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CO2 Emissions, Health Expenditures, and Economic Growth Nexus in Pakistan

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ABSTRACT

Climate change has an impact on human health, and it is generally known that environmental degradation and climate change are related. The utilization of fossil fuels results in more CO2 emissions into the atmosphere, a greenhouse gas that dramatically raises global temperatures. By replacing oxygen in the atmosphere, CO2 emissions have an impact on human health. While CO2 emissions hurt human health, sometimes economic expansion has a favorable impact on public health and vice versa. Using the Autoregressive Distributive Lag model (ARDL) and annual time series data from 1985 to 2020, this study aims to investigate the relationship between CO2 emissions, health spending, and economic growth in Pakistan. The empirical findings of this study demonstrate a substantial long-run and short-run relationship. To use technologies that cause emissions, the government must increase its investment in renewable energy sources and implement carbon taxes.

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1. Introduction

The nexus among health expenditure, economic growth, and CO2 emissions has been extensively discussed. Raising the deterioration in environmental conditions is a very serious issue across the world, bad environment affects human health because of the raising risk of global warming. Greenhouse, gas emissions are rising and creating a disturbing condition for climatic change and global warming (B. Zhang, Wang, & Wang, 2017). Greenhouse gas emissions and global warming increase due to burning fossil fuels which affect environmental quality. Due to human activity, greenhouse gases like carbon dioxide and sulfur dioxide, two major contributors to climate change, are having an ever-growing negative influence (Behera & Dash, 2017). CO2 emissions creates negative externalities and affects human health. This study is therefore intended to investigate the effects of both economic growth and CO2 emissions on health spending in the setting of Pakistan. CO2 emissions negatively affects health and this lead to reduce economic growth.

Previous studies describe the nexus between health expenditure, CO2 emissions, and economic growth for example, Baldacci (2004) explored expenditure on health impacts positively on economic growth because when peoples are healthy, they work more and productivity will increase. The industrial sector generates large amounts of CO2 emissions by using fossil fuels but this sector is important for strong economic growth and found that CO2 emissions negatively affects human health (Bakhsh, Rose, Ali, Ahmad, & Shahbaz, 2017). Moreover, Chaabouni and Saidi (2017) concluded in the previous studies, CO2 emissions rise health problem for human and this cause reduced economic growth, most of the previous literature describes the connection between CO2 emissions along with health expenditure and the results indicate that CO2 emissions positively links with health expenditure.

Sen, Kaya, and Alpaslan (2015) highlighted the fundamental nexus between GDP growth and health expenditure in eight developing states by employing Granger causality, causality results found unidirectional causal nexus from health spending to economic growth. Some researchers studied environmental degradation, especially CO2 emissions cause of various diseases in Pakistan such as skin allergy, cardiovascular disease, and asthma (Anwar, Ahmed, & Asghar, 2012; Majid, Madl, & Alam, 2012; Shahid & Hussain, 2013; Wang, Gillani, Nazir, & Razzaq, 2023). CO2 emissions is increased in the air because of the use of fossil fuels and this also causes climate change (Ahmad, Bhatti, Urooj, & Javed, 2022). CO2 emissions creates negative externalities and effects on both human health and economic growth. Some studies recognized the nexus between health expenditure and CO2 emissions for, example, Odusanya, Adegboyega, and Kuku (2014) raised the amount of CO2 emissions led to an increase in health expenditure in both the short and the long run.

Jacobson (2008) investigates the nexus between CO2 emissions and health expenditure and describes that CO2 is a main offender of air pollution because this increases matter and leads to an increase in ozone surface and also affects human health, also explains that increasing rate of hospitalized people and death that is severely effects on labor productivity and also economic growth. Similarly, there isa positive connection between health expenditure and CO2 emissions, the findings indicate that CO2 emissions have an impact on both healthcare costs and economic growth. Abdullah, Azam, and Zakariya (2016) examines CO2 emissions effects positively on health expenditure because when CO2 emissions increase then expenditure on health will also increase and also implying air pollution rises public spending on health, health expenditure, and income are greatly contributed to improving health conditions and Childhood mortality reducing by improving public health expenditure (Boachie et al., 2014). Several studies have been concluded to explore the environmental degradation effects on health expenditure and found a significant link between environmental degradation and health expenditure (Chaabouni, Zghidi, & Mbarek, 2016; Narayan & Narayan, 2008; Siti Khalijah, 2015; Toplicianu & Toplicianu, 2014).

