Measuring the Impact of Industrialization and Financial Development on Water Resources: A Case Study of Pakistan

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ABSTRACT
The objective of the study examines the impact of industrialization and financial development on water resources, in the specific context of Pakistan. Data set from 1975-2009 are taken for time series analysis. The result reveals that economic growth positively linked with the water resource, as water plays a pivotal role in the economic development of a country. Thus limiting this resource would affect the process of economic growth. Industrial processes have a negative environmental impact which causing water pollution. Financial development has an indirect effect on water consumption, as it shows that private firms finds more funding opportunities in a country, therefore, avoid dirty industry game.

KEYWORDS*:* *Economics growth, financial development, industrialization, water resource, cointegration, bonds test, Pakistan.*

JEL Classification: C32, O14, Q25

1. Introduction

In the Millennium Declaration of the UN General Assembly in 2000, a commitment was made to halve by 2015 the global proportion of people without access to safe drinking water (UN, 2000). The international community both confirmed and extended this commitment in the 2002 Johannesburg Declaration on Sustainable Development (UNCSD, 2002). The field of sustainable development conceptually broken into three main parts i.e., *environmental sustainability*, *economic* sustainability and *socio-political* sustainability (UNENF, 2005). In economic theory, the role of environmental factors is not outlined properly. These factors are built in a number of theories and theoretical models, but mostly they are examined as an element having only secondary significance. Policies for

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development and environment are evolving as tools of behavioral change throughout the world, and it is now understood that an essential prerequisite to effective policy making is accurate monitoring backed up by rigorous interdisciplinary science (Sullivan, 2002). Water is essential for life, and an adequate water supply is a prerequisite for human and economic development. It has been recognized that human behavior can have an impact both on water, and on the global ecosystem, and that there is a need to regulate that behavior in order to stabilize and sustain our future (WCED, 1987). Global water resources are limited, and only through a more sustainable approach to water management, and more equitable and ecologically sensitive strategies of water allocation and use, can we hope to achieve the international development targets for poverty reduction that have been set for 2015 (DFID, 2000).

As water resource is a central and integral part of the sustainable development because it is central to all major dimensions of environmental sustainability i.e., air pollution, dry land, forestry and climate change etc. Figure 1 show how the water resource maps on to each of these elements.

