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Foreign Direct Investment Settlement, Novel Energy Methods and CO_2 Emissions: Evidence from United Arab Emirates

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ABSTRACT

This paper explores the relationship between foreign direct investment (FDI) settlement, the contribution of clean energy and CO_2 emission in United Arab Emirates (UAE). Using the time-series estimation methods, this study opts cointegration test to find the long-run association between FDI and CO_2. Furthermore, energy source of UAE is based on fossil fuel, we employed fixed-effect regression model to determine the effect of FDI after controlling several other factors that causes CO_2 emission to find the magnitude. After obtaining the data from 1971 to 2019, we find that FDI plays a significant role in CO_2 emission in the economy. Another key contribution of this paper is regarding clean energy. The results confirm that clean energy helps to reduce the CO_2 emissions. The findings of this research endorses the initiative of the UAE launched “Energy Strategy 2050.” This implies that UAE is moving in a right direction to curb the CO_2 emission by increasing the contribution of clean energy in the total energy mix and would achieve this target through an effective implementation of the “Energy Strategy 2050.”

Keywords: Foreign Direct Investment, Carbon Emission, Clean Energy
JEL Classifications: Q56, Q59, B22

1. INTRODUCTION

The driving force behind economic and human development is investments, which is an effective way for increasing any economy and human community’s wealth (Aderemi et al., 2022; Kayani, 2021). There are various kinds of investments, one such investment is Foreign Direct Investment (FDI), which plays an influential part in the nation’s financial stability (Saqib et al., 2022). FDI is a means of attracting investors for developing and improving the economy of the country along with the quality of the human resources (Simionescu and Naros, 2019). According to the World Trade Organization (WTO), FDI is defined as when an investor is present in one country and makes an investment in another with the intention of managing that investment. FDI is an integral part of the process of economic growth and globalization since it contributes to additional foreign capital and encourages the transfer of advanced technology and improved skills to the host country.

Therefore, it holds crucial importance to explore the interrelation between FDI and economic development and is equally important for countries or organizations to understand the dynamic in the context of international economics (Huynh et al., 2020; Majeed et al., 2021). The two most vital factors affecting the environment of any country are economic development and FDI. Inward FDI is a means of providing direct financial capital, which helps in generating positive externalities for the stimulation of economic growth. Economic development is encouraged through the transfer of technology, productivity gains, and introducing new processes as well as managerial skills. Additionally, FDI is also a source of financial development in recipient countries, which signifies that the FDI helps in increasing the funds available in a financial system. Therefore, these funds not only help in developing financial markets but also promote economic development. On the contrary, increased economic development due to inward FDI can consequently lead to carbon emissions and ecological adverse impacts in the host countries, which is a newly emerging topic of interest in the research community (Cicea et al., 2020).

Undeniably, FDI plays a huge part in stimulating economic development in the host countries especially when the financial savings being generated indigenously are not enough to fulfil the domestic needs of the nation. However, the impact of FDI on the environment and pollution led by FDI should not be ignored. With reference to existing literature and empirical evidence regarding the correlation between foreign investments and degradation of environmental performance are unclear. This unclarity is probably because of the fact the theoretically, the relationship between FDI and environmental pollution and three major dimensions. Firstly, in accordance with the pollution haven Hypothesis, host countries that have weaker environmental policies tend to attract more inward FDI as most of the profit-driven organizations are looking for ways for circumventing expensive regulatory compliance in their country of origin. Therefore, this reason signifies that inward FDI will in turn result in more environmental deterioration (Shao, 2018). Secondly, in accordance with the pollution halo hypothesis, it is documented that when a universal environmental regulation is applied, those foreign organizations that are engaged in FDI are likely to expand their green technologies to the host countries by transferring them to their counterparts. By studying these opposite effects induced by FDI it can be concluded that FDI can be a source of either positive or negative affects which can consequently lead to either improving or destroying the environmental quality. Last but not the least, FDI and the environment's correlation are also elaborated through the scale-effect hypothesis. This hypothesis implies the existence of a scale to the degree that foreign organizations' FDI operations would be drastically contributing to the industrial productivity of the country hosting it and consequently to the emission levels which signifies deterioration of environmental quality in the host country. When considering the different economies of the world, both developing and developed it is imperative to identify the aspects which impacts the environmental quality, which have a more prominent role to play (Nadeem et al., 2021; Carvajal et al., 2022). This will help in understanding the resultant cost and benefits of this relationship in the context of economic development (Hanif et al., 2019).

