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ASYMMETRIC IMPACT OF ENVIRONMENTAL DEGRADATION ON PUBLIC HEALTH EXPENDITURE: THE CASE STUDY OF PAKISTAN

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ABSTRACT
The utilization of biofuels and the degradation of environmental quality have significant implications for the government's healthcare system, particularly in terms of public health expenditure, as well as for the financial burden on households. Therefore, the primary objective of this study is to examine the relationship between carbon emissions and public healthcare expenditure in Pakistan over the period 1980–2020. To achieve this, the study introduces modifications to the conventional ARDL model to investigate the asymmetric relationship between environmental degradation and public health expenditure. The bounds test results confirm the presence of a long-run nonlinear association among environmental degradation, public health expenditure, trade openness, urbanization, and economic growth in Pakistan. Findings from the NARDL model reveal that positive changes in carbon dioxide emissions significantly increase public health expenditure. Specifically, an increase in carbon emissions is associated with higher public health spending, while a decrease in emissions tends to reduce it in the long run. Both positive and negative shocks in economic growth exert significant effects on health expenditure. Moreover, a positive shock in trade openness increases public health expenditure, whereas a negative shock reduces it. The Wald test results indicate the presence of asymmetric effects in both the short and long run, except for trade openness, which shows a symmetric effect in the long run. The study concludes that policymakers should account for the asymmetric impacts of environmental degradation, economic growth, and trade openness when formulating public health expenditure policies in Pakistan

Keywords: Environmental Degradation, Health Expenditure, Trade Openness, Urbanization, Economic Growth

Introduction
In the past decade, mortality and morbidity rates have been increased worldwide predominantly brought about by different wellsprings of pollution (Yazdi & Khanalizadeh,

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2017a).The disproportionate increase in hazardous gases enhances the process of environmental degradation. The adverse impact of biomass gases such carbon dioxide and nitrogen dioxide on public health is the most controversial topic within the literature. Practically 50% of the total world population and 95% population in low income countries utilize firewood and biomass fuel to meet their energy needs, including cooking and heating, and this number is increasing in and other developing countries (Currie & Neidell, 2005). The utilization of biofuel and environmental quality degradation has considerable impact on the government health care system in the form public health expenditure and notable effect on the financial plan of the household. Public policies during this regard are vital to shield public health and ecosystem (Yazdi & Khanalizadeh, 2017a). Contaminated air and biomass fuel supply to households for consumption purposes reduce environmental quality and cause more diseases that resultantly enhance the health expenditure of the government as well as household. Notably, environmental degradation triggers pulmonary function and respiratory epidemics, such as breathing problems, chronic obstructive pulmonary disease (COPD), pulmonary disorders, lung leukemia (induced by a succession of mutagenic toxins that inserted into the body through pulmonary circulation), asbestosis (a type of lung cancer that usually happens 20–30 years after the initial exposure), tuberculosis, etc. Also, air pollution can cause leukemia, congenital abnormalities, and suppression of the immune system (Noor et al., 2024). It can also cause heart disease, brain hemorrhage, neuropsychiatric disorders neurological problems and delays in development), liver cancer, and other types of cancer.

Trade openness following the extensive utilization of biomass gasses and hydro innovation in the production units straight forwardly influences the climate, which in turn influences human health that further influences work efficiency in a hostile way. Biomass gasses lead to the climate breaking down and put focus on the health expenditures of the household and the public authority. Population density is the primary source that influences the urban climate and has a significant connection with the urban environmental framework. Because of enormous number of inhabitants in urban regions, deficient water supplies, inadequate drainage framework and shortage of green regions have an adverse impact on human health (Zeeshan et al., 2021) The World Health Organization [WHO] reported in 2014 that 30 percent of the world's population was living in urban areas in 1950, but that figure has risen to 54 percent in 2015 and is predicted to rise to 60 percent by 2030. Obviously, urban expansion has major economic, health, and environmental repercussions, particularly for emerging economies relative to advanced economies. As a result of this aggressive expansion, emerging economies are confronted with health-related concerns, which are one of the most significant socioeconomic issues. As per WHO, the biggest concerns are linked to water, the environment, aggression and trauma, non - communicable infection (such as malignancies and metabolic syndrome), poor diets and lifestyle factors, and excessive alcohol use (The WHO, 2010). In this regard, the World Bank's World Development Indicators show that current health expenditures per capita in lower- and middle - income economies were around 170 dollars in 2000, rising to 510 dollars in 2015. This data may suggest that urbanization has a stimulating influence on healthcare.

The Carbon dioxide emissions have seriously influenced the human health in Pakistan (Zaman et al., 2016). It is obvious from the previous literature that poor environmental quality especially carbon dioxide outflow in Pakistan is underlying driver of a few diseases such as skin hypersensitivity, cardiovascular infections, and asthma. The proportion of paramedic staff (specialists and attendants) is expanding yet they are not being utilized capably as they ought to(Ali & Audi, 2016;Shahid et al., 2013;Majid et al., 2012). Further, the investigation of Khwaja et al., (2013) stretched out the discoveries that because of air

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contamination, the hospitalization rate in medical clinics especially in cardiology section was high and subsequently increased the overall medical care cost of the government as well general public. As per the SBP Statistical Review of World Energy report, the carbon dioxide emission shows an expanding pattern in Pakistan. The carbon dioxide ejection from 2013 to 2017 is given as 145.5, 152.3, 160.6, 176.7, and 189.2 million tons of carbon dioxide which is expanding persistently on a yearly basis. A strong and healthy climate helps to achieve fruitful results in all areas of life, and through healthy and productive labour, leads to the development of a welfare society(Adeel, 2016). This finding was additionally upheld by (Faridi et al., 2016; Yaqoob et al., 2018) that the strength of affordable development of any state and country is built on premise of general public health. They deduced in their investigations that there is presence of positive connection among public health expenditure and economic growth with regards to Pakistan. They also stated that ecological factors were not fully considered in Pakistan economic planning, which has brought about hostile impacts on general public health. The research conducted in the context Pakistan so far has been bivariate in terms of carbon dioxide and healthcare costs.

There is a significant gap in studying the impact of carbon dioxide emissions on public health expenditure. This study will contribute by postulating new relationship by including trade openness, economic growth and urbanization as a control variable in the model with regard to Pakistan context. The previous literature investigated the relationship in linear framework. Therefore, this study is an attempt to investigate the relationship among healthcare expenditure and environmental pollution in non-linear framework for Pakistan to fill this gap. This study will shed light on the role of environmental degradation in government health policy, which is typically ignored by organizational decision-makers. The outcome of this research will endow with some fact-based understanding concerning the influence of environmental degradation, trade openness, urbanization and economic growth on health expenditures in Pakistan. The harmful impact of environmental degradation on human health is ignored by market forces. Due to its ignorance now, it is the liability of the government to address the issue. In this regard, this study is an important attempt to provide the guideline to policy maker about the asymmetric impact of environmental degradation on the health expenditure in Pakistan. According to the available research, there is a lack of clarity regarding how trade openness affects many health indicators such as life expectancy, health expenditure etc. This study is a critical attempt to further evaluate the relationship in an asymmetric framework because there in asymmetric framework the literature is not available in the context of Pakistan. The previous literature available on the urbanization and health expenditure in the context of Pakistan does not postulate the clear policy statement because the asymmetric effect of urbanization is ignored. In this regard, this study is an important attempt to provide guidelines to policy makers regarding the asymmetric behavior of urbanization.

