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Causal Economic Interactions between Co2 Emissions and Economic Growth

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Abstract

The environmental penalties of trade openness and foreign direct investment (FDI) got significant consideration in the current era. In this article, we aim to explore the impact of causal interactions of CO2 emission with FDI and trade openness on the economic growth of Pakistan's economy. The data are based on the period from 1972 to 2019. The Fully Modified OLS (FMOLS) cointegration procedure is used to gauge out the optimal long-run effects of these interactions on economic growth. The outcomes of cointegration regression show that the control variables; domestic investment, labor force and targeted variables CO2 emission, trade openness, FDI are having long-run significant relations with economic growth. The interaction terms, CO2 emission with trade openness and CO2 emission with FDI are showing positive relation to economic growth, but the interaction term of CO2 emission with FDI is not demonstrating a significant long-run relationship with economic growth. However, the second interaction term CO2 emission with trade openness is showing a significant positive relationship with economic growth. It indicates that a rise in foreign trade flourishes economic growth but at the cost of environmental damage.

Key Words: CO2 emission, Economic Growth, Foreign direct investment, Trade openness, Labor Force, Domestic investment.

JEL Codes: B22, C32, F18, F43, F64 and F66

1 Introduction

In the past few decades, the most difficult environmental issue has been climate change, which has attracted the attention of policymakers, global environmental organizations, scientists, and

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researchers (Acheampong, 2018). All global warming is due to a surge in energy consumption. And the concentration of energy consumption (Kaya, Yokobori, & University, 1997). There is no doubt that foreign trade is one of the main driving forces for the increase in carbon dioxide emissions. Increasing carbon dioxide emissions (Sun, Clottey, Geng, & Amissah, 2019). Although the relationship between Auburn emissions and foreign trade remains controversial, policymakers in developed countries have been interested in it (Mutascu & Sokic, 2020). As direct investment increases per capita GDP and ultimately changes the industrial structure and increases carbon dioxide emissions, there is a dynamic short-term relationship between direct investment and carbon dioxide emissions (Chenran, 2019). The increase in gross domestic product led to increase carbon emissions (Nathaniel, Barua, Hussain, & Adeleye, 2021).

The economic structure monitors and stimulates economic growth and development (Danish & Wang, 2018; Destek & Sarkodie, 2019). These economic advancements have led to huge environmental problems, such as carbon dioxide emissions (Dong, Sun, & Hochman, 2017). According to Deutsch and Narayan (2016) foreign direct investment can be defined as the proliferation of advanced technologies in technology, governance, and information services from developed economies to underdeveloped economies. The rapid increase in energy consumption has brought huge environmental problems. The state and root causes of climate change. The traditional energy production of fossil fuels will lead to high carbon dioxide emissions and can replace renewable energy sources (Li & Fang, 2017). The carbon emissions threaten the rapid growth of developing countries (Dong, Sun, Jiang, & Zeng, 2018).

According to Mahmood & Kanwal (2017) there is positive linkages between GDP growth and energy consumption and lead to an increase in CO2 emissions. The financial boom has also increased and ultimately promoted economic growth (Shahbaz & Lean, 2012). The relationship between energy consumption and economic development plays a fundamental role in economic policy because the interaction between economic performances

can strengthen this relationship (Amusa & Leshoro, 2013; Bayar & Özel, 2014; To, Wijeweera, & Charles, 2013).

Several empirical studies have shown that increasing the use of renewable energy and smart energy consumption can significantly reduce greenhouse gas emissions. However, the increase in foreign direct investment and GDP growth will lead to an increase in greenhouse gas production (Ben Jebli & Ben Youssef, 2015; Ertugrul, Cetin, Seker, & Dogan, 2016; Farhani, Mrizak, Chaibi, & Rault, 2014; Kohler, 2013; Shahbaz, Solarin, Mahmood, & Arouri, 2013; Shahbaz, Solarin, Sbia, & Bibi, 2015; Sugiawan, 2016; Xu & Lin, 2015; Yin, Zheng, & Chen, 2015; Zhang & Zhou, 2016) but it can be reduced through structural changes and effective strategies; they also believe that foreign direct investment.

