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Triangular relationship among energy consumption, air pollution and water resources in Pakistan

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ABSTRACT

Literature presents opposing findings about relationship among critical variables such as energy consumption, air pollution, water resources, and natural resource rents. This is particularly true in case of Pakistan. This study aims to narrow the gap by examining the long-run and causal relationship among these variables in Pakistan specific scenario covering a period of 38 years i.e. 1975 to 2012, where all inputs are subject to change. The results show that energy consumption and water resources have a significant positive relationship with air pollution both in short-run and long-run. The relationship further supports the unidirectional causality of the former with the latter and not vice versa. Similarly, the results indicate the continued influence of energy consumption and water resources over air pollution for the next 10 years. The total natural resources rent exhibits the least contributor to affect air pollution in Pakistan.

1. Introduction

Energy crisis has been hindering economic growth of Pakistan for the last few years. Since the start of millennium, electricity received greater attention because of the fast growth in its demand. Similarly, the environmental factors i.e., air pollution, inadequate water supply, sanitation, deforestation and rangeland degradation are the major environmental challenges faced by the country which pose a serious problem (GoP, 2013). Thus there is urgently required the shifting of fuel mix from expensive to cheaper. Fig. 1 shows that Pakistan has larger share of oil in electricity generation as compared to India and Bangladesh.

Pakistan faces severe deterioration of surface and ground water quality because of unabated industrial, municipal and agricultural pollution. The connected unfavorable health and productivity impacts are significant, poor bearing the brunt. Hence, polluted water causes rising incidence of water borne diseases in a country (GoP, 2012).

There is an interesting interplay between energy, environment, and water. Zhang et al. (2013) examined the relationship between China's economic growth and its energy consumption, air emissions and air environmental protection investment during 2000–2007. The results indicate that energy consumption rapidly rises with China's fast economic growth; however, energy efficiency and environmental loading intensity from energy consumption are reduced simultaneously. Litovitz et al. (2013) estimated the air pollutant emissions and health damages from the extraction of unconventional shale gas in Pennsylvania. The results show that the region-wide estimated damages ranged from US $7.2 to $32 millions for 2011. Rosa et al. (2014) carried out the 5-month household randomized controlled trial among 566 households in rural Rwanda to evaluate uptake, compliance and impact on environmental exposures of a combined intervention delivering high-performance water filtered and improved stoves for free. The results show that

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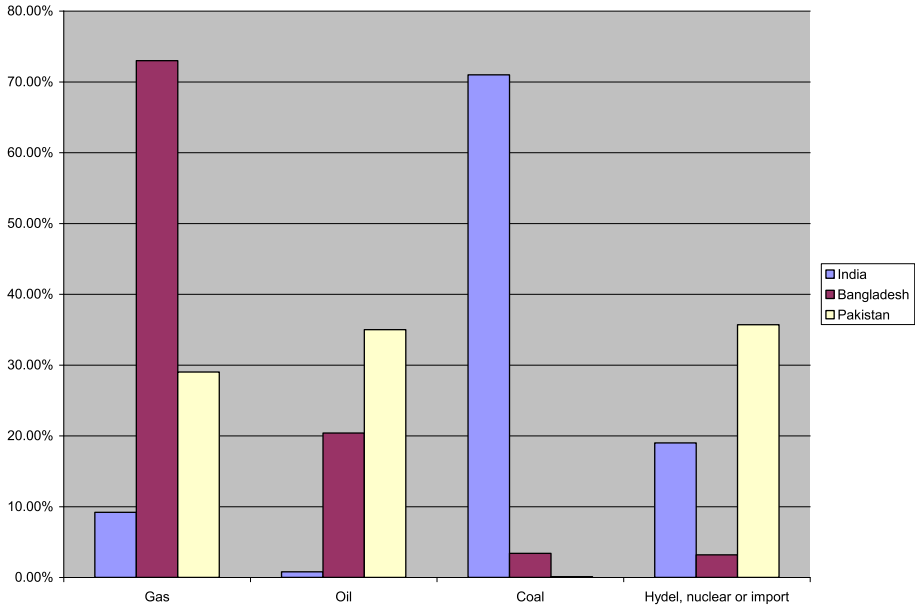

