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The Dynamic Links Between Environmental Quality, Foreign Direct Investment, and Economic Growth in the Middle Eastern and North African Countries (MENA Region)

Mohamed Abdouli[1] · **Sami Hammami**[1]

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Abstract This paper investigates the relationship between foreign direct investment (FDI) inflows, economic growth, and environmental degradation. This is also the case for Middle Eastern and North African countries; we outline a dynamic simultaneous equations model over the period of 1990–2012 using the GMM approach. Our results indicate that there is evidence of bidirectional causal relationship between economic growth and FDI inflows, between economic growth and CO_2 emissions, and between FDI inflows and CO_2 emissions for the global panel and Middle East, with the exception of the North Africa. The existence of unidirectional causality exists from FDI inflows to CO_2 emission. The study suggests that environmental and foreign policies promote economic growth in an environment without pollution and with a strong investment at the same time.

Keywords Carbon dioxide emissions · FDI · Economic growth · Middle East · North Africa

Introduction

The nexus between environmental degradation, economic growth, and foreign direct investment (FDI) inflows has been the subject of considerable academic research over the past few decades (Omri et al. 2014). According to the environmental Kuznets curve (EKC) hypothesis, as output increases, carbon dioxide emissions increase as well until

✉ Mohamed Abdouli
mohamedabdouli3@gmail.com

Sami Hammami
sami_hammami2005@yahoo.fr

[1] Faculty of Economics and Management of Sfax, Sfax, Tunisia

some threshold level of output was reached after which these emissions begin to decline. The main reason for studying carbon emissions is that they play a focal role in the current debate on the environment protection and sustainable development. Economic growth is also closely linked to the FDI inflows since higher level of FDI inflows leads to higher economic growth (Abdouli and Hammami 2015). However, it is also likely that the increase of FDI inflows requires a higher level of economic growth.

The relationship between FDI inflows, environmental quality, and economic growth is puzzling. The picture seems quite different for developing countries, especially Middle East and North African (MENA) countries.

Therefore, the question of sustainability of growth in the Middle Eastern and North African countries becomes central. On one hand, environmental constraints may lead to lower the necessary growth for the region in a context of demographic boom associated with a high rate of unemployment. On the other hand, new opportunities and benefits from technological transfer may lead to better trend of growth and sustainability. One of the most important questions that arise in this context is what is, until now, the nature of the relation between FDI inflows, economic growth, and environmental quality in the MENA countries? Do we have the same trends than elsewhere or is there some specificity for the region?

In recent decades, research on the relationship between FDI, $CO2$ emissions, and economic growth has attracted the interest among economic researchers. Therefore, the interaction between foreign direct investment, economic growth, and environmental quality has been the subject of considerable academic research. For that reason, it is interesting to study the relationship between FDI inflows, economic growth, and environmental degradation in the MENA region.

In literature, the link between FDI, $CO2$ emissions, and growth has attracted the attention of researchers in various countries for a long time. We can classify the previous studies in this area in three parts.

The first part concerns the relationship between CO_2 emissions and economic growth (Grossman and Krueger 1991; Richmond & Kaufmann 2006; Holtz-Eakin and Selden 1995; Fodha and Zaghdoud 2010; Christopher and Douglason 2011; Wang et al. 2011; Saboori et al. 2012; Omri 2013; Omri et al. 2014).

The second examines the relationship between economic growth and FDI flows (Tsai 1994; Nguyen and Nguyen 2007; Tang et al. 2008; Adams 2009; Klasra 2011; Anwar & Nguyen 2010; Adhikary 2011; Kumar 2011; Ahmadi and Ghanbarzadeh 2011; Lenuta 2012; Omri et al. 2014; Aga 2014).

The third part focuses on the link between CO_2 emissions and FDI inflows (e.g., Jorgenson 2007; Acharyya 2009; Zhang 2011; Hitam and Borhan 2012; Ming Qing and Jia 2011; Kahouli and Kadhraoui 2012; Lee 2013; Omri et al. 2014; Lau et al. 2014).

The objective of this study is to use production function approach where gross domestic product (GDP) depends on CO_2 emissions, the capital, and other inputs such as FDI inflows. The extended Cobb–Douglas production framework helps us to explore the causal relationships among the variables: economic growth, capital, CO_2 emissions, and FDI inflows. The variables are chosen to capture the particular characteristics of Middle East and North Africa. Our study thus contributes to the existing literature by giving the first integrated approach to examine the three-way linkages between economic growth, CO_2 emissions, and FDI inflows in 12 Middle Eastern countries and 5 North African countries over the period of 1990–2012 by using the dynamic simultaneous equation models (DSEMs) which follow the spirit of the conventional growth framework. The reason is that all the variables in a growth form model are stationary. While, cointegration demands that all variables, as a prerequisite, need to be non-stationary with panel data specifications. Specifically, this study uses three structural equation models, which allows one to simultaneously examine the impact of (i) the FDI and CO_2 emissions on economic growth, (ii) the economic growth and CO_2 emissions on FDI inflows, and (iii) the economic growth and FDI on CO_2 emissions.

The next section describes briefly the reviews related to literature. The "Econometric Method and Data" section outlines the econometric modeling approach and describes the used data. The "Data" section reports and discusses the empirical results. The "Results and Discussions" section concludes the article and offers some policy implications.

Literature Review

Several existing works have used panel data modeling techniques on the links between economic growth, CO_2 emissions, and FDI inflows. Thus, this paper reviews the literature under three subsections, i.e., (a) economic growth and CO_2 emissions; (b) FDI inflows and CO_2 emissions; and (c) economic growth and FDI inflows. We discuss them in turn below.

