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Impact of Private Investment, Economic Growth and Financial Development on Environmental Degradation: Evidence from Pakistan

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ABSTRACT

Private investment plays an important role in the process of economic growth and also impact natural environment of a country. The main purpose of the present study is to empirically analyze the impact of private investment and other macro economic variables on environmental degradation of Pakistan. For the purpose, time series data is collected for the years 1975 to 2017. The study used Linear regression model for analyzing the impact of private investment, energy consumption, financial development and economic growth on environmental degradation. Augmented Dickey Fuller (ADF) test and Phillips Perron (PP) test is used for identifying the unit root of the variables; first with an intercept then, with an intercept and a linear deterministic trend. Akaike Information Criterion (AIC) is used for selection of optimum lag whereas Johansen cointegration test is adopted for analyzing long run association in the variables. The results of linear regression model show that energy consumption and economic growth have a positive and statistically significant impact on CO2 emissions whereas the impact of private investment on CO2 emissions is negative. It means that in Pakistan, private investment is environment friendly. Based on study results, it is recommended that when formulating policies for economic growth and development, motivation should be given to private inverters in order to increase private investment.

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1. Introduction

Economic health of a country is reflected by its economic growth which is indicated by an

increase in Gross Domestic Product (GDP). GDP is defined as the total market value of all final goods and services produced by an economy during one financial year. A general agreement in all countries is that, economic growth and investment are closely inter connected as investment/capital formation leads to GDP growth. Economists such as New classical and Marxist suggested capital formation for GDP growth and consider investment as an engine for economic growth of a country. Due to investment, an increase occurs in capital goods that in turn leads to the production of other goods and boost the growth and income (Anwar and Sampath,1999). All growth models consider capital as one of the two central components for determining economic growth. Increase in capital is must for increasing production as GDP is higher in those countries that have high investment to GDP ratio. Likewise, endogenous growth theory suggests that investment is a key component for long run economic growth. Similarly, empirical studies confirmed the role of investment for better economic performance as investment promotes employment opportunities, improve technical progress, brings new techniques of production that helps in economic growth. Investment maintains long run economic growth through capital accumulation as suggested by Tadele (2014).

Investment in any country consists of public and private investment. Public investment means investment done by government on services like education and health etc. Private investment is investment done by private investers for the sake of profit. To answer whether public or private investment is better for robust economic growth, empirical studies presented that private sector investment is better as it increases economic growth by bringing more innovation, job creation, high revenue and improve the performance of human resources. Majid and Khan (2008) concluded that economic growth is higher in the countries that have more private investment. Tadele (2014) added that private investment brings robust economic growth due to less corruption and other such factors. Similarly, Muhammad and Shaheen (2016) proved that the effect of private investment is stronger on economic growth as private investment is more transparent and efficient as compare to public investment. So it plays a crucial role for uplifting economic growth. Attention has been given to increase private investment especially in developing economies in order to reduce unemployment and increase economic growth.

Private investment accelerates economic growth but economic growth is the cause of environmental problem as increase in production contributes to more pollution. Some of the studies considered it as a greatest challenge for all economies (Cederbary and Snobohn, 2016). Yousaf et al. (2016) showed that in Pakistan, GDP per capita, energy consumption, and Foreign Direct Investment (FDI) are positive determinants of environmental degradation. The study suggests that attention should be given to reduce Carbon Dioxide (CO_2) emissions with improvement in GDP and FDI. As CO_2 emissions contributes about 60% of global warming (Sinha and Bhatt,2017). As Pakistan is a victim of global warming and environmental degradation so attention is needed to look at the impact of economic growth and private investment on environmental quality. Although in Pakistan, a lot of research work has been done on many other determinants of CO_2 emissions such as GDP growth, energy use, urbanization, industrialization, trade openness as well as FDI, but it is dicorvered that private investment is a missing variable. The main purpose of the present study is trying to fill this research gap. This research work is a good contribution to the literature in general and in case of Pakistan in particular for analyzing the impact of private investment on degradation of environment in Pakistan.

The rest of the study is organized as follows. Section 2 represents the previous literature. Section 3 comprises the data and methodology. Section 4 is about the results and in section 5, the research

work is concluded along with some policy implications.

2. Literature Review

From the famous study of Grossman and Krueger (1991), the environmental Kuznets Curve (EKC) hypothesis has been empirically analyzed by researchers in different countries, by employing various indicators of environmental quality. Results provided by different researchers are not the same. Some studies Grossman and Krueger (1991) and Selden and Song (1994) support EKC hypothesis whereas some like, Saboori et al. (2012) contradict it. The EKC presents that degradation of environment first rises with the increasing level of income, then stabilize but after a turning point, it starts declining.