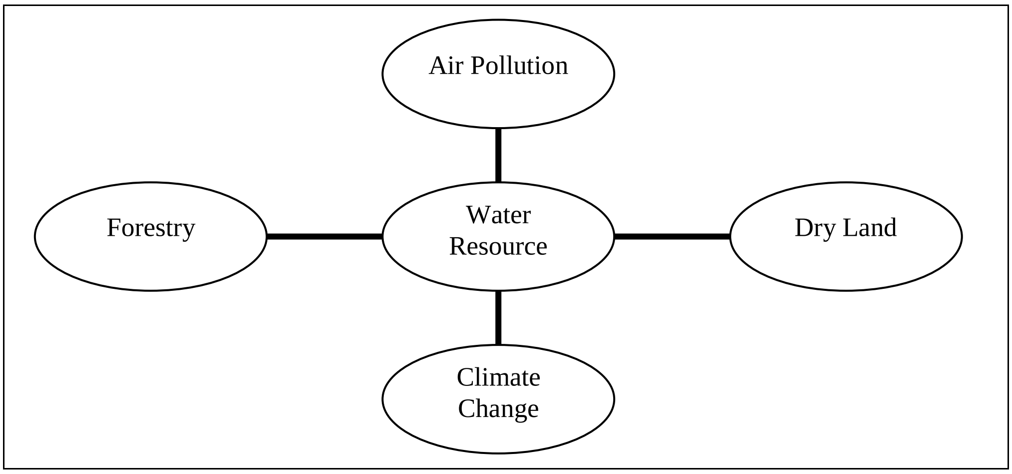

Figure 1 Water Resource and Environmental Development
Source: Self extracted

In terms of the air pollution of environmental development, the major factors causing degradation to air quality are rapidly growing energy demand and a fast growing transport sector (GoP, 2010). In terms of the dry land, unsustainable land management practices and increasing demand of natural resources causing enormous environmental problems which includes degradation of dry land ecosystems, loss of soil fertility, flash floods, loss of biodiversity, reduction in land productivity, soil erosion, water logging salinity, and many other associated problems to rapid growth in population is putting pressure on natural resources. Forests are under pressure due to expanding human and livestock populations which frequently leads to conversion or degradations of forests into unsustainable forms of land use. Finally, Climate change resulting from an increasing concentration of Greenhouse Gases (GHGs) in the atmosphere due to the use of fossil fuels and other human activities has become a major concern of Pakistan. Water resources are prerequisite for the fulfillment of many basic human needs and services. According to GoP (2010) reports, almost 25 to 30% water consumption are in industrial sector of Pakistan.

In this paper an analysis has been carried out to find a statistical relationship between water resource, industrialization and financial development in Pakistan using secondary data from 1975 to 2009. This paper does not include all dimensions and factors of the environmental sustainability but limited to the following variables:

- Water Resource: Water resource plays a pivotal role in the economic development of a country. According to ICTSD report (2006), the process of economic growth is the main driven force for the tremendous increased in accessed water availability. Thus limiting this resource would affect the process of economic growth.
- Economic Growth: According to UNECA (2006) report, economic growth requires appropriately managing water resources to ensure water use for all purposes in order to achieve harmonious economic, social and environmental goals for the sustainable development of a country.
- Industrialization: Industry value added is included as a proxy in the model for overall development policies pursued by Pakistan because industrialization has the potential to help and achieve a variety of social objectives such as employment, poverty eradication, gender equality, labour standards, and greater access to education and healthcare. At the same time, industrial processes can have negative environmental impacts, causing climate change, loss of natural resources, air and water pollution and extinction of species. These threaten the global environment as well as economic and social welfare (Europa, 2006).
- Financial Development: Present study uses liquidity liabilities i.e., M3 as percentage of GDP as a proxy for financial development. According to Grossman and Krueger (1995) and Halicioglu (2009) finds the negative relationship between financial development and environmental factors and argue that if private firms come across more funding opportunities, they will seek to avoid dirty industries.

The objective of this paper is to empirically examine the role of water resource on economic and financial development of Pakistan over a period of 1975-2009. The more specific objectives are:

i. To estimate whether there is a long-run relationship between water consumption, industrialization and financial development in Pakistan.

ii. To estimate the dynamic short-run causality effects of industrialization and financial development towards water resources in Pakistan.

The study arrange in the following manners: after introduction, Section 2 provides Literature Review. Data Source and Methodological Framework are included to share vision with the reader in Section 3. Results and Discussion are in the Section 4. Summary and Conclusion of the study are in the last.

2. Literature review

The concept of 'industrial ecology' implies the restructuring of whole industrial sectors based on a goal of reducing emissions and reusing materials at all stages of the production cycle (Frosch & Gallopoulos, 1989; Frosch, 1992; Ayres & Ayres, 1996; Socolow, 1994). Corporate reform and 'greening', as well as a broad cooperative effort between corporations and governments, will be needed to achieve goal. There is a considerable literature on the use of water resources (Anderson, 1991; DoE, 1996; Hammond et al, 1995; Rennings & Wiggering, 1997; Rogers et al., 1997; Salameh, 2000; Streeten, 1996; World Bank, 1998). While many of these allow policy makers and funding agencies to monitor progress for environmental change or poverty elimination, those of the Committee for Development Policy of the United Nations are particularly of use. None, however, recognizes the unique importance of water to all forms of life. Without adequate and efficient water supplies, i.e., where there is "water poverty," any measures to reduce income poverty are unlikely to be successful. Dinda and Coondoo (2006) apply a panel data cointegration methodology in a bivariate setting and find mixed results. A dynamic link between environmental emissions and income is suspected, suggesting a time series approach. Furthermore, water resource may precede economic growth from a production viewpoint. It may even be possible to observe emissions to precede energy use if the energy production industry is responsible for a significant portion of a country's emissions.

