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Nexus between CO_2, Trade openness, Economic growth, and Health expenditures in Pakistan: An application of the ARDL bounds testing approach.

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Abstract: This study aims to examine the nexus between CO_2, trade openness, economic growth, and health expenditures in Pakistan. Health is a significant element for wealth and revenue growth. Great wellbeing prompts higher profitability levels. CO_2 is the most important GHG that damages the environment and affects people's health. At the same time, economic growth often negatively, and vice versa, affects health conditions. The study conducted auto-regressive distributive lag (ARDL) using time series data from 1990–2017. The study findings show that the health expenditure, CO_2 emissions, and economic growth in Pakistan are significantly related both in the long-time period as well as in the short-term period. The bidirectional relationship of Granger causality was examined that health expenditures are the cause of CO_2 while there is no causality running from health expenditures to economic growth and trade openness. CO_2 emissions are not the Granger cause of health expenditures and TOP, while carbon emissions have a certain predictive effect on economic growth. GDP is not the Granger cause of HE and TOP, but there is a causality running from GDP to CO_2. Trade openness is not the granger cause of health expenditures, CO_2, and GDP.

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1. Introduction

Health is an important indicator of the quality of life in a country. Labour productivity depends on the health and educational conditions of the workers. Therefore, health expenditure is a significant factor that the government has made to accumulate human capital. Health becomes more important as technology becomes to develop. Hence, there bring more opportunities to people in terms of health issues and improving living standard, which improve work efficiency and productivity in other areas. Among other pollutants, CO_2 is usually acknowledged to be the significant supporter of natural contamination; it can have an unfavorable influence upon social and more, financial improvement of a general public (Chen *et al.*, 2019). CO_2 emissions will be polluting air and may bring about undesirable birth of infants conceived, particularly to ladies living close to the mechanical territories, babyhood beginning asthma, hospitalization for breathing and cardiovascular issues 1, 37, 40, 42 (Chen *et al*, 2019; Xu *et al*, 2013; He *et al*, 2016 and Jiang *et al*, 2018). CO_2 emissions will not only reduce generally ecological well-being but will also enforce to high charge of medical expenditure. Low quality of nature can have harmful effects on human wellbeing and an antagonistic impact on employment output (Yazdi and Khanalizadeh, 2017). Carbon Dioxide emissions are the main factor affecting the quality of the environment that adversely affects society's health. According to the research of medical, different types of mortality are caused by environmental pollution, such as particulate matter can cause work loss and bed disability in adults (Ostro and Rothschild, 1989). Various pollutants such as Sulphur Carbon Dioxide and total suspended particulate matter (TSP) increasing mortality (Schwartz and Dockery, 1992). The impact of CO_2 on health has important consequences to health expenditures, although most earlier literature shows that revenue is the main factor of health expenditure.

Trade openness can also be severely influenced the government health expenditures; trade affects health by affecting the availability of goods and services, price level, wealth of community, structure, and dynamics of the global economy. This includes the level and distribution of employment, investment, debt, accumulation, crises, and sustainability (Bljlt, 2007; Pachanee and Wibulpolprasert, 2007; Smith *et al.*, 2009; Lobstein, 2010). Panda (2014) argued that a nation's trade openness influences the macroeconomy by affecting financial development. This national level economic benefit of openness to trade is

anticipated to convert to different sectors of the economy, including the health sector (WHO, 2013). By the study of (Deaton, 2014) trade openness increases the utilization of medicinal merchandise and overflows the international knowledge of health.

Economic growth is usually considered as a fundamental and frequently adequate condition for the development of population wellbeing. The motivation for an increase in fiscal development will lead to an increase in normal earnings especially increasing the underprivileged public's income; results will improve access to and utilization of products and ventures that improve nutritional status and health (Vollmer *et al.*, 2014). Similarly, Fan and Savedoff (2012) found that increasing income and expenditures on medical technology result raises health expenditures.

