Impact of Financial Development and Energy Consumption on CO_2 Emissions: Evidence from Pakistan

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Abstract
This study is an attempt to investigate the impact of financial development, energy consumption, trade and economic growth on CO_2 emissions in Pakistan over the period of 1980 to 2015. We have used augmented dickey fuller (ADF) unit root test and auto regressive distributed lag (ARDL) bounds testing co-integration approach. The results of ARDL bound F-stat indicate that there is a long run relationship between CO_2 emissions, capital, trade, energy consumption, financial development and economic growth. The long run empirical findings show that energy consumption, financial development, economic growth and trade are the increasing factors of carbon dioxide emissions.

Keywords: Financial Development, Energy Consumption, Co_2 Emissions, ARDL Co-Integration Method
JEL Codes: G10, Q40, Q50

I. Introduction

The established purpose of every government is to raise the level of economic growth and development. To achieve the certain objectives, govt makes various policies which are helpful to increase the investment level, as it is considered that an economy grows if it is financially enough develop. Financial institutes are working as a right hand of government to boost investment by providing credit facilities to general public with flexible policies. Financial development is an indispensable for an economy as it provides the opportunities of capital and investment. It is also playing a vital role to enhance the production of goods and services. Energy is a basic factor of production along with capital and labor. Financial development promotes the use the energy which accelerate the economic growth (see, for example, Siddique and Majeed, 2015). The energy consumption and financial development are enhancing production level and economic growth but simultaneously raise carbon dioxide emissions and also affecting the climate badly (Siddique et al., 2016). The extensive use of power resources creates environment related problems such as CO_2 emissions, natural resource depletion etc. Bloch et al. (2012) found the two way causality between coal consumption and pollution in China for the period of 1965 to 2008. The study also investigated that a one-way causality is running from income to coal consumption. Shahbaz et al. (2013) investigated the relationship between economic growth, energy consumption, financial development, trade openness and CO_2 emissions in Indonesia. The results indicate that economic growth and energy consumption raises CO_2 emissions. There is bidirectional causality between energy consumption and CO_2 emissions, between CO_2 emissions and economic growth, and unidirectional causality from financial development to CO_2 emission. Lotfalipour et al. (2010) also reported the one way causal relationship from GDP and gas consumption to CO_2 emissions in whereas fossil fuel consumption does not cause carbon emissions in Iran during1967 to 2007. Energy consumption and financial development are stimulating the level of production which raise carbon dioxide emissions and affecting the environmental quality. So, it is necessary to incorporate these factors in energy and environment protection policies. The objective of this study is to find out the impact of financial development and energy consumption on CO_2 emissions in Pakistan over the time period of 1980 to 2015. This study is planned as; Section 2 consists of literature review and Section 3 covers the methodology. Section 4 and Section 5 describe the data and results and discussion respectively. At the end the paper is concluded in Section 6.

II. Literature Review

This section contains the review of literature regarding the relationship between financial development, energy consumption and CO_2 emissions. Siddique et al. (2016) investigated the impact of energy consumption and financial development on CO_2 emissions in South Asia over the period of 1983 t0 2013. Their findings show that financial development and energy consumption are polluting the environment by increasing CO_2 emissions. The empirical results express the two-way causality between CO_2 emissions and energy consumption in the long and short run. The causal relationship found between CO_2 emissions and financial development in the long run while no causality exist in the short run. The extensive use of power resources creates environment related problems such as CO_2 emissions, natural resource depletion etc. Bloch et al. (2012) found the two way causality between coal consumption and pollution in China for the period of 1965 to 2008. The study also investigated that a one-way causality is running from income to coal consumption. Lotfalipour et al. (2010) reported the one way causal relationship from GDP and gas consumption to CO_2 emissions in whereas fossil fuel consumption does not cause carbon emissions in Iran during1967 to 2007.

Alam et al. (2012) also checked the causality between electricity consumption, growth and CO_2 emissions in Bangladesh for 1972-2006. The findings exposed bidirectional causality between electricity and economic growth in the long run. They also explored the unidirectional causality from energy consumption to CO_2 emissions in short run and bidirectional causality in long run, while CO_2 emission causes economic growth in the short run as well as in the long run. Omri (2013) examined the relationship between CO_2 emissions, energy consumption and economic growth in 14 MENA countries for 1990-2011. He inferred the bidirectional causality between economic growth and CO_2 emissions, and unidirectional causality from energy consumption to CO_2 emissions. Ozturk and Acaravci (2010) found no causal nexus between energy consumption and CO_2 emissions in Turkey for 1968-2005. They suggested that limiting energy use and carbon emission does not affect real GDP.

