindh which are the main cause of emissions. Sindh government should move toward green development and cleaner technology to combat with carbon emissions. As new industries come into being because of CPEC project in future, the carbon emissions will lead to increase. So policy recommendation for Sindh as follows:

- Government should Enhance awareness of the impacts of climate change among all stakeholders for necessary appropriate measures to combat and minimize these impacts.
- A spread-out arrangement for sustainable national development ought to be planned which targets surveying and organizing supportable and environmentally friendly forms prompting alleviation and adjustment.
- Government should spend budget on research and development instead of giving subsidies on different product. R&D gives statistics through which most of the solution of different problem

such as poverty level, health problems, water problems and carbon emissions occurs then government can solve all these problems with more appropriate way.

- Sindh government should strictly put carbon tax on all the non-renewable resources generated firm to reduce carbon emissions.

### **5.1b. Policy recommendation for Punjab:**

Punjab government should also take serious action for mitigation of carbon emissions. Punjab has carbon emissions of 27%. Hence it come on 2<sup>nd</sup> number after Sindh. Punjab is using lot of energy resources to make country's economy strong but with these developments, the emissions are also raising. Policies for Punjab are as:

- There should be a special team to implement carbon tax on emissions generated industries and make sure the collection of these tax. These taxes should be used on other green technologies to overcome future emissions in the future.
- Develop an investment attraction strategy for foreign and domestic investors including PPPs, using carbon markets, applying for international climate funds and/or looking at opportunities for partnerships etc.
- Punjab government should likewise shape a positive strategy to energize manufacturing industries and private vitality who are consuming energy towards green venture like reimbursements on import or acquisition of machinery which are energy-efficient and sustainable power source.

### **5.1c. Policy recommendation for KPK:**

As KPK is producing 11% of carbon emissions from their energy sector. Although KPK government is doing good job to mitigate its emissions like billion tree tsunami project but

KPK government should concentrate more and put more effort to reduce its emissions level.

Policies for KPK are:

- Government of KPK should build up a policy that ought to permit less expensive credit to industrial and private buyers for introducing sustainable power sources like solar energy vitality, which won't just lessen the weight of supply of energy on government yet will likewise diminish carbon emissions along with private institution
- There was a deficiency of qualitative investigations with complete examination and clarifications of carbon emissions in province. Moreover, it is recommended that a more profound assessment of different areas ought to be directed that influences atmosphere, since the greater part of the retreat and flow investigate centers around explicit viewpoints yet needs point by point assessment of sectorial causes and effects of environmental change.
- De-carbonization technologies must be used which lead toward green growth.

#### **5.1d. Policy recommendation for Balochistan:**

Balochistan's province is producing only 7% of carbon emissions from total emissions of Pakistan. Balochistan is generating their emissions from natural gas and coal which are contributing in total emissions of Pakistan. Balochistan government have not done anything for their carbon emissions. It should concentrate on plan to mitigate its carbon emissions. Policies for Balochistan are:

- To reduce fragmentation of roles and responsibilities a climate change cell should be constituted in the P&D department to coordinate and oversee all climate-relevant investment and planning
- A Climate Change Authority should be established. This Authority should be responsible for formulating and enforcing climate-relevant laws and rules forming the basis for climate action



- The public should approach with their experience and comprehension of the climatic circumstance which can add to the improvement of alleviation and adjustment techniques at a higher degree.

## References:

Ahmad, E., & Stern, N. (1991). *The theory and practice of tax reform in developing countries*. Cambridge University Press.

Ahmad, E., Stern, N., (2009). *Effective Carbon Taxes and Public Policy Options: Insights from India and Pakistan*. Asia Research Centre Working Paper no. 28, London School of Economics and Political Science, London, UK.

Aichele, R., Felbermayr, G. (2013). The effect of the Kyoto Protocol on carbon emissions. *Journal of Policy Analysis and Management*, 32 (4), 731-757.