The literature has shown extensive interest in the relationship between FDI, economic growth, and environmental degradation. In what follows, we review the most significant works in this literature.

Economic Growth and CO_2 Emissions

In recent decades, research on the relationship between economic growth and CO_2 emissions has attracted the interest among economic researchers. Richmond and Kaufmann (2006) examined the link between carbon emissions and economic growth for 36 nations over the period from 1973 to 1997. Their study shows the presence of the neutrality hypothesis. Omisakin and Olusegun (2009) used the timing data from 1970 to 2005 to test the causality between $CO2$ emission and income in Nigeria; the author showed that there is no causality between environmental pollution and income changes. Jalil and Mahmud (2009) examined the causal relationship between $CO2$ emissions and economic growth in China of an autoregressive distributed lag (ARDL) methodology is employed for empirical analysis over the period of 1975–2005. Thus, unidirectional causality running from economic growth to $CO2$ emissions is uncovered in both directions: the short and long run. In addition, Halicioglu (2009) examined the causal relationships between carbon emissions, energy consumption, income, and foreign trade in Turkey over the period of 1960–2005 using Granger causality based on the vector error correction model (VECM) technique. Their result suggested that bidirectional Granger causality exists between economic growth and $CO2$ emissions. They suggested the feedback hypothesis to prove their results. Similarly, Ghosh (2010) investigated the causal relationship between $CO2$ emissions and economic growth for India by means of an ARDL bound testing approach complemented by Johansen–Juselius over the period of 1971–2006. The empirical evidence supports the existence of bidirectional short-run causality between them.

In contrast, Wang et al. (2011) examined the relationship between carbon dioxide emission and economic growth in China from 1971 to 2008 using a Granger causality test based on a VECM. The empirical evidence supports the existence of unidirectional causality from $CO2$ emissions to economic growth. Hossain (2011) examined the dynamic causal relationships between carbon dioxide emission, energy consumption, economic growth, trade, and urbanization of openness panel of ten newly industrialized countries by means of Johansen fisher panel cointegration test and Granger causality test based on a VECM using the time series data for the period from 1971 to 2007. The obtained results validate the short-run unidirectional causal relationship from $CO2$ emission to economic growth. Similarly, Alam et al. (2012) investigated the existence of dynamic causality between the energy consumption, environmental pollutions, and economic growth using the cointegration analysis for Bangladesh of a Johansen bivariate cointegration model and autoregressive distributed lag. The results from their Granger causality tests indicate the existence of strong unidirectional causality between $CO2$ emissions to economic growth. In the same context, Zanin and Marra (2013) found that the inverted U-shaped EKC is valid for France and Switzerland using the ARDL model. Unidirectional causality running from per capita GDP to per capita $CO2$ emissions is revealed in both the short and the long run. Azlina and Mustapha (2012) investigated the causal relationships between energy consumption, pollutant emission, and economic growth for Malaysia over the period of 1970–2010 using Johansen cointegration test, VECM, and Granger causality test. The result shows the existence of the long-run relationship between pollutant emissions to economic growth.

For the period of 1971–2008, Ahmed and Long (2012) investigated the EKC hypothesis using a sample from Pakistan. By means of a cointegration analysis using an ARDL, bounds testing approach is incorporated. The results support the hypothesis in both directions (the short-run and long-run) and an inverted U-shaped relationship between CO_2emission and growth. There is a unidirectional causality running from per capita CO_2 emission to economic growth.

On the other hand, Arouri et al. (2012) examined the links between energy consumption, economic growth, and $CO2$ emissions in 12 countries of Middle East and North Africa (MENA) over the period of 1981–2005. They found that GDP exhibits a quadratic relationship with $CO2$ emissions in the whole region. Saboori et al. (2012) examined the dynamic relationship between carbon emissions and economic growth for Malaysia. The authors used ARDL methodology using data from 1980 to 2009. The empirical results suggest the existence of an inverted U-shaped relationship between $CO2$ emissions and GDP both in the short and long run, thus supporting the EKC hypothesis. Also, there is an absence of causality between $CO2$ emissions and economic growth in the short run but a unidirectional causality from economic growth to $CO2$ emissions in the long run. Similarly, Govindaraju and Tang (2013) used a panel of cointegration approach to examine the nexus between renewable $CO2$ emissions, economic growth, and coal consumption for China and India covering a period from 1965 to 2009. The empirical evidence supports the existence of a unidirectional causality from economic growth to $CO2$ emissions in China. Moreover, a bidirectional causality between economic growth and $CO2$ emissions was shown in India.

By using panel data of BRIC countries, Lee (2013) explored a complex relationship between foreign direct investment, CO_2 emissions, and economic growth from 1971 to

2009 using panel cointegration approach. The empirical evidence supports the existence of unidirectional causality running from economic growth to CO2 emissions.

More recently, research from Sbia et al. (2014) investigated the relationship between foreign direct investment, carbon emissions, and economic growth using an ARDL methodology in the case of the UAE from 1975 to 2011, showing that relationship between carbon emissions and economic growth is bidirectional. In the same veins, Lau et al. (2014) have examined the relationship between economic growth and $CO2$ emission in the presence of foreign direct investment and trade openness in Malaysia from 1970 to 2008. The authors employed the Granger causality methodology to test the interrelationships between these variables. From one side, their study shows the presence of a bidirectional causality between $CO2$ and economic growth and between FDI and economic growth on the other side.

In addition, Ben Jebli et al. (2014) found no significant causality between carbon emissions and economic growth in Central and South America from 1995 to 2010, which supports the neutrality hypothesis.