One of the most prominent economies of the MENA region is Unites Arab Emirate (UAE). UAE has been the centre of the world for carrying out major events, property investment, tourism, and oil and gas. The countries of the Gulf Cooperation Council (GCC) have been experiencing rapid growth over the past few decades majorly because of its oil and gas reserves and the development of this sector. Due to high dependency on the oil and gas sector, it is a major cause of high carbon emissions (Arminen, 2018). Additionally, the quality of the environment is deteriorating due to the emissions particularly from the construction industry as the pollutants are affecting the quality of water and air in the region. As far as the CO_2 emissions of UAE are concerned, it has been seen that the emissions have experienced a continuous increase from 61 to 200 million tons from 1990 to 2013, respectively including other greenhouse gases too. The government of UAE launched Masdar in 2006, which was a sustainability initiative that focussed on the implementation of programs concerning renewable and alternate energy. The investment was made with an objective, that proper infrastructure could be created such as solar, wind, hydropower. The aim is to reduce carbon emissions and promote research in sustainable development, education, and manufacturing (Al-mulali and Che Sab, 2018). Additionally, various kinds of collaborations have been done by the government with the private sector for implementing green projects. The objective was to set certain standards regarding the import product's efficiency, for fuel and power consumption so that the quality of the environment can be improved (Abdouli and Hammami, 2020). In 2017, UAE government launched a UAE Energy Strategy 2050. According to this UAE by 2050 will take clean energy levels up to 50% from 25% and will reduce the CO_2 by 70%.

This study aims at the in-depth study of the nexus between inward FDI, and CO_2 emissions in the context of the UAE in presence of energy, clean energy and GDP as a key indicators. This research aims to provide the fresh and updated research on the UAE context in continuation of Shahbaz, et al., 2019 study which confirms the relationship between FDI and CO2 emissions. The Shahbaz, et al., 2019 study was based until the data of 2015 which is before the date of the UAE government initiative called as UAE Energy Strategy 2050 launched in 2017. The study aims to fill the existent knowledge gaps so that future research directions can be unveiled. Since it has been observed that FDI stimulates economic development and helps improve the economic growth of a countryTherefore, it is necessary to explore this dimension in the context of one of the most prominent economies of the developing world. The aim is to investigate the interrelation among inward FDI, and carbon emissions by addressing the globalization aspect as well. One component, which will help the competitiveness of UAE, is globalization, both in terms of the economy and environmental sustainability. The reminder of the article is composed on following parameters. Section 2 explains the literature. Section three discusses about methodology. Section 4 provides results and finally section 5 provides the conclusion.

2. LITERATURE REVIEW

2.1. Economic Growth, FDI, and CO_2 Emission

The relationship between the economic and environmental variables is becoming a topic of interest across the globe. On one hand, where economic growth and an increase in inward FDI call for a country's development and stability, it is often criticized when viewed from the sustainability lens. According to Anser et al. (2020), financial stability, inward FDI, and urbanization share a very significant relationship with environmental quality and carbon footprint. This industrialization requires energy to perform its operations hence carbon footprint ultimately very high. The authors emphasized controlling the rate of economic growth and import-export volumes to regulate the emission levels. Ahmed et al. (2020a) explored the GDP, FDI, human capital nexus, and ecological degradation explained in terms of the eco-footprint. The findings reported that GDP growth results in increased CO_2 emissions in China based on the data collected from 1970 to 2016. However, improvement in human capital has been observed to have a negative correlation with environmental deterioration. Nathaniel et al. (2020) also explored the urban development, fiscal stability, FDI inflows, and carbon emissions correlation. Urban development and economic growth have been found to positively influence pollution levels. This has been attributed to the use of coal as the major source of energy generation in the selected regions. In another similar research, Ahmed et al. (2020b) investigated the causality that exists between urban development, human capital, FDI, income level, and environmental quality in G-7 countries. The study investigated a positive correlation between CO_2 emissions and increased rates of urbanization and per capita income as the increase in economic activities in these countries is found to be associated with the large-scale utilization of fossil fuels.