Rich literature is available that empirically worked on the association of financial development and emissions of CO_2 on the basis of EKC hypothesis and presented mixed results. Studies like Sadosky (2011),Shahban and Lean (2012), Islam et al. (2013) and Tang and Tan (2014) presented a positive association of financial development and energy usage and emissions of CO_2 whereas other studies like Jalil and Feridun (2011), and Shahbaz et al. (2013) confirmed negative association of financial development ,energy usage and emissions of CO_2. Likewise, other researchers reported that financial development effects CO_2 emissions in many ways like, Zhang (2011) argued that financial intermediaries help in increasing loan availabilities to consumers that contribute to increase demand for houses and home appliances that is automobiles, refrigerators, air conditioners. All the things make life comfortable but also increase CO_2 emissions. Sehrawat et al. (2015) provided that investment is the second reason of positive contribution of financial development on CO_2 emissions. When more credit facility is provided to people by financial intermediaries, they invest money in new projects and business and directly contributes to CO_2 emissions. Third, Tamazian and Rao (2010) presented that financial development has important role in increasing Foreign Direct Investment (FDI) inflows, accelerates economic growth as well as CO_2 emissions. Fourth, Tamazian et al. (2009), and Kivyiro and Arminen (2014) showed that industrialization as well as economic growth accelerates due to financial development which contributes to pollution. In most of the empirical studies, researchers modeled the relationship of CO_2 emissions and financial development by EKC and found a unidirectional relationship between the two, based on GDP growth and energy use (Albiman et al., 2015). In addition, Tamazian and Rao (2010) in twenty four transition countries, Sadorsky (2011) for nine Central and Eastern European countries; Al-Mulali et al. (2013) for Middle East and North America (MENA) countries, and Mohapatra and Giri (2015) for India, found a positive cointegration between financial development and CO_2 emissions. On the other hand, Jalil and Feridun (2011) in China presented a negative association between the two.

The assocaition between GDP growth and emissions of CO_2 has been analyzed by researchers like, Yang et al. (2007), Song et al. (2008), Dhakal (2009), Jalil and Muhammad (2009), Fodha and Zaghdoud (2010), Wolde (2015). All the studies accepted the EKC hypothesis meaning that environmental degradation reduces due to economic growth, in long run. On the contrary, Akbostanci et al. (2009) not accepted the presence of EKC hypothesis between emissions of CO_2 and income for Turkey. Researchers also found mixed result for the association of energy use and CO_2 emissions. Studies such as, Hummami and Saidi (2015), Jamel and Derbeli (2016), Siddique et al. (2016) and, Pata (2017) presented a positive cointegration between energy use and CO_2 emissions i.e. negative impact on environment. On the other hand, Zue et al. (2011) and Gokmenoglu and Sadeghieh (2019) suggest negative impact of energy consumption on emissions of CO_2 i.e. positive impact of environment.

Similarly, literature regarding energy consumption, GDP growth and their impact on emissions of CO_2 provides mixed results. Studies such as Smyth and Lean (2010), Munir and Khan (2010), Borhan et al. (2012) and Kizilkaya (2017) presented a positive impact of GDP growth and energy use on CO_2 emissions. Likewise, Ali et al. (2016) studied the impact of energy usage and GDP growth for Nigeria and presented a significant positive impact of both the variables on emissions of CO_2. On the contrary, Thao and Chon (2015) found a negative impact of GDP growth and energy use on CO_2 emissions. Azam et al. (2016) conducted a study for the association between energy consumption, trade and emissions of CO_2. The study found a significant cointegration among the variables for USA, Japan, China and India. Similarly, Poumanyvong and Kaneko (2010) also confirmed a statistically significant cointegration between energy consumption and emissions of CO_2 for USA, China, India and Japan.

Moreover, studies are conducted to analyze empirically the effect of many other macro economic variables like FDI, trade openness, industrialization, urbanization with association of energy consumption on emissions of CO_2 yet, it is discovered that private investment is a missing variable in the literature. To mention just few studies like, Talukdar and Meisner (2001) for developing countries, Fu et al.(2014) for China and Hassan (2018) for Malaysia, studied the impact of private investment on environmental degradation. Talukdar and Meisner (2001) found that increase in private investment reduces environmental degradation in developing economies however, the impact of financial development and GDP growth was found insignificant in case of Malaysia.

The summary of the literature regarding the association between CO_2 emissions with the macroeconomic variables (financial development, economc growth, energy consumption, private investment is presented below in Table 1.