For 15 developing countries, Shaari et al. (2014) examined the relationship between foreign direct investment, economic growth, and $CO2$ emission. According to the availability of data, they used Granger causality based on VECM covering a period from 1992 to 2012. The findings indicate that in the short run, there is no effect of FDI and GDP on $CO2$ emission.

FDI Inflows and CO_2 Emissions

The relationship between FDI inflows and environmental degradation is not directly treating in the existing literatures, but they based their analyses on the causality from environmental regulation stringency to firm's competitiveness as entry point. They supposed that under globalization circumstance, the relatively lax environmental regulation in the developing countries becomes an attractive comparative advantage to the pollution-intensive foreign capital seeking for a "pollution haven" to avoid paying costly pollution control compliance expenditure domestically. Though this pollution haven hypothesis sounds reasonable, almost no empirical analysis has yet provided convincing supportive evidences revealing FDI's searching activity for the "production platforms" permitting lower pollution abatement cost (Zakarya et al. 2015).

Although the majority of the studies focused on economic growth and environmental degradation, many other studies have pointed out another possible determinant of environmental performance which is financial development. Frankel and Rose 2002 found that financial liberalization and development may attract FDI and higher degrees of R&D investments, which in turn can speed up economic growth and hence will affect the dynamic of the environmental quality. Similarly, Birdsall and Wheeler (1993) and Frankel and Rose (2002) indicated that financial development motivate developing countries and give them the opportunity to use new technology, and help them to use clean production, as consequence improving the global environment and enhancing the sustainability of regional development.

Additionally, Jensen (1996) and the World Bank have asserted that although FDI inflows may enhance economic growth, it may result in more industrial pollution and environmental degradation. Tamazian et al. 2009 found that a higher degree of economic and financial development decreases environmental degradation.

Very limited existing literatures directly treat the FDI pollution nexus. However, using a panel cointegration framework, Pao and Tsai (2010) estimated the dynamic relationships between $CO2$ emission, energy consumption, FDI, and economic growth for BRIC countries over the period of 1971–2005. The causality results indicate that there is strong bidirectional causality between CO2 emissions and FDI.

On the other hand, Lee (2013) supported the neutrality hypothesis of FDI inflows and CO2 emission interactions.

Recently, for the period of 1990–2012, Zakarya et al. (2015) analyzed the interactions between the total energy consumption, FDI, economic growth, and the emission of CO_2 in the BRICS countries, using cointegration tests and panel Granger causality. The empirical evidence supports the existence of a positive unidirectional causality running from FDI inflows to CO2 emissions. Omri et al. (2014) studied the causality links between $CO2$ emissions, foreign direct investment, and economic growth using dynamic and simultaneous equation panel data models covering 54 countries from 1990 to 2011. They concluded with the existence of bidirectional causality between FDI inflows and CO_2 emissions.

Over the period of 2000–2010, Abbes et al. (2015) examined the links between international trade, foreign direct investment and embodied CO_2 emissions in China's industrial sectors using the generalized method of moments (GMM) estimation model. The empirical evidence supports the existence of unidirectional causality from FDI inflows to CO_2 emissions. Using fixed effects model in 27 developing countries, Neequaye and Oladi (2015) suggest the existence of unidirectional causality from FDI inflows to CO_2 emissions, from examining the effects of foreign direct investment inflows and environmental aid disbursements on environmental degradation.

Economic Growth and FDI Inflows

The relationship between foreign direct investment (FDI) and economic growth in host countries remains one of the most important issues in the economic literature and met with renewed interest in recent years mainly for countries suffering from unemployment problems and lack of technological progress (Belloumi 2014).

Using panel data of 62 countries, Tsai (1994) analyzed the Granger causal relationships between FDI and GDP using Granger causality test; they found a bidirectional causality between FDI and GDP.

In Canada, Day and Graften (2003) by examining Granger causality between environmental quality and income, the authors found that there is bidirectional causality between them. Moreover, the link between foreign direct investment and economic growth in the five countries of the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Saudi Arabia, and United Arab Emirates (UAE)) from 1970 to 2004 by applying Granger causality test has been investigated. They found strong bidirectional causality between these variables. Furthermore, Rudra and Pradhan (2009) investigated the relationship between FDI and economic growth of five ASEAN countries during the period of 1970–2007. The authors employed cointegration and causality test in both individual and panel data level. Their result suggested that there is a foreign direct investment and economic growth. This finding is then consistent with the feedback hypothesis. However, Moudatsou and Kyrkilis (2011) looked at 16 countries in the EU group and 10 countries in ASEAN using data from 1989 to 2003 and from 1970 to

2003. Tests for long-run causality which are based on an error correction model indicate that there is a strong Granger causal relationship between FDI and GDP growth. The results point toward a bidirectional causality between FDI and growth.

In addition, Feridun and Sissoko (2011) used vector autoregression (VAR) and Granger causality test to analyze the relationship between GDP and FDI in Singapore. They recognized that no evidence proved that GDP and FDI had a unidirectional causality running from FDI. During the period of 1975–2009, Soltani and Ochi (2012) studied the causal relationship between FDI and economic growth in recent years in Tunisia by using the technical analysis of time series. They found significant effects from FDI to economic growth. Similarly, Olusanya and Olumuyiwa (2013) analyzed the impact of foreign direct investment inflow and economic growth in the Nigerian economy using a Granger causality test as the estimated technique between 1970 and 2010. The empirical evidence supports the existence of a unidirectional causality from economic growth to FDI.