Air pollution damages environmental conditions (Nazir, Gillani, & Shafiq, 2023). Pakistan is one of the more affected countries due to air pollution (Kalim, 2001). Air pollution affects human health negatively and also negatively affects the productivity of labor in every sector, hence this pollution affects economic growth (Shafiq, Gillani, & Shafiq, 2021). In China, air pollution harms both the environment and the economy, which in turn affects people's health (Zhang, Jin, & Zhu, 2018). The CO2 emissions contain severely affect the health condition of humans in Pakistan (Zaman, Shahbaz, Loganathan, & Raza, 2016). When the environment is healthy then would make It is easy to accomplish positive results in all facets of life, and doing so will contribute to the development of a culture that values welfare, a healthy environment, and gainful employment. Investment is important in a healthy workplace because this improves health conditions and increases productivity, when people are healthy then healthier people work more and harder, long, and better (Amiri & Ventelou, 2012; Bloom & Canning, 2000; Shafiq, ur Raheem, & Ahmed, 2020).

Considering the rapidly increasing environmental problem in Pakistan, the goal of this study is to explore the impact of CO2 emissions and economic growth in Pakistan and also examine the causal nexus among health expenditure, economic growth, and CO2 emissions. Past literature confirms causal relationships vary from country to country as well as the impact of CO2 emissions on health expenditure and the impact of economic growth on health expenditure, there are no unanimous results from all the literature so it is a very important issue so there is need to understand this topic in the context of Pakistan, that is why the purpose of this study find the nexus among CO2 emissions, economic growth and health expenditure in Pakistan. Our research's primary contribution to previous studies.

This study looks at the relationship between CO2 emissions, economic growth, and health spending in Pakistan. Second, this research will be useful for the policymakers of Pakistan and will give other developing nations like Pakistan some crucial insight. For the long-run and short-run estimations, we employ the autoregressive distributed lag technique. VECM Granger causality tests are used to determine the relationships between our study variables. ADF unit root test is also used to verify that the data are steady. Third, this analysis suggests all-encompassing policy recommendations for reducing CO2 emissions without sacrificing economic expansion and health spending. The following is the order in which our study is structured: "Literature Review" "Methodology." "Empirical results" "Discussion and Conclusion" includes a suggestion for policy.

2. Literature Review

A literature review is an inclusive summary of previous exploration on the topic. The objective of this section is to review relevant studies on the nexus between economic growth, CO2 emissions, and health expenditure. The following strands have examined the pairwise relationship between our study variables:

2.1 Health Expenditure and Economic Growth

Health shows a central part in stimulating economic growth. Several kinds of literature are available on this issue in emerging and advanced nations. According to Reza and Valeecha (2012), In Pakistan, there is a strong correlation between health spending and economic expansion. Rengin (2012) and Sevda (2014) in their study of Turkey found health spending positively impacts economic growth. Research conducted by Eggoh, Houeninvo, and Sossou (2015), they explored the context of 49 African states using data from 1996-2010 by applied panel and cross-sectional techniques and found negative nexus from health expenditure to economic growth. Mladenović, Milovančević, Mladenović, Marjanović, and Petković (2016), analyzed in the context of 28 countries in the European Union using data from 1974 to 2015 by using the ANFIS model and Toda Yamamoto causality technique and concluded there is bidirectional causal nexus between health spending and economic growth. Bedir (2016) explored the nexus between health spending and growth output in Asian nations using data from the period 1995 to 2013 by applying the Granger causality approach and found Health expenditure is a positive impact on per capita GDP. Similarly, Atilgan, Kilic, and Ertugrul (2017) also discovered a strong connection between GDP and health spending. Aboubacar and Xu (2017) explored linkages between GDP growth and health expenditure in Africa taking data from 1995-2014 by using the GMM technique and found both GDP and healthcare spending are positively linked and also provides policy recommendation, nations develop efficient healthcare program, create a good environment and arise healthcare expenditure.