The importance of an effective financial system to economic development was substantiated by Goldsmith (1969), McKinnon (1973) and Shaw (1973). During 1990s, number of researches emphasizes the role of financial intermediaries in improving the allocation of resources i.e., Greenwood and Jovanovic (1990) and King and Levine (1993) have developed financial models in which financial sector services contribute to economic growth. However, several doubts have been raised with regard to this approach in the environment of less developed countries (Lucas, 1990). Levine (1997) highlighted that comparisons of financial structure and economic development using only industrialized countries tend to suggest that financial structure is unrelated to the level and growth rate of economic development.

Other studies i.e., Alam et al (2007), Ang (2007, 2008), Soytas et al. (2007), Halicioglu (2009), Jalil and Mehmud (2009) and Shahbaz et al. (2010) which seems to suggest that water emission generally has a positive impact on economic growth, energy consumption, industrialization and rapid population in developing countries. This conclusion is confirmed by several surveys on this topic, as already noted in the beginning of the paper. Admittedly, the impact seems to be country specific, depending on factors, such as the level of per capita income, the human capital base, the degree of openness in the economy, and the level of financial market development. Consequently, the empirical literature on water resource and growth suffers from several shortcomings and must therefore be viewed with caution. This study is the first of its kind for Pakistan and thus is a pioneering effort to fill in a gap in environment literature via using system cointegration techniques.

3. Data source and methodological framework

The study is based on annual data covering a time period from 1975 to 2009 for Pakistan. All the time series data of water consumption (H2O), gross domestic product per capita GDP), industry value added (IND) and financial development (FD) which indicates liquidity liabilities i.e., M3 as percentage of GDP are compile from World Development Indicators (WDI, 2009). All these variables are expressed in natural logarithm and hence their first differences approximate their growth rates. The data trends are available for ready reference in Figure 2.

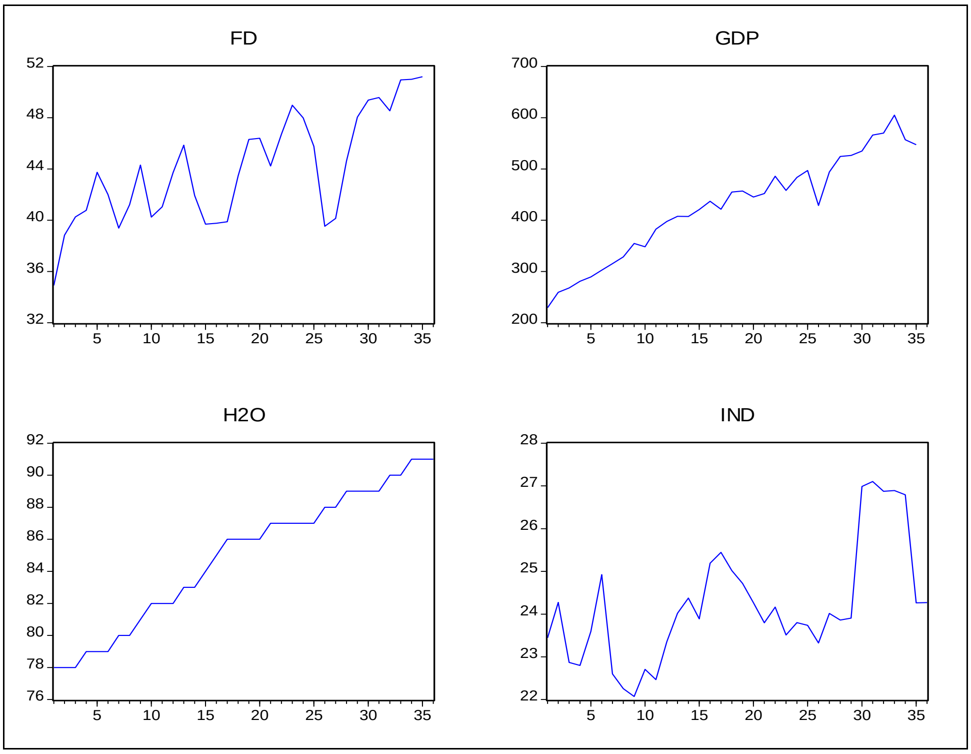

Figure 2: Water Resources, Economic Development and Financial Trend in Pakistan (1975-2009)