Recently, Rahman and Vu (2020) also examined the impact of urban development, inward FDI, and GDP on CO_2 levels in Canada. The results of the empirical analysis presented that GDP growth and carbon footprint has a positive correlation. In addition, increased FDI inflows also lead to higher CO_2 emissions. Similarly, Ulucak et al. (2020) explored the casual link between natural resource depletion, economic growth, FDI, and eco-sustainability in countries of the BRICS region over the years from 1992 to 2016. In the light of the results, environmental pollution indicators and economic growth are positively correlated with one another. With reference to UAE, Sbia et al., (2014) deployed the ARDL method and Granger causality for investigating the correlation between FDI, sustainable energy, trade liberalization, CO_2 emissions, and GDP growth from 1975 to 2011. The results have shown cointegration between the variables under study.

Furthermore, FDI is significant factors of country's growth. It helps the economy in several ways. For instance, it provides the foreign reserves which help to increase the GDP. It also helps to maintain the current account deficit for short time, however, for the continuous inflow of foreign reserve, the output of that investment supports the employment and industrialization. The industrialization ultimately requires energy to produce economic activity and in result increases the CO_2 emission. On the other hand, the FDI also provide the support to research culture. An increase in FDI, trade liberalization, and CO_2 levels are associated with a reduction in energy consumption.

3. METHODOLOGY

This research employed secondary annual data of per capita CO_2 emissions (measured in metric tonnes), per capita real FDI, per capita energy consumption (in kilograms of oil equivalent), per capita real GDP (in US$ currency), and the clean energy use as percentage of overall energy use. All of these factors are measured in US$ currency. This research study obtained data from year between 1971 and 2019 for its sample. The data of all variables extracted from the WDI (World Development Indicators) databases, which are maintained by the World Bank. The descriptive statistics of all variables is reported in Table 1. He descriptive statistics is based on the mean, median, standard deviation, minimum and maximum values.

To normalise the scaling of values, we take natural log of observations.

1. CO_2 emissions per capita in 2019 (metric tons)
2. FDI net inflows per capita during 1971–2019 (current US$)
3. Energy use per capita in 2019 (kilogram of oil equivalent)
4. GDP per capita in 2019 (current US$)
5. Clean energy use (% of energy use).

Before any form of aggregation can proceed, the data must initially be normalized since some of the variables are defined as thousands of tons of metric weight while others are expressed as thousands of dollars in US currency. As a result, transformation into a natural log is being carried out in order to reduce the likelihood of the series showing any adverse biases in its attributes, hence, all of the variables are transformed in the form of the natural logarithm.

Table 2 shows the Pearson correlation analysis. There is high correlation between CO_2 and FDI, energy, GDP, and the usage of clean energy. GDP, energy consumption, and clean energy usage are all significantly correlated with FDI. Correlation coefficients are positive and highly significant for all pairwise comparisons. While all variables are incorporated in multivariate regression models, the pairwise relationship may transform.

3.1. Unit Root Test

Several economic indicators are described by stochastic tendencies, which may lead to spurious interpretations get derived from data. When the autocovariances of a time series do not change as a function of time-series, we assert that the series is stationary. A unit root is present in any series that does not remain stationary. The unit root test is the conventional way of assessing whether a data set is stationary. The most current research in this field reveals that panel-based unit root tests have a greater power than individual time series-based unit root testing (Breitung, 2002; Im et al., 2003; Levin et al., 2002).