2.2 CO2 Emissions and Economic Growth

The second stand describes the nexus between CO2 emissions and economic growth. It is the most debated topic of research among economists and policymakers. The conclusions are drowning from these related studies may vary due to different data periods, data, and methodologies. The causal nexus can be understandable in four different ways through hypotheses such as the unidirectional hypothesis, bidirectional hypothesis,

neutrality hypothesis, and EKC hypothesis (Bhatti, ur Raheem, & Zafar, 2020). Saboori, Sulaiman, and Mohd (2012) in the context of Malaysia took data from the period 1980-2009 by using the ARDL model and VECM technique and found no causal link between CO2 emissions and GDP and support neutrality hypothesis. Al-mulali, Lee, Mohammed, and Sheau-Ting (2013) in America data from 1980 to 2008 by using Canonical cointegration, and Granger causality analysis found bidirectional nexus between CO2 emissions and accelerating GDP, Govindaraju and Tang (2013) in India taking data from 1965-2009 by using ARDL method and Johansen found unidirectional hypothesis. Farooq, Gillani, Subhani, and Shafiq (2023) in the context of BRICS economies took data from 2000 to 2019 by using the FMOLS and DOLS techniques found that economic policy uncertainty has positive impact on environmental degradation. Danish and Wang (2018) in the context of Pakistan uses structural breaks to analyze data from 1970 through 2011 and Johansen, ARDL method found cointegration among study variables and a unidirectional hypothesis. Ghorashi and Rad (2017) in Iran, a bidirectional nexus between CO2 emissions and GDP growth was discovered utilizing data from 1972 and 2012 combined with a dynamic simultaneous equation model, ADF test, and causality analysis. Using data from 1980 to 2014 and the ARDL approach, Chen, Wang, and Zhong (2019) in China discovered a bidirectional relationship between GDP growth and CO2 emissions. Similar findings were made by some research conducted in various nations, including Fazal, Gillani, Amjad, and Haider (2020) in Thailand, Gillani and Sultana (2020); Hanif, Nawaz, Hussain, and Bhatti (2022) in ASEAN countries.

2.3 CO2 Emissions and Health Expenditures

The third stand regarding the nexus between CO2 emissions and health spending. Boachie et al. (2014) in Ghana took data from 1970-2008 by using the FMOLS method and discovered that CO2 emissions had no impact on health care costs. Qureshi, Khan, Rasli, and Zaman (2015) using data from 2000 to 2013 in 5 SAARC countries this study covers the nexus between environmental quality and health spending and found no nexus between health expenditure and CO2 emissions. Yahaya, Nor, Habibullah, Ghani, and Noor (2016) in the context of 125 developing nations taking data from 1995 to 2012 by using panel cointegration and found that CO2 emissions negatively affects human health, this study also provides advice to policymakers that develop healthcare institutions, provide healthcare facilities to human and solve environmental problems. Chaabouni et al. (2016) in 51 countries covered the nexus between health expenditure, growth, and emissions of CO2 taking data from 1995 to 2013 by using a Simultaneous equation model and found bidirectional nexus from CO2 emissions to health spending, Balan (2016) in EU 25 countries taking data from 1990 to 2014 by using Panel least square method found a link between CO2 emissions and health. Chaabouni and Saidi (2017) in 51 countries taking data from 1995 to 2013 by using GMM and causality technique found unidirectional nexus from CO2 emissions to health. Khoshnevis Yazdi and Khanalizadeh (2017) using data from 1995 to 2014, MENA countries discovered that CO2 emissions and income have a long-term, favorable impact on health expenditure. Zaidi and Saidi (2018) establish environmental issues mainly emissions (CO2) create serious health problems for humans.