Anwar, J. (2014). The role of renewable energy supply and carbon tax in the improvement of energy security: a case study of Pakistan. *The Pakistan Development Review*, 53(4), 347-370.

Arouri, M. E. H., Youssef, A. B., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO<sub>2</sub> emissions in Middle East and North African countries. *Energy policy*, 45, 342-349.

Asian development bank. (2019). *Sri Lanka energy sector assessment, strategy, and road map*. ISBN 978-92-9261-888-9. Available at <https://www.adb.org/sites/default/files/institutional-document/547381/sri-lanka-energy-assessment-strategy-road-map.pdf>

Atlas, G. C. (2017). Available online: <http://www.globalcarbonatlas.org/en>. CO<sub>2</sub>-emissions (accessed on 3 August 2017).

Atlas, G. C. (2017). CO<sub>2</sub> emissions. Global Carbon Project, <http://www.globalcarbonatlas.org/en/CO2-emissions>.

Awodumi, O. B., & Adewuyi, A. O. (2020). The role of non-renewable energy consumption in economic growth and carbon emissions: Evidence from oil producing economies in Africa. *Energy Strategy Reviews*, 27, 100434.

Bernard, J. T., Kichian, M., & Islam, M. (2018). Effects of BC's Carbon Tax on GDP. USAEE Research Paper Series, (18-329).

Böhringer, C., & Rutherford, T. F. (1997). Carbon taxes with exemptions in an open economy: a general equilibrium analysis of the German tax initiative. *Journal of Environmental Economics and Management*, 32(2), 189-203.

Bruvoll, A., & Larsen, B. M. (2004). Greenhouse gas emissions in Norway: do carbon taxes work?. *Energy policy*, 32(4), 493-505.

Burtraw, D., Palmer, K., Bharvirkar, R., & Paul, A. (2002). The effect on asset values of the allocation of carbon dioxide emission allowances. *The Electricity Journal*, 15(5), 51-62.

Cass, D. (1965). Optimum growth in an aggregative model of capital accumulation. *The Review of economic studies*, 32(3), 233-240.

CDIAC (Carbon dioxide information analysis center). (2015). Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy. Available at <https://cdiac.ess-dive.lbl.gov/>

Chaudhry, Q. U. Z. (2017). Climate change profile of Pakistan. Asian Development Bank.

Coalition, C. P. L. (2019). Report of the High-Level Commission on Carbon Pricing and Competitiveness. Available online: <https://www.ipcc.ch/reports/> (accessed on 1 July 2019).

Cong, R., & Lo, A. Y. (2017). Emission trading and carbon market performance in Shenzhen, China. *Applied Energy*, 193, 414-425.

Cong, R., & Lo, A. Y. (2017). Emission trading and carbon market performance in Shenzhen, China. *Applied Energy*, 193, 414-425.

Congressional budget office (2016). The Budget and Economic Outlook. [Accessed on January 25, 2016]. Available at: <https://www.cbo.gov/>

CPEIR, (2015). Pakistan-climate public expenditure and institutional review (CPEIR). United nation development Programme, Islamabad.

Devarajan, S. D. S., & Delfin, S. Go, Sherman Robinson, and Karen Thierfelder, (2009). Tax Policy to Reduce Carbon Emissions in South Africa. The World Bank.

DP, C. (2018). CDP global climate change report 2015.

Epstein, L. G., & Zin, S. E. (1991). Substitution, risk aversion, and the temporal behavior of consumption and asset returns: An empirical analysis. *Journal of political Economy*, 99(2), 263-286.

Fang, G., Tian, L., Fu, M., & Sun, M. (2013). The impacts of carbon tax on energy intensity and economic growth—a dynamic evolution analysis on the case of China. *Applied energy*, 110, 17-28.