As per our knowledge, a significant space exists to investigate the consequences of CO_2 emissions and economic growth on health expenditures in the existence of trade openness in the context of Pakistan empirically. Because past studies have examined the impact of health expenditures on economic growth. Nevertheless, a combined impact of CO_2, trade openness and economic growth with health expenditures are not yet discovered. This examination intends to fill this exploration space by empirically examining the CO_2 emissions, trade openness, and economic growth on health expenditures in the context of Pakistan.

The remaining paper is prepared as; unit 2 present analyses of past studies, section 3 discuss data and methodology, section 4 investigates results, and section 5 shows conclusion and strategy recommendations.

2. Literature Review

The first string is regarding Carbon Dioxide emissions and health expenditure. The environment issue, especially CO_2 emission, has generally pulled the researchers and policy makers. In recent decades, the issue of the nature generally CO_2 emission has serious consequences, especially on health (Saida and Kais, 2018). Khwaja *et al.* (2013) found that because of air pollution, the rate of admission in cardiology departments was higher, and resultantly increased the health expenditure. Lu *et al.*, (2017) studied 30 provinces of China that concluded the negative relationship of CO_2 emission and other natural related contamination upon general wellbeing, but the health and ailment conditions were counted bearing extensive commitment in health advancement. The study of Yazdi *et al.*, (2014) investigated in the framework of Iran throughout 1967-2010 applied co-integration and ARDL technique that carbon monoxide and sulphur oxide have a positive influence on health spending. Boachie *et al.* (2014) were also founded in their study by used the FMOLS approach by taking the period of 1970-2008 that negative effect of CO_2 emission on health expenditure. Wang *et al.* (2018) examined the relation among CO_2 emission, health expenditure, and economic growth by using the ARDL model covering the annual data from 1995 to 2017. They found a constructive and factually huge connection between CO_2 emission and health expenditure in Pakistan. The result shows that when CO_2 emission increases, health expenditures also rise. Apergis *et al.*, (2018a) studied the effect of CO_2 emission on health expenditure in 50 U.S states. They concluded that CO_2 emission has a positive effect on health expenditure and additionally examined that this influence is great for those states which expend more amount on health sector. Similarly, Chaabouni and Saidi (2017a) discussed the impact of CO_2 emission on health expenditures by using panel data of 51 low- and high-revenue countries and found a two-way connection between CO_2 emission and health expenditure.

Ullah *et al.* (2019) investigated the linkages between trade openness, CO_2 emissions, and health expenditures in China, covering the data from 1990 to 2017. They used the simultaneous equation technique and found trade openness insignificantly influencing the CO_2 emission, resulting in raising the health expenditures. Qadir and Majeed (2018) investigated the effect of trade liberalization on health in Pakistan from 1975 to 2016. They found trade caused an adverse influence on health. Similarly, the study of (Novignon and Atakorah, 2016) examined the data of 42-Sub Saharan African countries in the time of 1995 to 2013 using a Fixed effect, Random effect, and GMM models. The result indicates an important and beneficial affiliation between trade openness health expenditures. The same findings concluded by Maryam and Hassan (2013), using data from 1976-2011, applied the ARDL technique to find the short-run and long-run link between trade openness and health expenditures in Pakistan. The study revealed that trade openness had a positive relationship with health expenditures in both the short-run and the long run. Increasing cross-border in goods, services, people, and capital influence health by different channels, includes the cross-border extent of infectious diseases, advertisement of an unhealthy lifestyle, and migration of health professionals (Smith *et al.*, 2015).