3. Methodology

3.1 Model Specification

By following the proposed model based on previous studies (Khoshnevis Yazdi & Khanalizadeh, 2017). The functional form of the model becomes

$$\mathrm{HE}_t = \mathrm{f}\left(\mathrm{CO}_{2_t}, \mathrm{GDP}_t\right) \quad (1)$$

Whereas in equation 1 HE is health expenditure, GDP is ga ross, domestic product, and CO2 is a carbon dioxide emission. After the functional form, the econometric form is as follows:

$$\mathrm{LHE}_t = \beta_0 + \beta_1 LCO_{2,t} + \beta_2 LGDP_t + \varepsilon_t \quad (2)$$

In equation 2, CO2 emissions is measured as CO2 emissions (Kilo ton per capita) data collected from the BP Statistical Review of World Energy, and health expenditure is measured as expenditure on health by government (per capita Pak Rs) data extracted from Pakistan Economic Survey published from Government of Pakistan, GDP per capita (Constant Pak Rs) used as an indicator to measure the economic growth data taken from the World Development Indicators (WDI) published from World Bank. Here is the period, $\beta_0, \beta_1, \beta_2$ are the slope parameters and ε_t is the error term. Health expenditure is the dependent variable, and GDP and CO2 emissions are independent variables. All variables are expressed in log form.

3.2 Econometric Methods

For examining short-term and long-term link among variables, we examine the effects of economic expansion and CO2 emissions on health expenditure by using the Autoregressive distributed lag technique. The main advantage of the ARDL approach if all variables have been stationary at the level or the first difference then ARDL approach is applicable. It is also applicable to mixed order of stationarity of variables such as I(0) and I(1). If the order of integration is more than I(1) means variables are stationary at the 2nd difference then ARDL cannot be applied. Therefore, first, we use the ADF unit root test to examine the stationarity of the variables. Time series annual data is stationary if some of these conditions are existing, such as variance, covariance, and mean all are found to be invariant. If the variables come stationary it means that the mean, variance, and auto covariance of the variables are constant but it does not mean that variable mean, variance, and auto covariance are not constant over time. Dickey and Fuller (1979) presented the idea of Augmented Dicky- Fuller (ADF) to analyze the data stationary of the variables with the help of the unit root analysis. Check the data's level (0) stationary first, which indicates that it is stationary at order I (0). If the variable is not stationary at the level, it is stationary at the first difference if it is stationary at order I (1). The variables are stationarity at the second difference in the DF test if they are not stationary at the level and first difference. We employed the Autoregressive distributed broadly approach after looking at the stationarity of the variables and applied the long and the s-term analysis. Pesaran, Shin, and Smith (2001) suggested this strategy. In terms of econometrics, the ARDL model is a time series data model in which present values of dependent values are forecasted based on both their present values and their lagged values using a regression equation. In ARDL form, equations can be written:

$$lnHE_t = \alpha + \beta_1 lnHE_{t-1} + \beta_2 lnCO_{2,t-1} + \beta_3 lnGDP_{t-1} + \sum_{i=1}^{p_1} \delta_1 \Delta lnHE_{t-1} + \sum_{i=0}^{p_2} \delta_2 \Delta lnCO_{2,t-1} + \sum_{i=0}^{p_3} \delta_3 \Delta lnGDP_{t-1} + \varepsilon_t \quad (3)$$

In this model, whereas α is a constant, Δ designates the first difference, and $\delta_i$is the short-run coefficient of ARDL models. And the β_i parameter is the long run multiplier. By using equations as given below, we can evaluate long and short run parameters, ε_t represent as error terms. The long-run equation is estimated by using the ARDL equation:

$$LHE_t = \alpha + \sum_{i=1}^{p_1} n_1 LHE_{t-1} + \sum_{i=0}^{p_2} n_2 LCO_{2,t-1} + \sum_{i=0}^{p_3} n_3 LGDP_{t-1} + \omega ECM_{t-1} + \varepsilon_t \quad (4)$$