Source: Author's designed

3.1. Theoretical Framework

The study follows the framework in Tamazian et al. (2009), Talukdar and Meisner (2001) and Shahbaz et al. (2010) in estimating resource depletion equation. These studies estimated the emissions-growth nexus in a single equation model. However, the present study modified the model according to country specific i.e.,

$$H2O = f(GDP, IND, FD) \qquad (1)$$

The log-linear specification of the model provides more appropriate and efficient results as compared to simple linear functional form of model (Cameron, 1994; Ehrlich 1975, 1996). Furthermore, logarithmic form of variables gives direct elasticities for interpretations. Therefore, specify estimable equation in log linear form is:

$$LH20 = \beta_1 + \beta_{GDP} LGDP + \beta_{IND} LIND + \beta_{FD} LFD + \mu_t \qquad (2)$$

Where, H20 is water availability, GDP is per capita real income, IND is industry value added, FD is financial development indicator i.e., liquidity liability and μ_t stands for residual or error term. This relationship is explained with Figure 3.

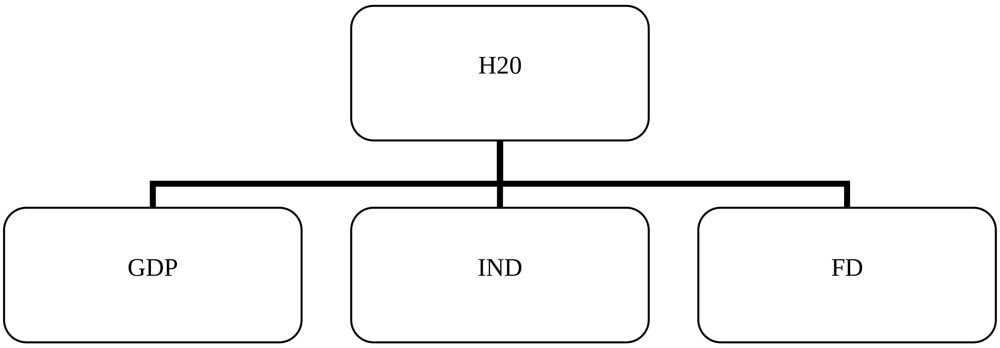

Figure 3: Research Framework for Equation 2
Source: Self Extract

The present study hypothesizes the following results which are shown in Table 1.

Table 1. Variables Identification and their Expected Signs

Variables	Symbol	Expected Sign
Dependent Variable:		
Water Availability	H2O	
Independent Variable:		
Economic Growth	GDP	Positive
Industry value added	IND	Positive
Financial Development	FD	Negative

Source: Self constructed

3.2. Econometric Modeling

Comparable to all other techniques, that utilize time series data, it is essential to distinguish that unless the diagnostic tools used account for the dynamics of the link within a sequential 'causal' framework, the intricacy of the interrelationships involved may not be fully confined. For this rationale, there is a condition for utilizing the advances in time-series version. The following sequential procedures are adopted as part of methodology used. Cointegration is a statistical property of time series variables. If two or more series are individually integrated (in the time series sense) but some linear combination of them has a lower order of integration, then the series are said to be cointegrated.

3.2.1. Auto-Regressive Distributed Lag (ARDL) Model

This section recapitulates the autoregressive distributed lag (ARDL) model, or bounds testing approach (Pesaran et al., 2001), which we take up to check the existence of short and long-run relationships between variables. Econometric theory designate a set of variables is cointegrated if there is a linear combination among them without stochastic trend. In this case, a long-run relationship subsists between these variables. However, this implication is only valid if the obligation of the same order of integration has been met. Assume an explanatory variable, which is stationary at level is regressed with another variable, which is non-stationary at level but is first-difference stationary, then this will capitulate a spurious regression and thereby give a deceptive and erratic conclusion.