Table-1: Summary of Earlier Studies

Authors	**Sample and time period**	**Variables**	**Methodology**	**Results**
Talukdar and Meisner (2001)	44 developing countries(1987-1995)	Private investment, energy consumption, CO_2 emissioons	Random-effects model	Increase in private investment in developing economies reduces CO_2 emissions.
Tamazian et al. (2010)	24 transition economies (1993-2004)	Financial development, economic development, CO_2 emissions	Beneralized method of movement(GMM approach)	Financial development and economic development increases CO_2 emissions/ negative impact on environmental quality.
Poumanyvong and Kaneko	China, USA, India, Japan(1971-2013)	Energy consumption, trade, CO_2	Panel-fully modified ordinary least	All the variables are significantly associated.

(2010)		emissions	squares (FMOLS) method	
Fodha and Zaghdoud (2010)	Tunisia(1961-2004)	GDP per capita, Sulfur dioxide (SO_2), Carbon dioxide CO_2 emissions.	Cointegration test	Long run cointegration was presented between per capita GDP with emissions of both both CO_2 and SO_2. Inverted U shaped relationship had identified between per capita GDP and emissions of SO_2 .
Hye et al (2013)	Indonesia(1975Q1 - 2011Q4)	Financial development, energy use, GDP growth,	Autoregressive distributed lag model(ARDL) bound test	Financial Development contribution is inverse on CO_2 emissions.
Sehrawat(2015)	India (1971-2011)	Emissions of CO_2 , Financial development, GDP, and energy consumption.	ARDL and error correction model (ECM)	Positive contribution of the variables towards the emissions of CO_2 in India.
Siddique et al (2016)	South Asia (1983-2013)	Energy consumption, GDP,CO_2 emissions	Panel cointegration	Positive contribution of the variables towards the emissions of CO_2.
Ali et al.(2016)	Nigeria (1971-2011)	GDP,CO_2 emissions, trade openness.	ARDL	Positive contribution of the variables towards the emissions of CO_2 both in short and long period.
Pata UK (2017)	Turkey (1974-2013)	Per capita GDP, energy use, emissions of	ARDL	Positive contribution of the variables towards the emissions of CO_2 both in

		CO_2, and financial development		short and long term.
Hassan (2018)	Malaysia(1976-2013)	CO_2, emissions, Private Investment, economic growth, financial development, energy use.	ARDL, ECM	Private investment, energy consumption shows positive contribution on emissions of CO_2. Financial development, GDP growth shows negative impact on CO_2 emissions.

3. Data and Empirical Method

3.1 Data Source and Variables Explanation

The present study used time series data for the span of 1975 to 2017. The variables included in the study are CO_2 emissions (metric tons per capita) which is used to represent environmental degradation, real private investment (used as a % of real GDP), economic growth (real GDP growth rate), real financial development (Real commercial bank credit provided to private sector, % of real GDP), energy consumption (kg of oil equivalent per capita. For all these variables, data is derived from World Bank Development Indicators (WDI).

3.2 Model Specifications

Researchers used different methods for analyzing the association between carbon dioxide (CO_2) emissions with other variables including energy consumption and GDP growth. The analytical techniques used by Azam et al. (2019) in his recent study are adopted for this study. First the Augmented Dickey and Fuller (1979) and Phillips and Perron (1988) tests have been adopted for cheking the stationarity of the data. Once it is confirmed that the variables are stationary at the same level, then Johansen's (1991, 1995) cointegration test is undertaken to analyze long-term cointegration among the variables. Linear Regression model is adopted for the evaluation of the coefficients.

The approach used by Jayanthakumaran et al. (2012) and Halicioglu (2009) is adopted for this research work to identify the association between CO_2 emissions, private investment and other macroeconomic variables. The model used is as follows.

$$CO_2 = W_0 + W_1 PRI + W_2 EG + W_3 FD + W_4 KT + \varepsilon_1 \qquad (1)$$

Where CO_2 is used for Carbon Dioxide Emissions (Metric tons per capita), PRI represents private investment, EG stands for economic growth (Real GDP annual growth in percentage), FD stands for financial development, KT represents energy consumption (Energy use, Kg of oil equivalent per capita)

and ε_1 represents error term.

The expection for the direction of the slope coefficients is
$w_1 > 0; w_2 > 0; w_3 > 0; w_4 > 0$

4. Empirical Results

4.1 Result of ADF and PP Unit root tests

For identifying stationarity in the data, Augmented Dickey-Fuller (ADF) (1979) as well as Phillips and Perron (1988) tests are used. Augmented Dickey-Fuller test in mathetical form can be presented as

$$\Delta z_t = \sigma z_{t-1} + \acute{x}\,\delta + \epsilon_t \qquad (2)$$

where $\sigma = \rho - 1$ $-1 \leq \rho \leq 1$ and the model is hypothesized as:

$$H_0: \sigma = 0 \; or \; \rho = 1$$
$$H_1: \sigma < 0 \; or \; -1 \leq \rho \leq 0$$

The t-ratio of the σ -coefficient of ADF test, when test statistic distribution is affected by serial correlation, is adjusted by Phillips-Perron (PP) test as follows:

$$t'_\sigma = t_\sigma \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0 - \gamma_0)(se(\hat{\sigma}))}{2 f_0^{\frac{1}{2}} s} \qquad (3)$$

Where f_0 is the zero occurrence of residual and γ_0 is the evaluation of error variance. The results of ADF and PP tests are presented in Table 2. It shows all the variables; economic growth, private investment, financial development, energy use and carbon dioxide emissions are non stationary at level at both trend, and with a trend and intercept. The variables are converted into stationary by taking first difference in ADF as well as PP test.