Literature Review

Health Expenditure and Environmental degradation

This section provides a comprehensive overview of the empirical association between environmental degradation and government healthcare expenditure. There have been a variety of examples and analytical approaches used in empirical literature to consider the link amid environmental degradation and healthcare spending with diverse results. In this regard Apergis et. al. (2018) employed auto regressive distribution lag methodology and claim that contaminated air encourages a unhygienic atmosphere that has a direct impact on human health and raises health issues of the general public. The authors recommend that industrial unit must be adopting the green energy approach to reduce the emission of

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carbon dioxide. Chaabouni & Saidi, (2017) carried a study over the period of 1995 to 2013 for fifty-one different countries including developing and developed countries. The author utilizes generalization method of moment (GMM) techniques and finding support the evidence that there exists two-way correlation between healthcare expenditure and carbon emission. The finding also demonstrates that carbon emissions probably contribute to out-of-pocket health expenditure. In addition to this Yahaya et al., (2016) applied penal data technique such as penal co-integration technique over the period of 1995 to 2012 and utilize database from 125 countries. The findings of his study support the linkage amid environmental quality and public healthcare spending. The result also states that carbon emission is the primary cause of increment in health expenditure.

In addition to this, Apergis, Gupta, et al., (2018) Re-consider the nexus among air contamination and healthcare cost in the context of United States over the period of 1996 to 2009. The author utilizes quantile regression estimation techniques and finds that effect of carbon dioxide emission is substantially greater at the upper end of healthcare spending conditional distribution. Similarly, Ghorashi et al., (2017) found a connection between CO2 emissions and healthcare expenditure in Iran over the period of 1972 to 2012 with the help of dynamic simultaneous equation models. Although Vasudeva Murthy & Ukpolo, (1994) used a co-integration test to identify the determinants that influence average US healthcare expenditure, they discovered that the incomes coefficient of healthcare expenditure differed dramatically from what they had expected. It's worth noting that Chaabouni & Saidi, (2017) examined the causal association between expenditure of health, carbon emission outflows, and economic development in 51 countries utilizing dynamic Simultaneous Equation Models during 1975 to 2013. Luo et al., (2018) collected data from thirty Chinese cities and concluded that greenhouse gas emission had a negative effect on health indicator such as life expectancy, mortality, and other disease. Environmental stewardship is widely publicized. Chine’s cities have the power to improve the quality of the water and air at local level, as explained here. The carbon emissions in China are increasing although the rate of rise appears to be very slowing in the future. According to the numerous reports, China has made considerable strides in environmental protection. According to the state of the environment report for 1998, progress has been made for controlling industrial pollution while urban environment has been improved significantly. On the top of all these things China is world largest possible emitter of CO2. An another research accompanied by Guan et al., (2016) utilize auto regressive distributed lag model and found that there is a positive relationship between environmental degradation and healthcare spending made by government on health care of citizen. Apergis, Gupta, et al. (2018) examined the relationship between environmental degradation and health expenditure for fifty different states including lower and higher income countries. The finding of their study reveals that there is strong nexus between the aforementioned variables. Further their finding also reveals that the relationship between the aforementioned variables is stronger in higher income group as compare to lower income countries. Yazdi & Khanalizadeh, (2017) studied the role of economic prosperity in allocating health expenditure. The authors analyzed time series data over the period of 1995 to 2014 from North African countries as well from Middle East countries with the help of auto regressive distributed lag model. The result of the estimated model put forward that economic prosperity of any country plays a critical role in determining the health expenditure. This result indicate that a country with higher economic growth allocate more funds for the health sector whereas a countries with lower economic prosperity has low budgetary allocation for health industry. Matthew, (2018) explored the effect of pollutant outpouring by chemical industry on Nigerian health indicators over the period of period of

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1985 to 2016. The author employed ARDL model and other co-integration technique and profound that there is an adverse effect of the pollution discharge by Nigerian chemical industry on life expectancy however, the estimated models report positive association with mortality rate in Nigeria which is contrary to the reality. Another study conducted by Moosa & Pham, (2019) to investigate the dynamic relationship between government health sector expenditure and environment quality. The per capita income is included in the model as a control variable to avoid the effect of omitted variables.

Hence from the above discussion it can be easily concluded that environmental degradation has a direct impact on immune system of human being, which is costly for both governments and individuals. Guan et al., (2016) found that water contamination and air pollution contributes to sickness. Similar studies have shown that pollution in the environment has the greatest impact on people's health. Furthermore, over the last two decades, there has been a huge increase in the amount of carbon emission as well as budgets of health expenditure Zhao et al., (2016) & Zhang & Wang, (2017). According to Ebenstein, (2012) healthcare status of the peoples is determined by the amount of money they spend on healthcare. Xu et al., (2003) focused on socioeconomic determinants, such as public facility and educational level have a direct impact on general public medical expenditure, which in turn affects their health status. Another study conducted by Neidell, (2004) found that Carbon monoxide exposure had a statistically significant impact on asthma in children aged 1 to 18 years; hence health expenditure of general public and government rises.

The previous literature had relatively limited discussion about the connection among government health expenditure, air pollution and economic prosperity. Chaabouni et al., (2014) evaluated whether or not there is a plausible connection between the two namely, government healthcare expenditure, environmental degradation, economic prosperity in the prospective of Tunisia. The authors carried out Granger causality tests, which led them to the conclusion that there is a strong causal relationship among the variables that were indicated earlier during the time period spanning from 1960 to 2008. The findings of their study reveal that there exists a two-way causal relationship running from economic prosperity to environmental degradation as well as from economic prosperity to governmental health expenditure. Additionally, the result also demonstrates that there also exists a uni-directional causal relationship running from environmental degradation to healthcare spending. However, the finding does not hold in low income countries. Mehrara et al., (2011) investigated the nexus between environmental degradation and governmental healthcare spending in the presence of economic prosperity as a control variable in the panel co-integration model. The author collected data from 114 emerging economies over the time period 1995 to 2007. The result of Mehrara et al., (2011) state that close unidirectional correlation amid public healthcare related spending and economic prosperity.

Summarizing the above discussion, it has been noticed that limited amount of research inspected the link amid carbon emission and healthcare expenditure in general and particular in Pakistan. The available literature concluded substantial and constructive association concerning environment contamination and healthcare related spending. Furthermore, the researcher paid attention to linear framework only whereas the relationship among the aforementioned variables is ignored in nonlinear framework.

Health Expenditure and Economic Growth

The core purpose of this section is to discuss the previous studies identified the nexus amid economics prosperity public healthcare spending. Majority of the previous study estimated

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the elasticity of health expenditure with respect to income, policy consequences of the budget provided to health sector and efficiency of the consumed budget. Ayuba, (2014) employed several econometric techniques to examine the nexus among health expenditure and economics prosperity for Nigeria. The result demonstrates that there is unidirectional association, successively running since economic prosperity to government health expenditure. Liu et al., (2019) collected data of economic prosperity and health status and study the co-moment of the aforementioned variables. The result reveals that both the aforementioned variables travel laid-back over the long-run period. Liu et al., (2019) examined the relationship amid public healthcare expenditure and business-cycle fluctuation in USA with the help of augmented VAR model and found noteworthy and constructive association concerning the aforementioned variable. Albulescu et al., (2017) utilized data from six European countries ranging from 1972 to 2013. The author studied the speed of adjustment of public healthcare spending and found that public healthcare expenditure doesn't converge according to health expenditure to gross domestic ratio. It's worth noting that Sami Chaabouni & Saidi, (2017) examined the underlying association amid general public health related expenditure, carbon emission outflows, and economic growth in 51 countries utilizing dynamic Simultaneous Equation Models during 1975 to 2013. The poor nations have reported unilateral pivotal relationship between economics prosperity and carbon emission, whereas bidirectional causality is reported amid economics prosperity and public healthcare related expense in rich countries. Additionally, the author conveyed that unidirectional causal relationship since from health-related expenditure to carbon dioxide emission. The result hold in global penal except for low-income countries. The new evidence suggests that rapid increase in economic prosperity in China exacerbated the country health concern and pushed up the health-related expenses. However, empirical approaches like OLS and QR were utilized to examine the issue. (Moosa & Pham, 2019: Grossman et al., 1995). The prior research was primarily concerned with the impact of CO2 outflows on health expenditure. This research contributing to available literature through establishment of hypothesis purely based on the discussion above.