Federal board of revenue, (2019). Income tax ordinance, 2001 amended up to 31.12.2019. Available: <http://download1.fbr.gov.pk/Docs/INCOME%20TAX%20ORDINANCE,%202001%20AMENDED%20UPTO%2031.12.2019-final.pdf>

Feltenstein, A., Mejia-Mantilla, C., Newhouse, D., & Sedrakyan, G. (2017). The poverty implications of alternative tax reforms: Results from a numerical application to Pakistan. The World Bank.

Funke, F., & Mattauch, L. (2018). Why is carbon pricing in some countries more successful than in others. *Our World in Data*, 10.

Global environment performance index (EPI). (2018). Air quality top public health threat [accessed on January 23, 2018]. Available at <https://epi.envirocenter.yale.edu/>

Gowdy, J., & Salman, A. (2007). Climate change and economic development: A pragmatic approach. *The Pakistan Development Review*, 337-350.

Grunewald, N., Martinez-Zarzoso, I. (2016). Did the Kyoto Protocol fail? An evaluation of the effect of the Kyoto Protocol on CO<sub>2</sub> emissions. *Environment and Development Economics*, 21 (01), 1-22

Hammar, H., Löfgren, Å., & Sterner, T. (2004). Political economy obstacles to fuel taxation. *The Energy Journal*, 1-17.

Hanson, D. L., & Koopmans, L. H. (1965). On the convergence rate of the law of large numbers for linear combinations of independent random variables. *The Annals of Mathematical Statistics*, 559-564.

Hong, J., Shen, G. Q., Feng, Y., Lau, W. S. T., & Mao, C. (2015). Greenhouse gas emissions during the construction phase of a building: a case study in China. *Journal of cleaner production*, 103, 249-259.

Husnain, M. I. U., Haider, A., Salman, A., Zahid, H. M., Khan, M., & Shaheen, F. (2016). An econometric analysis of the statistical relationship between carbon dioxide emissions and infant mortality in South Asia. *Journal of Scientific Research and Reports*, 1-8.

Husnain, M. I., Haider, A., & Salman, A. (2015). Determining the Optimal Level of Taxes in South Asia: An Unbalanced Budget Approach. *The Empirical Economics Letter*, 14(8), 809-815.

Ian Parry (2019). What Is Carbon Taxation? Carbon taxes have a central role in reducing greenhouse gases finance & development, VOL. 56, NO. 2. Available at <https://www.imf.org/external/pubs/ft/fandd/2019/06/pdf/what-is-carbon-taxation-basics.pdf>

INDC, (2015). Pakistan- Intended nationally determined contribution, submitted to COP21. <http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx> (accessed 02-06-2016)

Iqbal, K. M. J., & Ahmad, M. (2011). Mainstreaming Pakistan for Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+): The way forward to Readiness Phase. Islamabad: Sustainable Development Policy Institute.

Irfan, Muhammad, and Javaid Attari., (2011).The Decomposition Analysis of CO 2 Emissions and Economic Growth in Pakistan India and China 5(2): 330–343.

Jing, R., Cheng, J. C., Gan, V. J., Woon, K. S., & Lo, I. M. (2014). Comparison of greenhouse gas emissions accounting methods for steel production in China. *Journal of cleaner production*, 83, 165-172.

K. A. Mir and M. Ijaz. (2015). Greenhouse Gas Emissions Inventory of Pakistan for the Year 2011–2012. Islamabad: Global Change Impact Studies Centre (GCISC).

Khan, Asghar & Rehman, Ashfaq & Ahmad, Ayaz & Ashfaq, Shughla. (2018). Environmental governance and the assessment of manifestos of Pakistan's political parties. 6. 1750-1761.

Khan, M. K., Khan, M. I., & Rehan, M. (2020). The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. *Financial Innovation*, 6(1), 1-13.

Kreft, S., Eckstein, D., Dorsch, L., Fischer, L., (2016). Global Climate Risk Index. Who suffers most from extreme weather weather-related loss event in 2014 and 1995-2014? <http://germanwatch.org/en/download/13503.pdf> (accessed 26-03-2016)

Lin, B., & Ahmad, I. (2017). Analysis of energy related carbon dioxide emissions and reduction potential in Pakistan. *Journal of cleaner production*, 143, 278-287.