Similarly, Owen and Wu (2002) studied a board information of 139 established and emerging countries throughout 1960-1995. Used fixed effect technique and found a positive and significant association between trade and population health. They also revealed that population health is benefited from trade openness both in developed and developing countries,

but developing countries benefited more than developed countries. Applying a fixed effect technique on a board information of oil-rich countries covering the duration of 1980 to 2009 (Ramzi, 2012) discovered a critical and positive connection between the openness of trade and life expectancy, while a significant negative relationship found between openness of trade and infant mortality. Yaqoob *et al.* (2018) explored the impact of economic and population factors on health expenditures in Pakistan by using Multivariate models for the time series data of 1960-2010. The results show that GDP has an encouraging and vastly noteworthy effect on health expenditures in Pakistan in the study period. Using the ARDL technique, Ercelik (2018) found a positive and statistically significant association between economic growth and health expenditure in Turkey from 1980 to 2015. Conducted the research on emerging markets in Europe and Middle East countries covering the period of 1995 to 2013, used the Toda and Yamamoto (1995) test of Causality test, Bedir, (2016) found increasing in the level of income stimulate healthcare spending in emerging markets economies. Hassan and Kalim, (2012) estimated the causality among education expenditure, health expenditure, and GDP for Pakistan throughout 1972-2009. The result indicates that there exists bidirectional causality between GDP and health expenditures in the long run. Mayer (2001) investigated18 Latin American countries to find whether there is granger causality of health expenditures on income and concluded a strong causality of income on18 Latin American countries. Erdil and Yetkiner (2009) used the Granger causality technique to panel data to inspect the association between economic growth and per capita health expenditures. They found unidirectional causality runs from income to health expenditures in lower and middle-income countries.

Similarly, Wang (2011) investigated the association between GDP growth and the health investment in the production function. The data from 31 countries over the time of 1986 to 2007. The finding indicates that economic growth will decrease health expenditure growth. Amiri and Ventelou (2012) studied causality between economic growth and healthcare expenditures and found bidirectional Granger causality is predominant. Elmi and Sadeghi (2012) investigated the causality and cointegration association between GDP and health expenditures in developing countries in the period of 1990-2009. Their results indicated that income is an important factor across developing countries in the level and health expenditures growth. Khan *et al.* (2016) examined the health expenditures and economic growth in SAARC countries from the period 1995 to 2012. Applying (DOLS) and Seemingly Unrelated Regression (SUR) techniques. The result shows the long-run relationship, while in the short run, there existed bidirectional causality exists between the variables. Hitris (1997) studied annual data from 1960 to 1991 of 10 European countries, utilized a log-linear model to found the relation among GDP per capita and health expenditures. The result indicates health expenditures depend on each country's GDP, and the health care system is different.

3. Material and Methods

This paper aims at examining the nexus between CO_2, trade openness, economic growth, and health expenditures using annual data from 1990 to 2017 in Pakistan. Data on CO_2, trade openness, economic growth, and health expenditures are gathered from World Development Indicators (WDI). Health expenditures are taken as a dependent variable, which is computed as a percentage of absolute GDP. While explanatory variables that were nominated for the pragmatic research are carbon dioxide emissions CO_2 calculated in metric tons of lubricant equal trade openness measured as export + import /GDP while GDP is the gross domestic product.

The use of ordinary least square methods, simple regression, was usually explored in previous research, CO_2, trade accessibility, economic growth, and correlation with health expenditure. However, econometric methods allow for assessment of long-term relationships with short-term associations while taking into consideration the association between CO_2, economic growth, and HE on trade openness. This research performs a complete time-series analysis of health determinants in Pakistan for the first time. Until conducting cointegration tests, it is essential to check for stationarity each time series because the regression test results are unreliable if a time series is not stationary. Furthermore, one of the conditions of the bounds testing method is that no parameter in order two is combined with a mixed order. For this function, ADF is used.

$$\Delta x_t = \varphi x_{t-1} + \sum_{i=1} m\ \delta \Delta x_{t-i} + \varepsilon_t$$

$$\Delta x_t = \alpha + \varphi x_{t-1} + \sum_{i=1} m\ \delta \Delta x_{t-i} + \varepsilon_t$$

$$\Delta x_t = \alpha + \omega t + \varphi x_{t-1} + \sum_{i=1} m\ \delta \Delta x_{t-i} + \varepsilon_t$$

Where Δ stand for difference operator; α is the intercept; t is a time index; φ shows coefficient presenting process root, i.e. focus on checking; γ is the coefficient on a time trend; m represent several lags of the autoregressive model and ε_ random error term.