Health Expenditure and Urbanization

There are two aspects of the effect of urbanization on general public health status. First, accessibility of the people to modern healthcare facilities, improved drinking water and batter architecture for drainage. On the other hand, urbanization posits negative effect on the health indicators of citizen in term of unbalance diet, nerve-racking way of life, cardiac disease and increase in health related risk (Ventriglio et al., 2021).

Majority of the previous studies concerning the effects of urbanization were carried out in prosperous countries. Many researchers believe that urbanization posits unfavorable effects on the public healthcare of its inhabitants, which in turn drives up the cost of providing medical treatment. According to Rygaard, (2021), that likelihood of social process disintegration, poor child bonding, especially adolescent molestation significantly expanded in Europe as a result of within country migration from rural to urban areas, therefore caused youngsters to confront an increasing psychological problem. The research conducted by Peen et al., (2010) shows that physiological problem is more in metropolitan areas as compare to urban areas. The psychological problem such depression and anxiety in urban areas is more than by 38 percent and 21 percent respectively in rural areas. For this purpose, the author collected fact and figure from population censes carried out in highly developed countries since 1985. New data suggested increasing urbanization could impact one's fitness through multiple channels, including those related to the ecosystem,

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economy, and society. For instance, a high quantity of carbon dioxide emissions makes the greenhouse effect worse, and the expansion of urbanization contributes to enhance the contamination of water and air quality, including PM2.5, which is harmful to public wellbeing. Both of these factors have negative effects (Su et al., 2021: Wang et al., 2021). Conversely, it is the reality that urbanization is linked to a more sophisticated workplace atmosphere, availability of improved healthcare services, and strengthened interpersonal connections shows that urbanization could have a beneficial influence on one's healthcare wellbeing (Moore et al., 2003). According to the findings of a study that was carried out in Korea, the average life expectancy of out-of-hospital heart attack as evaluated by rescue personnel accelerated throughout urban and municipality communities, and there was no significant rise in rural settings (Ro et al., 2013). According to Cheung et al., (2015), inhabitants in outlying and distant parts of Ontario, Canada, had lower healthcare and incurred greater medical costs than those in urban areas due to room and non-space medical availability limits. Moreover, the research conducted by Phillips, (1993) reveals that there is no single field of study or approach that can satisfactorily address the connection involving urbanization and health, as well as the myriad of issues that are associated with metropolitan physical wellbeing. Because the urban environment can take on a variety of forms, there are a variety of lengths of time and approaches that an individual can take to get exposed to it. Assah et al., (2011) found that urban population of Sub-Saharan Africa had considerably less vigorous exercise, calorie intake and a greater chance of cardiovascular risk than people in rural areas. This was in comparison to the rural people. It has been hypothesized that the likelihood of an individual later developing a mental illness is higher if they were born in a city or if they spent their formative years in an urban environment. This hypothesis is especially prevalent in developing nations, where the percentage of residents living in the metropolises has exploded in recent decades. According to Mutatkar, (1995) the prevalence of non-communicable diseases like diabetes, cardiovascular disease, and mental illness has dramatically increased in the urban regions located throughout India. In addition to this, the India national mental health survey carried out a comprehensive study that found the prevalence of anxiety diseases in urban regions to be two to three times higher than the prevalence in rural and semi-rural areas (Murthy, 2017). In addition to these Tajudeen et al., (2018) used a structural time series model (STSM) to reconsider the significance of the predominant underpinning determinants of healthcare spending in Tanzania. They came to the conclusion that urbanization is a significant contributor to healthcare spending. The relationship between urbanization, health, and the cost of health care in China has been the subject of research by a significant number of academics. In comparison to the findings obtained in other countries, those obtained in China through various approaches at various times produced results that were distinct and sometimes even diametrically opposed to one another. The majority of the research in China was carried out in a particular region or city. According to some researchers, while urbanization in China causes health issues for citizens, those who relocate to cities have more access to batter health facilities as compare to those who remain in rural areas (Chen, 2011: L. Zhang et al., 2015). According to the findings of Chen et al. Chen et al., (2019), when compared with children living in urban areas, children living in rural regions showed higher levels of anxiety and depressive symptoms, as well as poorer self-reported mental health. This was attributed to the fact that rural areas have lower education levels and less access to medical services. After conducting an interactive session with senior citizens in Yang et al., (2017), came to the conclusion that a lower urbanized way of life seems to have a close connection with disability. On the other hand, the majority of research concluded that urbanization has a more negative impact on

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people's health than it does on the environment, which has led to a rise in the cost of medical and health care services. According to Miao & Wu, (2016), the decline in physical activity and rise in consumption of foods rich in cholesterol that accompany urbanization cancel out the positive effects of higher income on one's health, despite the fact that income rises alongside the progression of urbanization in China. The rising rate of urbanization in China has led to an accompanying rise in the population's expectations regarding medical treatment. In addition to these Lin et al., (2017), in Taiwan, as a result of the democratization of government and the rise in popularity of the concept of fundamental values, an increasing number of individuals perceive access to medical facilities as a fundamental human right and demanding that they be provided with health care. Therefore, it will lead to higher medical expenditures in regions that have a higher level of urbanization, which will ultimately result in a disparity in the number of medical resources available between urban and rural areas. Due to the unequal distribution of medical resources that occurs throughout the development of urbanization, Luo et al., (2018) discovered that the degree of urbanization has a favorable impact on the amount of money spent on personal medical care.

The researchers Ahmad et al., (2020) used a healthcare expenditures-augmented growth analysis to explore the evolving such as ongoing causality among urban aggregation and spending on healthcare facilities across formative discrepancies in China. They encountered proactive two-way causality linkages between urban aggregation and the growth of healthcare spending. Even though a significant amount of pertinent research has investigated the connection between urbanization and the cost of medical care, there is still potential for additional research. First, the available literature makes the assumption that the influence of urbanization on health care expenditures is linear. This assumption does not take into account the time-varying properties of time - series data or the exogenous fundamental transformations, which might also cause the findings to be erroneous. We are able to derive more precise findings using non-linear auto regressive distributed lag model, as well as answering the un-attempted questions that exist in this field. Second, much of the research on urbanization and healthcare expenditure in Pakistan is conducted in a single district or region, thus there is a dearth of detailed assessment on a large premise. Assessing the effect of urbanization from a macro level is helpful for policymakers in making comprehensive decisions on nationwide urbanization policies. This is certainly relevant for Pakistan, which is a significant growing economy with a vast population.