Lin, B., & Li, X. (2011). The effect of carbon tax on per capita CO<sub>2</sub> emissions. *Energy policy*, 39(9), 5137-5146.

Litschke, T. (2005). Innovative technologies for exploration, extinction and monitoring of coal fires in North China: detailed mapping of coal fire sites in combination with in situ flux measurements of combustion-gases to estimate gas flow balance and fire development (Wuda Coal Field, Inner Mongolia Autonomous Region). Unpublished PhD thesis) Universität Duisburg-Essen, Dortmund (<http://www.coalfire.caf.dlr.de/media/download/results/Diplomarbeit-Litschke.pdf> (accessed 22 March 2013)).

Loganathan, N., Shahbaz, M., & Taha, R. (2014). The link between green taxation and economic growth on CO<sub>2</sub> emissions: fresh evidence from Malaysia. *Renewable and Sustainable Energy Reviews*, 38, 1083-1091.

Loulou, R., Goldstein, G., & Noble, K. (2004). Documentation for the MARKAL Family of Models. *Energy Technology Systems Analysis Programme*, 65-73.

Malik, W., Shahid, H., Zafar, R., Uddin, Z., Wazir, Z., Anwar, Z., & Ali, S. S. (2012). Role of Pakistan in global climate change through greenhouse gas emissions (GHGs). *Research Journal of Environmental and Earth Sciences*, 4(11), 996-1001.

Malik, W., Shahid, H., Zafar, R., Uddin, Z., Wazir, Z., Anwar, Z., & Ali, S. S. (2012). Role of Pakistan in global climate change through greenhouse gas emissions (GHGs). *Research Journal of Environmental and Earth Sciences*, 4(11), 996-1001.

Marron, Donald, Eric Toder, and Lydia Austin. (2015). "Taxing Carbon: What, Why, and How." Washington, DC: Urban-Brookings Tax Policy Center. (June 25, 2015).

Metcalf, G. E. (2009). Designing a carbon tax to reduce US GREENHOUSE GAS emissions. *Review of Environmental Economics and Policy*, 3(1), 63-83.

Metcalf, G. E. (2019). On the economics of a carbon tax for the United States. *Brookings Papers on Economic Activity*, 2019(1), 405-484.

Metcalf, G. E., & Stock, J. H. (2020). Measuring the Macroeconomic Impact of Carbon Taxes. In *AEA Papers and Proceedings* (Vol. 110, pp. 101-06).

Munir, S., & Khan, A. (2014). Impact of fossil fuel energy consumption on CO<sub>2</sub> Emissions: Evidence from Pakistan (1980-2010). *The Pakistan Development Review*, 327-346.

National aeronautics and space administration. (2018). Missions That Observe CO<sub>2</sub>. [Accessed on April 2020]. Available at: <https://climate.nasa.gov/vital-signs/carbon-dioxide/>

National Climate Change Policy, (2012). Ministry of Climate Change, Government of Pakistan, Islamabad. [Accessed on September 2012]. Available at: [http://www.gcisc.org.pk/National\\_Climate\\_Change\\_Policy\\_2012.pdf](http://www.gcisc.org.pk/National_Climate_Change_Policy_2012.pdf)

National Treasury. (2013). Carbon tax policy paper: Reducing greenhouse gas emissions and facilitating the transition to a green economy.

Nava, P. (2009). Minimizing carbon emissions in metal forming (Doctoral dissertation). Queen's University Kingston, Ontario, Canada.

Nor, N. H. M., Selamat, S. N., Rashid, M. H. A., Ahmad, M. F., Jamian, S., Kiong, S. C., & Yokoyama, S. (2016). Carbon Sequestration and Carbon Capture and Storage (CCS) in Southeast Asia. In *Journal of Physics: Conference Series* (Vol. 725, No. 1, p. 012010). IOP Publishing.