After estimating long-run equation, the short-run equation can be estimated with an error correction model based on the following equation:

$$\Delta LHE_t = \alpha + \sum_{i=1}^{p_1} \lambda_1 \Delta LHE_{t-1} + \sum_{i=0}^{p_2} \lambda_2 \Delta LCO_{2,t-1} + \sum_{i=0}^{p_3} \lambda_3 \Delta LGDP_{t-1} + \omega ECM_{t-1} + \varepsilon_t \quad (5)$$

Table 1
Measurement of Variables

Variables	Description	Measurement	Source
LCO2	Log of CO2 emissions	Kilo ton	BP (SRWE)
THE	Log of health expenditure	Per capita Pak rupees	Pak. Economic Survey
LGDP	Log of Gross domestic product	Per capita (Const. PKR)	WDI

Source: Compiled by author

3.3 Data and Sources

This study uses the annual time series secondary data from the period 1982 to 2018. Due to no availability of data after 2019, on GDP, health expenditure, and CO2 emissions, this study uses data up to 2018. Data on gross domestic product is taken from the World Development Indicators (WDI, 2021) published by World Bank. Data on health expenditure is extracted from Pakistan Economic Survey (2021) published by the Government of Pakistan. The Statistical Review of World Energy by BP (2021) is where information on CO2 emissions is gathered.

In present study:

- Health expenditure is used as an indicator to measure expenditure on health by the government and expressed in natural log
- GDP per capita (Constant Pak Rs) used as an indicator to measure economic growth and is expressed in natural log
- CO2 emissions (kt) used as an indicator to measure the carbon dioxide emissions and expressed in natural log

4. Estimation Results and Discussions

By using the ADF unit root technique to check the stationarity of variables. Dickey and Fuller (1979) presented the idea of Augmented Dicky- Fuller (ADF) to analyze the data stationary of the variables with the help of the unit root analysis. The results of the ADF test are represented in table 2, which shows all are non-stationary at the level and stationary at 1st difference. The ADF analysis results decide the econometric techniques. The ADF test for unit root results recommended us for using the ARDL technique because all the variables are integrated at I(I). After estimating the results of the ADF unit root test we check cointegration among the variables by applying ARDL bound testing. The results of the ARDL model for the long run and short run are represented in table 3. As F-statistics value is greater than the upper bound at 1 percent 5 percent and 10 percent. This means long-run relationship exists when health expenditure is the dependent variable.

4.1 ADF Unit Root Results

The ADF unit root test results are presented in table 2 which shows the stationarity of the variables, variables the log of health expenditure, log of CO2 emissions, and log of GDP all are non-stationary at the level and stationary at 1st difference.

Table 2
ADF Unit Root test

Variables	at level	P- value	at 1st diff	P- value	Status
THE	-2.275541	0.1850	-6.432330	0.0000*	I(1)
LCO2	-1.628560	0.7615	-5.924169	0.0000*	I(1)
LGDP	-0.181602	0.9318	-3.607804	0.0106**	I(1)

Note; *Significant at the 1 percent **Significant at the 5 percent

4.2 Lag Length Selection Criteria

Table3
Lag selection Criteria

Lagi	LagL	LR	FPE	AIC	SC	HQ
0	13.98314	NA	0.000105	-0.646067	-0.511388	-0.600138
1	134.7957	213.1987	1.47e-07	-7.223277	-6.684562*	-7.039560
2	147.5305	20.22584*	1.20e-07*	-7.442970*	-6.500218	-7.121465*
3	150.8966	4.752121	1.73e-07	-7.111564	-5.764775	-6.652270

Note. *represents optimal lag length, LR represents Likelihood Ratio, FPE represents Final Prediction Error Criterion, AIC represented Akaike Information Criteria, SC represented Schwarz Criteria, and HQ represents Hannan- Quinn Criteria.

Lag selection is importance because after lag selection we can choose lag the length for estimation. We estimate the lag length criteria by using estimate VAR analysis through unrestricted VAR estimates. The lag length criteria results show in table 3.

4.3 Bound Test Estimation

The value of F statistics must be greater than the upper bond, if the F statistics value is smaller than the upper bond then results are not accurate and we can't find reliable results, so the F statistics value must be greater than the upper bond. In the table 4, K denotes to parameters.