Health Expenditure and Trade Openness

This section presents the wide-range overview of the existing literature on subject i.e. nexus between trade openness and health expenditure. Bahadur, (2011) conducted research to examine how the impact of trade liberalization has been felt in terms of health care. Especial attention was paid to the influence of trade openness on human development, the promotion of women's rights, and the reduction of unemployment in emerging nations. The author employed penal data techniques such as fixed effect model over the period of 1997 to 2006 having 124 countries in penal. The result demonstrates that there exist a major and statistically favorable influence of trade openness on poverty specifically on human right and gender development. Stevens et al., (2013) assessed the impact of trade liberalization on general public healthcare with the help of penal data techniques. The findings of his analysis address that there exists a positive influence of trade liberalization on health status particularly in poor countries. In addition, the study postulated that there are two possible pathways that could lead to the link being seen. First, free trade enhances

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economic prosperity and enables the political leadership to spend more money on general public healthcare. The other pathway includes that there would be information repercussions, meaning that there would be enhanced cognitive and commercial dissemination. This can be seen in everything from the fundamental germ theory to the most cutting-edge pharmacological and medical products.

The concept of globalization could be broken down even into more subcategories such as economic, social, and geopolitical elements. Tsai, (2007) applied a dynamic approach and conducted experimental research to investigate the consequences that worldwide movements have on human wellbeing. The author employed random effect models on three different sets of panels over the period ranging from 1980 to 2000 and reached the conclusion that trade globalization has affirmative and statistically significant effect on human health. Whereas political and social globalization have no evident influence on human health when cognitive grading and spatial variations were used as a control variable in the model. Because of non-availability of empirical observation, the research has the drawback that quality of life is not quantified in subjective well-being. Additionally, no quantitative examination for a complete insight into human implications of globalization has been carried out.

Bergh et al., (2010) conducted research to determine the extent to which the trade openness is linked to changes in life expectancy. The research looked at data from 92 different jurisdictions between the years 1970 to 2005. According to the KOF index, which is an indicator of globalization, the findings indicate that globalization seems to have a beneficial and considerable effect on life expectancy. There are some additional conclusions that may be derived by utilizing a method that eliminates high net worth economies out of the group, then re-estimates, and finally gets progressively closer to low-income countries. According to these findings, a positive link exists when countries with high net worth are present; when approaching middle income, the relationship becomes irrelevant; and when examining the poorest countries, the relationship is once again substantial and favorable.

The studies focusing on the commercial aspect of globalization are extremely relevant to the current investigation. Owen & Wu, (2007) conducted research to investigate the connection between a nation's degree of economic openness and a variety of health indicators. The panel data approach such as fixed effect approach was utilized, with its panel consisting of 139 different nations. According to the data, global trade is linked with minimal rates of child impermanence as well as significantly better life expectancy. This link is less clear in wealthy countries, but in underdeveloped countries the results are extremely strongly supported by the evidence. Because the gains from trade are mostly reaped by the world's poorest countries, it's possible that worldwide health inequities will eventually reduce. Novignon et al., (2018) conducted research to investigate the effects of growing trade connectivity on the healthcare industries of 42 sub-Saharan African nations. The research looked at the life expectancy rate, the infant mortality rate, and the under-five death rate as three different indices of overall health. According to the findings, there is a negative correlation between higher bilateral trade and improvements in all health metrics.

In addition to this, Jorgenson et al., (2004) examined the relationship among trade openness, mortality rate and water contamination in OECD and non-OECD countries. According to the findings of the study, the accumulation of exported goods does not have an effect on infant mortality directly but rather indirectly through water pollution. Which in turn affects mortality rate of the imported countries In addition, a number of research imply that trade can be further segmented into two categories, namely legitimate trade and

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illicit trade. Similar to Huynen et al., (2005), performed a theoretical investigation for the consequences that trade openness has on people's health. The consequential model made it clear that trade openness has an effect on the institutional, economic, socio-cultural, and ecological factors that determine health. According to the findings of this study, there are two categories of trade: legitimate trade and illicit trade. The unlawful trade, such as that of drugs, has a detrimental effect on people's health, whereas the legal trade has positive effects.

The available literature on the subject i.e. trade openness and health expenditure in limited to few studies that has explored the relationship in Pakistan perspective. The research conducted by Alam et al., (2016) in Pakistan perspective shows that life expectancy of the general public increases with the increase in worldwide trade and investment coming international market such as FDI. The analyses were carried out in time series framework over the period of 1972 to 2013. Another study carried by Ali & Audi, (2016) to investigate the effect of wealth distribution, environment quality and trade openness on average life expectations. The author utilized auto regressive distributed lag approach and found that unequal distribution of wealth and lowering of environmental quality had an adverse impact on the average life expectations. Whereas average life expectancy increases with an increase in trade openness

The above discussion clearly demonstrate that international trade globalization and healthcare has strong connection, however it has been also noticed that the connection between international trade and health related expenditure need examination in the presence of control variables in the model such environmental degradation, economic growth and urbanization etc. in addition, focusing on single indicator of healthcare such as life expectancy could provide inaccurate result. Therefore, in this research the author is trying to make an effort so that new additions can be made to the empirical by assessing the influence of international trade on health expenditure by including another determinant in the model also. The literature studies concluded that most of the previous research conducted on the subject focused upon bilateral relationships involving the three main topics particularly environmental degradation, health care spending and economic growth in linear framework. Several researchers have investigated the link among the three-core concern with the help of panel co-integration in geographical configuration. In addition, for individual economies the core concern has been examined with the help of time series analysis in linear framework. In spite of this, it is a dire need of the time to investigate the link between environmental degradation, public health expenditure, urbanization, trade openness and economic growth in nonlinear framework and to put forward a well-structured policy recommendation for Pakistan. Nonlinear ARDL model is an approach that utilizes partial sum of any series to generate nonlinear short run and long run results.

METHODOLOGY

This study utilizes health expenditure, environmental degradation, trade openness, urbanization and economic growth. This study investigates different sources to extract the data on the aforementioned variables used in this study. The dataset for health expenditure, carbon emission, and urbanization and gross domestic product of Pakistan is obtained from world development indicator (2020). The trade openness series is calculated by utilizing import, export and population dataset. Trade openness is derived by dividing net trade by population. Net trade is the difference between export and import of goods and services. The export and import dataset are obtained from SBP databank. The time spin of the

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dataset used in this study ranges from 1980 to 2020 (Table 1).

Table 1: Description of the Variables

Variables Name	Abbreviation	Unit of Measurement	Definition
Health Expenditure	HE	Current US Dollar	Current expenditure on health per capita
Carbon Dioxide	CO	Metric Ton	The carbon emission is released from using coal, oil, gas and other solid and liquid fuel.
Gross Domestic Product	GDP	Constant 2010 US dollar	It is the value of gross domestic product divided by population to get per capita GDP
Urbanization	URB	Total Urban Population (millions)	Total urban population living in cities.
Trade Openness	TO	Index	Export plus Import divide by GDP.