Nordhaus, W. D. (2007). A review of the Stern review on the economics of climate change. *Journal of economic literature*, 45(3), 686-702.

Nordhaus, W. D., & Yang, Z. (1996). A regional dynamic general-equilibrium model of alternative climate-change strategies. *The American Economic Review*, 741-765.



Nordhaus, William D. (1992). An optimal transition path for controlling greenhouse gases. *Science* 258 (November 20): 1315–19.

Nordhaus, William D. (1994). *Managing the global commons: The economics of climate change*. Cambridge, MA: MIT Press.

Nordhaus, William D. (2008). *A question of balance: Weighing the options on global warming policies*. New Haven, CT: Yale University Press.

Nordhaus, William D. (2010). Economic aspects of global warming in a post-Copenhagen environment. *Proceedings of the U.S. National Academy of Sciences* 107, no. 26:11721–26.

Office of national statistics UK (2018). A guide to interpreting monthly gross domestic product. [Accessed on 10 July, 2018]. Available at <https://www.ons.gov.uk/economy/grossdomesticproductgdp/methodologies/aguidetointerpretingmonthlygrossdomesticproduct>

Palamalai, S., Ravindra, I., & Prakasam, K. (2015). Relationship between energy consumption, CO<sub>2</sub> emissions, economic growth and trade in India. Srinivasan P, Inder SR and Karthigai P.(2015), Relationship between Energy Consumption, CO<sub>2</sub> Emissions, Economic Growth and Trade in India, *International Journal of Economics*, 2(1), 1-17.

Pao H, Tsai C. (2010). CO<sub>2</sub> Emissions, energy consumption and economic growth in BRIC countries. *Energy Policy* 2010; 38:7850–60.

Plumer, B., & Popovich, N. (2019). These Countries Have Prices on Carbon. Are They Working? *The New York Times*, the New York Times.

Qayyum, M. (2019). *Environmental Mainstreaming in Pakistan: A Public Policy Analysis for Environmental Assessment* (Doctoral dissertation, National Defence University, Islamabad).

Quadrat-Ullah, H. (2015). Independent power (or pollution) producers? Electricity reforms and IPPs in Pakistan. *Energy*, 83, 240-251.

Ramsey, F. P. (1928). A mathematical theory of saving. *The economic journal*, 38(152), 543-559.

Rogelj, J., Den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., Meinshausen, M. (2016). Paris Agreement climate proposals need a boost to keep warming well below 2° C. *Nature*, 534 (7609), 631-639.

Saidi, K., & Hammami, S. (2015). The impact of CO<sub>2</sub> emissions and economic growth on energy consumption in 58 countries. *Energy Reports*, 1, 62-70.

Saleem, M. M., Khan, M. B., & bin Sarwar, U. (2015). The Impact of Carbon Tax Policies on Future Carbon Emissions from Pakistan's Energy Sector Using the Times Modeling Framework. *Explore Islamabad J. Soc. Sci.*, 1(6), 193-198.

Shahbaz, M., & Feridun, M. (2012). Electricity consumption and economic growth empirical evidence from Pakistan. *Quality & Quantity*, 46(5), 1583-1599.

Sher, H. A., Iqbal, S., & Qureshi, S. A. (2006). Kyoto Protocol and its Implementation in Pakistan; Hurdles and Expectations. *Technology*, 217(11), 228.

Sterner, T., & Köhlin, G. (2003). Environmental taxes in Europe. *Public finance and management*, 1.

Sterner, T., Dahl, C., & Franzen, M. (1992). Gasoline tax policy, carbon emissions and the global environment. *Journal of transport economics and policy*, 109-119.

Tan, C. S., Maragatham, K., & Leong, Y. P. (2013). Electricity energy outlook in Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 16, No. 1, p. 012126). IOP Publishing.