Table 4
Bound Test Estimation

Test statistics	**Value**	**K**
F Statistics	5.588059	2
Critical value bound		
Significance	**I(0) Bound**	**I(I) Bound**
10	2.63	3.35
5	3.1	3.87
1	4.13	5

We calculate F- statistics and its value is 5.588059 which is greater than the upper bound at 1 percent 5 percent and 10 percent. Which means long run relationship exist when health expenditure is dependent variable.

4.4 Long run Estimation

The table 5 show that the variables such as GDP are significant at 10 percent and CO2 emissions is insignificant. Whereas GDP significantly and positively effects on health expenditure. The results indicate that there is positive nexus between GDP and health expenditure. A one % increase in GDP increases 0.067 percent health expenditure. The GDP increase health spending in the long run. There is no impact of CO2 emissions on health expenditure in long run in the Pakistan.

Table 5
Long Run Estimation

Dependent Variable: LHE				
Variable	**Coefficient**	**Std. Error**	**t-stat**	**prob**
LnCO2	-0.045	1.038	-0.043	0.965
LnGDP	0.067	2.756	1.838	0.075**
C	-64.685	18.057	-3.582	0.001*

Note; *Significant at 1 % **Significant at 10 %

4.5 ARDL Short Run Estimations

To check short run nexus on the basis of long run nexus we employ the Error Correction Mechanism, also referred to as ECM. It delivers the information about existence of long run relationship and long run equilibrium. This data is based on the ECM value's sign. If the value is negative, it indicates convergence toward the long-term equilibrium, and if it is positive, it indicates divergence from equilibrium.

Table 6
Short Run Estimation

Dependent Variable: ∆LHE				
Variable	**Coefficient**	**Std. Error**	**t-stat**	**prob**
∆LnCO2	-0.038	0.866	-0.043	0.965
∆LnGDP	0.229	2.436	1.736	0.092**
ECM (-1)	-0.834	0.180	-4.621	0.000*

Note; *Significant at 1 percent **Significant at 10 percent

The table 6 shown that there is no impact of CO2 emissions on health expenditure in the short run. The GDP has positive and significant impact on health expenditure in short run and the value of ECM -0.834 shows that 83 percent divergence will be removed in 1 year.

4.6 Diagnostic Test Results

Table 7
Diagnostic Test

	Tests	F stat	P values
Normality Test	Jarque- Bera	1.259	0.532
Heteroskedasticity	Breush-Pagan-Godfrey	1.027	0.393
Serial correlation	Breush-Godfrey LM	1.799	0.182
CUSUM		Stable	
CUSUMSQ		Stable	

The table 7 showing the results of diagnostic tests. Results shows error term is normally distributed and homoscedastic. The model was analyzed through Breush-Godfrey Correlation LM test. If the p value less than the significant level that is 5 percent then autocorrelation exist among the variables. If p value greater than 0.5 percent then no correlation among variables. The above results showed that p value is 0.182 means this value is greater than 0.05, so no autocorrelation among the variables. Breush-Pagan-Godfrey test is use to check whether heteroskedasticity exists in the model or not. The above results show that p value is 0.393 means this value is greater than 0.05 so no heteroskedasticity exist in the model. Results also show that model is stable. And the results of the figure 5.10 show that the figures of CUSUM and CUSUMSQ are relying under boundaries. Both the graphs are positioned between the lower and higher bounds. This demonstrates the effectiveness of ARDL estimations. These graphs confirm that the model is stable.