Data of all the variables is sought out from WDI. The data range from 1980 to 2020.
The following linear function is developed to examine the nonlinear effect of environmental degradation on Pakistan's public health expenditures.

$$HE_t = f(CO_t + GDP_t + URB_t + TO_t) \quad (1)$$

Where HE_t is the public health expenditure, while$CO2_t$, URB_t $TO_t$and GDP_t represents carbon dioxide, urbanization, trade openness, and economic growth respectively The symmetric association among the proposed variables is denoted by equation (3.6). However, the key aim of the author is the determination of non-linear effect of the proposed variables such as environmental deterioration, trade openness, and economic growth on public health expenditure. As a result, the following regression is used to decompose time series:

$$D_t = \varphi^+ E_t^+ + \varphi^- E_t^- + \mu_t \quad (2)$$

Long term coefficients are linked with φ^+ and $\varphi^-$where $E_t$the vector of desired variables E_t^+ and E_t^+ are the partial sums of the desired independent variables' positive and negative changes. The partial sums of positive and negative change in environmental degradation, urbanization, trade openness, and economic growth are shown in the following equation ranging from 3 to 10.

$$CO^+ = \sum_{k=1}^{m} \Delta CO2_k^+ > 0 = \sum_{k=1}^{m} \max(\Delta CO2_k^+, 0) \quad (3)$$

$$CO^- = \sum_{j=1}^{n} \Delta CO2_k^- < 0 = \sum_{k=1}^{m} \min(\Delta CO2_k^-, 0) \quad (4)$$

$$GDP^+ = \sum_{j=1}^{n} \Delta GDP_k^+ > 0 = \sum_{j=1}^{n} \max(\Delta GDP_k^+, 0) \quad (5)$$

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$$GDP^{-} = \sum_{j=1}^{n} \Delta GDP_k^{-} < 0 \quad = \quad \sum_{j=1}^{n} \min\left(\Delta GDP_k^{-}, 0\right) \qquad (6)$$

$$TO^{+} = \sum_{j=1}^{n} \Delta TO_k^{+} > 0 = \sum_{j=1}^{n} \max(\Delta TO_k^{+}, 0) \qquad (7)$$

$$TO^{-} = \sum_{j=1}^{n} \Delta TO_k^{-} < 0 \quad = \sum_{j=1}^{n} \min(\Delta TO_k^{-}, 0) \qquad (8)$$

The next step involves the incorporation positive and negative shocks of the variables in linear model except urbanization. The urbanization variable cannot be decompose into partial sum of positive and negative change because the urbanization exhibit increasing trend only (Sociais & 2018: Zahra et al., 2022). As a result of equation (1) becomes:

$$HE_t = f(CO2_t^{+}, CO2_t^{-}, GDP_t^{+}, GDP_t^{-} TO_t^{+}, TO_t^{-}, URB_t) \qquad (9)$$

The conventional auto regressive distributed lag model of Pesaran et al., (1999) and Pesaran et al., (2001) is extended to asymmetric auto regressive distributed lag model by Shin et al., (2014). After this development in simple ARDL model, it is possible to calculate the asymmetric elasticity of a desired variable over the short run and long run. According to recent literature such as Economou et al., (2018) Raza et al., (2016) and considering the nonlinear impact of environmental degradation, trade openness and economic growth, we established the NARDL model in the following manner:

$$HE_t = \delta_0 + \delta_1(CO2_t^{+}) + \delta_2(CO2_t^{-}) + \delta_3(GDP_t^{+}) + \delta_4(GDP_t^{-}) + \delta_5(TO_t^{+}) + \delta_6(TO_t^{-}) + \delta_7(URB_t) + \mu_t \qquad (10)$$

Long-term parameters are represented byδ_i. The nonlinear component of the desired variables is incorporated in the equation (10) by including the partial sum of positive change in CO^{+}, TO^{+}, and GDP^{+} partial sum of negative changesCO^{-}, TO^{-}, and GDP^{-}. Equation (10) represents the long run relationship only, therefore must be reworked under an error correction method so that the short-run coefficient can be extracted:

$$\Delta HE_t = \delta + \sum_{m=1}^{n} \varphi_k \Delta HE_{t-m} + \sum_{m=1}^{n} \Delta CO_{t-m}^{+} + \sum_{m=1}^{n} \Delta CO_{t-m}^{-} + \sum_{m=1}^{n} \Delta GDP_{t-m}^{+} + \sum_{m=1}^{n} \Delta GDP_{t-m}^{-} + \sum_{m=1}^{n} \Delta TO_{t-m}^{+} + \sum_{m=1}^{n} \Delta TO_{t-m}^{-} + \sum_{m=1}^{n} \Delta URB_{t-i} + \alpha_1 HE_{t-1} + \alpha_2 CO_{t-1}^{+} + \alpha_3 CO_{t-1}^{-} + \alpha_4 GDP_{t-1}^{+} + \alpha_5 GDP_{t-1}^{-} + \alpha_6 TO_{t-1}^{+} + \alpha_7 TO_{t-1}^{-} + \alpha_7 URB_{t-1} + \varepsilon_t \qquad (11).$$

The equation (11) is error correction approach because it includes both short run and long run coefficients. The differencing term shows the short run coefficients where α_i term represents long run parameters.

Finally, Shin et al., (2014) estimate the equation (11) and utilize bound testing approach to investigate both short run and long run asymmetric relationship among the projected variables. The bound testing approach is appropriate both for linear models as well as for nonlinear ARDL models.

After estimating equation (11), Shin et al., (2014) employed the bound testing approach advanced by Pesaran et al., (1999) and Pesaran et al., (2001) recommended that bound test

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posits same results for the equation (3.16), whereas the inclusion of positive and negative shocks of the time series such as environmental degradation, trade openness, urbanization and economic growth make the model nonlinear ARDL. Compared to the more traditional co-integration approach, the ARDL model has several advantages. For example, this method does not require all variables to be stationary in the same order as with typical co-integration forms (Engle & Granger, 1987; Rasheed, et al., 2022). The ARDL has no concern with stationarity of the series whether it is stationary at level or first difference except second order of integration in the model. The ARDL model is also applicable if the variables are integrated at different orders like some variable's stationary at first difference and few at level (Rafique et al. 2024). This method performs effectively with a relatively small sample size (Panopoulou & Pittis, 2004).

The estimation of non-linear Auto regressive distributed-lag (NARDL) model involves the following phases.

In first step, the order of the integration of the variables is scrutinized, to avoid the presence of second order of integrated series, which would invalidate the F-statistics of a bound test and make the estimation result irrelevant. The benefit of this framework is that it may be used with any circumstances of different combinations of levels variable and 1st differences of variables. This study will use the ADF unit root test and Phillip-Peron unit root test to diagnose the stationarity of the variables.

In 2nd step, general to specific approach of Katrakilidis & Trachanas, (2012) and Ibrahim, (2015) is adopted to approximate the equations (11) by utilizing the conventional OLS approach. In this step, the respective time series is disentangled into their respective asymmetric form.

In the third step, the process continuously involves the extraction and deletion of insignificant lag till the parsimonious estimated model is achieved.

In the fourth step, the abound testing approach
of long run relationship established by Pesaran et al., (2001) and stretched by Shin et al., (2014) is recycled headed for exploring the longer-term connection among proposed variables. Hypotheses for a bound test of co-integration are presented below.

$$H_0;\ \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$$
$$H_a;\ \text{at least one } \alpha \neq 0$$

If the bound test F-statistics are above the threshold value, then we reject the null hypothesis of no co-integration among the projected variables and accept alternative hypothesis.

In the final step, an asymmetric effect of environmental degradation, urbanization, trade openness, and economic growth on public health expenditure is investigated with the help of Wald test.