Tetzlaff, A. (2004). Coal Fire quantification using ASTER, ETM and BIRD satellite instrument data (Doctoral dissertation, lmu).

The World Bank (2018). Building a Climate-Resilient South Asia. [Accessed on April 20, 2018]. Available at <https://www.worldbank.org/>

The World Bank. (2010). World Bank Energy Project in Pakistan: Pakistan Energy Situation. Available at <https://www.worldbank.org/>

United nation for climate change. (2018). Unlocking the Inclusive Growth Story of the 21st Century. [Accessed on September 5, 2018]. Available at <https://www.un.org>

United States Environmental protection agency (2018). U.S. Greenhouse Gas Emissions and Sinks. Environmental System Science Data Infrastructure for a Virtual Ecosystem. Available at: <https://www.epa.gov/>

Verde, S. F., & Tol, R. S. (2009). The distributional impact of a carbon tax in Ireland. *The Economic and Social Review*, 40(3), 317.

Wei, J., Hennlock, M., Johansson, D. J., & Sterner, T. (2012). The fossil endgame: strategic oil price discrimination and carbon taxation. *Journal of Environmental Economics and Policy*, 1(1), 48-69.

Willenbockel, D. (2011), "Environmental tax reform in Vietnam: an ex ante general equilibrium assessment", MPRA Paper, 44411.

Wissema, W., & Dellink, R. (2007). AGE analysis of the impact of a carbon energy tax on the Irish economy. *Ecological economics*, 61(4), 671-683.

World Resources Institute's Climate Analysis Indicator Tool (WRI CAIT). (2015). Available at <https://www.wri.org/our-work/project/cait-climate-data-explorer>.

Yamazaki, A. (2017). Jobs and climate policy: Evidence from British Columbia's revenue-neutral carbon tax. *Journal of Environmental Economics and Management*, 83, 197-216.