In a more recent research, Abbes et al. (2015) analyzed the relationship between foreign direct investment and economic growth in 65 countries over the 1980–2010 period, using cointegration and panel Granger causality tests in panel data. Their finding indicated the existence of a unidirectional causality running from FDI inflows to economic growth. Aga (2014) employed time series techniques to analyze the effect of foreign direct investment on economic growth in Turkey during the period of 1980–2012. The authors used the VAR model to check if there is causality. Their result demonstrates that there is no causality linkage between GDP and FDI.

We summarize the country-specific and multicountry studies in Table 1. Overall, our literature review suggests that the empirical results of the previous studies are inconclusive except for some studies on the link between FDI inflows, economic growth, and $CO2$ emissions (Shaari et al. 2014; Omri et al. 2014).

Econometric Method and Data

Econometric Method

To examine the three-way linkages between CO_2 emissions and economic growth and FDI inflows in Middle East and North Africa countries, we used a Cobb–Douglas production function whereby the gross domestic product (GDP) depends on capital and labor force (Hall and Mairesseb 1996; Kosztowniak 2013 and Omri et al. 2014).The income depends also on energy consumption, which is directly related to CO_2 emissions (e.g., Pao and Tsai 2010; Arouri et al. 2012 and Omri 2013). Specifically, we use the following extended Cobb–Douglas production function:

$$Y = AK^{\alpha}E^{\lambda}L^{\beta} \quad (1)$$

where Y is the real GDP; E, K, and L denote respectively energy consumption, capital stock, and labor force. The term A refers to technology and e the error term. α, λ, and β are the production elasticities with respect to domestic capital, energy consumption, and labor force, respectively. When Cobb–Douglas technology is restricted to $\alpha + \lambda + \beta = 1$, we get constant returns to scale. Given the technology level at any given point in time,

Table 1 Summary of the existing empirical research

Author (s)	Countries	Econometric techniques	Causality results
Panel A: country-specific studies			
Day and Graften (2003)	Canada	Granger causality test	$GDP \leftrightarrow CO_2$
Omisakin and Olusegun (2009)	Nigeria	EKC hypothesis	$CO_2 \neq GDP$
Jalil and Mahmud (2009)	China	Autoregressive distributed lag (ARDL) Granger causality based on VECM	$CO_2 \rightarrow GDP$
Halicioglu (2009)	Turkey		$GDP \leftrightarrow CO_2$
Ghosh (2010)	India	Autoregressive distributed lag (ARDL and Johansen cointegration	$CO_2 \leftrightarrow GDP$
Zhou et al. (2013)	China	Granger causality based on VECM	$CO_2 \rightarrow GDP$
Alam et al. (2011)	Bangladesh	Johansen bivariate cointegration model	$CO_2 \rightarrow GDP$
Feridun and Sissoko (2011)	Singapore	VAR and Granger causality test	$GDP \rightarrow FDI$
Zanin and Marra (2013)	France	Autoregressive distributed lag (ARDL)	$GDP \rightarrow CO_2$
Azlina and Mustopha (2012)	Malaysia	Johansen cointegration test and Granger causality based on VECM	$FDI \rightarrow GDP$
Saboori et al. (2012)	Malaysia	Autoregressive distributed lag (ARDL)	$CO_2 \neq GDP$; $CO_2 \rightarrow GDP$
Ahmed and Long (2012)	Pakistan	Autoregressive distributed lag (ARDL)	$CO2 \rightarrow GDP$
Olusanya and Olumuyiwa (2013)	Nigerian	Granger causality test	$GDP \rightarrow FDI$
Ben Jebli et al. (2014)	Central and South America	ADF regressions	$CO_2 \neq GDP$
Aga (2014)	Turkey	Vector autoregression (VAR)	$FDI \neq GDP$
Sbia et al. (2014)	UAE	Autoregressive distributed lag (ARDL)	$CO_2 \leftrightarrow GDP$
Lau et al. (2014)	Malaysia	Autoregressive distributed lag (ARDL) and (UECM)	$FDI \leftrightarrow GDP$; $CO_2 \leftrightarrow GD$
Day and Graften (2003)	Canada	Granger causality test	$GDP \leftrightarrow CO_2$
Panel B: multicountry studies			
Tsai (1994)	62 countries	Granger causality test	$FDI \leftrightarrow GDP$
Rudra and Pradhan (2009)	5 ASEAN countries	Cointegration and causality test	$FDI \leftrightarrow GDP$
Hossain (2011)	10 newly Industrialized Countries	Johansen bivariate cointegration model	$CO_2 \rightarrow GDP$

Table 1 (continued)

Author (s)	Countries	Econometric techniques	Causality results
Pao and Tsai (2010)	BRIC countries	Vector autoregression (VAR) and ECM	FDI $\leftrightarrow CO_2$
Moudatsou and Kyrkilis (2011)	26 countries	Causality based on an error correction model	FDI $\leftrightarrow$ GDP
Sebri and Ben Salha (2014)	19 BRICS countries	Autoregressive distributed lag (ARDL) and error correction model (VECM).	$CO_2 \leftrightarrow$ GDP
Arouri et al. (2012)	12 Countries (MENA)	Cointegration tests	$CO_2 \leftrightarrow$ GDP
Govindaraju and Tang (2013)	China and India	Panel cointegration	GDP $\rightarrow CO_2$; $CO_2 \leftrightarrow$ GDP
Lee (2013)	BRIC countries	Panel cointegration	FDI $\rightarrow$ GDP; GDP $\rightarrow CO_2$
Omri et al. (2014)	54 countries	Dynamic simultaneous equation	FDI $\leftrightarrow$ GDP; FDI $\leftrightarrow CO_2$; $CO_2 \rightarrow$ GDP
Shaari et al. (2014)	15 developing countries	Granger causality based on VECM	FDI $\neq CO_2$; GDP $\neq CO_2$