A recent study used the methodology (ARDL) known as the autoregressive distributed lag model to

capture long and short-term dynamics. Pasaran *et al.* (2001) introduce this approach to check the long-run association between the different nexuses of factors. Many researchers have applied multiple techniques of co-integration in past and present literature. Other co-integration methods have certain inconveniences (Phillips and Hansen1990, Johansen and Juselius1990; Engle and Granger 1987) such as these strategies do not provide an estimate of structural breaks. Therefore, compared with previously mentioned methods, we choose to choose the best approach of ARDL boundary tests for this function. This methodological approach contains many benefits and is suitable if the variables are cointegrated on either level I (0) or level I (1). This method of modeling is used here.

$$\Delta HE_t = \beta_0 + \sum_{i=1}^{t} \beta_1 \Delta(GDP)_{t-1} + \sum_{i=0}^{u} \beta_2 \Delta(TOP)_{t-1} + \sum_{i=0}^{v} \beta_3 \Delta(CO2)_{t-1} + \beta_4 (GDP)_{t-1} + \beta_5 (TOP)_{t-1} + \beta_6 (CO2)_{t-1} + \mu_t$$

Where the symbol Δ indicates the first difference term, HE shows health expenditures, GDP represents domestic growth product, CO_2 means carbon dioxide, and TOP shows trade openness. Terms εcm-1 is the error correction term that deferred error from the co-integrating vectors equation produced by the Johansen cointegration test.

The next step is to compare F-statistical calculation to the Narayan critical values (2005) created between 30 and 80 observations for a small sample size. For one set, all variables in the model are I (0), and in the other, they are all I (1). If the F-statistics calculated exceeds the highest critical limits, the HO is rejected. The test is inconclusive if the F numbers fall within the boundaries. Eventually, if the F-statistic falls below the lower critical limit value, there is no co-integration.

When the quality of the climate decreases, this adversely affects the health of the people. Deterioration of health requires more spending on health care. This follows that the quality of carbon dioxide deteriorates by creating smog and thus has a harmful effect on human wellbeing. This means the demand for healthcare will increase (Narayan, Narayan & Mishra, 2010).

Table Operational Definitions and Measurement of the Variables

Variable		Type	Measurement Technique
HE	Health expenditures	D.V	*a share of total GDP*
CO2	Carbon Dioxide	IV	*measured in metric tons of oil equivalent*
TOP	Trade Openness	IV	*export + import /GDP*
GDP	Gross domestic product	IV	

4. Results and Discussion

Table Unit root testing

	At-level		**At 1st-difference**		
Variables	Constant	Constant with trend	Constant	Constant with trend	Conclusion
HE	-0.454	-2.901	-3.843*	-4.010*	I (1)
CO2	-1.580	-0.540	-4.380*	-4.687*	I (1)
GDP	-1.792	-3.793	-4.600*	-5.317*	I (1)
TOP	-1.790	-2.537	-4.308*	-5.353*	I (1)

*Note: * represent significance levels at 5% percent.*

The stationarity of variables was checked through Augmented Dicky Fuller tests, and the outcomes of the ADF tests display that HE was non-stationary- at level but became stationary at first difference. Similarly, when CO2 was tested through the ADF test, and it was not stationary at I (0) but became stationary at 1st difference. The GDP was not stationary at level. Similarly, TOP was non-stationary at levels but converted into first difference, then they all became stationary but became stationary at 1st difference. This study, therefore, concluded that all variables are stationary at first difference level. Hence, it gives room to employ an ARDL approach to cointegration.