Results and Discussion

Distinguishing data characteristics, such as mean, median, and the standard deviation, is the core of descriptive statistics. The mean value is a critical statistical instrument that provides the overall average value of any series during its study period. From the result of descriptive statistics, it can be easily observed that GDP per capita carried the highest mean value of 830.6 US dollars followed by urbanization having mean value of 45.89 million people living in cities. The trade openness carried lowest mean value of 0.561 followed by carbon dioxide having average value of 0.684 metric ton per capita. The maximum value of GDP per capita of Pakistan were (1197) lying in the year 2018 followed by urbanization

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having value of 89.09 in the year 2018 also. The carbon emission and health expenditure of Pakistan carried maximum value of 1.527 metric ton per capita and 16.51 US dollar in the year 2020 and 2018 respectively. The minimum GDP per capita of Pakistan during the study period was 487.8 US dollar lying in the year 1980, followed by carbon dioxide emission having value of 0.331. The outcomes of "descriptive statistics" are presented in the below table 2:

Table 2: Outcome of Descriptive Statistic

Variable	Mean	Median	Maximum	Minimum
HE	5.054	3.329	16.51	1.162
CO2	0.684	0.681	1.527	0.331
GDP	830.6	807.8	1197	487.8
TO	0.561	0.382	0.773	0.173
URB	45.89	43.93	82.09	18.36

To avoid false results, it is imperative to analyze the data series' stationarity before testing the co-integration in the dataset. The Philips Perron (PP) and an Augmented Dickey-Fuller (ADF) test is utilized to investigate the stationarity of the time-series. Initially, the order of integration of the series is examined at level by counting trend and intercepts term in the model. In the consequent step, the order of variables is investigated at first difference in the presence of interception in the equation. The outcomes augmented dickey filler (ADF) and Phillip-Perron tests there displayed in table 3, which shows that the entire variable, except carbon dioxide emissions and urbanization stand integrated at the initial transformation; therefore, the integration results permit us to perform auto regressive distributed lag model and bound test of long run association. The ARDL model can be used regardless of which variables are integrated at what order in a model, except for those that are second order. The bound test F-statistics lose their validity if a variable integrated at a second difference is present (Ibrahim, 2015: Ilyas et al., 2010). Because all other co-integration strategies need the variables to be integrated in a specified order, the ARDL bound testing approach obviously surpasses them all (Engle & Granger, 1987).

Table 3: Order of Integration Test results

Variable	ADF Test		PP Test		Conclusion
	Level	First Difference	Level	First Difference	
LNHE	-0.334690 (0.9111)	-7.828904 (< 0.01)	-0.214281 (0.9289)	-7.829005 (< 0.01)	I(1)
LNCO2	-4.185664 (< 0.001)	-	-4.099049 (< 0.002)	-	I(0)

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LNGDP	-2.2170 (0.4667)	-4.0568 (< 0.03)	-1.8963 (0.6737)	-4.1844 (< 0.02)	I(1)
LNTO	-1.8297 (0.3617)	-5.2829 (< 0.01)	-2.0231 (0.2762)	-5.2727 (< 0.01)	I(1)
LNURB	-4.4009 (< 0.01)	-	-4.4070 (< 0.01)	-	I(0)

After determining stationarity status of the proposed variables for this study, the next step is to investigate the long-term correlations. The value of F-statistics against its critical value for the bound test significantly depending on the lag selection structure (Bahmani-Oskooee & Nasir, 2004: Bahmani-Oskooee & Bohl, 2000). According to Stock & Watson, (2012) Stock and Watson (2012), it is complicated to get reliable information if only a few lags are included in the model. The most correct model can be selected using the standard bench mark postulated by Pesaran et al., (2001). On the base of "AIC" and "SBC" criteria, the most suitable model must be including three lag of dependent and independent variables. At 1% level of significance, the calculated-value of F-Statistics exceeds the tabulated value, showing a long-term association among the projected variables at a 5% level of significance. Different factors such as number of regressors, stationarity condition of the time series sample size and sampling method affect the distribution of F-statistic (Boutabba, 2014). The outcome of bound test is given in the below table 4:

Table 4: Results of Bound Test

F-Statistics	9.209	
Significance Level	**Lower Bound**	**Upper Bound**
10%	2.03	3.13
5%	2.32	3.50
2.5%	2.6	3.84
1%	2.96	4.26

Note: Critical values are derived from Pesaran et al. (2001)

This research presents the long run nexus between health expenditure, environmental degradation, urbanization, trade openness and economic growth in the context of Pakistan. The outcome of the NARDL estimated model is presented in table 5.

The outcome of the estimated NARDL model shows that public health expenditure and environmental degradation are correlated asymmetrically in the long run. The estimated elasticity of LNCO2_P in environmental degradation significantly increases the public health expenditure by 34 percent whereas the LNCO2_N in environmental degradation enhances public health expenditure by 19 percent but has a statistically insignificant impact on public health expenditure. The positive relationship between positive shocks in environmental degradation and health expenditure is quite realistic. Chaabouni & Saidi, (2017) carried a study over the period of 1995 to 2013 for fifty-one different countries including developing and developed countries. The findings support the evidence that there exists two-way correlation between healthcare expenditure and carbon emission. The finding also demonstrates that carbon emissions probably contribute to out-of-pocket health expenditure. In addition to this Yahaya et al., (2016) applied penal data technique such as penal co-integration technique over the period of 1995 to 2012 and utilize database from 125 countries. The findings of his study support the linkage amid environmental

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quality and public healthcare spending. The result also states that carbon emission is the primary cause of increment in health expenditure.

This study's long-term findings demonstrate the presence of a coincidental association between healthcare costs and economic progression in Pakistan. Favorable changes in economic progress have a relatively greater influence on public health expenditures, but negative changes in economic progress have a statistically insignificant and negative impact. This result can be justified by providing the reason that increase in economic activities, increase in industrial production significantly contributing environmental degradation and as a result adverse impact on human health which led to increase government health spending. On the other hand, the said result can be justified by stating that positive shock in economic growth significantly increases government allocation to health industry. The finding of this study also supported the previous finding made by (Li et al., 2019) and (Chaabouni et al., (2016). Mehrara et al., (2011) investigated the nexus between environmental degradation and governmental healthcare spending in the presence of economic prosperity as a control variable in the panel co-integration model. The author collected data from 114 emerging economies over the time period 1995 to 2007. The result of Mehrara et al., (2011) state that close unidirectional correlation amid public healthcare related spending and economic prosperity.

Trade openness has been a fundamental factor for economic prosperity in many countries, creating jobs, knowledge dissemination, and international trade, increasing competitiveness among enterprises, increasing income, and reducing poverty. The long run result indicates that positive component of trade openness has statistically significant and favorable impact on public health expenditure (Rasheed et al. 2025). One percent proliferation in trade openness accounts for 23% increase in public health expenditure. On the hand side, negative shock in trade openness reduces public health expenditure of Pakistan by 15 percent. This result indicates that trade liberalization increases health related risks such as infectious diseases like HIV aid and COVID-19 which endanger public health. On the other hand, the result also states that trade liberalization enables government to generate more revenue from trade related taxation, and hence more budget is available to government for spending on public health. The negative shock in trade openness reduces government spending on health-related matters such as construction of new hospitals, hiring of medical staff and provision of medicine etc. The finding is supported by previous literature such as Novignon et al., (2018). Jorgenson et al., (2004) examined the relationship among trade openness, mortality rate and water contamination in OECD and non-OECD countries. According to the findings of the study, the accumulation of exported goods does not have an effect on infant mortality directly but rather indirectly through water pollution. Which in turn affect mortality rate of the imported countries. In addition, a number of research imply that trade can be further segmented into two categories, namely legitimate trade and illicit trade. Similar to Huynen et al., (2005), performed a theoretical investigation for the consequences that trade openness has on people's health. The consequential model made it clear that trade openness has an effect on the institutional, economic, socio-cultural, and ecological factors that determine health. According to the findings of this study, there are two categories of trade: legitimate trade and illicit trade. The unlawful trade, such as that of drugs, has a detrimental effect on people's health, whereas the legal trade has positive effects.

Consequently, this study also explores the nature of relationship between urbanization and health-expenditure in longer term. The estimated result of NARDL model shows that urbanization is enter into the model without any positive and negative shock due to positive and linear trend of urbanization in Pakistan. The result state that urbanization has

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statistically significant and positive impact on public health expenditure in Pakistan. Tajudeen et al., (2018) used a structural time series model (STSM) to reconsider the significance of the predominant underpinning determinants of healthcare spending in Tanzania. They came to the conclusion that urbanization is a significant contributor to healthcare spending.