There is a relationship between GDP growth and carbon dioxide emissions. The main factor behind his relationships are foreign direct investment and trade liberalization. Therefore, it is important to check the consequence of their interaction. However, we cannot find any research on these relationships to specifically test this correlation. So, there is significant need to explore these relationships but we could not find very specific study on it. That is why this study emphasis on to find the associations between the carbon dioxide emission and GDP growth.

2 Literature Review

This section summarizes the latest research results of this article and shows the importance of studying the impact of causal economic interaction on carbon emissions on GDP growth.

Nathaniel et al., (2021) empirically explored the relationship between corban emission and economic growth in case of developing countries like Pakistan. They employed FGLS procedure with PCSEs estimators as static model and for dynamic modeling used GMM model. The results of their study validate the existence of energy-led-growth hypothesis. They also concluded that there is positive relationship between energy use and economic growth.

Rafique, Li, Larik, and Monaheng (2020) describe the long-term negative correlation between foreign direct investment and financial development. Technological innovation and carbon dioxide emissions in the BRICS countries. They also found that business opening, urbanization, energy use, and economic growth are positively correlated with carbon dioxide emissions.

Khan and Ozturk (2020) show that foreign direct investment has a positive effect. Although the results of the FDI model indicate that carbon emissions are the source of natural pollution, a strong long-term bilateral relationship links the problem with FDI. Higher profit margins in the energy sector attract foreign direct investment and more energy. The production and consumption of carbon dioxide are increasing.

Mahmood, Wang, and Hassan (2019) found that increased carbon dioxide emissions limit income and renewable energy. Also, open trade increases carbon dioxide emissions, and human capital also helps reduce carbon dioxide emissions. They tested this relationship using the ecological hypothesis of the Pakistan Kuznets curve. (Liobikienė & Butkus, 2019) studied the relationship between trade opening and greenhouse gases. Besides, they believe that urbanization, trade, and GDP growth can reduce CO2 emissions through efficient use of energy.

Shahbaz & Lean (2012) studied the impact of energy consumption on Pakistan's economic growth. The empirical results show that these variables are integrated. It is also found that the consumption of renewable and non-renewable energy sources contributes to the growth of the economy, capital, and labor.

Mahmood & Kanwal (2017) used Pakistan as a paradigm to demonstrate the correlation between carbon dioxide emissions and financial rise. The results indicate that management should focus on asset creation to ensure satisfactory economic survival by gradually increasing assets from sustainable energy sources, Norway and Germany. Mauritius is in Europe and Africa. Over the years, these countries have continued to use sustainable resources to build resilience.

Siddique & Majeed (2015) pointed out economic development, economic growth, and power intake. The same is true for business growth. They are essential for growth. Almost 1% of the twill results were used for exchange profits, an increase of 0.08%, 0.39%, and 0.11% respectively. The causality is as follows: In the short term, the Granger causality test results show that there is an input relationship between development and vitality.

Bayar & Özel (2014) describe power intake and industrial development in developing countries. Energy-saving and power-saving. The experimental results show that Hungary's energy consumption, financial development, and powerful forces have affected the development of the Hungarian currency and have little impact on Indonesia.

Amusa & Leshoro (2013) studied the relationship between energy costs and economic development in Botswana and found that there is a long-term relationship between GDP and electricity consumption. The results show that energy consumption will not have any short-term impact on GDP. But this will have full effect. On the other hand, GDP has short-term and long-term effects on energy consumption, although it is not worth mentioning.

To et al. (2013) take Australia as a paradigm to explain the correlation between power intake and financial rise. Also, this finding is consistent with the recovery of the Australian economy. Australia's economy is based on a big assembly industry. In any case, the results clearly show that measures to assess CO2 emissions and protect flexibility will not hurt Australia's financial development.