Table 1: Summary statistics

	Mean	St. Deviation	Minimum	Maximum
CO_2	25.056	4.7903	18.391	31.778
FDI	21.930	22.431	20.708	23.713
Energy	9.0640	7.9344	7.9618	9.4069
GDP	10.424	8.8174	10.012	10.714
Clean energy	0.1267	0.1176	0.0000	0.6700

Table 2: Pearson correlations

	CO_2	FDI	Energy	GDP	Clean
CO_2	1.000				
FDI	0.595***	1.000			
Energy	0.792***	0.655***	1.000		
GDP	0.588***	0.700***	0.179***	1.000	
Clean energy	0.399***	0.980***	0.481***	0.251***	1.000

***P-value 0.01, Correlation is significant at the 0.01 level (2-tailed)

Table 3: Panel unit root test

Methods/variables		CO_2	FDI	Energy	GDP	Clean energy
Levin et al. (2002)	Level	1.655	1.939	1.853	1.133	1.314
	1st dif.	7.896***	5.903***	4.242***	8.687***	7.160***
Breitung (2002)	Level	3.292	0.489	8.588	5.344	1.364
	1st dif.	2.511***	4.205***	3.761**	7.421***	2.188***
Im et al. (2003)	Level	0.254	0.362	0.802	0.279	0.485
	1st dif.	8.267***	17.104***	9.672***	8.042***	12.274***
Fisher-ADF	Level	31.866	34.327	27.003	31.976	39.423
	1st dif.	127.539***	398.499***	319.966***	195.247***	182.394***
Fisher-PP	Level	37.511	32.245	23.149	30.480	34.622
	1st dif.	322.603***	737.938***	125.531***	365.960***	327.466***

Probability values for rejection of the null hypothesis of a unit root are employed at the 0.05 level. ***P-value 0.01. **P-value 0.05 based on MacKinnon (1996) one-sided *P* values

Table 3 reports the results of unit root testing. The least squares approach was used to examine all of the regression equations with intercepts as regressors. Fixed effects and linear trends are both described for as regressors in the Breitung (2002) unit root test equation. Asymptotic chi-square distributions are used to determine the probability of Fisher-type tests (Maddala and Wu, 1999). A data series is declared non-stationary, as the numerical values demonstrate that the null hypothesis cannot be rejected at the series level. The null hypothesis for each series may be rejected at the 1% level, however, when the unit root tests are applied to the first difference in the series. All the initial difference series are stationary, proving they are first order integrated.

3.2. Panel Cointegration Test

A linear combination of non-stationary time series i.e., more than one may be stationary (Engle and Granger, 1987). Granger (1988) defines cointegration as the integration of non-stationary variables with stationary residuals. In case of cointegrated variables, there is a state of symmetry in the long run because of a force. The cointegrating equation may be described to represent a relationship between variables that is in a state of long-run equilibrium. Since the maximum likelihood procedure has significantly large and finite sample properties, Maddala and Wu (1999) suggested that the Fisher-type panel cointegration test using the Johansen (1991) test methodology is more effective than using the Engle-Granger test method when testing cointegration equations. This is because the Fisher-type panel cointegration test uses the Johansen (1991) test methodology. In order to determine how many cointegration relationships exist, the Johansen test uses two ratio tests: the trace test and the maximum eigenvalue test. While both may be used to count cointegrating vectors, they don’t always agree on how many are really there. If the findings from a maximum eigenvalue test and a trace statistics test vary, the maximum eigenvalue test is the one to employ since it allows for individual tests to be performed on each eigenvalue.

The results of the Johansen panel cointegration test are shown in Table 4. Panel least squares techniques were used for test equations. The assumptions of cointegration tests enable individual effects but no individual linear trends in vector autoregression, which is used in the Johansen panel cointegration test (Khobai and Le Roux 2017). At the 0.01 significance level, we reject the no-cointegration null hypothesis. At the same time, the trace statistic and the maximum eigenvalue statistic both suggest that there are at least three cointegrating vectors at the 0.01 and 0.05 levels, respectively. If cointegrating equations exist, then there must be a long-term association between the variables. Granger (1988) proposed that short-term unidirectional or bidirectional Granger causality is possible when there is no cointegration between two time series. The significance of combined coefficient of the differentiated independent variable is examined using an F-test or a Wald test to examine Granger causality. The statistical significance of the regressor’s coefficient may be interpreted to the F-statistic of the coefficients on the lagged endogenous variable provided by the paired Granger causality test. To determine the Granger causal influence on the dependent variable, the F-statistic may be utilized. Here, we hypothesize that the Granger dependent variable is unrelated to the lagged endogenous variable. However, the cointegration test indicates that the time series variables are cointegrated. For that reason, Granger causality tests will not be used in this investigation.