Table 5:- Long Run Outcomes

Variable	Coefficient	S. Error	t-Stat	P-Value
LNCO2_P	3.433	0.616	5.573	< 0.02
LNCO2_N	1.909	1.650	1.156	0.271
LNGDP_P	4.945	1.984	2.492	< 0.05
LNGDP_N	-0.619	12.86	-0.048	0.962
LNTRD_P	2.327	0.419	5.553	< 0.02
LNTRD_N	-1.514	0.246	-6.145	< 0.01
LNURB	4.017	1.313	3.059	< 0.01

Note: All the variables are in logarithmic form, Whereas P and N represent Positive and Negative Shock respectively.

The short run elasticities of the independent variables are estimated with the help of NARDL model and outcomes are given below in table 6. The short run outcomes show that entire variables at level and their lag have statistical significance except urbanization at level and negative shocks in economic growth both at level and lag are statistically insignificant. The environmental degradation has statistical influence on public health expenditure in Pakistan over the study period. This result assumes that environmental degradation positive shock immediately decreases labor productivity and health expenditure via the national income concept. However, in the following year its effect turns aside and reduces public health expenditure. Whereas negative shocks in environmental degradation both at level and first lag enhance government health care expenditure. Next, economic growth in the given year positively affects healthcare expenditure whereas in following year the impact becomes adverse. This result indicates that in the given year increase in economic growth immediately increases government allocation to health sector however, in the following year it decreases due to lack of reflections in the market transaction. In addition, the positive shock in trade openness shows significant and positive impact on healthcare cost whereas, each lag exerts negative impact on health expenditure in short run. This outcome indicates that trade openness immediately poses positive impact on health expenditure through increase in health-related import and hence health expenditure increases in short run. Whereas in the following year, this effect becomes negative due to medical related technology transfer from developed countries and as a result cost of medical services decreased.

Urbanization in short runs both at level and lag enhances public health however, at level the impact of urbanization is statistically insignificant. The increase in urbanization in developing countries promotes communicable disease, lack of suitable sanitation system in urban areas, contaminated drinking water and air pollution has an adverse impact on health status of the public which in turn increases health related expenses. The error correction term shows the promptness of correction of the dependent variable in case, if dependent variable deviates from equilibrium in short run it comes to equilibrium in long run with the speed of 95 percent per annum.

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Table 6:- Short Run

Variable	Coefficient	S. Error	t-Stat	P-Value
D(LNCO2_P)	-3.091	0.229	-13.49	< 0.01
D(LNCO2_P(-1))	0.795	0.251	3.167	< 0.08
D(LNCO2_N)	2.018	0.828	2.437	< 0.01
D(LNCO2_N(-1))	2.220	1.044	2.126	< 0.01
D(LNGDP_P)	6.397	0.878	7.285	< 0.01
D(LNGDP_P(-1))	-1.144	0.156	-7.333	< 0.01
D(LNGDP_P(-2))	-2.033	0.880	-2.310	< 0.02
D(LNGDP_N)	-3.708	1.664	-2.228	< 0.01
D(LNGDP_N(-1))	-0.419	3.821	-0.109	0.333
D(LNGDP_N(-2))	2.663	3.616	0.736	0.914
D(LNTRD_P)	0.711	0.122	5.827	< 0.01
D(LNTRD_P(-1))	-2.270	0.185	-12.27	< 0.01
D(LNTRD_P(-2))	-1.235	0.109	-11.33	< 0.01
D(LNTRD_N)	-0.309	0.147	-2.102	0.059
D(LNTRD_N(-1))	1.571	0.193	2.958	< 0.01
D(LNTRD_N(-2))	0.474	0.134	3.537	< 0.04
D(LNURB)	2.039	1.159	1.759	0.928
D(LNURB(-2))	3.765	1.051	3.582	< 0.03
ECM(-1)	-0.983	0.063	-15.43	< 0.01

Note: All the variables are in logarithmic form, Whereas P and N represent Positive and Negative Shock respectively.

The main purpose of WALD test of asymmetry is to evaluate the asymmetric or nonlinear effect of aforementioned variables on health expenditure in Pakistan. The null hypothesis demonstrates that "there is no asymmetric effect of the carbon dioxide emission, economic growth and trade openness variables on the health expenditure in Pakistan" on the other hand, the alternate hypothetical statement of WALD test is "there is significant asymmetric or nonlinear effect of the carbon dioxide emission, economic growth and trade openness variables on the health expenditure in Pakistan. The acceptance and rejection of null and alternative hypothesis depend upon the Probability value of the WALD statistics. If P-value exceeds the 5 % indicating that there is no asymmetric effect of the projected variable on the health expenditure, and we admit that there is no asymmetric effect of the proposed variables. in contrary to that, if probability value remains below 5 percent level of significant meaning that there is significance and have nonlinear effect of the aforementioned variables on health expenditure in Pakistan and we accept alternative hypothesis. The result of WALD test is provided in table 4.6, representing that P-value is less than 5 percent and concluding that all the aforementioned variables in the model have nonlinear effect on public health expenditure of Pakistan both in short run as well as in long run except trade openness which has symmetric effect on health expenditure in long run. The outcome of WALD test of asymmetry is provided in table 7:

Table 7: WALD Test of Asymmetry

Variables	WALD statistics	X^2 Statistics	Probabilities	Status
CO2-Short Run	21.06	57.20	< 0.01	Asymmetric
GDP-Short Run	14.34	86.04	< 0.01	Asymmetric

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TO-Short Run	6.705	13.41	0.0125	Asymmetric
CO2-Long Run	5.573	11.14	0.0213	Asymmetric
GDP-Long Run	20.09	40.18	< 0.02	Asymmetric
TO-Long Run	1.005	2.010	0.397	Symmetric
Urbanization	-	-	-	Symmetric

To determine whether or not the model is adequate, one can look at things like autocorrelation, heteroscedasticity, the normality of the residuals, and many other things. We put the technique for making estimates through its paces by carrying out a number of different tests. The result of the diagnostic test is provided in table 7, indicating that estimated model is adequate and accurate.

The autocorrelation in the residual of the model is investigated by utilizing the "BG Serial-Correlation LM" test. This above-mentioned test is composed of null and alternative hypothesis. The null hypothesis postulate that the "residual of the estimated model have no problem of serial correlation" whereas the alternative hypothesis postulate that the "residual have a second order serial correlation problem". The decision is made on the basis of F-statistics, if the value of F-statistics exceeds the 5 percent level of significance then we accept null hypothesis and conclude no serial correlation problem in the residual of estimated model. The result of the Breusch-Godfrey Serial Correlation LM test demonstrates that there is no serial correlation problem in the residual term of the estimated model. Consequently, the Brush-Pegan heteroscedasticity test is applied to investigate the heteroscedasticity in the above model. This test is composed of null and alternative hypothesis. The null hypothesis of Brush-Pegan heteroscedasticity test demonstrate that the "standard error of the error term is constant" where the alternative hypothesis postulate that the "standard error of the error term of the estimated model is not constant. The decision regarding the heteroscedasticity is made on the base of chi-square probability value. If chi-square probability value exceeds 5 % level of significant indicating that there is no heteroscedasticity problem in the model otherwise the model has a serious problem heteroscedasticity. The result of the test is provided in table 5 indicating that model is free from heteroscedasticity problem.