$\rightarrow$, $\leftrightarrow$, and $\neq$ indicate the unidirectional causality hypothesis, feedback hypothesis, and neutral hypothesis, respectively

VECM vector error correction model, *ECM* error correction model, *EKC* environmental Kuznets curve there is a direct linear relationship between energy consumption and CO_2 emissions (Zhao 2011) such as E = bC. Then, we have

$$Y = b^{\lambda} e^{\varepsilon} A K^{\alpha} CO_2^{\lambda} L^{\beta} \tag{2}$$

In our model, we allow technology to be endogenously determined by FDI inflows and within an augmented Cobb–Douglas production function (Anwar and Sun 2011); Soltani and Ochi 2012); Olusanya and Olumuyiwa 2013); Omri et al. 2014). The inflow of foreign direct investment and transfer of superior technology promotes economic growth via capital formation in making its efficient use. Therefore, we have

$$A = \theta \, FDI\,(t)^{\psi} \tag{3}$$

where θ is time-invariant constant, and FDI is defined by FDI inflows. Substituting Eq. (3) into Eq. (2), we have

$$Y\,(t) = \theta.\; CO_2(t)^{\lambda 1}\; FDI\,(t)^{\lambda 2}\, K\,(t)^{\alpha}\, L\,(t)^{1-\alpha} \tag{4}$$

After dividing Eq. (4) by L, we have

$$Y\,(t) = \theta.\; CO_2(t)^{\lambda 1}\; FDI\,(t)^{\lambda 2}\, K\,(t)^{\alpha}\, L\,(t)^{1-\alpha} \tag{5}$$

Then, the productions function in Eq. (5) is transformed into linear log as follows:

$$Ln\,Y_t = \alpha_1 \;\; + \alpha_2\, LnCO_{2t} + \alpha_3\, Ln\,FDI_t + \alpha_4\, LnK_t + \varepsilon_t \tag{6}$$

Since our study is a panel data study, Eq. (6) can be written in panel data form as follows:

$$Ln\,Y_{it} = \alpha_1 \;\; + \alpha_{2i}\, LnCO_{2it} + \alpha_{3i}\, Ln\,FDI_{it} + \alpha_4\, LnK_{it} + \varepsilon_t \tag{7}$$

We write Eq. (7) in growth form with a time series specification as follows:

$$g(\,Y)_{it} = \alpha_1 \;\; + \alpha_{2i}\, g(CO_2)_{it} + \alpha_{3i}\, g(FDI)_{it} + \alpha_{4i}\, g(K)_{it} + \varepsilon_t \tag{8}$$

The subscript i = 1, …, N denotes the country (*N* = 17 in our study), t = 1, …, T denotes the time period, g(Y) represents the growth rate of per capita GDP, g(K) the growth rate of capital stock, $g(CO_2)$ the growth rate of per capita CO_2 emissions, and g(FDI) the growth rate of per capita foreign direct investment.

To simultaneously examine the interactions between per capita CO_2 emissions, per capita FDI inflows, and per capita GDP, we use the production function in Eq. (7). These simultaneous equation models are also built on the basis of theoretical and empirical lessons of the previous literature which allow the investigation of the three-way relationship between our variables of interest.

$$g(Y)_{i,t} = \alpha_0 + \alpha_{1i} g(C0_2)_{i,t} + \alpha_{2i} g(FDI)_{i,t} + \alpha_{3i} g(K)_{i,t} + \varepsilon_{i,t} \quad (9)$$

$$g(FDI)_{i,t} = \alpha_0 + \alpha_{1i} g(Y)_{i,t} + \alpha_{2i} g(C0_2)_{i,t} + \alpha_{3i} g(FD)_{i,t} + \varepsilon_{i,t} \quad (10)$$

$$g(C0_2)_{i,t} = \alpha_0 + \alpha_{1i} g(Y)_{i,t} + \alpha_{2i} g(FDI)_{i,t} + \alpha_{3i} Trade_{i,t} + \alpha_{4i} EN_{i,t} + \varepsilon_{i,t} \quad (11)$$

In the above equations, Eq. (9) examines the impact of the FDI inflows (FDI), CO_2 emissions, and capital stock on economic growth (Jalil and Mahmud 2009; Ghosh 2010; Kahouli and Kadhraoui 2012; Azlina and Mustapha 2012 and Omri et al. 2014). Equation (10) postulates that economic growth, environmental degradation, and the level of financial development (FD) have great impact on FDI flows (for example, Pao and Tsai 2010; Anwar and Sun 2011; Olusanya and Olumuyiwa 2013; Lee 2013; Omri and Sassi-Tmar 2014). Finally, Eq. (11) assumes that FDI inflows, economic growth, energy consumption, and trade openness (trade) as measured by the ratio of exports plus imports to GDP negatively affect CO_2 emissions (Jalil and Mahmud 2009; Pao and Tsai 2010; Omri 2013).

Estimation Procedure

At the empirical level, we allow our dynamic simultaneous equation models in Eqs. (9), (10), and (11) to have a dynamic panel specification where the one-period lagged levels of the dependent variables (i.e., growth rate of per capita GDP, per capita FDI inflows, and per capita CO2 emissions) can affect their current levels. Our dynamic models with panel data are then simultaneously estimated by using the Arellano and Bond (1991) GMM estimator. This approach uses a set of instrumental variables to solve the endogeneity problem of the regressors. It also avoids the estimation biases that can arise from the correlation between the lagged dependent variables and the error terms when the ordinary least squares (OLS) method is used.