The study of Jalil and Feridun (2011), suggested that financial development is helpful to reduce the carbon emissions in China. They also exposed the Environmental Kuznets Curve (EKC) and found that energy use and trade are the major causes of CO_2 emissions. Shahbaz et al. (2013) examined the financial development impact on CO_2 emissions in Malaysia for 1971-2011. The findings expressed the long run relationship among financial development, CO_2 emissions, energy use and economic growth. The empirical results showed that financial development improve the quality of environment by reducing carbon emission while growth and energy use increases the pollution. Tamazian et al. (2009) scanned the relationship between financial development and quality of environment in Brazil, Russia, India and China over 1992-2004. They investigated that openness, financial liberalization and financial development diminish the carbon dioxide emissions. Tamazian and Rao (2010) also

examined the relationship between financial development and CO_2 emissions in 24 countries for 1993-2004. The empirical results exposed that financial developments are important factors for better environment while trade increases the CO_2 emissions. The study of Farhani et al. (2014), also investigated unidirectional causality from real GDP and energy consumption to CO_2 emissions in the short run, and trade also cause CO_2 emissions in the short run.

Hossain (2011) scanned the relationship between CO_2 emissions, energy consumption and trade in newly industrialized economies individually. The study found unidirectional causality from trade and economic growth to CO_2 emissions in the short run. The findings also suggest that energy is an increasing factor of pollution.
Sebri and Salha (2013) examined the relationship among energy consumption, CO_2 emissions, trade and economic growth in BRICS[1] for 1971-2010. The two-way causality found between energy consumption and economic growth. They concluded that trade openness and CO_2 emissions are increasing energy use. Kohler (2013) investigated the positive bidirectional nexus among energy consumption and CO_2 emission. The empirical results also reported that trade reduces the carbon emission because of technological innovation in South Africa.

Shahbaz et al. (2013) investigated the relationship between economic growth, energy consumption, financial development, trade openness and CO_2 emissions in Indonesia. The results indicate that economic growth and energy consumption raises CO_2 emissions. There is bidirectional causality between energy consumption and CO_2 emissions, between CO_2 emissions and economic growth, and unidirectional causality from financial development to CO_2 emission.

Similarly Ozturk and Acaravci (2013) found a long run relationship between per capita carbon emissions, per capita energy consumption, real per capita income, the square of per capita real income, openness and financial development. The empirical results indicate that foreign trade raises the CO_2 emissions. In the long run financial development has no strong and significant impact on per capita CO_2 emissions.
A substantial body of literature explained that energy consumption is a basic factor that increases the trade, economic growth and pollution as well. There is a need of some kind of innovations in technology as well as energy efficiency.

The empirical evidence showed that financial development and trade are direct and indirect increasing factors of economic growth. Economic growth, trade and financial development are playing an essential and important role in increasing energy consumption. But these results are not final and ending results that economic growth, trade and financial development increase the energy consumption; it might be possible that financial development reduces the intensive use of energy. It might be possible that financial development has power to reduce energy consumption by increasing energy efficiency.

III. Methodology

The purpose of our study is to find out the impact of energy consumption and financial development on CO_2 emissions in Pakistan. We have used CO_2 emissions as a dependent variable and financial development, trade, capital, energy and economic growth as independent variables.

$$CO = f(K, E, FD, Y, T)$$

In literature these variables are also used, see for example, Siddique et al. (2016). The functional form of our model with natural logarithm is as follows:

$$CO_t = a_0 + a_1 K_t + a_2 E_t + a_3 FD_t + a_4 Y_t + a_5 T_t + \mu_t$$

Where CO is carbon dioxide emissions, K is capital, FD is financial development, E denotes energy consumption, Y shows economic growth and T is used for trade. The term t is for time period from 1980 to 2015, a_0 is intercept, a_1 is the elasticity of capital with respect to CO_2 emissions, a_2 is the elasticity of energy consumption, a_3 is the elasticity of financial development, a_4 is the economic growth elasticity of CO_2 emissions, a_5 is the trade elasticity with respect to CO_2 emissions, and μ is the error term.

To investigate the relationship between financial development, energy consumption and CO_2 emissions, we have applied various tests and techniques. As it is a time series model and data is annually so first we have applied the unit root test to check the stationary of the variables. We have employed the ADF test to check the stationary of the variables and the specification for the ADF test is as follows:

[1] BRICS refers to the countries of Brazil, Russia, India, China and South Africa.

$$\Delta Y_t = \alpha + \beta t + \rho Y_{t-1} + \sum_{i=1}^{p} \Delta Y_{t-1} + \mu_t$$

The ADF test includes lagged difference as a key ingredient in order to counter autocorrelation. The optimum number of lags are used by using Schwartz selection criteria.