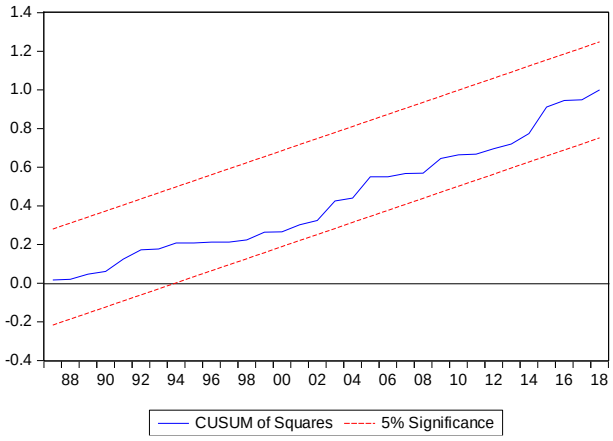

Figure 1

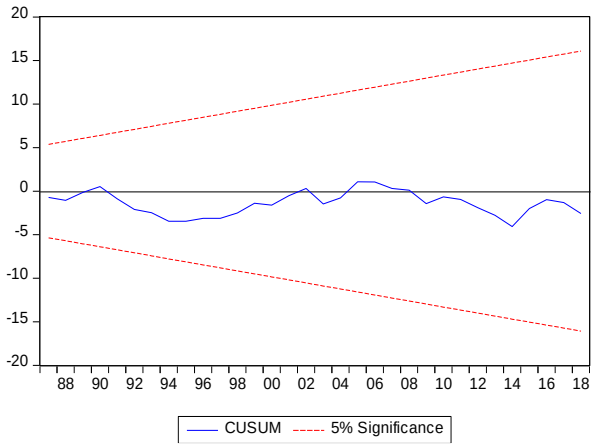

Figure 2

4.7 VECM Granger Causality Technique

Table 8
VECM Granger Causality

Variable	ΔlnHE	ΔlnCO2	ΔlnGDP	ECT_{-1}
ΔlnHE	-	1.744405 (0.1866)	0.749623 (0.3866)	-0.231802 [-2.58670]***
ΔlnCO2	3.218282 (0.0728) **	-	1.708027 (0.1912)	-0.015947 [-3.08507]***
ΔlnGDP	0.368263 (0.5440)	4.647633 (0.0311)*	-	0.002996 [1.20246]

Note; *Significant at 5 percent **Significant at 10 percent, () represent P value, [] represent t value, *** significant because t value is greater than 2.

It is designated by results of cointegration, that the existence of the long- and short-term nexus among variables. This study uses VECM, to find out the direction of causal linkages. Difference (Δ)describe short term causal nexus among variables and in long run error correction term (ECT) shows causality nexus between variables. If the sign of ECT value is negative, it shows there is long term significant nexus and if the sign is positive, it shows long term insignificant causality nexus among variables.

The results reported in table 8 shows that long run causal nexus exists among health expenditure and CO2 emissions because ECT_{-1} value is significant. In short run CO2 emissions cause the health expenditure but health expenditure not cause the CO2 emissions in the short run. The GDP cause the CO2 emissions but CO2 emissions not cause the GDP in the short run. And there is no causal link between health expenditure and GDP in the short run.

5. Discussion

The study's discussion section includes its findings and the underlying economic theories. According to the results of ARDL, there exists long-run nexus between health expenditure and economic growth. The results reported in the table 5.5 show that GDP has statistically significant and positively impacts on heath expenditure in long run in Pakistan. Results show that impact of GDP on health expenditure is positive and the significant in the long run. Reason behind this is that economic growth increase so the nation is more able to devote on health care services then health expenditure will increase. Our results are similar with (Boachie et al., 2014) discovered a connection between health spending and economic expansion, as well as evidence that the GDP has positive and significant effects on health spending. (Hitiris, 1999) and (Kiymaz, Akbulut, & Demir, 2006) examined nexus between the economic growth and health expenditure, indicate that arises in country income has positive effects on health spending in the long-term results. Results shows that there is no impact of CO2 emissions on health expenditure in the long run.

The short-term estimations results described in the table 5.6 shows that in the short term, GDP has positive and considerable effects on public health expenditures, but CO2 emissions have no such effects. The results described in the table 5.7 shows that there is no problem of autocorrelation and heteroskedasticity in the model. And the model is normality distributed.