Table Bounds co-integration test

Level of significance	Critical values		F-Statistic
	Lower Bound	Upper Bound	
1 Percent	3.65	4.66	
5 Percent	2.79	3.67	4.66
10 Percent	2.37	3.20	

Note: The bounds test values are based on Narayan (2004): Case D: restricted constant and no time trend.

The result of the estimated Wald F-test along critical values taken from Narayan (2004) is provided in Table 2. The computed F-statistic is 4.66, which is greater than the upper bound critical value at a 5% significance level. This establishes the long-term relationship between the underlying variables.

Table: Long-run coefficients

Variable	Coefficient	Std. Error	T-ratio	P-value
CO2	0.090	0.040	2.500	0.010
GDP	-3.702	0.624	-5.930	0.000
TOP	22.75	19.90	1.143	0.277
C	-22.25	7.017	-3.171	0.009

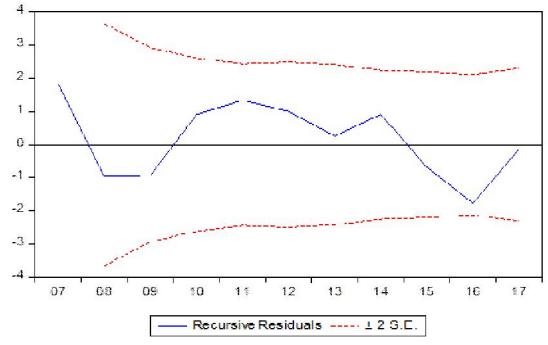
In the above table, the estimated coefficients describe that CO_2 effects HE significantly with a positive magnitude. The impact of GDP on HE is negative and statistically significant. The outcomes display a strong positive association between emissions of CO_2 and health spending, given the long-term carbon emission coefficient (0.090), and the likelihood value (0.010). This coefficient shows that health expenditure also increases if CO_2 emissions are increased. These reports support the factual studies of previous years (Beatty and Shimshack, 2014; Mead et al., 2005; Chaabouni et al., 2016). Pakistan faces harsh environmental and climate degradation and makes some contribution to overcoming these serious changes in climate (Zaidi et al. 2018).

In contrast, the economic growth coefficient (-3.702) is a negative but important impact on spending on education. That relationship explains how health expenses decline as growth rises due to improved individuals ' incomes. It also means that the productivity of the economy is negatively affected as health spending increases. As reported in Bedir and Business's (2016) study, an increase in expenditure on health is connected to a low level of hominid productivity in a country due to poor health, disrupting that country's economic development. The outcomes of our research are in line with those of Jude Eggoh and Sossou (2015). The trade openness has no impact on the HE as the P-value of TOP is insignificant.

Table: Short run error correction model

Variable	Coefficient	Panel (A) Std Error	Tratio	P-value
D (CO2)	-0-.010	0.001	-10.00	0.000
D (CO2(1)	-0-.020	0.009	-2-.22	0.035
D (CO2(2)	-0-.005	0.002	-2.50	0.010
D (GDP)	-0.724	0.141	-5.131	0.000
D (GDP (1)	-1.332	0.324	-4.111	0.001
D (GDP (2)	-0.417	0.175	-2.372	0.037
D (TOP (2)	-23.26	9.765	-2.382	0.036
ECM (1)	-0.678	0.120	-5.637	0.000

Panel (B)	
Diagnostic Tests	
R squared	0.828
DW statistic	2.170
Serial correlation	1.630(0.202)
Normality	1.139(0.933)
Heteroscedasticity	15.57(0.273)