The use of the bounds technique is based on three validations. First, Pesaran et al. (2001) advocated the use of the ARDL model for the estimation of level relationships because the model suggests that once the order of the ARDL has been recognized, the relationship can be estimated by OLS. Second, the bounds test allows a mixture of I(1) and I(0) variables as regressors, that is, the order of integration of appropriate variables may not necessarily be the same. Therefore, the ARDL technique has the advantage of not requiring a specific identification of the order of the underlying data. Third, this technique is suitable for small or finite sample size (Pesaran et al., 2001).

Following Pesaran et al. (2001), we assemble the vector autoregression (VAR) of order p, denoted VAR (p), for the following growth function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t$$

where z is the vector of both x and y,
where y is the dependent variable which is the vector matrix which represents a set of explanatory and t is a time or trend variable. According to Pesaran et al. (2001), must be I(1) variable, but the regressor can be either I(0) or I(1). We further developed a vector error correction model (VECM) as follows:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t$$

where Δ is the first-difference operator. The long-run multiplier matrix as:

$$\lambda = \begin{bmatrix} \lambda_{YY}\, \lambda_{YX} \\ \lambda_{XY}\, \lambda_{XX} \end{bmatrix}$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either I(0) or I(1). If , then Y is I(1). In contrast, if , then Y is I(0).

The VECM procedures described above are imperative in the testing of at most one cointegrating vector between dependent variable and a set of regressors. To derive model, we followed the postulations made by Pesaran et al. (2001) in Case III, that is, unrestricted intercepts and no trends. After imposing the restrictions the hypothesis function can be stated as the following unrestricted error correction model (UECM):

$$\Delta(H2O)_t = \beta_0 + \beta_1 (H20)_{t-1} + \beta_2 (GDP)_{t-1} + \beta_3 (IND)_{t-1} + \beta_4 (FD)_{t-1} + \sum_{i=1}^{p} \beta_5 \Delta(H2O)_{t-i} +$$

$$\sum_{i=0}^{q} \beta_6 \Delta(GDP)_{t-i} + \sum_{i=0}^{r} \beta_7 \Delta(IND)_{t-i} + \sum_{i=0}^{s} \beta_8 \Delta(FD)_{t-i} + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where Δ is the first-difference operator and u_t is a white-noise disturbance term. H2O is a dependent variable and GDP, IND and FD are the independent variables.

Equation (3) also can be viewed as an ARDL of order (p, q, r, s). Equation (3) indicates that dependent variable (Y) tends to be influenced and explained by its past values. The structural lags are established by using minimum Akaike's information criteria (AIC). From the estimation of UECMs, the long-run elasticities are the coefficient of one lagged explanatory variable (multiplied by a negative sign) divided by the coefficient of one lagged dependent variable (Bardsen, 1989). After regression of Equation (3), the Wald test (F-statistic) was computed to differentiate the long-run relationship between the concerned variables. The Wald test can be carry out by imposing restrictions on the estimated long-run coefficients. The null and alternative hypotheses are as follows:

$H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ (no long-run relationship)

Against the alternative hypothesis

$H_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ (a long-run relationship exists)

The computed F-statistic value will be evaluated with the critical values tabulated in Table CI (iii) of Pesaran et al. (2001). According to these authors, the lower bound critical values assumed that the explanatory variables are integrated of order zero, or I(0), while the upper bound critical values assumed that are integrated of order one, or I(1). Therefore, if the computed F-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between poverty and its determinants. Conversely, if the computed F-statistic is greater than the upper bound value, then agriculture expenditure and its determinants share a long-run level relationship. On the other hand, if the computed F-statistic falls between the lower and upper bound values, then the results are inconclusive.