According to the findings of the causality analysis using the Vector Error Correction Mechanism, there is a short-term causal relationship between economic growth, health expenditure, and CO2 emissions as well as a long-term causal relationship between health expenditure and CO2 emissions. The results illustrated in table 5.8. there is the unidirectional causal link from CO2 emissions to health expenditure in the short term. Our results are in the line with Chaabouni and Saidi (2017) investigate the nexus among GDP, health expenditure and carbon emissions and found unidirectional causal link from the CO2 emissions to health expenditure. Results shows one-way causal link from the GDP to the CO2 emissions in the short run. Our findings are in the line with Fodha and Zaghdoud (2010) analyzed nexus between health spending, economic growth and CO2 emissions and found unidirectional causal nexus from economic growth to CO2 emissions. The causality analysis found no causality nexus between health expenditure and GDP in the short run. Our results are in the line with Devlin and Hansen (2001) support neutrality hypothesis, establish no causal link between health expenses and GDP.

The study's causality findings demonstrate that in Pakistan is economic growth and CO2 emissions both increase then health expenditure increases. Industrial activities generate CO2 emissions because industrial activities pollute the environment but the industrial sector is important for strong economic growth (Farooq, Subhani, Shafiq, & Gillani, 2023). One of life's most crucial aspects is health and play very important role at workplace in society because healthy environment leads to more productive results.

Economic activities increase CO2 emissions and this CO2 emissions badly impacts on human health then health expenditure will increase.

6. Conclusion and Policy Implications

Countries across the world facing rapid increases in CO2emissionss which causes major challenges for Governments and societies. The rapid increase in CO2 emissions and economic growth increases the expenditure on health. The process of economic growth generates more CO2 emissions these emissions negatively impact on human health then health expenditure increase. Researcher suggest that health plays a vital role in economic growth because healthy environment led to more productive results. Economic growth rises the environmental degradation cost which arise the danger of pollution and these are the cause of health diseases. Environmental degradation becomes a modern issue due to the utilization of fossil fuels and other natural resources in the industrial sectors and also households and these fossil fuel generates CO2 emissions.

Regarding the importance of health at workplace in the society, health has very implications in economic activities regarding too long and short terms. This study's goal is to look into the connection among economic growth, CO2 emissions and the health expenditure in Pakistan from the period 1982 to 2018. GDP data is extracted from WDI, health expenditure data taken from Pakistan Economic Survey and CO2 emissions data taken from BP Statistical Review of World Energy. The ADF test of unit root is applied to check stationarity of the study variables and ARDL approach is applied for cointegration. The Breush-Godfrey the autocorrelation is checked using the serial correlation test, and our findings indicate that there is no autocorrelation in the model. Breush-Pagan-Godfrey test illustrates that the model does not contain heteroskedasticity, if the heteroskedasticity exist in the model, then we cannot find accurate results. Results shows there is no heteroskedasticity exist in the model. The causality connection between health expenditure, economic growth, and CO2 emissions is examined using the VECM Granger causality technique.

The ARDL approach's findings indicate that GDP has a positive impact on health spending in the long and the short run, its means that increasing GDP growth increases health expenditure in Pakistan. Long-term and short-term effects of CO2 emissions on health care costs are nonexistent. The results of VECM granger causality shows long run causality nexus exist between health expenditure and CO2 emissions and short run causality nexus exist among health expenditure, CO2 emissions and GDP, the unidirectional causal link from CO2 emissions to health expenditure and GDP to CO2 emissions in the short run its means that increasing CO2 emissions increases health expenditure in Pakistan, because the process of economic growth generates more CO2 emissions these emissions negatively impacts on human health then health expenditure increases. There is no direct causal nexus between health expenditure and GDP in short run. Based on finding of this study some important policy implications are invented. First, daily CO2 emissions rise as a result of rapid economic growth. For control CO2 emissions, Government investment in the renewable energy source must rise and impose carbon taxes to discourage the emissions usage of induced, technologies. Second, it is recommended that countries need to increase investment for promoting environmental protection, and increase the technological transfer to reduce the environmental damages.

Authors Contribution

Sidra Mehfooz: original draft, methodology, data analysis
Muhammad Mansha: data curation, data collection, visualization
Majid Khan: study design, incorporation of intellectual content, drafting
Sabbah Musharaf: critical revision, writing reviewing and editing

Conflict of Interests/Disclosures

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