When the variables are stationary at level then OLS is applied, and if the variables are stationary at first difference we have used Johansen co-integration technique. If the some variables are stationary at level and remaining at first difference, the ARDL bounds testing co-integration test is suitable and applicable. In our case, some variables are stationary at first difference and others are at level, so, we have used the ARDL co-integration approach. We have also used langrage multiplier (LM) test of residual serial correlation, heterosecedasticity test and Ramsey reset test to check the functional form of our model.

III.I. Data

To investigate the empirical relationship we have used the data on carbon dioxide emissions (metric tons per capita), gross capital formation (as a share of GDP), credit to private sector as a proxy of financial development which is also used Siddique and Majeed (2015), energy consumption (kg of oil equivalent per capita), per capita GDP as a proxy of economic growth which is also used in the literature (see, for example, Siddique et al., 2016) and trade is measured as a percentage of GDP, and the data is taken from WDI (2016).

IV. Empirical Results and Discussion

This section contains the empirical results and discussion. Table 1 carries the results of augmented dickey fuller (ADF) unit root test. The ADF results show that all the variables used in our analysis are stationary at first difference except energy consumption which is stationary at level. In this case, when some variables are stationary at level and others are at first difference then ARDL co-integration technique is suitable. So, we have applied ARDL bounds testing co-integration approach.

Table 1: Results of Unit root test (ADF test)

Variables	Levels	First Difference
CO		-7.4331
K		-5.8963
E	-3.2562	
FD		-4.6312
Y		-3.8895
T		-7.5614

The results of ARDL bounds F-test co-integration approach are shown in Table 2. The first column of the table explains the lag length of the variables. The lag length of CO_2 emissions is three, zero for capital and trade, four for energy consumption, one for financial development and two for economic growth. The value of F-stat is 5.99 that is greater than the critical values at 1% and 5% for both zero and one bounds. The greater value of F-stat shows the co-integration relationship between CO_2 emissions, capital, trade, energy consumption, financial development and economic growth in Pakistan.

Table 2: Results of ARDL Bounds F-test Co-Integration

ARDL Model 1	Lag length	F-statistics	Critical Value 1%		Critical Value 5%	
			I(0)	I(1)	I(0)	I(1)
CO| K,E,FD,Y,T	(3,0,4,1,2,0)	5.99328	3.06	4.15	2.39	3.38

The short and long run co-integration are found after the confirmation of co-integration by bounds F-stat test. The results are reported in Table 3. The short run results show that capital has negative impact on CO_2 emissions but insignificant, energy consumption has positive impact on emissions and it has negative impact with its lag. Financial development and trade have positive and insignificant impact on CO_2 emissions. The variable economic growth has positive impact without its lag and negative impact on CO_2 emissions with its lag. The co-integration term has a negative sign that indicate the long run co-integration relationship between CO_2 emissions, capital, trade, energy consumption, financial development and economic growth in Pakistan.

The long run results show that energy consumption, financial development, economic growth and trade are the increasing factors of carbon dioxide emissions. The coefficient of capital is negative which shows the negative and insignificant impact on CO_2. The coefficient of energy consumption is 1.02 which employs that a 1 percent increase in energy use causes a 1.02% increase in carbon emissions. The coefficient of economic growth is 0.5963

which means that a one percent increase in economic growth causes a 0.596 % rise in CO_2 emissions. The coefficient of trade is 0.0230 which express that a 1% rise in trade caused 0.023 % increase in CO_2 emissions but it is statistically insignificant.

The value of R-square 0.99 which means the explanatory variables used in our analysis are explaining 99% of dependent variable and there is minimum residual sum of square that is 0.0105, both are explaining the goodness of model. The p-value of LM test is greater than 0.1 that employs there is no serial correlation, the p-value of heteroscedasticity test is greater than 0.1 which means there is no problem of heteroscedasticity. The p-value of Ramsey reset test is also greater than 0.1 that employs there is no any issue in functional form of model. Our empirical results are consistent with the literature (see, for example, Siddique et. al, 2016; Shahbaz et. al, 2013).