Siddiqui (2004) studied energy and economics. Pakistan's development. The results show that energy expansion can lead to gradual growth, while insufficient power will slow down the expansion process. The impact of all energy sources on economic growth is uneven. Electricity and fuel consumption are not lower than statistically significant electricity consumption. However, for oilseeds, causality is dangerous. All studies have been done. There

is a relationship between GDP growth and carbon dioxide emissions. They are due to foreign direct investment and trade liberalization. Therefore, it is essential to check the effect of their interaction. However, we cannot find any research on these relationships to specifically test this correlation.

3 Methodology and Theoretical Explanation

This study explores the correlation between carbon dioxide secretion and vital financial indexes. Pakistan's economic growth, foreign direct investment, trade openness, domestic investment, and labor. The data is based on the period from 1972 to 2019. We use a fully modified OLS cointegration technique. Explore long-term relationships.

The functional form of model is following:

$$\mathrm{GDPG_t} = \mathrm{f}(\mathrm{CO_{2,t}}, \mathrm{FDI_t}, \mathrm{TO_t}, \mathrm{LF_t}, \mathrm{DI_t}) \quad (1)$$

After introducing interaction terms, the function form is following:

$$\mathrm{GDPG_t} = \mathrm{f}(\mathrm{CO_{2,t}}, \mathrm{FDI_t}, \mathrm{TO_t}, \mathrm{LF_t}, \mathrm{DI_t}, \mathrm{CO_{2,t}} * \mathrm{FDI_t}, \mathrm{CO_{2,t}} * \mathrm{TO_t}) \quad (2)$$

It can be written in econometrics form,

$$\mathrm{GDPG_t} = \beta_0 + \beta_1 \mathrm{CO_{2,t}} + \beta_2 \mathrm{FDI_t} + \beta_3 \mathrm{TO_t} + \beta_4 \mathrm{LF_t} + \beta_5 \mathrm{DI_t} + \beta_6 \mathrm{CO_{2,t}} * \mathrm{FDI_t} + \beta_7 \mathrm{CO_{2,t}} * \mathrm{TO_t} + \varepsilon_t \quad (3)$$

Where:

GDPG is per capita gross domestic product (constant US$). The CO2 emission is Carbon dioxide emission (metric tons per capita). The FDI is foreign direct investment, net inflows (constant US$). The TO is trade openness (constant US$). The DI is domestic investment (constant US$). The LF is labor force (total). The ε_t is error term.

4 Results and Discussion

This section is based on the final factual results and their exposition based on the research purpose. First, we use the variance expansion test to test the multicollinearity between

explanatory variables due to the use of the term carbon dioxide emission interaction. The results are given in table 1:

Table 1
Variance Inflation Factors

Variable	VIF
FDI	1.253882
DI	2.308887
CO2	8.198253
LF	7.835282
TO	2.499872
CO2*FDI	7.894356
CO2*TO	9.423674

Source: Author's own estimations

Table 1 shows the VIF results, which show the relationship between all explanatory variables. The result of the coefficient of increased variance shows that there is no multicollinearity in the variables because the impulse rule is that the VIF value should not exceed 10, and all values should be less than 10. The conclusion is that there is no multicollinearity in the variables data.

4.2 Descriptive Analysis

Descriptive statistics are used to analyze behavior and preliminary understanding of variables. Provide average trends and data distributions to expand your research and better predict future behavior. The table summarizes the descriptive results.

Table 2
Descriptive Statistics

	GDP	FDI	DI	CO2	LF	TO
Mean	592.182	3.83873	3.50994	0.66769	39.116	3.42680
Median	453.002	3.85202	3.49645	0.69808	33.618	3.42529
Maximum	1467.73	4.12449	3.99572	0.99103	69.969	3.99739
Minimum	100.300	2.00000	3.00874	0.30860	19.610	3.00175
Std. Dev.	395.062	0.30225	0.30673	0.22295	14.515	0.30284
Skewness	0.97853	-	-0.18304	-0.1806	0.5686	0.35344