Lastly, the distribution of the residual term is examined by utilizing the Jarque-Bera test. Primarily, the fundamental objective of Jarque-Bera statistics is to investigate whether the residual term of the estimated model following the assumption of normal distribution or not. The result of Jarque-Bera statistics is provided in table 8 indicating that residual term is fulfilling the assumption of normal distribution.

Table 8:- Outcomes of Diagnostics Tests

BG Serial-Correlation LM Test			
F-Statistics	0.623	P-Value	0.448
Observed R Squared	2.404	Chi-Square P Value	0.121
BPG Heteroscedasticity Test			
F-Statistics	0.619	P-Value	0.857
Observed R Squared	23.07	Chi-Square P Value	0.681
J-B Normality Test			
F-Statistics	2.762	P-Value	0.251

The CUSUM and CUSUM of square test are critical for ensuring the long-term stability

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of the estimated parameters. Usually, the result of CUSUM and CUSUM of square test are obtained in the form of graph given below. The blue line demonstrates the level of significance where the red line represents the critical value. In case the blue lines cross the red line meaning that the long run estimated parameters are not stable over time and unreliable. On the other hand, if the blue line is moving inside the red band, indicating that long run estimated parameters are stable over time and can be concluded reliable. From the graph below, it can be easily concluded that blue line is moving within the red line meaning that our long run estimated parameters are stable and reliable (Figure 1).

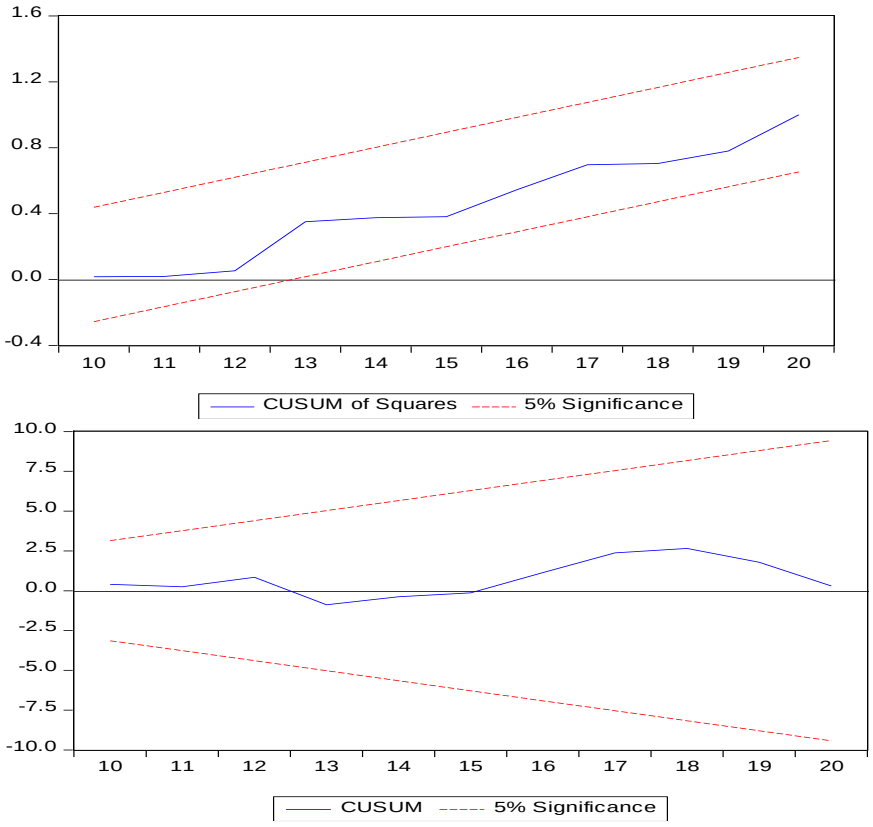

Figure 1: CUSUM AND CUSUM of Square

Conclusion and Policy Recommendations

This research aims to explore the relationship between public health expenditure, environmental degradation, trade openness, gross domestic product and urbanization in respect of Pakistan during the times spin ranging from 1980 to 2020. The stationarity of the proposed variables is investigated through Augmented Dickey Filler Test and Phillp-Perron test. The bound test approach is utilized to investigate the long run nexus among the aforementioned variables. In the following step NARDL model is applied to estimate the short run and long results of the aforementioned independent variables. Consequently, the nonlinear impact both over the long run and short run is examined through WALD test of asymmetry. The adequacy of the NARDL model is examined through BG Serial Correlation LM test, Brush-Pegan heteroscedasticity test and JB test etc. The stability of the parameter is judged from CUSUM and CUSUM of square testing approach.

The finding of augmented dickey fuller (ADF) and Phillip & perron (PP) test designate that all the time series variables are integrate at level except carbon emission and GDP

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integrated at first order. The bound test result shows the presence of long run asymmetric association among the proposed variables utilized in this study. The long result shows that all the variables have been statistical influence on public health expenditure in Pakistan except the negative component of environmental degradation and economic growth. The desirable change in environmental degradation increases the health expenditure in Pakistan. The long run result demonstrates that positive change in economic prosperity has significant relationship with public health expenditure whereas the unfavorable change in economic growth has statistically insignificant and adverse impact on public health expenditure in Pakistan over the study period. In addition to these results, both types of shocks in trade openness have statistically significant impact on health expenditure in Pakistan. The positive shocks in trade openness accelerate public health expenditure whereas negative shocks in trade openness adversely impact public health expenditure in Pakistan.

Consequently, the result of NARDL model shows that urbanization also plays an important role in determining public health expenditure in Pakistan. In our study the urbanization variable is enter into the model without any type of shocks because the urbanization in Pakistan is constantly increasing therefore this study utilize urbanization as an independent variable without transforming into positive and negative shocks. The result indicates that urbanization has a positive impact on health expenditure in Pakistan over the study period. The nonlinear effect of the aforementioned independent variables is examined with the help of WALD test of asymmetry. The results of WALD test of asymmetry indicate that all the aforementioned variables have short run and long run asymmetric effect except trade openness which has symmetric effect in long run. The adequacy of the estimated model is investigated and concluded that the entire test provides satisfactory results. The results of diagnostic test show that there is no problem of autocorrelation, heteroscedasticity and residual of the model are normally distributed. The CUSUM and CUSUM of square test provide that estimated long run results are stable across the study period.

On the basis of above findings, this study suggests following recommendation to the concerned quarter for the revision of policy statement.

The policy maker must consider the asymmetric long run association between public health care expenditure and environmental degradation.

The concerned quarter must include the asymmetric effect of urbanization in the policy formulation.

This study recommends that policy makers must consider the issue of asymmetric effect of trade openness and gross domestic product on public health care expenditure.

Limitations of the Study

This study has three types of limitations, i.e. nature of data and inclusion of independent variables in the model. This study does not include some important determinants of health expenditure such institutional quality, literacy rate, etc. These variables also determine health expenditure in developing countries. Second, this study utilizes time series data which does not provide more diverse results due to lack of variability, minimum information etc. The time series data cannot minimize estimation biases which may arise in estimation procedure. Finally, the health status of any country can be measured with different proxies such as mortality rate, life expectancy, out of pocket health expenditure (OOP) etc. This study utilized only a single proxy i.e. health expenditure to measure the health status of Pakistan.

Future Direction of Research

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The impact of environmental degradation on health expenditure can be tested in penal data framework because penal data provide individual and common characteristics of the country. Additionally penal data provides more diverse and efficient result as compere to time series dataset. This topic can be further explored by differentiating the effect of environmental degradation on health expenditure in developing and developed countries.

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