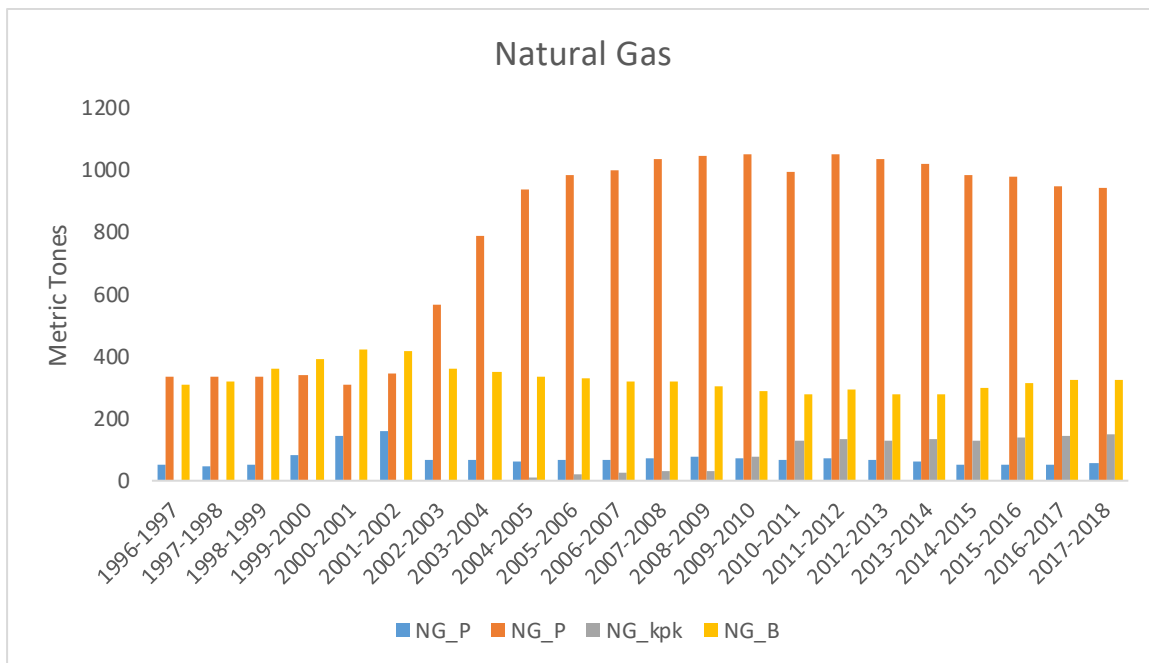
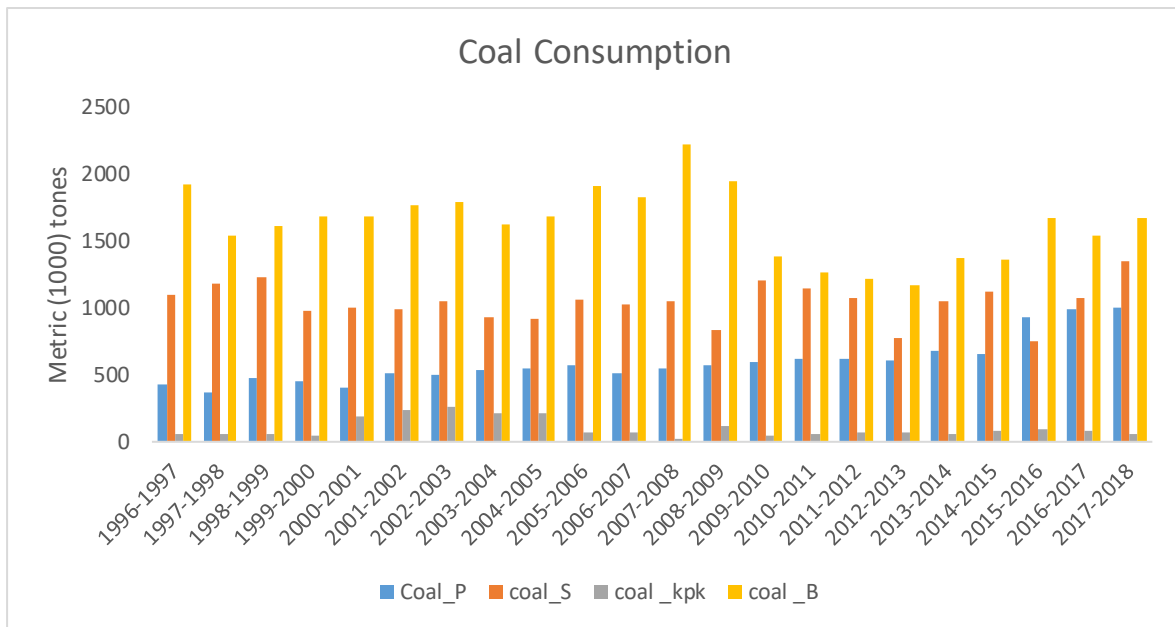
## **Appendix I:**