		4.96531				
Kurtosis	2.68170	31.1961	1.92239	1.66109	2.1342	2.10962
Jarque-Bera	7.53530	1712.81	2.48253	3.68597	3.9159	2.47719
Probability	0.02310	0.00000	0.28901	0.15834	0.1411	0.289791
Sum	27240.3	176.582	161.4576	30.71387	1799.3	157.6331
Sum Sq. Dev.	7023349	4.11098	4.233744	2.2368	9481.7	4.127232

Source: Authors' Estimations

Table 2 provides illustrative stats for all variables cast off in this study. This descriptive analysis is based on 48 observations, enough to show the distribution of the data. The average is the center value of the data. The central data trend is measured by the mean and median. The median represents the center of the analyzed data. The average value of the gross domestic product (GDP) is 592.1822 and the median is 453.0025, which is the highest value of the gross domestic product. Gross domestic product (GDP) data 1467.737. The minimum value of gross domestic product (GDP) data is 100.3003. The standard deviation indicates the range of the data used, while the maximum standard deviation indicates the larger range. The default value of the deviation is 395.0625. Use asymmetry values to measure data trends. The asymmetry of GDP is 0.978539. He showed that asymmetry is positive. The kurtosis value of the gross domestic product (GDP) is 2.681705, and its positive value indicates that the data used is not normally distributed. The Jarque-Bera test for the gross domestic product (GDP) has a value of 7.535304 and a P value of 0.023106, which is less than 0.5, which indicates that the data is not normally distributed.

External direct financing, the average, and median were 3.838739 and 3.852025, respectively. The maximum and minimum values of foreign direct investment are 4.124496 and 2. So far, the data is 0.30225. The skewness value is -4.96531. The kurtosis is 31.19616, which shows that foreign direct investment is not normally distributed, because Jarque-Bera is 1712.811, and the P-value is less than 0.05. For domestic investment (ID), the mean and mean are 3.509947 and 3.496452 respectively.

The maximum and minimum values are 3.995726 and 3.008749, respectively, and the data lance is 0.30673 each. The skewness value is -0.18304, and the kurtosis value is 1.922399. Yarke-Bera is 2.482533, and the P-value is 0.289018. Carbon dioxide emissions, the average, and average carbon dioxide emissions are 0.667693 and 0.698088, respectively. The maximum and minimum carbon dioxide values are 0.99103 and 0.308601, respectively, while the data distribution is 0.22295, the skewness value is -0.1806 and the kurtosis value is 1.661098, Jarque-Bera 3.685974, and the P-value is 0.158344. The fifth variable in Table 2 is (LF) Labor Force.

The average and average LF are 39.11625 and 33.61, respectively. The maximum and minimum LF values are 69.96 and 19.61, respectively. The data 14.51566 appears in each case. The skewness value is 0.568674 and the kurtosis value is 2.134243. The Jarque-Bera value is 3.91593, and the P-value is 0.141145. The sixth variable in Table 2 is trade openness (TO). The average and average TO are 3.426806 and 3.42529, respectively. The maximum and minimum values of TO are 3.997394 and 3.001751, respectively, while the data length is 0.3028, the skewness value is 0.353442, the kurtosis value is 2.109629, the Jarque-Bera value is 2, 477191, and the P-value is 0.289791.

After descriptive analysis we employed cointegration procedure to find out the relationship between variables. The results of cointegration given below in table 2. The variables are having unit root and the relationship is linear, so we use the FM-OLS method to find the long-term relationship between variables. The results are shown in Table 2 below is Foreign Direct Investment (FDI). The foreign direct investment ratio is 55.234, and the P-value is 0.1641. This means that foreign direct investment has a small but positive impact on GDP growth supported by (Malik, 2015). Second, the variable is the domestic investment (VI), which also has no significant relationship with GDP growth supported by (Bakari, 2018). The third variable is carbon dioxide emissions. The value of the carbon dioxide emission factor is 36.402, the P-value is 0.0042. The results show

that there is a positive relationship between carbon dioxide emissions and GDP. They show that if per capita carbon dioxide emissions increase by 1 ton, GDP will increase by 36.4 units per person. According to (Syeda Anam & Inayatul, 2017) the relationship between economic growth and carbon dioxide emissions is positive and significant.