Table 4: Fisher-type Johansen cointegration test

Number of cointegrating equation	Trace statistics	Maximum-eigen statistics
None	260.4***	233.4***
At most 1	102.2***	616.3***
At most 2	49.8***	15.9**
At most 3	79.4	37.2
At most 4	51.2	52.1

The test equation is as follow: CO_2=*f* (FDI, Energy, GDP, Clean energy). Probability values for rejection of the null hypothesis of no cointegration are employed at the 0.05 level. ***P-value 0.01. **P-value 0.05 based on the MacKinnon (1996) P values

3.3. Testing the Hypotheses Using Regression

In case a variable is non-stationary and cointegrated, then a corresponding error correction state in the short-run dynamics of the variables may be impacted due to the divergence from symmetry (Engle and Granger, 1987; Granger, 1988). The findings of a long-run symmetry association obtained from the test of cointegration are utilized as input for a two-step technique that accounts for a long-run relationship by using a panel-based error correction model.

In light of this, error correction models may be developed in the following manner:

$$CO_2 = f\,(FDI,\ Energy,\ GDP,\ Clean\ energy) \qquad (1)$$

Table 5: Results of hypothesis test using fixed effects models

Variables/ models	Regression model[a]	Regression model[b]	Regression model[c]
CO_2		0.041***	0.554***
FDI	0.521***	0.000	0.039
Energy	0.890***		0.332***
GDP	1.552***	1.233***	1.742***
Clean energy	0.632***	0.042***	
Constant	7.497	4.256	5.615
R-squared	0.754	0.820	0.842
Adj. R-squared	0.788	0.870	0.752
F-statistic	452.25	2836.12	152.54

Probability values for rejection of the null hypothesis of zero (0) coefficient are employed at the 0.01 level. ***P-value 0.01. [a]Regression model 1: $CO_2 = f$ (FDI, Energy, GDP, Clean energy). [b]Regression model 2: FDI = f (CO_2, FDI, Energy, GDP, Clean energy). [c]Regression model 3: Clean energy = f (CO_2, FDI, Energy, GDP)

$$CO_2 = f\ (FDI,\ GDP,\ Clean\ energy) \quad (2)$$

$$CO_2 = f\ (FDI,\ Energy,\ GDP) \quad (3)$$

Table 5 demonstrates the positive significant direct effect of FDI-CO_2 relationship at the 0.01 level. This was done for the purpose of Hypothesis 1, which claims that FDI takes the lead to CO_2. When we examine the direct impact that FDI has on CO_2 using bivariate panel regression scenario, we find that there is a positive association between FDI and CO_2 for the UAE (FDI's coefficient equals 0.470). It suggests that rising levels of FDI will also result in higher levels of carbon dioxide emissions. We continue to determine evidence of a positive link between the two variables regardless of the context in which we do the regression analysis. The findings of the two different regression models point to the fact that there is a consistent association between FDI net inflows and CO_2 levels. It is hypothesized that a one percent increase in FDI net inflows would result in a 0.521% boost in CO_2 emission for the UAE.

4. CONCLUSION

This study employs a multivariate framework for cointegration tests using panel data from UAE, including both FDI and CO_2 emissions use. A long-run equilibrium relationship between these factors has been uncovered and clarified by this study. Notably, for the purposes of an exploratory research, the results suggest that FDI has a direct impact on CO_2 emissions in the UAE. The results have practical significance since they suggest that FDI is essential to the region's ongoing economic development (Leitão, 2014) and to attaining emission reductions via policy and practice reforms. Widespread implementation is necessary for improving energy efficiency, expanding access to renewable energy sources, and commercializing breakthrough low-carbon energy solutions. Policy makers may help the economy and the environment by making concerted efforts to encourage FDI via policy initiatives such as Energy Strategy 2050'.

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