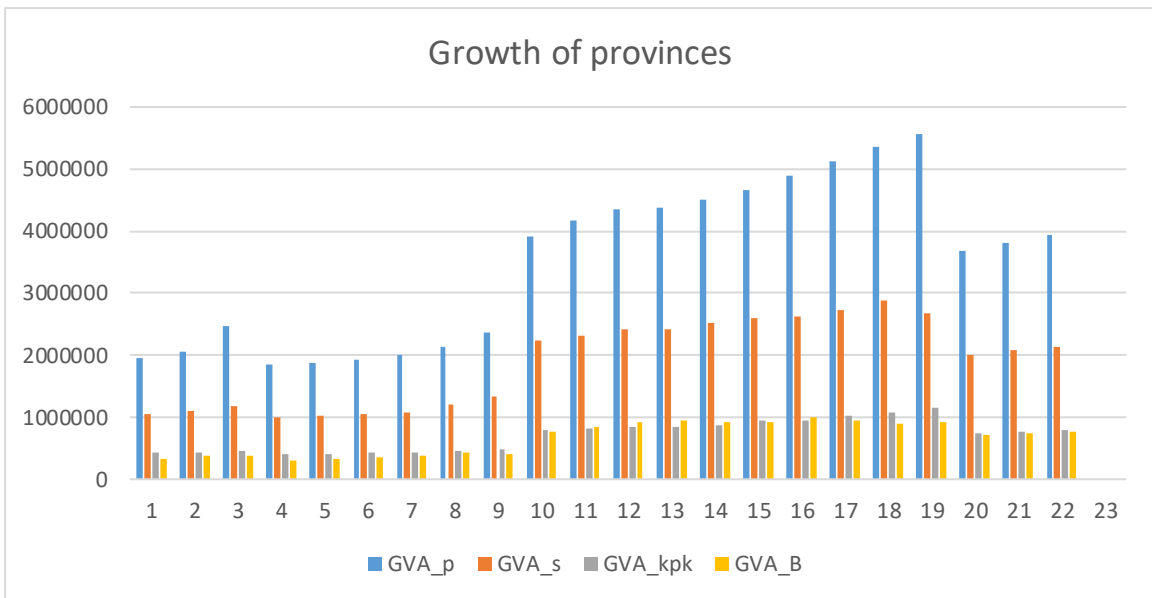
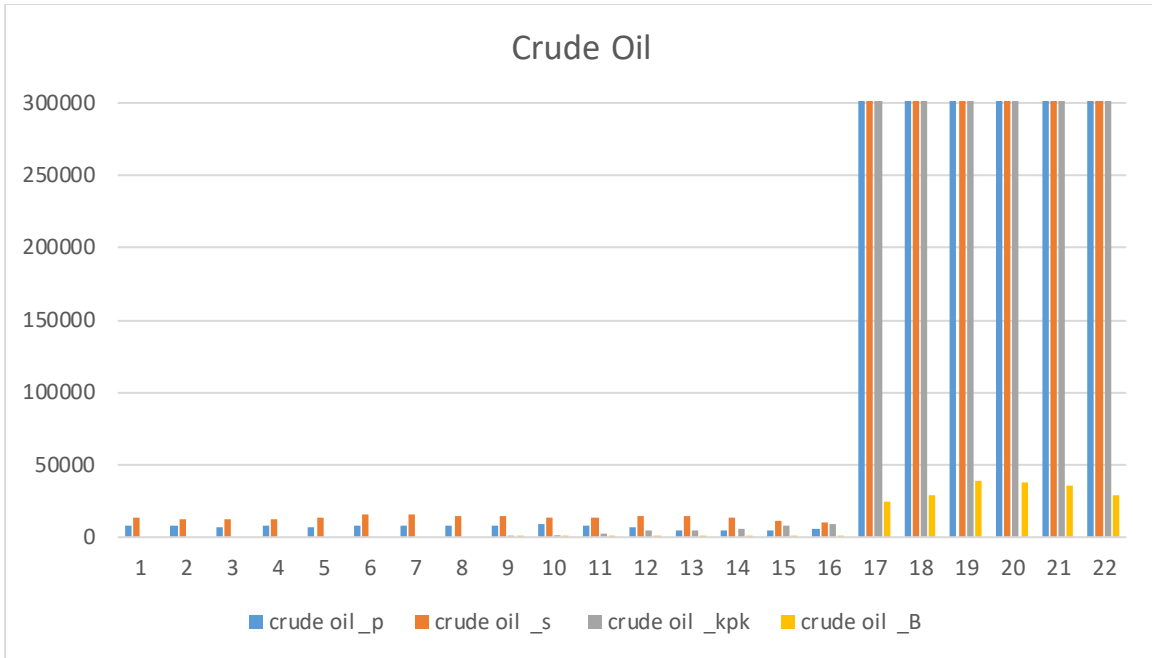
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## Appendix II: Graphical presentation of all the variables:





# Electricity