Data

We use annual data for the per capita GDP, per capita CO_2 emissions, per capita FDI inflows, per capita capital stock, per capita trade openness, financial development (DF), and per capita energy consumption. All the data are collected for the period along from 1990 to 2012; they are sourced from the World Bank's World Development Indicators. To estimate our models, we divide the variables by the population to get the variables in per capita terms.

Our study covers 17 countries selected on the basis of data availability. They include (a) 12 Middle Eastern countries namely Kuwait, Oman, Qatar, Saudi Arabia, Lebanon, Iraq, United Arab Emirates, Turkey, Syria, Iran, Yemen, and Jordan and (b) 5 North African countries namely Algeria, Morocco, Tunisia, Egypt, and Libya.

Descriptive Statistics

The descriptive statistics of the different variables for the two subpanel regions are presented in Table 2. On average, the highest level of per capita CO_2 emissions is found for the Middle Eastern countries, with 1.966, metric tons, while the lowest mean is in the North African countries with, 1.020 metric tons.

The highest average of per capita GDP is obtained for Middle Eastern countries; it is also worth highlighting that this region's overall economic output is almost 8.727 GDP per capita, whereas for the North African countries, it is 7.860 GDP per capita. The same pattern is found for FDI inflows, as the Middle Eastern countries have the highest average of 1.484, whereas for North African countries, they are 0.976. Additionally, Middle Eastern countries have the highest volatility (defined by the standard deviation) in per capita CO_2 emissions (1.151), per capita GDP (1.335), and per capita FDI inflows (3.037), respectively. The North African countries have the lowest and the highest volatility in per capita CO_2 emissions, per capita GDP, per capita FDI inflows by 0.628, 1.536, and 0.590, respectively.

Finally, the highest coefficient of variation per capita GDP (0.152), per capita FDI inflows (0.585), and per capita CO_2 emissions (2.046) as measured by the standard deviation-to-mean ratio, followed by the Middle Eastern countries, while the North African countries have the lowest coefficient of variation.

Results and Discussions

We begin our analysis with the implementation of the panel unit root test proposed by Im et al. (2003). The objective is thus to decide which of the considered variables should enter into our empirical modeling in the growth rate form and which of them should be in their level form. Our results indicate that the null hypothesis of a unit root is rejected for financial development, energy consumption, and trade openness. This finding holds effectively for the two panels we consider: the Middle East and North Africa and the global panel. These results imply that the abovementioned variables are stationary in levels and no transformation is needed for further statistical analysis. While, the Im et al. (2003) test cannot reject the null hypothesis of a unit root for the four remaining variables (i.e., GDP, FDI, CO_2 emissions, and capital stock). Clearly, these four variables are not stationary in levels and they need to be first differenced before they can be used in further statistical analysis. The use of their growth rates in our empirical modeling is thus suitable.

We then use the Arellano and Bond (1991) GMM approach to estimate the three-way linkages between CO_2 emissions, foreign direct investment, and economic growth for the two panels under consideration. For each panel, three specifications that correspond to Eqs. (9), (10), and (11) are simultaneously estimated. Tables 3 and 4 report the results for which diagnostic tests (the Hansen-J test for overidentification, Durbin–Wu–Hausman endogeneity test, and Arellano–Bond test for the existence of the second-order autocorrelation in first differences) provide good statistical performance.

Beginning with Table 3, which contains the empirical results for panels of two different regions, we find that the impact of the one-period lagged values of GDP, FDI

Table 2 Summary statistics for the period of 1990–2012

Panels	Descriptive statistics	GDP per capita (constant 2005 USD)	FDI (net inflows)	CO_2 (metric tons per capita)	Domestic capital (constant 2005 USD) (per capita)	Financial Development (per capita)	Trade openness	ENC (kg of oil equivalent per capita)
Middle East	Mean	8.727	1.484	1.966	7.442	3.416	8.783	7.768
	Standard deviation	1.335	3.037	1.1517	1.357	2.146	1.351	1.1892
	CV	0,152	2.046	0,585	0,182	0,628	0,1538	0,153
North Africa	Mean	7.860	0.976	1.020	6.258	2.920	7.462	6.793
	Standard deviation	0.628	1.536	0.590	0.927	0.792	0.792	0.684
	CV	0,0798	1,573	0,094	0,317	0,106	0,106	0,100

Std. Dev. standard deviation, *CO2* per capita carbon dioxide emissions, *GDP* per capita economic growth, *FDI* FDI inflows per capita, *ENC* per capita energy consumption, *GDP* per capita real GDP, *K* real capital per capita, *FD* level of financial development, *CV* the coefficients of variation (standard deviation-to-mean ratio)

Table 3 Estimation results for the two subpanels

	Middle East			North Africa		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Independent variables	GDP	FDI	CO_2	GDP	FDI	CO_2
GDP	–	0.198[a] (0.009)	1.090[a] (0.000)	–	−0.425[a] (0.000)	1.030[a] (0.001)
GDP(t-1)	0.955 (0.000)	–	–	0.549[a] (0.000)	–	–
FDI	0.993[a] (0.000)	–	0.597 (0.000)	−0.419[a] (0.000)	–	0.811[a] (0.000)
FDI(t-1)	–	0.686[a] (0.000)	–	–	0.693[a] (0.000)	–
CO_2	−1.634[a] (0.000)	1.104[a] (0.000)	–	−0.625[a] (0.000)	0.253 (0.266)	–
CO_2(t-1)	–	–	0.737[c] (0.083)	–	–	0.832[a] (0.000)
K	0.783[a] (0.000)	–	–	1.098[a] (0.000)	–	–
FD	–	−0.036 (0.839)	–	–	0.739[a] (0.000)	–
Trade	–	–	0.032 (0.590)	–	–	−1.247[a] (0.000)
EN	–	–	1.492[a] (0.000)	–	–	0.428[b] (0.015)
Hansen J-test (*p* value)	2.698 (0.1005)	2.223 (0.1359)	6.332 (0.099)	9.319 (0.0023)	30.159 (0.0000)	11.819 (0.211)
DWH test (*p* value)	7.474 (0.0238)	1.390 (0.0499)	11.279 (0.0036)	17.053 (0.0002)	9.511 (0.0086)	8.581 (0.0137)
AR2 test (*p* value)	1.37 (0.171)	1.12 (0.264)	−0.41 (0.684)	0.83 (0.404)	0.94 (0.345)	0.06 (0.950)