Table 3: Results of Short and Long Run ARDL Co-Integration

Variables	Short run Elasticities		Long run Elasticities	
	Coefficients	**P-value**	**Coefficients**	**P-value**
CO (-3)	1.0242	(0.0131)		
K	-0.05777	(0.5545)	-0.0251	(0.4474)
E	1.2527	(0.0076)	1.0202	(0.0000)
E (-4)	-0.4779	(0.1209)		
FD	0.0116	(0.9051)	0.0353	(0.0554)
FD (-1)	0.6552	(0.6660)		
Y	0.7659	(0.1524)	0.5963	(0.0000)
Y (-2)	-1.0656	(0.0165)		
T	0.0470	(0.5469)	0.0230	(0.4531)
CointEq(-1)	-3.5695	(0.0000)		
Constant	-40.7583	0.0005	-10.6598	(0.0000)
RSS	0.0105			
R^2	0.9928			
χ^2_{LM}	1.7346	(0.2123)		
χ^2_{HET}	0.4687	(0.9249)		
χ^2_{RESET}	1.4940	(0.2404)		

V. Conclusions

This study investigated the impact of financial development, energy consumption, trade and economic growth on CO_2 emissions in Pakistan over the period of 1980 to 2015. We have used the ADF unit root test and auto regressive distributed lag bounds testing co-integration approach. The results of ARDL bound F-stat indicate that there is a long run relationship between CO_2 emissions, capital, trade, energy consumption, financial development and economic growth in Pakistan. The short run results show that capital has negative impact on CO_2 emissions but insignificant, energy consumption has positive impact on emissions and it has negative impact with its lag. Financial development and trade have positive and insignificant impact on CO_2 emissions. The variable economic growth has positive impact without its lag and negative impact on CO_2 emissions with its lag. The co-integration term has a negative sign that indicate the long run co-integration relationship between CO_2 emissions, capital, trade, energy consumption, financial development and economic growth in Pakistan. The long run results show that energy consumption, financial development, economic growth and trade are the increasing factors of CO_2 emissions. The coefficient of capital is negative which shows the negative and insignificant impact on CO_2. The coefficient of energy consumption is 1.02 which employs that a 1 percent increase in energy use causes a 1.02% increase in carbon emissions. The coefficient of economic growth is 0.5963 which means that a one percent increase in economic growth causes a 0.596 % rise in CO_2 emissions. The coefficient of trade is 0.0230 which express that a 1% rise in trade caused 0.023 % increase in CO_2 emissions but it is statistically insignificant.

References

Alam, Jahangir, M., Ara Begum, I., Buysse, J., and Van Huylenbroeck, G. (2012). Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. *Energy Policy*, *45*, 217-225.

Bloch, H., Rafiq, S., and Salim, R. (2012). Coal consumption, CO 2 emission and economic growth in China: empirical evidence and policy responses. *Energy Economics*, *34*(2), 518-528.

Hossain, S. (2011). Panel estimation for CO2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. *Energy Policy*, *39*(11), 6991-6999.

Jalil, A., and Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics*, *33*(2), 284-291.

Kohler, M. (2013). CO2 emissions, energy consumption, income and foreign trade: A South African perspective. *Energy Policy*, *63*, 1042-1050.

Lotfalipour, M. R., Falahi, M. A., and Ashena, M. (2010). Economic growth, CO2 emissions, and fossil fuels consumption in Iran. *Energy*, *35*(12), 5115-5120.

Omri, A. (2013). CO2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Economics*, *40*, 657-664.

Ozturk, I., and Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics*, *36*, 262-267.

Ozturk, I., and Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. *Renewable and Sustainable Energy Reviews*, *14*(9), 3220-3225.

Sebri, M., and Ben-Salha, O. (2014). On the causal dynamics between economic growth, renewable energy consumption, CO 2 emissions and trade openness: fresh evidence from BRICS countries. *Renewable and Sustainable Energy Reviews*, *39*, 14-23.

Shahbaz, M., Solarin, S. A., Mahmood, H., and Arouri, M. (2013). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. *Economic Modelling*, *35*, 145-152.

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., and Leitao, N. C. (2013). Economic Growth, Energy Consumption, Financial Development, International Trade and CO2 Emissions, in Indonesia. *Renewable and Sustainable Energy Reviews*, *36*, 262-267.

Siddique, H. M. A., Majeed M. T., and Ahmad H. K., (2016). The Impact of Urbanization and Energy Consumption on CO2 Emissions in South Asia. *A Research Journal of South Asian Studies*, *31*(2), 745-757.

Siddique, H. M. A. and Majeed, M. T. (2015). Energy Consumption, Economic Growth, Trade and Financial Development Nexus in South Asia. *Pakistan Journal of Commerce and Social Science*, *9*(2), 658-682.

Tamazian, A., and Bhaskara Rao, B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy Economics*, *32*(1), 137-145.

Tamazian, A., Chousa, J. P., and Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy*, *37*(1), 246-253.