Table 2 Unit root test results

Variables	ADF Test Result		PP-Test Result	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Real GDP	-2.265	-0.046	-1.593	1.223
	-4.011*	-4.351*	-4.011*	-3.852*
Real Private Investment (PRI)	-0.470	-1.341	-0.501	-1.341
	-6.258*	-6.449*	-6.258*	-6.459*
Financial Development (FD)	-0.069	-0.382	0.980	0.674
	-4.926*	-5.311*	-4.926*	-4.907*
Energy Consumption (KT)	-2.056	0.152	-1.952	0.151
	-5.404*	-6.332*	-5.471*	-6.349*
Environmental Degradation (CO_2 emissions)	-2.235	-2.149	-4.043	-1.741
	-7.727*	-8.260*	-7.627*	-17.126*

*Significant at 5% significance level

4.2 Cointegration Test Results

Johansen (1988) suggested likelihood ratio tests to identify the presence of a long-term association among the variables. The tests can be presented in two different equations given below:

$$J_{max} = -Tln\left(1 - \widehat{\lambda_{r+1}}\right) \quad (4)$$

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln\left(1 - \widehat{\lambda_i}\right) \quad (5)$$

Where λˆi is the i^{th} largest known association. The T presents the size of the sample in the above two equations. Table 3 represents the results of cointegration test. It indicates, for all five variables, the null hypothesis of no cointegration is not accepted meaning that longrun cointegration is confirmed in all variables.

Table 3 Cointegration test results

N. Hypothesis	A. Hypothesis	Trace Test Statistics	
		Statistics	Critical Value
r = 0	r = 1	106.35*	69.82
r ≤ 1	r = 2	71.51*	47.86
r ≤ 2	r = 3	40.65*	29.80
r ≤ 3	r = 4	23.10*	15.49
r ≤ 4	r = 5	6.48*	3.84

Levels of significance: *p < 0.05;

4.3 Regression Results

Table 4 represents the estimates of linear regression model. The results reveal that energy consumption and GDP growth have positive significant impact on emissions of CO_2. The effect of financial development is also positive but insignificant. Interestingly, the impact of private investment on emissions of CO_2 is negative meaning that, with more private investment, environmental degradation got reduces in case of Pakistan.

The results further show that 1% rise in energy consumption and GDP degrades environment by 1.88% and 0.033% respectively. These empirical results are like the results of Munir and Khan (2010), Hitam et al. (2012), Siddique et al (2016), Pata (2017), Pan et al. (2019). Similarly, 1% improvement in financial development leads to contaminate environment by 0.012%. The result is supported by Sadosky (2001), Shahban and Lean (2012), Islam et al. (2013) and Tang and Tan (2014). The researchers argued that due to financial development, demand of consumers' goods i.e. home appliances like air conditioner, refregirator etc and producers' goods; investment, increase in vehicle, machinery etc. increases thus contributing to CO_2 emissions. In addition, 1% increase in private investment brings 0.005% decrease in CO_2 emissions. Likewise, Talukdar and Meisner (2001) also confirmed negative cointegration between private investment and emissions of CO_2 in developing countries whereas, Hassan (2018) found positive association of private investment with CO_2 emissions in Malaysia.

Table 4 Regression Results

DV is CO_2	
Variables	**Coefficients**
C	-11.906 (0.000)
PRI	-0.005 (0.356)
EG	0.033* (0.011)
FD	0.012 (0.625)
KT	1.879* (0.000)
R^2	0.965
DV Dependent variable	

*significant at 5% significant level

5. Concluding Remarks

Private investment has an important role in the growth process of an economy but its impact on environmental degradation is ignored by researchers. The main purpose of this study was to analyse the relationship of private investment with environmental degradation in Pakistan.

The estimates of linear regression model confirmed a negative impact of private investment on CO_2 emissions in Pakistan. It means that private investment is in favour of environment in case of Pakistan however, the impact of energy consumption, Financial development and GDP growth on emissions of CO_2 is positive meaning that all the variables are degrading environment in Pakistan.

On the basis of the results, it is recommended that in Pakistan, policies regarding GDP growth and financial development should be revised and more attention should be given to private investment to reduce emissions of CO_2 in the country.

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