Fig. 1. Comparison of electricity generation by sources.
Source: GoP (2013).

the most householders filter the drinking water for primary cooking stove. On the other hand, some householders continued to drink untreated water which badly affects the households' health. Lee and Meene (2013) examined the relationship between per capita primary greenhouse gases emissions and carbon dioxide in the major Asian cities. The results found that a city's energy inefficiency, waste generation per capita, and GDP per capita are positively connected with the carbon dioxide emissions per capita.

Arent et al. (2014) investigated the renewable electricity for supply chains in the United States. The results show that the greenhouse gas emissions are reduced proportionally and water use is reduced up to 50%. Huaman and Jun (2014) confer the viewpoints for development of Carbon Capture and Storage (CCS) technologies in the global fight against climate change. The results show that the distribution of the carbon dioxide intensity relates to the CCS. The study further highlights the barriers, strategies for accelerating and the stages in the technology deployment. According to the Mukhopadhyay and Pandit (2014, p. 35),

> "The environmental issue has become a major subject in the last few decades affecting science and technology throughout the world due to the serious environmental impacts caused by industrial air pollution".

Bhutto et al. (2014) investigated the renewable energy projects in Gulf Cooperation Council (GCC) countries. For this purpose, number of publications on renewable energy in reference to GCC countries since 2005 was summarized. The results show that the GCC countries benefit from clear advantage for the development of solar and wind energy. Lim and Yoo (2014) examined the causal relationship between carbon emissions, oil consumption and Philippines' income, over a period of 1965–2012. The results show the bidirectional causality between the oil consumption and economic growth on one hand, while on the other hand, oil consumption also have bidirectional causality with the carbon emissions in Philippines.

Zaman et al. (2011) examined the relationship between multiple growth factors and energy consumption in Pakistan, by using the time series data from 1980 to 2009. The results evident the feedback hypothesis between carbon dioxide emission and energy demand on one hand, while on the other hand, industrialization Granger cause energy demand via both route. In addition, there is a unidirectional causality running from energy demand to population growth but not vice versa. Khan et al. (2013) examined the causal relationship between economic growth, greenhouse gas emissions, and energy consumption in Pakistan by using time series data from 1975 to 2011. The results show that greenhouse gas emissions correlate with the economic growth and energy consumption in Pakistan. Among all the variables, greenhouse gas emissions, combustible renewables and waste exerted the largest contribution to changes in energy consumption in Pakistan. Mudakkar et al. (2013) shows the long-run relationship among energy consumption, economic growth, environment, natural resources and industrialization in the context of Pakistan, over a period of 1975–2011. The results confirm the feedback hypothesis, unidirectional causality and neutrality hypothesis in various conjunctions of the variables. Akhmat et al. (2014) examined the causal relationship between air pollution, climatic factors and energy consumption in the panel of 35 EU countries, over a period of 1975–2012. The results suggest that nuclear energy decreases the quantity of air pollution and greenhouse gas emissions.

Bhutto et al. (2013) discussed the past, present and the future of wind energy use in Pakistan. The results conclude that there is a potential of wind energy in Pakistan, however, the significant efforts are required to effectively make use of this cheap renewable energy source. Mumtaz et al. (2014) examined the long-run and causal relationship between growth factors and energy consumption in Pakistan for the period of 1975–2010. The results indicate that there is a unidirectional causality running towards energy consumption to trade factors but not vice versa. In majority of the cases, the causality running from energy consumption to macroeconomic factors, but not the other way round. Abbas et al. (2014) examined the progress of geothermal energy sources, technologies and its potential. The results suggest that there is a need to develop geothermal technologies to supplement the long-term energy