Table 2
The FM-OLS Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	25.234	11.886	2.123	0.0164**
DI	22.855	11.229	2.028	0.031**
CO2	36.402	17.802	2.0448	0.004***
LF	13.139	3.1418	4.182	0.000***
TO	44.690	21.603	2.068	0.045**
TO*CO2	39.195	13.264	2.954	0.005***
FDI*CO2	48.103	45.952	1.046	0.302
R-squared	0.9908	Durbin-Watson stat		1.9024
Adjusted R-squared	0.9891			

Source: Software Eviews09 Note: Foreign direct investment, Domestic investment, Carbon dioxide emission, Labor force and Trade openness; *, ** and *** show the significance level which checked at 10%, 5% and 1% respectively.

The fourth variable in the table is the economically active population. The results show that the labor force (LF) has a positive and significant relationship with GDP growth, same result found by (Amir, Khan, & Bilal, 2015). The employment rate is 13.139, and the P-value is 0.0002. The working population (UAA) will increase by 1 unit and GDP will increase by USD 13.13, result supported by(Bakhsh, Rose, Ali, Ahmad, & Shahbaz, 2017). The fifth variable in the model is the openness of transactions. The trade openness (TO) is 44.690, and the P-value is 0.0458, same result found by (Ahmad et al., 2017). In this study, the openness of labor trade was used as a control variable. The results show that there is a significant positive correlation between trade openness (TO) and GDP growth. The concept of FDI*CO2

interaction plays a regulatory role, with a coefficient value of 39.195 and a P-value of 0.0054. This shows that foreign direct investment and carbon dioxide emissions together contribute to GDP growth. Other relevant variables tested together carbon dioxide emissions and commercial openness to TO*CO2. The value of the coefficient here is 39.195, and the value of P is 0.0054. The results show that the combination of trade openness and carbon dioxide emissions have a positive and significant impact on GDP growth, which means that (CO2*TO) per capita will increase by 1 ton, and then GDP will increase by USD 39.19. This means that 99% of the deviations in the model are caused by independent variables. We also used some remaining metrics to perform the reliability of regression analysis.

Table 3
Auto-correlation Testing

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	56.833	P-Value	0.8452

Source: Authors' calculations using Eviews09 software

The results in Table 3 indicate that there is no sequence relation in the residuals because the tested P-value is greater than 5%. For heteroscedasticity, we used the Breusch Pagan Godfrey test. The results are shown in Table 3 below:

Table 4
Heteroscedasticity Testing

Heteroscedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	29.8294	P-Value	0.628

Source: Authors' calculations using Eviews09 software

Table 4 states the aftermath of the heteroscedasticity test. The results show that the F statistic is 29.8294, and the P-value is 0.028, which is greater than 0.05. That means there is no problem with heteroscedasticity.

The results indicate that the trade openness, foreign direct investment, and CO2 all have positive log run relationship with economic growth. The most important the interaction terms also

have positive impact on growth. It shows that even though the trade openness and FDI increase economic growth but at the cost of environmental degradation.

5 CONCLUSION

The utmost purpose of this research is to analyze the effect of Pakistan's interplay between foreign direct investment (FDI) and trade openness (TO) on the correlation between carbon emissions and economic growth (GDP) from 1972 to 2019. In the current study, we tested the impact of each variable separately, such as CO2 emissions, domestic investment (GCFF substitution of total fixed capital investment), foreign direct investment (FDI), trade openness (TO) and labor force (LF) survey results on Pakistan's economic growth (GDP) show that CO2 emissions have a positive and statistically significant impact on Pakistan's economic growth. Positive and statistically insignificant impact on Pakistan's GDP. Trade openness (TO) has a positive and significant impact on economic growth (GDP), while the labor force (LF) has a positive and significant impact on GDP. The impact of domestic investment (FDI) on GDP is negligible, which means that due to the inefficiency of reasonable investment, the lack of a competitive market, and the lack of skilled labor, domestic investment has no effect on a country's development speed. The most important is the interaction between trade openness and carbon dioxide emissions. With the trade openness, the production and transportation of imports and exports have increased, which ultimately affects carbon dioxide emissions. This combined effect has an impact on the growth of GDP.