Values in parenthesis are the estimated *p* values. Hansen J-test refers to the overidentification test for the restrictions in GMM estimation. DWH test is the Durbin–Wu–Hausman test for endogeneity. The AR2 test is the Arellano–Bond test for the existence of the second-order autocorrelation in first differences.

[a] Significance at the 1 % levels

[b] Significance at the 5 % levels

[c] Significance at the 10 % level

inflows, and CO_2 emissions on the dependent variables is still positive and significant. The results for the Middle Eastern panel indicate a bidirectional causal relationship between economic growth and FDI inflows, between economic growth and CO_2 emissions, and between FDI inflows and CO2emissions. More precisely, model (1) shows that economic growth is affected positively by FDI inflows and negatively by CO_2 emissions. This suggests that an increase in FDI inflows per capita leads to an increase of economic growth, but the increase in CO_2 emissions decreases economic growth at the 1 % level. Moreover, a 1 % increase in foreign direct investment raises the economic growth for the global panel by around 0.99 %. Our empirical evidence is thus consistent with the results reported by Abbes et al. (2015) for 65 countries and Omri et al. (2014) for 54 countries. Economic growth is also affected negatively and significantly by CO_2 emissions as a 1 % increase in CO_2 emissions decreases the economic growth by around 1.63 %. Hence, the higher level of pollution emissions might lead to the decline of the production capacity of a country. The coefficient of capital is positive and significantly impacts on economic growth.

In model 2, we find that economic growth and CO_2 emissions have a significant positive impact on FDI inflows at the 1 % levels. This suggests that an increase in economic growth and CO_2 emissions per capita leads to an increase of FDI inflows. The magnitude implies that a 1 % increase in economic growth and CO_2 emissions increases FDI inflows of the Middle Eastern countries by 0.198 and 1.104, respectively. This implies that the growth rate and higher level of polluting emissions send positive signals to prospective foreign investors. Our empirical evidence is thus consistent with the results reported by Omri et al. (2014) for three regional subpanels and Bozkurt and Akan (2014) for Turkey. For financial development, the coefficient is statistically positive and significant. This implies that increase of financial development increases FDI inflows.

Regarding the pollutant variable in model 3, it appears that economic growth, FDI inflows, and energy consumption have a significant positive impact on CO_2 emissions, but the trade openness has no significant positive impact. Therefore, we can say that the effects of economic growth, FDI inflows, and energy consumption on CO_2 emissions are statistically significant at the 1 % level. This implies that a 1 % rise in the three variables increases CO_2 emissions by around 1.09, 0.59, and 1.492 %, respectively.

However, the FDI flows may have resulted in pollution havens and that lowering the environmental regulations may help to attract and retain foreign investments. This confirms the results showed by Jalil and Mahmud (2009) in China; Ren et al. (2014) for China; and Arouri et al. (2012) for 12 Middle Eastern and North African countries.

As regards the North African countries, our results point out the existence of a bidirectional causal link between CO_2 emissions and economic growth and between FDI inflows and economic growth. Moreover, a unidirectional causality exists from FDI inflows to CO_2 emission.

The difference with the results of the Middle Eastern countries is that in economic growth and FDI inflows, one decreases the other at the 1 % level. Effectively, a 1 % increase in economic growth decreases FDI inflows by around 0.42 %, and in turn, the increase in FDI inflows decreases the economic growth by 0.41 %. This result is somewhat consistent with the study by Fadhil et al. (2012) for Qatar and Bayar (2014) for Turkey. Moreover, the trade openness variable has a negative significant impact on the CO_2 emissions. This indicates that an increase in the trade openness tends to decrease the CO_2 emission per capita. The result is consistent with the findings of Akin (2014) for 85 countries.

The results of global panel are presented in Table 4, which show that there is a bidirectional causal relationship between economic growth and FDI inflows, between economic growth and CO_2emissions, and between FDI inflows and CO_2 emissions.

Table 4 Results for the global panel

	Global panel		
	Model 1	Model 2	Model 3
Independent variables	GDP	FDI	CO_2
GDP	–	−0.127[b]	0.619[a]
		(0.037)	(0.000)
GDP(t-1)	0.969[a]	–	–
	(0.000)		
FDI	1.516[a]	–	0.631[a]
	(0.000)		(0.000)
FDI(t-1)	–	0.573[a]	–
		(0.000)	
CO_2	−1.077[a]	1.071[a]	–
	(0.000)	(0.000)	
CO_2(t-1)	–	–	0.875[a]
			(0.000)
K	0.829[a]	–	–
	(0.000)		
FD	–	−0.230	–
		(0.130)	
Trade	–	–	−0.140[a]
			(0.005)
EN	–	–	1.090[a]
			(0.000)
Hansen J-test (*p* value)	15.441	10.289	11.230
	(0.001)	(0.016)	(0.003)
DWH test (*p* value)	56.477	6.075	17.303
	(0.000)	(0.048)	(0.000)
AR2 test (*p* value)	1.33	1.21	−0.10
	(0.185)	(0.225)	(0.923)

Values in parenthesis are the estimated *p* values. Hansen J-test refers to the over-identification test for the restrictions in GMM estimation. DWH test is the Durbin–Wu–Hausman test for endogeneity. The AR2 test is the Arellano–Bond test for the existence of the second-order autocorrelation in first differences.