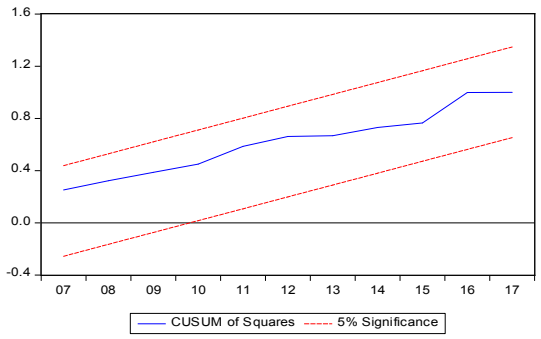


Table shows the results of the error correction method. It can be seen from panel (A) that the coefficient of ECM is negative and highly significant at one percent significance level is another evidence of the stable long-term relationship. The estimated coefficient of the ECM is -0.678, suggests that the

short-term disequilibrium can be rectified at the speed of 68 percent. The model reveals that in the short-run, CO_2 has an adverse impact on health expenditures, and the effect is statistically significant. GDP is undesirably and pointedly connected to health expenditures. In addition, the short-term findings suggested that the relationship between gross trade openness and expenditure on health is significant. We also used diagnostic tests to check the reliability of the design. Such results do not reflect a serial correlation with a model miscarriage or heteroscedasticity, as shown in table. The cumulative sum (CUSUM) and cumulative sum of squared residual plots (CUSUMSQ) are obtained, and stable long-run and short-run relationships are further rectified. The results are shown in figure. The values for CUSUM and CUSUM SQ fall between the upper and lower critical boundaries (at 5 percent meaning levels), which determine the consistency and strongness of long and short-run connection.

Table: Granger Causality Results based on VECM

DV	**IV**			
	D (HE)	D (CO2)	D (GDP)	D (TOP)
HE	--	1.92 (0.01)	3.82 (0.15)	3.80 (0.15)
CO_2	1.21 (0.55)	--	1.36 (0.04)	4.37 (0.11)
GDP	2.94 (0.23)	6.44 (0.44)	--	3.53 0.17
TOP	0.91 (0.63)	1.76 (0.41)	1.66 0.43	--

From the granger causality test result, health expenditures are the cause of CO_2 while no causatives is running from expenditures of health to economic growth and trade openness. CO_2 emissions are not the Granger cause of health expenditures and TOP, while carbon emissions have a certain predictive effect on economic growth. GDP is not the Granger cause of HE and TOP- but there is a causality running from GDP to CO_2. Trade openness is not the granger cause of health expenditures, CO_2, and GDP.

5. Conclusion

The study shows the sound effects on expenditure in Pakistan of CO_2 emissions, openness to trade, and economic growth. The literature on health expenditures, openness to trade, carbon emissions, and economic growth is limited. The research used the ARDL technique to test short and long-term dynamics between variables. The results verify both the long-term and the short-term relationship between expenditure, CO_2 emissions, openness to trade, and growth in Pakistan. Diagnostic tests such as Jacque-Bera Normality Tests, the Breusch-Godfrey Serial Correlations LM test, have shown that the model is correct. Overall results showed that Granger's two-way causality is between expenditure and carbon emissions, furthermore between the consumptions on health and economic growth. Health expenditures are the cause of CO_2, while there is no antecedent running from expenditures on health to economic growth and trade openness. CO_2 emissions are not the Granger cause of health expenditures and TOP, while $_{CO2}$ carbon emissions have a certain predictive effect on economic growth. GDP is not the Granger cause of health expenditures and trade openness. However, some issues cause GDP to CO_2. Trade openness is not the granger cause of health expenditures, CO_2, and GDP. The results in this research conclude that there are considerable effects on expenditure on carbon emissions (environmental degradation) and economic growth. In this respect, the most important policy is to reduce emissions of carbon Pakistan has great power generation and saving potential among other one Belt and one Road countries if effectively uses its mineral resources Zhang et al. (2018d).

A detailed strategy is necessary for this respect. All the stakeholders are accountable, such as leadership of the country, organizations, promoters, and customers, their job should be to reduce CO_2 emissions. It is clear that the government will have the biggest role. Investments should be increased in sustainable energy fonts; carbon tax increases to deter emission-related activities; health benefits should be implemented by recommendations and initiatives to reduce the country's CO_2 emissions; and common people's s awareness programs to promote healthy practices.

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