Table 2. Bounds Test for Cointegration Analysis

Critical value	Lower Bound Value	Upper Bound Value
1%	3.74	5.06
5%	2.86	4.01
10%	2.45	3.52

Note: Computed F-statistic: 3.278 (Significant at 0.05 marginal values).Critical Values are cited from Pesaran et al. (2001), Table CI (iii), Case 111: Unrestricted intercept and no trend.

4. Results and discussion

Economic time-series data are often found to be non-stationary, containing a unit root. Ordinary Least Squares (OLS) estimates are efficient if variables included in the model are stationary of the same order. Therefore, first we check the stationarity of all variables i.e. H2O, GDP, IND and FD used in the study. For this purpose the study employed Augmented Dickey-Fuller (ADF) test. Table 3 gives the results of ADF tests.

Table 3. Augmented Dickey-Fuller (ADF) Test on the levels and on the First Difference of the Variables (1975-2009)

Variables	Level		First Difference		Decision
	Constant	Constant & Trend	Constant	Constant & Trend	
H2O	-0.811 (0)	-2.085 (0)	-7.267* (0)	-.7.269*(0)	Non Stationary at level but stationary at first difference i.e., I (1)
GDP	-1.540 (2)	-3.597** (0)	-6.172*(1)	-6.311*(1)	Stationary at level i.e., I (0)
IND	-2.179 (0)	-4.095* (4)	-5.479*(0)	-5.364*(0)	Stationary at level i.e., I (0)
FD	-2.187 (0)	-4.268* (1)	-5.597*(1)	-5.506*(1)	Stationary at level i.e., I (0)

Note: The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis is based on MacKinnon (1996) critical values i.e., at constant: -3.646, -2.954 and -2.615 are significant at 1%, 5% and 10% level respectively. While at constant and trend: -4.262, -3.552 and -3.209 are significant at 1%, 5% and 10% level respectively. First Difference: at constant: -.3646, -2.954 and -2.615 are significant at 1%, 5% and 10% level respectively and at constant and trend: -4.262, -3.552 and -3.209 are significant at 1%, 5% and 10% level respectively The lag length are selected based on SIC criteria, this ranges from lag zero to lag four.

Based on the ADF tests GDP, IND and FD are stationary at the level i.e., I (O) variables, however, H2O is non-stationary at level, but stationary at their first difference. Noticeably, the mixture of both I(0) and I(1) variables would not be possible under the Johansen procedure. This gives a good justification for using the bounds test approach, or ARDL model, which was proposed by Pesaran et al. (2001). The results of bounds testing approach are presented in Table 4.

Table 4. Estimated Model

Dependent Variable: Log (H20)

Variable	Coefficient	Std. Error	t-Statistic
LOG(H20(-1))	-0.741*	0.097	-7.577
LOG(GDP(-1))	0.068*	0.017	3.826
LOG(IND(-1))	0.084*	0.024	3.451
LOG(FD(-1))	-0.053**	0.022	-2.393
Constant	0.671**	0.292	2.297
DLOG(GDP)	0.101*	0.030	3.373

DLOG(GDP(-1))	0.033	0.027	1.242
DLOG(GDP(-2))	0.055	0.036	1.525
Dlog(GDP(-3))	0.012	0.015	1.389
DLOG(IND)	-0.012	0.039	-0.310
DLOG(IND(-1))	-0.074***	0.040	-1.865
DLOG(IND(-2))	-0.084**	0.031	-2.684
DLOG(IND(-3))	-0.070***	0.035	-1.975
DLOG(FD)	-0.106*	0.031	-3.427
DLOG(FD(-1))	0.031	0.037	0.836
DLOG(FD(-2))	-0.057***	0.028	-1.987
DLOG(FD(-3))	0.012	0.025	0.486
AR(1)	-0.783*	0.159	-4.901