The findings of this study confirm the impact of causal interaction of trade openness and FDI on economic growth with CO2 emission. The policy makers can use these results to make policies regarding environment and trade by conserving their environmental costs. Also, there is limitation in study is that it only considers current value impacts, but it can be extended in future by employing simultaneous equation modeling to make proper among variables

References

Acheampong, A. O. (2018). Economic growth, CO2 emissions and energy consumption: What causes what and where? *Energy Economics, 74*(C), 677-692.

Amir, H., Khan, M., & Bilal, K. (2015). Impact of Educated Labor Force on Economic Growth of Pakistan: A Human Capital Perspective. *undefined*.

Amusa, K., & Leshoro, T. (2013). The relationship between electricity consumption and economic growth in Botswana.

Bakari, S. (2018). The Impact of Domestic Investment on Economic Growth New Policy Analysis from Algeria. *Bulletin of Economic Theory and Analysis, 3*(1), 35-51.

Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. *Journal of Environmental Management, 196*, 627-632.

Bayar, Y., & Özel, H. A. (2014). Electricity Consumption and Economic Growth in Emerging Economies. *Journal of Knowledge Management, Economics and Information Technology, 4*(2), 1-18.

Ben Jebli, M., & Ben Youssef, S. (2015). Economic growth, combustible renewables and waste consumption, and CO_2 emissions in North Africa. *Environmental Science and Pollution Research International, 22*(20), 16022-16030. doi:10.1007/s11356-015-4792-0

Chenran, X. (2019). Measuring the Effect of Foreign Direct Investment on CO_2 Emissions in Laos. *Journal of*

resources and ecology, v. 10(no. 6), pp.-685-691. doi:10.5814/j.issn.1674-764x.2019.06.014

Danish, & Wang, Z. (2018). Dynamic relationship between tourism, economic growth, and environmental quality. *Journal of Sustainable Tourism, 26*(11), 1928-1943. doi:10.1080/09669582.2018.1526293

Destek, M. A., & Sarkodie, S. A. (2019). Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development. *The Science of the Total Environment, 650*(Pt 2), 2483-2489. doi:10.1016/j.scitotenv.2018.10.017

Dong, K., Sun, R., & Hochman, G. (2017). Do natural gas and renewable energy consumption lead to less CO2 emission? Empirical evidence from a panel of BRICS countries. *Energy, 141*(C), 1466-1478.

Dong, K., Sun, R., Jiang, H., & Zeng, X. (2018). CO2 emissions, economic growth, and the environmental Kuznets curve in China: What roles can nuclear energy and renewable energy play? *Journal of cleaner production*.

Ertugrul, H., Cetin, M., Seker, F., & Dogan, E. (2016). The impact of trade openness on global carbon dioxide emissions: Evidence from the top ten emitters among developing countries. *Ecological Indicators, 67*, 543-555. doi:10.1016/j.ecolind.2016.03.027

Farhani, S., Mrizak, S., Chaibi, A., & Rault, C. (2014). The environmental Kuznets curve and sustainability: A panel data analysis. *Energy Policy, 71*, 189-198. doi:10.1016/j.enpol.2014.04.030

Kaya, Y., Yokobori, K., & University, U. N. (1997). *Environment, energy, and economy*: UN University Press.