[a] Significance at the 1 % levels

[b] Significance at the 5 % levels

[c] Significance at the 10 % level

Therefore, we can conclude that the same results were found for Middle Eastern countries. The lagged values of GDP, FDI inflows, and CO_2 emissions also have a significant and positive impact on their current values, suggesting an increasing tendency of these variables over time. In particular, the FDI level in the previous year provides a general indicator for new investors.

For models 1, 2 and 3, the unique difference with the results of Middle East is that the impact of the stock of foreign direct investment and CO_2 emissions on economic growth is positive and negative, respectively. This implies FDI inflows raise the economic growth, but CO_2 emissions decrease economic growth at a 1 % level. This result is somewhat consistent with the study by Abdouli and Hammami (2015) for MENA countries.

Overall, the above-discussed results regarding the links between the CO_2 emissions, FDI inflows, and economic growth links for the global panel as well as for the two subpanels provide four interesting insights. First, the FDI inflows raise economic growth in all the panels, except for North Africa wherein the increase in FDI inflows decreases economic growth, while they significantly increase the CO_2 emissions in all the panels. This implies the validation of the pollution haven hypothesis. The global panel in our study includes developing countries which impose very low environmental standards and regulations to FDI inflows. These findings are in line with those of Pao and Tsai (2010) and Sharma (2011), Ren et al. (2014) for China, and Omri et al. (2014) for 54 countries.

Second, economic growth was affected negatively by CO_2 emissions in all the panels. These indicate that the increase in CO_2 emissions decreases economic growth, whereas CO_2 emissions affect significantly and positively FDI inflows in all the panels. Generally, the environmental degradation can encourage potential foreign investors but slow down economic growth. These findings are in line with those of Omri et al. (2014) for three regional subpanels and Bozkurt and Akan (2014) for Turkey, Abdouli and hammami (2015) for the MENA countries, and Abbes et al. (2015) for 65 countries.

Finally, we find evidence that environmental quality is positively linked to economic growth only for the North African panel. One potential explanation is that countries in the early stages of economic development are more polluting. This finding seems to validate the EKC hypothesis, which is also confirmed by the results of our finding that is consistent with that of Ang (2007); Jalil and Mahmud (2009); Iwata et al. (2010); and Nasir and Rehman (2011).

Conclusion and Policy Implications

This paper attempts to highlight an empirical investigation of the relationship between the economic growth, FDI inflows, and environment for the Middle Eastern and North African countries over the period of 1990–2012 by using GMM approach. The results of the unit root test show that all the variables are stationary.

Our analysis suggests that there is a bidirectional relationship between economic growth and CO_2 emissions and between FDI inflows and CO_2 emissions for the global panel and for the Middle Eastern countries. Moreover, in the case of the North African countries, there is a unidirectional causality which exists from FDI inflows to CO_2 emission.

Many policy implications could be drawn from this paper: first, the feedback effect between foreign direct investment and economic growth in Middle Eastern countries implies that an increase in the FDI inflows contributes to promoting economic growth, and that economic growth, in turn, creates favorable conditions for attracting and retaining further FDI flows. The negative causality from economic growth to FDI inflows suggests that apart from the countries in Middle East, the remaining countries in our panels should implement sound economic policies to eliminate legal and non-legal barriers that prevent foreign investment.

Second, the existence of bidirectional and positive causality links between FDI inflows and environmental quality for all the panels implies that foreign direct investment causes environmental pollution, and the same is true from opposite side. Accordingly, governments for the global panel should implement more environmental regulation policies in order to control carbon emissions and to prevent FDI capital flights. At the same time, the positive causality direction from FDI inflows to CO_2 emissions typically evinces that policymakers should pay heed to the "environmental quality" of foreign direct investments in order to avoid pollution haven traps through encouraging the coordinated know-how and "clean" technological transfer with foreign companies. However, these countries should enforce stringent environmental laws and encourage the use of environment-friendly technologies to enhance domestic production. It is crucial (obligatory) for the governments to stop licensing polluting industries such as cement and gypsum firms and foundries that emit more CO_2 emissions comparatively. Polluting firms must be offered more incentives for following legal emission standards and considering economic and environmental factors during decision-making (Shahbaz et al. 2015).

Third, the bidirectional causal relationship between economic growth and CO_2 emissions in the countries of the Middle East and North Africa entails that the increase of economic growth leads to the damage of the environmental quality. However, to some extent that the decrease in economic growth may put strong pressure on the state budget and employment in these countries, important efforts should be made in order to encourage industries to adopt clean development mechanisms and environmentally friendly technologies. Moreover, these countries should implement policies that encourage environmentally friendly as well as green technologies in order to reduce carbon emissions and to promote economic growth simultaneously.

Finally, we can say that there is link between FDI, GDP, and the environment and governments of these countries should put under consideration the strong economic growth, good environmental quality, and a favorable environment for FDI inflows. It is mandatory to encourage domestic and foreign investors to invest in domains that do not affect the quality of the environment. This case may provide a strong economic growth in an environment without pollution and with a strong investment at the same time.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

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