11. Model criteria / Goodness of Fit:

R-square = 0.996; Adjusted R-square = 0.991; Wald F-statistic = 2006.31 [0.000]*

111. Diagnostic Checking:

JB = 0.156 [0.924]; LM-1 = 0.010 [0.921]; LM-2 = 0.385 [0.689]; LM-3 = 0.767 [0.540]; ARCH (1) = 15.99 [0.216]; ARCH-2 = 2.281 [0.122]; ARCH-3 = 1.550 [0.228]; Ramsey RESET = 2.009 [0.155]

*, ** and *** indicate significance at 0.01, 0.05 and 0.10 level respectively. Probability values are quoted in square brackets. MA and ARCH denote LM-type Breusch-Godfrey Serial Correlation LM and ARCH test, respectively, to test for the presence of serial correlation and ARCH effect. JB and RESET stand for Jarque-Bera Normality Test and Ramsey Regression Specification Error Test, respectively.

Using Hendry's general-to-specific method, the goodness of fit of the specification, that is, R-squared and adjusted R-squared, is 0.996 and 0.991 respectively. The robustness of the model has been definite by several diagnostic tests such as Breusch- Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test. All the tests disclosed that the model has the aspiration econometric properties, it has a correct functional form and the model's residuals are serially uncorrelated, normally distributed and homoskedastic. Therefore, the outcomes reported are serially uncorrelated, normally distributed and homoskedastic. Hence, the results reported are valid for reliable interpretation. The results of the bounds co-integration test demonstrate that the null hypothesis of against its alternative is easily rejected at the 1% significance level. The computed F-statistic of 2006.31 is greater than the lower critical bound value of 2.86, thus indicating the existence of a steady-state long-run relationship among H20, GDP, IND and FD.

In Table 5, GDP and IND both are positively correlated to H2O, with the estimated elasticity of 0.091 and 0.113% respectively. This analysis demonstrates that, in the long-run, economic activity and industrialization are stimulated by an increase in environmental pollutants While, FD is negatively correlated to H2O. It shows that if more funding opportunities are made available for private firms, they will seek to avoid dirty industries. The results are in consistent with the research of Grossman and Krueger (1995) and Halicioglu (2009).

Table 5. Long-Run Elasticities and Short-Run Elasticities of H2O in Pakistan

1. Long-Run Estimated Coefficient

Variable	Coefficient
GDP	0.091*
IND	0.113*
FD	-0.079**

11. Short-run Causality Test (Wald Test F-statistic):

ΔGDP	ΔIND	ΔFD
87.287*	27.421*	0.328
(0.000)	(0.000)	(0.689)

* and **denote significant at 1% and 5% level, respectively. Figures in brackets refer to marginal significance values.

The dynamic short-run causality among the relevant variables is shown in Table 5 Panel II. The causality effect can be acquired by restricting the coefficient of the variables with its lags equal to zero (using Wald test). If the null hypothesis of no causality is rejected, then we wrap up that a relevant variable Granger-caused economic growth. From this test, we initiate that GDP and IND both are statistically significant to Granger-caused H2O at a 1 percent significance level. To sum up the findings of the short-run causality test, we conclude that causality running from GDP to H20 and IND to H2O respectively.

5. Conclusions

The objective of the study is to examine the relationship between water consumption, industrialization and financial development in the specific context of Pakistan. Water resource (H2O) is taken as a dependent variable while economic growth (GDP), industry value added (IND) and financial development (FD) are taken as independent variables in the study. The results suggest following conclusions:

- Water availability (H2O) has non-stationary series at level, but stationary at their first difference i.e., I (1) variable.
- GDP, IND and FD has stationary series at level i.e., I (0) variables.
- Bounds testing approach are employed for testing I (0) and I (1) variables.
- The result reveals that H2O, GDP, IND and FD have a long-run relationship between them.
- To sum up, the findings of the short-run causality test, we conclude that causality running from GDP to H20 and IND to H2O respectively.

The results are quite robust not only in terms of statistical powers, but also in terms of economic instinct. The government officials, policymakers and private investors could be benefit from this study because it provides useful information regarding the environment and growth factors in the context of Pakistan.

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