Khan, M. A., & Ozturk, I. (2020). Examining foreign direct investment and environmental pollution linkage in Asia. *Environmental Science and Pollution Research International*, *27*(7), 7244-7255. doi:10.1007/s11356-019-07387-x

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

Li, G., & Fang, C. (2017). Urbanization, economic growth, energy consumption, and CO2 emissions: Empirical evidence from countries with different income levels. *Renewable and Sustainable Energy Reviews*, *81*. doi:10.1016/j.rser.2017.06.025

Liobikienė, G., & Butkus, M. (2019). Scale, composition, and technique effects through which the economic growth, foreign direct investment, urbanization, and trade affect greenhouse gas emissions. doi:10.1016/J.RENENE.2018.09.032

Mahmood, N., Wang, Z., & Hassan, S. T. (2019). Renewable energy, economic growth, human capital, and CO₂ emission: an empirical analysis. *Environmental Science and Pollution Research International*, *26*(20), 20619-20630. doi:10.1007/s11356-019-05387-5

Mahmood, T., & Kanwal, F. (2017). Long Run Relationship between Energy Efficiency and Economic Growth in Pakistan: Time Series Data Analysis. *Forman Journal of Economic Studies*, *00*, 105-120. doi:10.32368/FJES.20170005

Malik, K. (2015). Impact of Foreign Direct Investment on Economic Growth of Pakistan. *American Journal of*

Business and Management, 4. doi:10.11634/216796061504624

Mutascu, M., & Sokic, A. (2020). Trade Openness - CO2 Emissions Nexus: a Wavelet Evidence from EU. *Environmental Modeling & Assessment, 25*(3), 411-428. doi:10.1007/s10666-020-09689-8

Nathaniel, S., Barua, S., Hussain, H., & Adeleye, N. (2021). The determinants and interrelationship of carbon emissions and economic growth in African economies: Fresh insights from static and dynamic models. *Journal of Public Affairs, 21*(1), e2141. doi:10.1002/pa.2141

Rafique, M. Z., Li, Y., Larik, A. R., & Monaheng, M. P. (2020). The effects of FDI, technological innovation, and financial development on CO2 emissions: evidence from the BRICS countries. *Environmental Science and Pollution Research International, 27*(19), 23899-23913. doi:10.1007/s11356-020-08715-2

Shahbaz, M., & Lean, H. H. (2012). The dynamics of electricity consumption and economic growth: A revisit study of their causality in Pakistan. *Energy, 39*(1), 146-153.

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

Shahbaz, M., Solarin, S. A., Sbia, R., & Bibi, S. (2015). *Does Energy Intensity Contribute to CO2 Emissions? A Trivariate Analysis in Selected African Countries* (64335).

Siddique, H. M. A., & Majeed, M. T. (2015). Energy consumption, economic growth, trade and financial

development nexus in South Asia. *Pakistan Journal of Commerce and Social Sciences (PJCSS), 9*(2), 658-682.

Siddiqui, R. (2004). Energy and Economic Growth in Pakistan. *The Pakistan Development Review, 43*(2), 175-200.

Sugiawan, Y. (2016). The environmental Kuznets curve in Indonesia: Exploring the potential of renewable energy. *Energy Policy, 98*, 187-198. doi:10.1016/j.enpol.2016.08.029

Sun, Z., Clottey, Geng, Y., & Amissah, J. C. K. (2019). Trade Openness and Carbon Emissions: Evidence from Belt and Road Countries. *Sustainability, 11*, 2682. doi:10.3390/su11092682

Syeda Anam, H., & Inayatul, H. (2017). The impact of economic growth, trade openness and energy consumption on carbon emissions in nexus of EKC for Pakistan.

To, H., Wijeweera, A., & Charles, M. B. (2013). Energy consumption and economic growth–The case of Australia. In *Australian Conference of Economists*.

Xu, B., & Lin, B. (2015). How industrialization and urbanization process impacts on CO2 emissions in China: Evidence from nonparametric additive regression models. *Energy Economics, 48*(C), 188-202.

Yin, J., Zheng, M., & Chen, J. (2015). The effects of environmental regulation and technical progress on CO2 Kuznets curve: An evidence from China. *Energy Policy, 77*(C), 97-108.

Zhang, C., & Zhou, X. (2016). Does foreign direct investment lead to lower CO2 emissions? Evidence from a regional analysis in China. *Renewable and Sustainable Energy Reviews, 58*(C), 943-951.